AMRITA

VISHWA VIDYAPEETHAM

श्रद्धावान् लभते ज्ञानम्

DEEMED TO BE UNIVERSITY UNDER SECTION 3 OF UGC ACT. 1956

INTEGRATED MASTER OF COMPUTER APPLICATIONS

2026

<u>Integrated MCA (Integrated Master of Computer Applications)-2026</u>

AMRITA VISHWA VIDYAPEETHAM

REGULATIONS FOR THE INTEGRATED MCA PROGRAMME UNDER COMPUTING

(Effective from 2026 admissions)

GENERAL

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1. Candidates who have passed the final examination under the 10 +2 system or its equivalent, with a minimum of 50% of marks in aggregate, are eligible to apply for admission to the UG degree programme. However, the eligibility criterion is subject to modification as per the directives of competent authorities.

2. The procedure for admission will be decided from time to time by the University in accordance with the guidelines from competent authorities.

3. The duration of the Programme will normally be ten semesters, spread over five academic years. There is an exit option after the successful completion of the first 6 semesters.

4. The award of the respective UG and PG degree will be recommended by the Academic Council and approved by the Board of Management in accordance with the regulations of the University.

5. Notwithstanding anything stated above, the Amrita Vishwa Vidyapeetham reserves the right to modify any of the ordinances, as deemed fit, from time to time.

R.1 Admissions

R.1.1 The admission to the programme will be as per the ordinances and regulations of the University.

R.1.2 The intake to each school will be decided by the University from time to time.

R.1.3 Transfer of students from one campus to another is generally not permitted. However, based on the availability of vacancies in the discipline and the academic merit of the student, special cases may be allowed at the beginning of the third semester, on the mutual consent of the Heads of both the Departments and Schools and with the approval of the University. The decision of the University will be final in this matter.

R.2 Language of Instruction

The language of instruction will ordinarily be English, for all courses. For *Cultural Education*, instruction may be given partly in Indian languages. In the case of languages, instruction may be in English or the language concerned.

R.3 Structure of the Programme

R.3.1 The Programme will be structured on a credit-based system and continuous evaluation, following a semester pattern.

R.3 2 The programme consists of the following:

(a) Core courses in the primary area of the programme, including seminars, projects, etc.

(b) Humanities and General Studies (like *Environmental Sciences, Open Electives, Languages, Amrita Value Programmes* and *Cultural Education*, etc.

(c) Electives (Regular, AI & DS, Cyber Security, and IoT & Embedded Systems)

Additionally, soft skill training and social interaction/social work programmes, such as Live-in Labs, may also be offered.

R.3.3 The curriculum of the UG and PG degree programme will have credits, apportioned as below in the following knowledge segments:

Core courses
Electives
Humanities and General Studies

R.3.4 Credits are assigned to the courses based on the following general pattern -

One credit for each lecture period per week
One credit for each tutorial period per week
One credit for each laboratory course/practical of two/three periods per week

R.3.5 Each integrated degree programme shall have a prescribed curriculum and syllabi, which will be periodically updated according to the requirements and approved by the Academic Council.

R.3.6 All the Schools will be governed by the same curricula and syllabi, for the respective programmes.

R.3.7 Certain courses are identified as Core courses and a few others as electives.

There is a mandatory registration and credit-earning requirement for core courses. While it is mandatory to register for the elective courses, failure to earn credit in them does not necessarily require repeating the courses. Often, another elective course may be permitted as a replacement course, through Regular registration, with the concurrence of the Class Advisor and the Head of the Department.

R.3.8 Students are allowed to take online courses through Government portals such as NPTEL and SWAYAM

1. Amrita's grade, equivalent to the score secured in online courses to be decided by the class committee, and the same is to be awarded to the students.
2. The Class committee should authorize the courses before registration.
3. Students who have a Cumulative Grade Point Average (CGPA) of 6.5 or higher are eligible to enrol in NPTEL/SWAYAM courses for credits. However, the number of credits should not exceed twelve during the first three years of the programme. In the last two years of the programme, students can opt for a maximum of eight credits.
4. The Course registration requisite of a maximum of 28 credits per semester is to be maintained while registering for online courses.

R.3.8 **Programme Educational Objectives (PEOs)**

PEO 1: Graduates will be technically strong with comprehensive knowledge and skills to design and develop innovative software for emerging requirements.

PEO 2: Graduates will be continuous learners with an aptitude for research with a societal focus.

PEO 3: Graduates will be proficient to be employed as consultants / Entrepreneurs in the IT and ITES industries.

R.3.9 **Programme Outcomes (POs)**

PO 1. **Foundation Knowledge:** Apply knowledge of mathematics, programming logic and coding fundamentals for solution architecture and problem solving.

PO 2. **Problem Analysis:** Identify, review, formulate and analyse problems for primarily focussing on customer requirements using critical thinking frameworks.

PO 3. **Development of Solutions:** Design, develop and investigate problems with as an innovative approach for solutions incorporating ESG/SDG goals.

PO 4. **Modern Tool Usage:** Select, adapt and apply modern computational tools such as development of algorithms with an understanding of the limitations including human biases.

PO 5. **Individual and Team Work:** Function and communicate effectively as an individual or a team leader in diverse and multidisciplinary groups. Use methodologies such as agile.

PO 6. **Project management and finance:** Use the principles of project management such as scheduling, work breakdown structure and be conversant with the principles of Finance for profitable project management.

PO 7. **Ethics:** Commit to professional ethics in managing software projects with financial aspects. Learn to use new technologies for cyber security and insulate customers from malware.

PO 8. **Life-long learning:** Change management skills and the ability to learn, keep up with contemporary technologies and ways of working.

R.4 Tuition Fees

At the beginning of each academic semester, students shall pay all the fees prescribed. A student who drops out of the programme or whose registration is canceled due to any reason, cannot claim a refund of any fees paid.

R.5. Mentor and Class Advisor

R.5.1 In order to (i) guide the students in planning their courses of study, (ii) advise them on academic programmes and (iii) monitor their progress, the departments will assign a batch (class) of certain number of students to a faculty member, who will be designated as their Class Counsellor.

R.5.2 One among the Counsellors, shall be designated as the Class Advisor, who shall coordinate the functions of the Class Counsellors.

R.6. Course Committees

R.6.1. Course committees are constituted for running courses which are common for more than one discipline. Course committees will be set up in each School for each group of similar courses as decided by Head of the School.

R.6.2. Each course committee will consist of the following members:

(i) The chairperson of the course committee, nominated by the Head of the School.

(ii) All teachers involved in teaching the courses, shall be included in the course committee

(iii) Two student members from each discipline nominated into the committee by the chairpersons of departments with equal representation to boys and girls, to the extent possible.

(iv) Chairpersons of the departments and School Head may attend meetings of the course committees.

R.6.3. The Course Committees shall meet at least thrice in a semester. The Course committees shall meet at the beginning of the semester to finalize the course plans for the academic programme. They shall meet at the end of the semester, without the student representatives, to finalize the results of the respective courses. The results shall be submitted to the Head of the School, who shall approve and forward the same, to the Examination section.

R.6.4. The Course committees shall be reconstituted at the beginning of every semester.

R.7 Class Committees

R.7.1 Every class of a Degree programme in each School will have a Class Committee constituted by the Head of the School, based on recommendation of the Chairperson of the department.

R.7.2. The Constitution of the Class Committee will be as follows:

a) The Chairperson of the class committee, nominated by Head of the School,

b) All the teachers handling courses for the class,

c) Two student representatives nominated by the Chairperson of the department, from each class with equal representation of boys and girls, to the extent possible.

d) The Chairperson of the department and School Head may attend the committee meetings.

R.7.3. The Class Committee shall meet at least thrice in a semester. The Class committee shall meet at the beginning of the semester to finalise the academic programme. At the end of the semester, the committee (without student representatives) will meet, to finalise the results. The results shall be submitted to the Head of the School, who shall approve and forward the same, to the Examination section.

R.7.4. The Class committees shall be reconstituted at the beginning of every semester.

R.8 Registration and Enrolment

R.8.1 Every student shall register for the courses which he/she wishes to undergo during a semester.

R.8.2 Except for the first semester, pre-registration for a semester will be done during a specified week before the end-semester examination of the previous semester. The consent of the Class Advisor is mandatory before registering for every course.

R.8.3 From the second semester onwards, all students have to enroll on a specified day at the beginning of a semester. A student will be eligible to enroll only if he/she has cleared all the dues to the Institution, hostel, library, etc., at the time of enrolment and if he/she is not debarred from enrolment, as part of any disciplinary action of the Institution.

R.8.4 Late enrolment will be permitted on payment of a prescribed late fee, up to a specified date, to be notified well in advance.

R.8.5 A student can register for a maximum of 28 credits, in a semester, including all the remedial provisions.

R.8.6 **Pre-requisites:** A student is not permitted to register for a course unless he/she has already attended the pre-requisite course, wherever specified. A student will not be deemed to have attended the pre-requisite, if he/she gets an ‘FA’ grade in such a course.

R.9 Dropping /Substituting Courses

R.9.1 If a student finds his/her load heavy in any semester, or for any other valid reasons, he/she may drop courses, within **first ten working days** of the commencement of the semester, with the written approval of his/her Class Advisor and Chairperson of the Department.

Withdrawal from one or more enrolled courses after the specified date will entail academic penalties in the form of a 'Failed due to insufficient attendance' 'FA' grade appearing in the grade sheet.

R.9.2 A student can substitute a course registered earlier, by another for valid reasons, within the **first ten working days** of the commencement of the semester, with the consent of the Class Advisor and Chairperson of the Department.

R.10 Maximum Duration of the Programme

R.10.1 A student is expected to complete the programme in ten semesters. However, a student may complete the programme at a slow pace within fifteen semesters, with the prior permission of his/her Class Advisor and Chairperson of the Department and Head of the School.

R.10.2 A student may be permitted by the concerned Head of the School to withdraw from the programme for a semester or a longer period for reasons of ill health or on other valid grounds. However, the programme should be completed within a total span of ten semesters.

R.10.3 In the event of any student requiring more than ten semesters to complete the programme, the extension can be considered on the merits of the case, by the Vice-Chancellor and ratified by the Academic Council.

R.11 Attendance

R.11.1 Attendance of the students will be marked by the concerned teacher during every hour of the course.

R.11.2 Students who have been selected to be trained for International competitions or have secured distinction in the previous year examinations and are working on directed research under a faculty member, and approved by the Chairperson of the Department, shall be given a waiver of up to 25% attendance.

R.11.3 Leave shall be availed by students only under unavoidable circumstances. Students must apply in the prescribed form before proceeding on leave. Leave letter recommended by the Class Advisor shall be submitted to the Chairperson of the department who will consider grant of the leave. Unauthorized absence will be treated as a breach of discipline.

Request for leave for more than three consecutive days on medical grounds must be supported by a proper medical certificate. In non-medical cases, requests for leave for more than three consecutive days must be countersigned by the parent/guardian or the Warden, whichever is applicable.

Leave granted will not be counted as physical presence.

R.11.4 Students going on official duty, such as representing the college/University for sports and cultural activities, or presenting papers in seminars, conferences, etc., will be eligible for 'duty leave' on the recommendation of the Class Advisor and approval by the Chairperson of the Department. **Students should get this leave sanctioned before proceeding on 'duty leave'. They will be granted attendance for the periods they missed on account of the duty leave upon production of the relevant participation certificate after attending the duty.**

All kinds of leave, authorized by the Chairperson of the Department, shall not exceed 25% of the total hours in the course.

R.11.5 Finalization of attendance for every course shall be done three working days before the last instruction day of the semester. Any student failing to secure a minimum of 75% attendance in a course, will not be eligible to appear for the end-semester examination in that course.

R.11.6 In case a student who is not permitted to attend the end-semester examination in any course due to shortage of attendance, will be awarded 'FA' grade in that course, indicating "failed due to insufficient attendance" and mentioned in the grade sheet.

Students awarded 'FA' grade in a course, shall re-register for the course, when offered next or as a run-time re-do course.

R.12 Assessment Procedure

R.12.1 The academic performance of each student in each course will be assessed based on Internal Assessment (including Continuous Assessment) and an end-semester examination.

Normally, the teachers offering the course will evaluate the; performance of the students at regular intervals and in the end-semester examination.

In theory courses (that are taught primarily in the lecture mode), the weightage for the Internal Assessment and End-semester examination will be 50:50. The Internal assessment in theory courses shall consist of one mid-term examination, weekly quizzes, assignments, tutorials, viva-voce etc. The weightage for these components, for theory-based courses shall be 25 marks for the Continuous assessment, comprising of Quizzes, assignments, tutorials, viva-voce, etc. and 25 marks for the mid-term examination.

At the end of the semester, there will be an end-semester examination of three hours duration, with a weightage of 50 marks, in each lecture-based course.

R.12.2 ***Evaluation pattern for the course having only Theory components***

Courses having only lecture or tutorial hours without a lab component, the relative weight for Internal assessment and End-semester examination will be 50:50. 25 marks will be for continuous assessment, 25 marks for the mid-term examination, and 50 marks for the theory end-semester examination.

Evaluation pattern for the course having only lab components

In the case of laboratory courses and practicals, the relative weight for the internal assessment and End-semester examination will be 70:30. The weight for the components of the internal assessment will be decided by the course committee/class committee at the beginning of the course. 70 marks will be for continuous assessment, and 30 marks for the lab end-semester examination.

Evaluation pattern for the course having both Theory and Lab components:

Courses having one or more lecture hours with lab, the relative weight for Internal assessment and End-semester examination will be 70:30. The Lab component evaluation will be based on continuous evaluation, without any end-semester practical evaluation. 10 marks will be for continuous assessment of the theory portion, 20 marks for the mid-term examination, 30 marks for the theory end-semester examination, and 40 marks for continuous assessment of lab work.

Courses having only tutorials without lecture hours will be treated as a Lab course, for evaluation purposes, and the evaluation pattern will be 70 marks for continuous assessment of the lab. work and 30 marks for the end-semester lab Examination.

R.12.3 It is mandatory that the students appear for the end-semester examinations in all theory and practical courses, for completion of the requirements of the course. Those who do not appear in the end-semester examinations will be awarded an ‘F’ grade, subject to meeting the attendance requirement.

At the end of a semester, examinations shall be held for all the subjects that were taught during that semester and those subjects of the previous semesters for which the students shall apply for supplementary examination, with a prescribed fee.

R.12.4 **Project Work:** The continuous assessment of project work will be carried out as decided by the course committee. At the completion of the project work, the student will submit a bound volume of the project report in the prescribed format. The project work will be evaluated by a team of duly appointed examiners.

The final evaluation will be based on the content of the report, presentation by the student and a viva-voce examination on the project. There will be 60% weightage for continuous assessment and the remaining 40% for final evaluation.

If the project work is not satisfactory, he/she will be asked to continue the project work and appear for assessment later.

Course Category	**L-T-P**	**Internal: External**	**Internal (%)**		**External (%)**	**Total Theory Weightage (%)**	**Total Lab Weightage (%)**
			Mid-term	**CE**			
Theory without a lab component	4-0-0/ 3-1-0/ 3-0-0 / 2-1-0/ 2-0-0/ 1-1-0/ 1-0-0	50:50	25	25	50	100	-
Theory with a lab component	2-0-1/ 3-0-1	70:30	20	50	30	60	40*
Lab courses	0-1-1/ 1-0-1/ 0-0-2/ 0-1-2/ 0-2-2	70:30	70		30	-	100
Mini/Major Project		60:40	60		40	-	-
	*No end-semester practical exam.						

R.13 PUBLICATION / INTERNSHIP / GRACE MARKS

R.13.1 All students, if they are to be considered for the award of PG Degree (without exit option) at the time of graduation, are required to submit/publish ONE paper in a Scopus-indexed Journal/Conference. The publication shall be as per the guidelines prescribed by the University.

R.13.2 All students who publish a paper in a Scopus-indexed Journal/Conference in the first 6 semesters (UG level) will be awarded an additional mark of 5-10 for each publication, subject to a maximum of two publications.

The additional marks shall be awarded in the semester in which the paper is published or accepted for publication, if applied for, before the publication of the results of the concerned semester.

R.13.2 **Co-curricular Activities**

The students during their period of study in the University are encouraged to indulge in sports, arts, Social/Community service, and Seva activities. In the UG level (first 6 semesters), bonus marks (5 to 10 marks) shall be awarded for representing AMRITA University in Sports, Cultural, and Seva activities. The procedure for awarding these marks will be published by the University from time to time.

R.14 REMEDIAL PROVISIONS

R.14.1 **Supplementary Examinations:**

Students who failed in a non-semester course (i.e. courses not registered by the student during the current semester), shall apply by appearing in the respective examination, paying a prescribed fee, and taking the examination.

A student who has secured an ‘F’ grade in a course may take the supplementary examination for a maximum of three additional attempts (excluding the regular end-semester examinations), carrying the previous Internal marks earned by them. Students failing to pass the course after three additional attempts shall henceforth appear for the supplementary examination for the entire 100 marks, and the Internal assessment marks earned by them in the regular registration shall not be considered.

If a student wishes to improve his/her internal marks, he/she can do so, by re-registering for the course by choosing any of the appropriate remedial options. In this case, the internal marks obtained by the student will be valid for the end of the semester of the re-registration and three additional attempts.

R.14.2 **Other options:** Certain courses may be offered as run-time-redo or as contact courses, as and when necessary to enable students who have dropped courses or failed in some courses to register and endeavour to complete them.

a) Re-registration: Students who have failed in a course and opt to re-do the course may do so by re-registering for the course, along with a junior batch of students.

b) Run-time re-do: Certain courses may be offered specially for the benefit of failed students during the semester, on a regular pattern.

The above two modes enable possible improvement of the Internal assessment marks.

c) Contact courses: Final-semester students and term-out students (students who have completed a three-year period) may register for contact mode to clear the failed courses, if any, subject to the approval of the Head of the School.

A maximum of only two courses can be taken under contact mode, in the entire programme of study.

R.14.3 Supplementary examinations will be evaluated against the most recent grade rule (whenever the course was offered recently in the regular semester).

R.15 Grading

R.15.1 Based on the performance in each course, a student is awarded at the end of the semester, a letter grade in each of the courses registered. Letter grades will be awarded by the Class Committee in its final sitting, without the student representatives.

The letter grades, the corresponding grade points, and the ratings are as follows:

Letter Grade	***Grade Point***	***Ratings***
O	10.00	Outstanding
A+	9.50	Excellent
A	9.00	Very Good
B+	8.00	Good
B	7.00	Above Average
C	6.00	Average
P	5.00	Pass
F	0. 00	Fail
FA	0. 00	Failed due to insufficient attendance
I	0. 00	Incomplete (awarded only for Lab courses/ Project / Seminar)
W		Withheld

R.15.2 'FA' grade once awarded stays in the record of the student and is replaced with the appropriate grade when he/she completes the course successfully later.

Students who have secured an 'FA' in a course must re-register for the course or register for the course, if offered, under run-time re-do mode.

R.15.3 A student who has been awarded an 'I' Grade in a Lab course, due to reasons of not completing the Lab, shall take up additional Lab whenever offered next and earn a pass grade, which will be reflected in the next semester's grade sheet.

The 'I' grade, awarded in a Project/Seminar course, will be subsequently changed into appropriate grade, when the student completes the requirement during the subsequent semester. If he/she does not complete it in the next semester, it will be converted to an 'F' grade.

R.15.4 A student is considered to have completed the course and earned the credit if he/she scores a letter grade 'P' or better in that course.

R.16 Declaration of Result

After finalization of the grades by the Class Committee and subsequent approval of the Head of the School, the result will be announced by the Controller of Examinations.

R.17 Revaluation of answer Papers

On publication of the results, an aggrieved student can request revaluation of answers scripts of the end-semester examination, within five working days of publication of the results, along with the prescribed revaluation fees. The request has to be made to the Examination Section through the Head of the School.

If the revaluation leads to a better grade, the revised grade will be awarded to the student and in such cases, the revaluation fee will be refunded in full.

Revaluation is permitted only for lecture-based courses.

R.18 Course completion

A student is said to have successfully completed a course and earned the corresponding credits, if he/she has:

- registered for the course:
- put in 75% or more attendance in the course
- appeared for the end-semester examinations
- obtained a pass grade 'P' or better in the course
- no pending disciplinary proceedings against him/her.

R.19 Grade Sheet

The Grade Sheet issued to the student at the end of a semester will contain the following information:

- Name, Roll No. Grade Sheet No., Semester, Branch, Month and Year of the Examination
- Course Code, Course Title, Credits, Grade obtained, and Grade points earned for the courses registered
- Credits registered and earned during the semester
- Cumulative credits earned and Grade Points
- SGPA
- CGPA

R.20 Semester Grade Point Average (SGPA)

On completion of a semester, each student is assigned Semester Grade Point Average (SGPA) which is computed as below for all courses registered by the student during that semester.

Semester Grade Point Average = $\sum (C_i \text{ x } Gp_i) / \sum C_i$

where C_i is the credit for i^{th}course in that semester and Gp_i is the grade point for that course.

The summation is over all the courses registered by the student during the semester, including the failed courses. The SGPA is rounded off to two decimals.

R.21 Cumulative Grade Point Average (CGPA)

The overall performance of a student at any stage of the Degree programme is evaluated by the Cumulative Grade Point Average (CGPA) up to that point of time.

Cumulative Grade Point Average = $\sum (C_i \times Gp_i) / \sum C_i$

where C_i is the credit for i^{th} course in any semester, and Gp_i is the grade point for that course.

The summation is over all the courses registered by the student during all the semesters up to that point of time, including the failed courses. The CGPA is also rounded off to two decimals.

R.22 Ranking

The ranking of the students in a batch at any intermediate or final stage is based on CGPA. Only those students who have passed all courses up to that stage in the first attempt are considered for ranking.

Students are eligible for final ranking only if they complete the programme within the normal duration, i.e., within three years of joining the programme.

R.23 Classification of successful candidates:

R.23.1 A student shall be considered to have completed the programme if he/she has:

i) registered and completed all the core courses, electives and projects as mentioned in the curriculum;

ii) earned the required minimum number of credits as specified in the curriculum corresponding to the programme, within the stipulated time;

iii) Submitted/ Published a paper as mentioned in R.13.1

R.23.2 Candidates who have successfully completed the programme, within ten semesters from entering the programme, shall be classified as follows:

Candidates securing a CGPA of 8.00 and above – FIRST CLASS WITH DISTINCTION

Candidates securing a CGPA between 6.50 and 7.99 – FIRST CLASS

and the same be mentioned in the Degree certificate;

If the programme is completed after ten semesters of study, the candidates securing even a CGPA of 8.00 and above, shall be classified to have completed the programme, only with FIRST CLASS.

R.23.3 A student who wish to exit from the programme after successful completion of first six semester courses, is eligible to get a BCA Degree.

R.24 Transcript

The Controller of Examinations will also issue, on request and payment of a prescribed fee, a detailed transcript with his signature or facsimile to every student after completion of the programme. It shall contain all the information that is contained in the grade sheets. Additionally, it shall also include the month and year of passing each course. The transcript card shall contain only the final grades secured, but will not indicate the earlier failures, if any. The detailed transcript, will contain the CGPA and the class, if any obtained.

R.25 Discipline

Every student is required and expected to observe strict discipline and decorous behavior both inside and outside the campus. He/she should not indulge in any activity which may tarnish the fair name and prestige of Amrita Vishwa Vidyapeetham. Any act of indiscipline or misbehavior including unfair practice in the examinations will be dealt with by the Disciplinary Action Committee of the Institution, constituted by the Head of the School concerned. The committee will enquire into the charges and make recommendations to the Head of the School concerned. Based on the findings of the committee, Head of the School will take appropriate disciplinary action. Serious act of indiscipline on the part of the students may even attract penalty up to the extent of expulsion from the University.

R.26 Redressal of grievances

Students have the right to seek redress of grievances. For this, they have to appeal in writing to the Head of the School concerned, who will take necessary steps in the matter.

R.27 Award of the Degree

A student will be declared eligible for the award of the respective Degree, if he/she has:

a) completed the programme successfully as described in R.23.1 and

b) no outstanding dues against him/her.

c) Specialization – any student who completes the program with a minimum requirement **(5 and above out of 8 electives in UG and 3 out of 5 in PG)** in the respective stream will be awarded the degree with the following specialization:

1. Artificial Intelligence and Data Science (AI&DS)

2. Cyber Security

3. IoT and Embedded Systems

The UG and PG degrees, indicating the discipline and specialization (if applicable), will be awarded by the Board of Management of Amrita Vishwa Vidyapeetham on the recommendation of the Academic Council.

Only the UG Degree, indicating the discipline and specialization (if applicable), if a student takes an exit option after successful completion of the first six semesters, will be awarded by the Board of Management of Amrita Vishwa Vidyapeetham on the recommendation of the Academic Council.

R.28 Interpretation Clause

Related to any of the academic matters, whenever there arises any doubt or dispute on the interpretation of regulations or rules, the decision of the Academic Council will be final as well as binding on all concerned.

R.29 Amendment to Regulations

Notwithstanding anything stated above, the Amrita Vishwa Vidyapeetham reserves the right to modify any of the regulations, as deemed fit, from time to time.

CURRICULUM AND SYLLABUS 2026

SEMESTER I

Course Code	Title	L T P	Credit
22ADM101	Foundations of Indian Heritage	2 0 1	2
24ENG101	English I	2 0 0	2
	Language 1	2 0 0	2
	Mathematics for Computing 1	3 1 0	4
22AVP103	Mastery Over Mind	1 0 2	2
26ENV100	Environmental Studies	2 0 0	2
26CSA101	Computer Fundamentals and Digital Electronics	3 0 2	4
26CSA102	Programming Fundamentals	3 1 0	4
26CSA181	Programming Foundation Lab	0 0 2	1
26CSA182	Linux Programming Lab	0 0 2	1
	Total		**24**

SEMESTER II

Course Code	Title	L T P	Credit
22ADM111	Glimpses of Glorious India	2 0 1	2
24ENG111	English II	1 0 2	2
	Language II	2 0 0	2
	Mathematics for Computing II	3 1 0	4
26CSA111	Object-Oriented Programming using Java	3 1 0	4
26CSA112	Computer Organization and Architecture	3 1 0	4
26CSA113	Database Management System	3 0 0	3
26CSA183	Object-Oriented Programming using Java LAB	0 0 2	1
26CSA184	Database Management System LAB	0 0 2	1
26CSA185	User Interface Design	0 0 2	1
	Total		**24**

SEMESTER III

Course Code	Title	L T P	Credit
	Amrita Value Programme 1	1 0 0	1
	Mathematics for Computing III	3 1 0	4
26CSA201	Data Structures	3 1 0	4
26CSA202	Operating Systems	3 0 0	3
26CSA203	Introduction to Python	3 0 0	3
26CSA204	Web Technologies	2 0 2	3
26CSA205	Computer Networks	3 0 2	4
26CSA281	Data Structures Lab	0 0 2	1
26CSA282	Python Programming Lab	0 0 2	1
	Total		**24**

SEMESTER IV

Course Code	Title	L T P	Credit
	Amrita Values Programme II	1 0 0	1
26CSA290*	Live in Labs I*/ Open Elective	3 0 0	3
26CSA211	Full Stack Frameworks	3 0 0	3
26CSA212	Software Engineering & UML	2 0 2	3
26CSA213	Fundamentals of AI	3 0 0	3
26CSA283	Full Stack Frameworks Lab	0 0 2	1
	Elective I		3
	Elective II		3
	Elective III		4
	Total		**24**

SEMESTER V

Course Code	Title	L T P	Credit
26CSA390*	Live in Labs II*/ Open Elective	3 0 0	3
26CSA301	Mobile Application Development	0 1 2	2
26CSA302	Algorithms	3 0 0	3
23LSK201	Life Skills I	1 0 2	2
26CSA381	Algorithms Lab	0 0 2	1
26CSA303	Competitive Programming	0 1 2	2
	Elective IV		3
	Elective V		4
26CSA396*/ 26CSA397#	Minor Project*/ Internship I#		4
	Total		**24**

SEMESTER VI

Course Code	Title	L T P	Credit
26CSA311	Automata Theory and Compiler Design	3 1 0	4
	Elective VI		3
	Elective VII		3
	Elective VIII		4
26CSA399*/26CSA 398#	Major Project*/ Internship II#		6
	Total		**20**

SEMESTER VII

Course Code	Title	L T P	Credit
	Mathematics for Computing IV	3 1 0	4
26CSA401	Advanced-Data Structures	3 0 0	3
26CSA402	Advanced JAVA and J2EE	3 0 0	3
26CSA403	Programming for Problem Solving	3 0 0	3
26CSA404	Advanced DBMS	3 0 0	3
26CSA481	Advanced-Data Structures Lab	0 0 2	1
26CSA482	Advanced JAVA and J2EE Lab	0 0 2	1
26CSA483	Programming for Problem Solving Lab	0 0 2	1

26CSA484	Advanced DBMS Lab	0 0 2	1
	Elective IX	3 0 0	3
23LSK211	Life Skills II	1 0 2	2
	Total		**24**

SEMESTER VIII

Course Code	Title	L T P	Credit
26CSA411	Design and Analysis of Algorithms	3 1 0	4
26CSA412	Principles and Implementation of Design Patterns	3 0 2	4
26CSA487	Problem Formulation & Research Tools	0 0 2	1
26CSA414	Advanced Programming Using Python	3 0 0	3
26CSA485	Design and Analysis of Algorithms Lab	0 0 2	1
26CSA486	Advanced Programming Using Python Lab	0 0 2	1
	Elective X		4
23LSK301	Life Skills III	1 0 2	2
	Total		**25**

SEMESTER IX

Course Code	Title	L T P	Credit
26CSA501	Generative AI and Intelligent Systems	3 1 0	4
	Elective XI		4
	Elective XII		4
	Elective XIII		3
26CSA598	Dissertation Phase I		6
	Total		**21**

SEMESTER X

Course Code	Title	L T P	Credit
26CSA599	Dissertation Phase II		12
	Total		**12**

Mathematics for Computing

Course Code	Title	L T P	Credit
26MAT131	Algebra and Number Theory	3 1 0	4
26MAT132	Mathematical Foundation	3 1 0	4
26MAT133	Advanced Mathematical Foundation	3 1 0	4
26MAT134	Linear Algebra	3 1 0	4
26MAT135	Statistical and Numerical Methods	3 1 0	4

Languages

Sl. No.	Course Code	Course Title	L T P	Credits
Paper I				
1	24MAL101	Malayalam I	2 0 0	2
2	24HIN101	Hindi I	2 0 0	2
3	24KAN101	Kannada I	2 0 0	2
4	24SAN101	Sankrit I	2 0 0	2
5	24TAM101	Tamil I	2 0 0	2

6	24ENG100	Additional English – I	2 0 0	2
Paper II				
7	24MAL111	Malayalam II	2 0 0	2
8	24HIN111	Hindi II	2 0 0	2
9	24KAN111	Kannada II	2 0 0	2
10	24SAN111	Sanskrit II	2 0 0	2
11	24TAM111	Tamil II	2 0 0	2
12	24ENG110	Additional English - II	2 0 0	2

UG Electives
Electives - 3 Credits

AI & DS Stream

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA331	Python for AI & DS	2 0 2	3
2	26CSA332	Introduction to Neural Networks	3 0 0	3
3	26CSA333	Fundamentals of Data Science	2 0 2	3
4	26CSA334	Applied Statistics for Data Science	3 0 0	3
5	26CSA335	Computer Vision Basics	2 0 2	3
6	26CSA336	Ethics and Data Privacy	3 0 0	3
7	26CSA337	Data Governance	3 0 0	3
8	26CSA338	Big Data Foundations	3 0 0	3

Cyber Security Stream

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA341	Introduction to Cybersecurity	3 0 0	3
2	26CSA342	Network Security Basics	3 0 0	3
3	26CSA343	Cryptography Fundamentals	2 0 2	3
4	26CSA344	Cyber Laws & Digital Forensics	3 0 0	3
5	26CSA345	Linux Security & Hardening	2 0 2	3
6	26CSA346	Wireless & Mobile Security	3 0 0	3
7	26CSA347	Digital Forensics	3 0 0	3

IoT & Embedded Systems Stream

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA371	Introduction to IoT	3 0 0	3
2	26CSA372	IoT Programming	2 0 2	3
3	26CSA373	IoT Network Basics	3 0 0	3
4	26CSA374	IoT Security Fundamentals	3 0 0	3
5	26CSA375	Fundamentals of Edge Computing	3 0 0	3
6	26CSA376	Industrial Internet of Things	3 0 0	3

Electives – 4 Credits

AI & DS Stream

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA231	Machine Learning Basics	3 0 2	4
2	26CSA232	Computational Intelligence	3 0 2	4
3	26CSA233	Time Series Analysis	3 0 2	4
4	26CSA234	Non-Relational Databases	3 0 2	4
5	26CSA235	R Programming	3 0 2	4
6	26CSA236	Probability & Statistics for ML	3 1 0	4

Regular

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA361	Client Server Computing	3 0 0	3
2	26CSA362	E-Commerce Technologies	3 0 0	3
3	26CSA363	Knowledge Management	3 0 0	3
4	26CSA364	Soft Computing	3 0 0	3
5	26CSA365	Systems and Network Administration	3 0 0	3
6	26CSA366	Multimedia Applications	3 0 0	3
7	26CSA367	Software Testing & Quality Assurance	3 0 0/202	3

Cyber Security Stream

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA241	Blockchain & Web3	3 0 2	4
2	26CSA242	Intrusion Detection & Prevention Systems	3 0 2	4
3	26CSA243	IoT Security	3 0 2	4
4	26CSA244	Secure Software Development	3 0 2	4
5	26CSA245	Cyber Risk Management	3 1 0	4
6	26CSA246	Cybercrime & Criminology	3 1 0	4

IoT and Embedded Systems

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA271	Introduction to Embedded system	3 1 0	4
2	26CSA272	Embedded C Programming	3 1 0	4
3	26CSA273	Firmware Development	3 1 0	4
4	26CSA274	Wireless Sensor Networks	3 1 0	4
5	26CSA275	IoT Application Development	3 1 0	4

REGULAR

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA261	IoT Architectures and Programming	3 0 2	4
2	26CSA262	Computer Graphics and Visualization	3 0 2	4
3	26CSA263	Architecture and Deployment of Secure and Scalable WAN	3 0 2	4
4	26CSA264	Bigdata Analytics	3 0 2	4
5	26CSA265	C# and ASP.NET	3 0 2	4
6	26CSA266	Cloud Computing	3 0 2	4
7	26CSA267	Web Mining	3 0 2	4

PG - Electives - 3 Credits

AI & DS Stream

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA530	Deep Learning	3 0 0	3
2	26CSA531	Linear Algebra and Applications	3 0 0	3
3	26CSA532	Artificial Intelligence	3 0 0	3
4	26CSA533	Database Administration	3 0 0	3
5	26CSA534	Information Retrieval	3 0 0	3
6	26CSA535	Information Science and Ethics	3 0 0	3
7	26CSA536	Pattern Recognition	3 0 0	3
8	26CSA537	Recommendation Systems	3 0 0	3
9	26CSA538	Web Mining	3 0 0	3
10	26CSA539	Business Analytics and Visualization	3 0 0	3
11	26CSA540	Computational Intelligence	3 0 0	3

Cyber Security Stream

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA550	Essentials of cyber security	3 0 0	3
2	26CSA551	Malware Analysis	3 0 0	3
3	26CSA552	Blockchain and Decentralized Applications	3 0 0	3
4	26CSA553	Fundamentals of cyber security operations	3 0 0	3
5	26CSA554	Cloud and Infrastructure security	3 0 0	3
6	26CSA555	Cybersecurity Governance, Risk and Compliance	3 0 0	3
7	26CSA556	Cyber Security Law	3 0 0	3
8	26CSA557	Machine learning and artificial Intelligence in Cyber security	3 0 0	3
9	26CSA558	Mobile Security and Defense	3 0 0	3
10	26CSA559	Cyber Forensics	3 0 0	3

IoT & Embedded Systems Stream

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA571	Embedded Operating Systems	3 0 0	3
2	26CSA572	Cloud IoT Platforms	3 0 0	3
3	26CSA573	Embedded Linux porting with Yocto	2 0 2	3
4	26CSA574	IoT Data Analytics	2 0 2	3
5	26CSA575	Embedded C Programming II	2 0 2	3

Regular

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA560	Compiler Design	3 0 0	3
2	26CSA561	Advanced Operating Systems	3 0 0	3
3	26CSA562	Software Testing	3 0 0	3
4	26CSA563	Theory of Computation	3 0 0	3
5	26CSA564	Enterprise Resource Planning Management	3 0 0	3
6	26CSA565	Automation and Robotics	3 0 0	3
7	26CSA566	Software Defined Networks	3 0 0	3
8	26CSA567	Robotic Operating System	3 0 0	3
9	26CSA568	Software Quality Assurance	3 0 0	3
10	26CSA569	Web Services	3 0 0	3
11	26CSA570	Software Project Management	3 0 0	3

PG - Electives - 4 Credits

AI & DS Stream

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA631	**Data Modelling and Visualization**	**3 0 2**	**4**
2	26CSA632	**Exploratory Data Analysis**	**3 0 2**	**4**
3	26CSA633	**Data Mining and Applications**	**3 0 2**	**4**
4	26CSA634	**Machine Learning**	**3 0 2**	**4**
5	26CSA636	**Big Data Analytics**	**3 0 2**	**4**
6	26CSA637	**Natural Language Processing**	**3 0 2**	**4**
7	26CSA630	NLP for Robotics	**3 0 2**	**4**
8	26CSA638	**Large Language Models**	**3 0 2**	**4**
9	26CSA639	**Computer Vision**	**3 0 2**	**4**
10	26CSA640	Generative AI	**3 0 2**	**4**

Cyber Security Stream

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA641	**Ethical Hacking and Information Security**	**3 1 0**	**4**
2	26CSA642	**System Security**	**3 0 2**	**4**
3	26CSA643	**Web Application Security**	**3 0 2**	**4**
4	26CSA644	**Advanced Network Security**	**3 0 2**	**4**
5	26CSA645	**VAPT (Vulnerability and Penetration Testing)**	**3 0 2**	**4**
6	26CSA647	Secure DevOps	**3 0 2**	**4**

IoT & Embedded Systems Stream

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA671	Embedded application development in Linux I	**3 0 2**	4
2	26CSA672	Embedded application development Linux II	**3 0 2**	4
3	26CSA673	AI-IoT Application	**3 0 2**	4
4	26CSA674	AI-IoT Application Framework development	**3 0 2**	4
5	26CSA675	Cloud Integration for IoT	**3 0 2**	4

Regular

Sl. No.	Course Code	Course Title	L T P	Credits
1	26CSA651	**Complex Network Analysis**	**3 0 2**	**4**
2	26CSA655	DevOps	3 0 2	4
3	26CSA656	Digital Image Processing	3 0 2	4
4	26CSA657	Advanced Computer Networks	3 0 2	4
5	26CSA658	Advanced Web Technologies and Mean Stack	3 0 2	4
6	26CSA659	Mobile Application Development	3 0 2	4
7	26CSA660	Multivariate Statistics	3 1 0	4
8	26CSA661	Graph Theory and Combinatorics	3 1 0	4
9	26CSA662	Operations Research and Optimization	3 1 0	4

AMRITA VALUE PROGRAMMES FOR UG PROGRAMMES

Course Code	Title	L-T-P	Credits
22ADM201	Strategic Lessons from Mahabharata	1-0-0	1
22ADM211	Leadership from Ramayana	1-0-0	1
22AVP210	Kerala Mural Art and Painting	1-0-0	1
22AVP201	Amma’s Life and Message to the modern world	1-0-0	1
22AVP204	Lessons from the Upanishads	1-0-0	1
22AVP205	Message of the Bhagavad Gita	1-0-0	1
22AVP206	Life and Message of Swami Vivekananda	1-0-0	1
22AVP207	Life and Teachings of Spiritual Masters of India	1-0-0	1
22AVP208	Insights into Indian Arts and Literature	1-0-0	1
22AVP213	Traditional Fine Arts of India	1-0-0	1
22AVP214	Principles of Worship in India	1-0-0	1
22AVP215	Temple Mural Arts in Kerala	1-0-0	1
22AVP218	Insights into Indian Classical Music	1-0-0	1
22AVP219	Insights into Traditional Indian Painting	1-0-0	1
22AVP220	Insights into Indian Classical Dance	1-0-0	1
22AVP221	Indian Martial Arts and Self Defence	1-0-0	1
22AVP209	Yoga and Meditation	1-0-0	1

SYLLABUS

SEMESTER I

22ADM101	FOUNDATIONS OF INDIAN HERITAGE	L-T-P-C: 2-0-1-2

Course Objective(s)

To introduce students to the depths and richness of the Indian culture and knowledge traditions, and to enable them to obtain a synoptic view of the grandiose achievements of India in diverse fields. To equip students with a knowledge of their country and its eternal values.

Course Outcomes

COs	Description
CO1	Increase student understanding of true essence of India's cultural and spiritual heritage.
CO2	Emancipating Indian histories and practices from manipulation, misunderstandings and other ideological baggage thus shows its contemporary relevance.
CO3	Understand the ethical and political strategic concepts to induce critical approach to various theoriesabout India.
CO4	Familiarize students with the multi dimension of man's interaction with nature, fellow beings and societyin general.
CO5	Appreciate the socio-political and strategic innovations based on Indian knowledge systems. Gives an understanding of bringing Indian teaching into practical life.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	-	-	2	-	-	-
CO2	-	-	-	-	2	-	-	-
CO3	-	-	-	-	2	-	-	-
CO4	-	-	-	-	2	-	-	-
CO5	-	-	-	-	2	-	-	-

Syllabus

1. Chapter 1 - Educational Heritage of Ancient India
2. Chapter 2 - Life and Happiness
3. Chapter 3 - Impact of Colonialism and Decolonization
4. Chapter 4- A timeline of Early Indian Subcontinent
5. Chapter 5 - Indian approach towards life
6. Chapter 6 - Circle of Life
7. Chapter 7- Pinnacle of Selflessness and ultimate freedom
8. Chapter 8- Ocean of love; Indian Mahatmas.
9. Chapter 9 - Become A Strategic Thinker (Games / Indic activity)
10. Chapter 10 - Man's association with Nature
11. Chapter 11 - Celebrating life 24/7
12. Chapter 12 - Metaphors and Tropes
13. Chapter 13 - India: In the Views of foreign Scholars and Travellers.

Self-Study/ Self-reading

14. Chapter 14 - Personality Development Through Yoga.
15. Chapter 15 - Hallmark of Indian Traditions: Advaita Vedanta, Theory of oneness
16. Chapter 16 - Conversations on Compassion with Amma

Textbooks/References

1. Foundations of Indian Heritage

Evaluation Pattern

Assessment	Weightage (%)
Midterm	30
Continuous Assessment	20
End Semester Exam	50
Total Marks	100

24ENG101	ENGLISH I	L-T-P-C: 2-0-0-2

Course Objective(s)

To help students obtain an ability to communicate fluently in English; to enable and enhance the students' skills in listening,speaking, reading, and writing; to impart an aesthetic sense and enhance creativity.

Course Outcomes

COs	Description
CO1	Demonstrate competence in the mechanics of writing
CO2	Summarize audio and written texts to convey messages effectively
CO3	Apply the mechanics of writing and AI tools to draft academic and professional documents
CO4	Organize ideas and thoughts for clear written and oral communication
CO5	Critically evaluate literary texts

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2
CO3	-	-	-	-	2	-	-	2
CO4	-	-	-	-	2	-	-	2
CO5	-	-	-	-	2	-	-	2

Syllabus

Unit I

Mechanics of writing - Parts of speech – use of prepositions, adjectives, adverbs and determiners – word order – collocation –concord (Subject-Verb, Pronoun-Antecedent) – kinds and patterns of sentences

Unit II

Tenses - Modal auxiliaries - Reported speech - Active and Passive Voice - Phrasal Verbs - Linkers/ Discourse Markers - QuestionTags

Unit III

Pre-writing techniques - Paragraph writing – Cohesion – Development – types: definition, comparison, classification, contrast, cause and effect - Essay writing: Descriptive and Narrative - Introduction to the use of Gen AI in writing (AI tools, Do’s and Don’ts while using AI, how to write prompts, etc.)

Unit IV

Listening comprehension (3 pieces – Do Schools kill creativity? By Sir Ken Robinson, Steve Jobs’ 2005 Stanford Commencement Address, India Questions Dr Abdul Kalam- Aired August 2007) - Reading Comprehension – Skimming and Scanning- Inference and Deduction – Reading different kinds of material – Speaking**:** Narration of incidents / stories/ anecdotes.

Unit V

Shashi Tharoor – “‘Kindly Adjust’ to Our English
A. G. Gardiner – “A Fellow Traveller”Ruskin Bond – “The Eyes Have It” Mrinal Pande – “Girls”
W. H. Auden – “Unknown Citizen”W H Davies - “Leisure”

References:

1. Murphy, Raymond, Murphy’s English Grammar, CUP, 2004
2. Syamala, V. Speak English in Four Easy Steps, Improve English Foundation Trivandrum: 2006
3. Martinet, Thomson, A Practical English Grammar, IV Ed. OUP, 1986.

4. The Week - June 03, 2018, LAST WORD; https://www.theweek.in/columns/shashi-tharoor/2018/05/25/kindly-adjust-to-our english.html?fbclid=IwAR3IhtdXqvuV4ySECn9S7SA6HmCEYISyd1QHd3BlwKgiNKKwdkeSg3qWp-U/
5. A G Gardiner – Leaves in the Wind, Digicat (e-book), 2015
6. Ruskin Bond – The Best of Ruskin Bond; India Penguin. April 2016.
7. Mrinal Pande – Stepping Out; Penguin India; 2003
8. W H Auden – Another Time; Random House Pub; 1940
9. William H Davies – Songs of Joy and Others; Andesite Press, August 2017.
10. Sir Ken Robinson – "Do schools kill creativity?". https://go.ted.com/6WoC
11. Steve Jobs' 2005 Stanford Commencement Address. https://youtu.be/UF8uR6Z6KLc?si=1nMNYJOk3Yw7H7tF
12. India Questions Dr Abdul Kalam (aired: August 2007). https://youtu.be/erg3CmVm6M4?si=YudsxXZOFY1do91C

Evaluation Pattern

Assessment	Weightage (%)
Midterm	30
Continuous Assessment	20
End Semester Exam	50
Total Marks	100

24MAL101	MALAYALAM I	L-T-P-C: 2-0-0-2

Course Objectives:

- To enable the students to acquire basic skills in functional language.
- To develop independent reading skills and reading for appreciating literary works.
- Enable students to communicate in the language they have studied in a range of contexts and for a variety of purposes
- To analyze language in context to gain an understanding of vocabulary, spelling, punctuation and speech

Course outcomes:

COs	Description
CO1	Develop the ability to read and critically appreciate a given text.
CO2	Develop fluency in speaking the language.
CO3	Ability to blend language and Indian spirituality.
CO4	To learn and practice MAOM meditation in daily life.
CO5	To understand the application of meditation to improve communication and relationships.
CO6	To be able to understand the power of meditation in compassion-driven action.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2
CO3	-	-	-	-	2	-	-	2
CO4	-	-	-	-	2	-	-	2
CO5	-	-	-	-	2	-	-	2
CO6	-	-	-	-	2	-	-	2

Syllabus

- Adhyatmaramayanam, Tharopadesam(Enthinnu Sokam….thulom). Jnanappana (sthanamanangal…. Trishnakondubhramikkunnathokkeyum)
- Modern Poets: Mampazham-Vyloppilly Sreedharamenon Critical analysis of the poem.
- Short stories from period 1/2/3: **Poovanpazham**-Vaikaom Muhammed Basheer.
- Literary Criticism: **Bharatha Paryatanam-***Vyasante Chiri*–Ithihasa studies-Kuttikrishna Marar-Outline of literary Criticism in Malayalam Literature.
- Error-free Malayalam: 1. Language; 2. Clarity of expression; 3. Punctuation-Thettillatha Malayalam – Writing- a. Expansion of ideas; b.PrecisWriting; c. Essay Writing.

Textbooks

1. Adhyatmaramayanam – Thunjath Ramanujan Ezhuthachan
2. Ramayanavichinthanam-Dr. A. M. Unnikrishnan
3. Adhyatmaramayanam – Thunjath Ramanujan Ezhuthachan
4. Ramayanavichinthanam-Dr. A. M. Unnikrishnan
5. Thunjan Padhanangal-Prof.Panmana Ramachandran
6. Compleate Works including Jnanappana-Poonthanam
7. Vyloppilly-M.N.Vijayan
8. Vyloppilli-Vyakthi,Kavi-Dr.M.Leelavathi/S.Gupthan Nair
9. Basheerinte Poonkavanam-Prof.M.N.Karasseri
10. Basheer-Life & Works
11. Bharatha Paryatanam-Kuttikrishna Marar
12. Lavanyasastrathinte Yukthisilpam-Dr.Thomas Mathew
13. Thettillatha Malayalam – Prof.Panmana Ramachandran Nair (His all books on Error Free Malayalam)

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	100

24HIN101	HINDI I	L-T-P-C: 2-0-0-2

Course Objectives:

The course will enable the students to understand the basics of grammar and usage, to appreciate the literary compositions, and to understand the intricacies of language and literature.

Course Outcomes:

COs	**Description**
CO1	Distinguish various literary genres.
CO2	Explore tradition and culture through literature.
CO3	Apply the basics of grammar.
CO4	Critically analyse the prescribed literary texts

CO-PO Mapping

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO								
CO1	**-**	-	-	-	2	-	-	2
CO2	**-**	-	-	-	2	-	-	2
CO3	**-**	-	-	-	2	-	-	2
CO4	**-**	-	-	-	2	-	-	2

Syllabus

UNIT 1

Hindi Sahithya ki Panch shresht Kahaniyam**:**

a. Sughmay Jeevan –Chandradhar Sharma, Guleri
b. Dhan ki Bhent-Rabindranath Tagore
c. Anbola –Jayashankar Prasad
d. Swamini (Manasrovar bhagh-1) Premchand

UNIT 2

Hindi Kavitha:

a. ’Aarya” –Maithili Sharan Gupth
b. “Meribhi abha he Ismein”., “Mubarak Ho Naya Saal”-_Nagarjun
c. “Nishaa Ki rod eta Rakesh- Nihar se’.,Shoonya Mandir meinBanoongi-Sandhya Geet se - Mahadevi varma
d.’KhoobLadi Mardani vahtho Jhansi Vali rani thi’-subhadra Kumari chohan

UNIT 3

Hindi Ekanki**:**

a) Mohan Rakesh: Andeke Chilke
b) Vishnu Prabhakar: Sarkari Noukari

UNIT 4

Grammar: 1) Karak 2) Upasarg 3) Pratyay 4) Vakya Rachana 5) Padaparichay. 6) Sarvanam 7) kriya 8) Adjective 9) Adverb 10) Tenses.

Textbooks/ References:

1. Sugam Hindi Vyakarn: Prof.Vanshidhar & Dharmapal Shastri
2. Vyavaharik Hindi Vyakarantatha Rachana: Dr.Hardev
   Bahari Shiksharthi HindiVyakaran: Dr. Nagappa
3. Hindi Sahithya ki Panch shresht Kahaniyam**:** Edited by: Dr.Sachidanandh Shuklu
   (Printed and Published by V&S publishers, Abridged, AnsariGanj, Delhi)
4. Hindi Samay.com,/Hindikahani.com/exotic indiaart.com
5. Adhyatmaramayanam – Thunjath Ramanujan Ezhuthachan
6. Ramayanavichinthanam-Dr. A. M. Unnikrishnan
7. Thunjan Padhanangal-Prof.Panmana Ramachandran
8. Compleate Works including Jnanappana-Poonthanam
9. Vyloppilly-M.N.Vijayan
10. Vyloppilli-Vyakthi,Kavi-Dr.M.Leelavathi/S.Gupthan Nair

11. Basheerinte Poonkavanam-Prof.M.N.Karasseri
12. Basheer-Life & Works
13. Bharatha Paryatanam-Kuttikrishna Marar
14. Lavanyasastrathinte Yukthisilpam-Dr.Thomas Mathew
15. Sugam Hindi Vyakarn, :Prof.Vanshidhar & Dharmapal Shastri
16. Vyavaharik Hindi Vyakarantatha Rachana: Dr.Hardev Bahari
    Shiksharthi HindiVyakaran:Dr. Nagappa
17. Hindi Sahithya ki Panch shresht Kahaniyam**:** Edited by: Dr.Sachidanandh Shuklu
    (Printed and Published by V&S publishers, Abridged, AnsariGanj, Delhi)
18. Hindi Samay.com/ Hindikahani.com/ exotic indiaart.com**.**

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	100

24KAN101	KANNADA I	L-T-P-C: 2-0-0-2

Course Objectives:

- To enable the students to acquire basic skills in functional language.
- To develop independent reading skills and reading for appreciating literary works.
- Enable students to communicate in the language they have studied in a range of contexts and for a variety of purposes
- To analyze language in context to gain an understanding of vocabulary, spelling, punctuation and speech

Course Outcomes:

COs	Description
CO1	Develop the ability to read, listen and write in Kannada and to understand and use the language in a variety of contexts and situations
CO2	To Enable the learners to understand the grammatical structures of classes of words
CO3	Develop ability to speak fluently and interactively in both personal and professional context

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2
CO3	-	-	-	-	2	-	-	2

Syllabus

UNIT – 1

Adalithadalli Kannadada balake: (Use of Kannada in business and administration)
Bhashe – swaroopa, stityantaragalu,
Aadu bhashe, pradeshika bhashe, Grantika bhashe
Paaribhaashika padagalu

UNIT – 2

Padagala rachane,deshiya – anya deshiya padagalu
Lekhana Chinnhegalu
Kannada bharavanigeya shuddha mattu ashuddha roopagalu,
Dwiruktigalu, jodunudigalu

UNIT – 3

Nudigattgalu, gaade vistarane
Listening to radio speech, tongue twister - practice

UNIT – 4

Patra Lekahna - aupachaarika haagu anoupachaarika
Kandikegala rachane
Prabandhagalu: vivaranaatmaka haagu niroopanatmaka

UNIT – 5

Poems

- Vachanagalu – kaalugalembavu gaali kandaya – Allamaprabhu,Ratnada sankoleyaadade todarallve – Akkamahadevi, ole hatti uridare nilabahudallade - Basavanna
- Keerthanegalu – Tanuva nirolagaddi phalavenu – Purandaradasa, Tallanisadiru kandya taalu manave - Kanakadaasa
- Tripadigalu – Saalavanu kombaaga haalogarundante - Sarvagna
- Janapada geetegalu - Yaake badtaadti tamma

Short stories

- Sambhanda – Shrikrishna Alanahalli
- Moksha – Sethuram

Prabandhagalu

- Namma Maneya Deepa – Ha.Ma.Nayak
- Bhadhuku Kanasalla, Ondhu Kale – N K Kulakarni

Textbooks/References

1. H.S.Krishnaswamy Iyangaar – Adalitha Kannada – Chetana publication, Mysuru
2. Kannada Vyakarana mattu Rachane – N.Gopalakrishna Udupa, M.C.C.Publication
3. G.H.Naayak – Kannada Sanna Kathegalu – Chetana Book House
4. Shatamaanada Lalitha Prabandha – Gurulinga Kaapase - Karnataka Sahitya Academy
5. Naavalla – Kathasankalana – Sethuram
6. Basavannanavara Vachanagalu – G.V.Shastri – Paaru prakashana
7. Kannadada Balake – H.S.Krishnaswamy Iyangaar – Chetana book house
8. Sarvagnana Vachanagalu – Venkata Subbaiha, Vijayavaahini Publications

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	100

24SAN101	SANSKRIT I	L-T-P-C: 2-0-0-2

Course Objectives:

- To enable the students to acquire basic skills in functional language
- To develop independent reading skills and reading for appreciating literary works.
- To analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech
- Grasp the connection between Sanskrit language and Indian philosophy

Course Outcomes:

COs	Description
CO1	Read and understand Sanskrit verses and sentences and communicate in Sanskrit
CO2	Imbibe values of life and Indian tradition propounded by the scriptures

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2

Syllabus

Unit I

Introduction to Sanskrit language, Devanagari script - Vowels and consonants, pronunciation, classification of consonants, conjunct consonants, words – nouns and verbs, cases – introduction, numbers, Pronouns, communicating time in Sanskrit. Practical classes in spoken Sanskrit.

Unit II

Verbs- Singular, Dual and plural — First person, Second person, Third person.
Tenses – Past, Present and future – Atmanepadi and parasmaipadi-karthariprayoga.

Unit III

General group words for communication and moral stories.

Unit IV

ChanakyaNeeti chapter III (part I), Bhagavad Gita chapter 14 (part I)

Unit V

Translation of simple sentences from Sanskrit to English and vice versa.

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	100

24TAM101	TAMIL I	L-T-P-C: 2-0-0-2

Course Objectives:
To teach Tamil for effective communication in different spheres of life: - cultural relations in society.

Course Outcomes:

COs	Description
CO1	Giving exposure to the history of Tamil literature and the introduction of select Classics.
CO2	Initiating Students to the spirit of Bhakti literature
CO3	Encouraging the creativity of students by teaching Contemporary Literature poetry, modern poetry, Short Story, Prose, Novel, etc.
CO4	Introduction of basic Grammar, Letter writing and essay writing skills of Tamil language

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2
CO3	-	-	-	-	2	-	-	2
CO4	-	-	-	-	2	-	-	2

Syllabus

அலகு-1

தமிழ்இலக்கியவரலாற்றில்சங்கஇலக்கியம்: முதல், இடை, கடைசங்கம்.
சங்கஇலக்கியங்கள்பத்துப்பாட்டு.
குறுந்தொகை (6,8பாடல்கள்),
புறநானூறு (184,192பாடல்கள்).
சங்கம்மருவியகாலஇலக்கியம்:
சிலப்பதிகாரம் (வழக்குறைக்காதை),
பதிணெண்கீழ்கணக்குநூல்கள்,
திருக்குறள் (மருந்து)

UNIT-1 History of Tamil Literature: First, Intermediate, Last sangam. Sangam Literature, Pattuppaattu. Kur̲untogai, Pur̲anaanuuru.
Literature of the Sangam Maruviya period – Silappathiagaram (vazhakkuraikaathai), PatiṇeṇkiizhKaṇakkuNuulkal. Tirukkur̲aL (Marunthu)

அலகு 2

பக்திஇலக்கியம்:–
பன்னிருதிருமுறைகள்அறிமுகம்,
மாணிக்கவாசகர் (திருவாசகம்- சிவபுராணம்)

UNIT 2 Bhakti Literature – Introduction to PanniruThirumuraikal, Manikkavasagar (Thiruvasagam- Siva Puranam)

அலகு -3

தற்காலஇலக்கியம்:-
கவிதை: பாதியார் (குயில்பாட்டு), பாரதிதாசன் (தமிழின்இனிமை).
உரைநடை: ஞா.தேவநேயப்பாவாணர் (தமிழும்திரவிடமும்சமமா?),
பரிதிமாற்கலைஞர் (தமிழ்மொழியின்வரலாறு (ஆதிவரலாறு)).
சிற்பி (வள்ளுவர்வகுக்கும்இன்பம்)
சிறுகதை: அழகியபெரியவன் – (வனம்மாள்)
நாவல்: இமையம் (பெத்தவன்)

UNIT-3 Contemporary Literature: Poetry - Bharathiar(kuyilpāṭṭu), Bharathidasan (tamil̲in̲in̲imai, in̲pattamil̲) Pattukottai Kalyanasundaram.
Prose: G. DevaneyaBhavanar (TamizhumDhiravidamumsamamaa?), Paritimār̲kalaiñar (paranarkettaparisu), chirbi (valluvarvakukkuminbam)
Short Story: Azhagiya Periyavan – (VanammaaL)

Novel: Imaiyam (Peththavan)

அலகு – 4தொல்காப்பியம்:
எழுத்து – பிறப்பியல்.
நிறுத்தக்குறிகள்மற்றும்
கடிதம்எழுதுதலும்கட்டுரைஎழுதுதலும்
UNIT – 4tolkāppiyam: Alphabet – pi̲rappiyal. Punctuation marks and Letter writing and essay writing.

REFERENCE

இமையம், *பெத்தவன்*, க்ரியாவெளியீடு 2019.
அழகியபெரியவன் ,*அழகியபெரியவன்கதைகள்*, நற்றிணைபதிப்பகம், 2016
சி.பாலசுப்பிரமணியன், *கட்டுரை-வளம்*, நறுமலர்ப்பதிப்பகம், பத்தாம்பதிப்பு 1994
பரிதிமாற்கலைஞர் ,*தமிழ்மொழியின்வரலாறு*, பூம்புகார்பதிப்பகம், ஆறாம்பதிப்பு 2013.
அகளங்கன், *பன்னிருதிருமுறை – அறிமுகம்*, இந்துமாமன்றம்வவுனியா, 1994
ரா. சீனிவாசன ,*தமிழ்இலக்கியவரலாறு* ,https://ta.wikisource.org/s/99uk
மாணிக்கவாசகர் (திருவாசகம்- சிவபுராணம்
பொன்மணிமாறன் “அடோன்தமிழ்இலக்கணம் “அடோன்பப்ளிஷிங்குரூப், வஞ்சியூர், திருவனந்தபுரம், 2007.
http:/www.tamilvu.org/libirary/libindex.htm.
http:/www.gunathamizh.com/2013/07/blog0post_24.html

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	100

24ENG100 ADDITIONAL ENGLISH I L-T-P-C: 2-0-0-2

Course Objectives:

- To expose students to various genres of English literature
- To expose the students to Indian English Writing of different timelines.
- To develop a sensibility to read and understand literary works.
- To introduce a few linguistic devices to enable them to appreciate literary forms stylistically

Course Outcomes:

COs	Description
CO1	Develop the ability to read, listen and write in Kannada and to understand and use the language in a variety of contexts and situations
CO2	To Enable the learners to understand the grammatical structures of classes of words
CO3	Develop ability to speak fluently and interactively in both personal and professional context

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2
CO3	-	-	-	-	2	-	-	2
CO4	-	-	-	-	2	-	-	2

Syllabus

Unit-I

Introduction to Literature – Nature & Elements of Literature, literature as an expression of personal & historic aspects. Narrative structure & technique. Introduction to Indian Literature: Pre-independence, postindependence, themes, writers, and problems.

Unit-II

Linguistic Devices: Theme, Diction, syntax & syntactical deviations, Rhetorical devices, figures of speech

Unit-III

Poetry:

The Frog and the Nightingale by Vikram Seth
An Indian Love Song by Sarojini Naidu
Death of the Wolf by Toru Dutt

Unit IV

Short stories:

Detail - *A Dog's Life* by Mulk Raj Anand
Interpreter of Maladies by Jumpha Lahiri

Unit-V

Non-Detail Reading:

Three Persons by Vijay Sheshadri
The Wolf's Postcript To 'Little Red Riding Hood' by Agha Shahid Ali
The Naive Friends by Premchand
The Woman on Platform 8 by Ruskin Bond

Core Reading:

- Iyengar, Srinivasa ***– The Indian Contribution to English Literature.*** Karnatak ishing House, Bombay, 1945
- Iyengar, Srinivasa – ***Indian Writing in English: 1800-1980*** – Sterling Publishing House, 2019

References

- Seth, Vikram, ***Beastly Tales,*** Penguin India, 2013
- Naidu, Sarojini, ***The Golden Threshold*** 1905
- Dutt, Toru - ***A Sheaf Gleaned in French Fields*** 1876

- Anand, Raj Mulk, ***Selected Short Stories*** Penguin India, 2006
- Tagore, Rabindranath, ***Mashi and Other Stories,*** True Sign Publishing House, 2021
- Lahiri, Jumpha - ***Interpreter of Maladies*** Harpercollins Publishers India, 2005
- Sheshadri, Vijay – POETRY Magazine, December 2010
- Ali, Shahid Agha, ***The Wolf's Postcript To 'Little Red Riding Hood'*** Academy of American Poets, poets.org
- ***Premchand - , Mindfuel's 4 In 1 Story By Munshi Premchand - Power Of A Curse, The Naive Friends, A Complex Problem & A Lesson In The Holy Life*** **Mindfuel Publishers,** ***2020***
- *Bond, Ruskin -* ***The Woman on Platform 8,*** **The Illustrated Weekly of India**

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	**100**

22AVP103 MASTERY OVER MIND (MAOM) L-T-P-C: 1-0-2-2

Course Objective(s)

- Mastery Over Mind (MaOM) is an Amrita initiative to implement schemes and organize university-wide programs to enhance the health and wellbeing of all faculty, staff, and students (UN SDG -3).
- It gives an introduction to the immediate and long-term benefits of MA OM meditation and equips everyattendee to manage stressful emotions and anxiety, in turn facilitating inner peace and harmony.
- This course will enhance the understanding of experiential learning based on the University's mission: "Education for Life along with Education for Living" and is aimed to allow learners to realize and re-discover the infinite potential of one's true Being and the fulfilment of life's goals.

Course Outcomes

COs	Description
CO1	To be able to describe what meditation is and to understand its health benefits.
CO2	To understand the causes of stress and how meditation improves well-being.
CO3	To understand the science of meditation.
CO4	To learn and practice MAOM meditation in daily life.
CO5	To understand the application of meditation to improve communication and relationships.
CO6	To be able to understand the power of meditation in compassion-driven action.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	-	-	-	-	-	1
CO2	-	-	-	-	-	-	-	1
CO3	-	-	-	-	-	-	-	1
CO4	-	-	-	-	-	-	-	1
CO5	-	-	-	-	1	-	-	1
CO6	-	-	-	-	1	-	-	1

Syllabus

Unit I

Describe Meditation and Understand its Benefits (CO1)
A: Importance of meditation. How does meditation help to overcome obstacles in life (Pre- recorded video with Swami Shubhamritananda Puri)
Reading 1: Why Meditate? (Swami Shubamritananda ji)
Reading 2: 'Stillness of the Mind' Chapter 17 in Amritam Gamaya (2022). Mata Amritanandamayi MissionTrust.
Additional Reading: Abhyasa Yoga: The Yoga of Practice. (Br. Achyutamrita Chaitanya)
B: Understand how meditation works. Understand how meditation helps in improving physical and mental health. Understand how meditation helps in the development of personality (Pre-recorded video with Dr. RamManohar)
Reading 1: Allen, Cynthia (2020) The Potential Health Benefits of MeditationAdditional Reading: Sharma, Hari (2022) Meditation: Process and Effects

Unit II

Causes of Stress and How Meditation Improves Well-being (CO2)
A: Learn how to prepare for meditation. Understand the aids that can help in effectively practicing meditation. Understand the role of sleep, physical activity, and a balanced diet in supporting meditation. (Pre-recorded video with Dr. Ram Manohar)
B: Causes of Stress. The problem of not being relaxed. Effects of stress on health. How meditation helps to re-lieve stress. Basics of stress management at home and the workplace. (Pre-recorded video with Prof Udhaykumar)
Reading 1: Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress. Mayo Clinic. https://www.mayoclinic.org/tests-procedures/meditation/in- depth/meditation/art-20045858 (PDF provided)
Reading 2: 'Efficient Action.' Chapter 28 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Unit III

The Science of Meditation (CO3)

A: A preliminary understanding of the Science of meditation. What can modern science tell us about thistradition-based method? (Pre-recorded video with Dr. Shyam Diwakar)

B: How meditation helps humanity according to what we know from scientific research(Pre-recorded video with Dr. Shyam Diwakar)

Reading 1: Does Meditation Aid Brain and Mental Health (Dr Shyam Diwakar)

Reading 2: 'Science and Spirituality.' Chapter 85 in Amritam Gamaya (2022). Mata AmritanandamayiMission Trust.

Unit IV

Practicing MA OM Meditation in Daily Life (CO4)

Guided Meditation Sessions following scripts provided (Level One to Level Five)

Reading 1: MA OM and White Flower Meditation: A Brief Note (Swami Atmananda Puri)

Reading 2: 'Live in the Present Moment.' Chapter 71 in Amritam Gamaya (2022). Mata AmritanandamayiMission Trust.

Unit V

Improving Communication and Relationships (CO5)

How meditation and mindfulness influence interpersonal communication. The role of meditation in improving relationship quality in the family, at the university and in the workplace. (Pre-recorded video with Dr Shobhana Madhavan)

Reading 1: Seppala E (2022, June 30th) 5 Unexpected Ways Meditation Improves Relationships a Lot. Psychology Today. https://www.psychologytoday.com/intl/blog/feeling-it/202206/5-unexpected-ways-medita-tion-improves-relationships-lot

Reading 2: 'Attitude.' Chapter 53 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Unit VI

Meditation and Compassion-driven Action (CO6)

Understand how meditation can help to motivate compassion-driven action. (Pre- recorded video withDr Shobhana Madhavan)

Reading 1: Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: What do we(not) know? Current Opinion in Psychology, 44, 151-156.

Reading 2: 'Sympathy and Compassion.' Chapter 100 in Amritam Gamaya (2022). Mata Amritandamyi Mission Trust.

Textbooks/References

1. Meditation and Spiritual Life-Swami Yatiswarananda, Ramakrishna Math
2. The Complete Works of Swami Vivekananda Vol Vii by Advaita Ashram Mayavati Almora Himalayas
3. Dhyana Yoga-Holy Gita Swami Chinmayanda
4. Voice of God, Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
5. Hindu Dharma-Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
6. Mind: It's Mysteries and control-Swami Sivananda Saraswati
7. Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.
8. Books on Amma's teachings like Awaken children, From Amma's Heart etc.
9. The Science of Meditation: How to Change Your Brain, Mind and Body by Daniel Goleman and Richard. J. Davidson.
10. Allen, Cynthia (2020) The Potential Health Benefits of Meditation
11. Seppala E (2022, June 30th Unexpected Ways Meditation Improves Relationships a Lot.Psychology Today
12. Sharma, Hari (2022) Meditation: Process and Effects
13. Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress.
14. Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: What do we (not) know? Current Opinion in Psychology, 44, 151-156

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

26ENV100	ENVIRONMENTAL STUDIES	L-T-P-C: 2-0-0-2

Course Objective(s)

- This course aims to familiarize students with basic environmental concepts, their relevance to business operations, and forthcoming sustainability challenges.
- This course will equip students to make decisions that consider environmental consequences.
- This course will enable future business graduates to become environmentally sensitive

Course Outcomes:

COs	Description
CO1	Explore the basic environmental concepts and issues relevant to the business and management field
CO2	Recognize the interdependence between environmental processes and socio-economic dynamics.
CO3	Determine the role of business decisions, policies, and actions in minimizing environmental degradation.
CO4	Identify possible solutions to curb environmental problems caused by managerial actions.
CO5	Develop skills to address immediate environmental concerns through changes in business operations, policies, and decisions.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	-	-	1	-	2	2
CO2	-	-	-	-	1	1	2	2
CO3	-	-	-	-	2	2	2	2
CO4	-	-	-	1	2	2	3	2
CO5	-	-	2	2	2	3	3	2

Syllabus

Unit I

Environment, Natural Resources & Sustainability. Concept and components of environment. Man–environment relationship and environmental movements. Natural resources: renewable and non-renewable. Over-utilization of resources and conservation strategies. Sustainability concepts and sustainable development. Issues: deforestation, water scarcity, energy security, food security. Intergenerational and intragenerational equity. Role of education and public awareness.

Unit II

Ecosystems, Biodiversity & Sustainable Practices. Structure and functions of ecosystems. Types of ecosystems (forest, grassland, aquatic – conceptual). Ecosystem resilience, homeostasis, and carrying capacity. Biodiversity: meaning, values, and threats. Conservation strategies: in situ and ex situ. Protected areas and India as a mega-diverse nation.

Unit III

Environmental Pollution, Waste & Disaster Management. Types of pollution: air, water, soil, noise, marine. Causes and impacts of pollution. Climate change, greenhouse effect, ozone depletion, acid rain. Pollution issues and case examples from India. Solid waste management and cleaner technologies. Natural and man-made disasters and disaster management. Role of organizations and businesses in disaster risk reduction.

Unit IV

Social Issues, Legislation & Sustainable Development. Sustainable development and environmental ethics. Role of industry and business in sustainability. Environmental legislation in India: Water (Prevention and Control of Pollution) Act, 1974, Air (Prevention and Control of Pollution) Act, 1981, Environment (Protection) Act, 1986. Role of judiciary in environmental protection. Environmental justice, refugees, rehabilitation and resettlement.

Textbooks/ References

1. Poonia, M.P. Environmental Studies (3rd ed.), Khanna Book Publishing Co.
2. Bharucha, E. Textbook of Environmental Studies (3rd ed.) Orient Blackswan Private Ltd.
3. Poonia, M.P. & S.C. Sharma, Environmental Engineering, Khanna Publishing House.
4. Kant & Kant, Air Pollution Control, Khanna Publishing House.
5. Gupta, O.P., Elements of Environmental Pollution Control, Khanna Publishing House

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA101 COMPUTER FUNDAMENTALS AND DIGITAL ELECTRONICS L-T-P-C: 3-0-2-4

Course Objective(s)

1. To provide an understanding of the fundamental components and functional units of a Digital Computer and itsfunctionalities.
2. To provide the understanding of how to perform number conversions from one system to another system.
3. To gain the knowledge of how to design basic digital electronic circuits.

Course Outcomes

COs	Description
CO1	Students will identify and design the basic components of computer systems and with its functionality.
CO2	Students will apply fundamental mathematical concepts to perform number conversions from one system to another system.
CO3	Students will use Boolean algebra to design and implementation of various logic circuits.
CO4	Implement and design various types of combinational circuits, sequential circuits, and develop its functionalities

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	1	-	-	-	-	-
CO2	3	1	2	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-

Syllabus

Unit I

Computer Fundamentals: Brief history of Computer, Classification of Computers, Functions & Components of a Computer, Central Processing Unit, Storage units, Bus, Input and output Devices. Types of memory, RAM, ROM, Variants of ROM, Secondary storage devices- hard disk-disk components and geometry. Other Secondary Storage devices: CD/DVD Family, Blue ray Disc, Flash Drive, Memory stick, smart cards. Computer Languages- Machine, Assembly Language and Higher Level languages. Operating systems, Bootstrapping. Program execution with illustrative examples.

Unit II

Number Systems: Decimal Numbers, Binary Numbers, Decimal to Binary Conversions, Binary Arithmetic, 1's and 2's complements of Binary Numbers, Signed Numbers, Arithmetic Operations with Signed numbers, Hexadecimal Numbers,Octal Numbers and Error Detection Codes.

Unit III

LOGIC GATES: The NOT gate, The AND gate, The OR gate, The NAND gate, NOR gate, The Exclusive–OR gate andExclusive-NOR gate; Boolean algebra - Basic laws and theorems, Boolean functions, truth table, minimization of booleanfunction using K map method and SOP minimizations.

Unit IV

Logic Circuits: Combinational logic circuits: Half adder, Full adder, Parallel binary adder, subtractor, Decoders, Encoders,Multiplexers, De-multiplexers. Sequential logic circuits- Flip Flops – RS, JK, T and D Flip Flops, Edge triggered Flip Flops, Master slave Flip Flops.

Lab Syllabus:

Introduction to Computer Fundamental and Communication, Various components of a computer, Installing Windows operating system on a system, Installing Linux operating system on a system, Basics of digital electronics, Basic gates and Universal Gates, Half Adder and Full Adder, Half Subtractor and Full Subtractor, Encoder and Decoder, Multiplexer,Demultiplexer, Types of Multiplexers: 4:1, 8:1 and 16:1, Project Presentation and Document submission

Textbooks

1. Floyd, Thomas L: Digital Computer Fundamentals, 11th Edition, Pearson International, 2015.
2. Morris Mano, "Digital logic and Computer design", First Edition, Prentice Hall of India, (2004).

References

1. Malvino, Paul Albert, Leach, Donald P,GautamSaha: Digital Principles And Applications, TMH ,8th Edition, 2015.
2. Bartee, Thomas C: Digital Computer Fundamentals, 6Edition, TMH, 2010.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA102	PROGRAMMING FUNDAMENTALS	L-T-P-C: 3-1-0-4

Course Objective(s)

- Provide foundational understanding of programming concepts for students from non-computer science backgrounds.
- Develop problem analysis skills using algorithmic and logical thinking.
- Enable learners to design and structure programmatic solutions using fundamental constructs.
- Cultivate the ability to implement, test, and evaluate simple programs systematically.
- Foster self-learning capability and adaptability for learning new programming tools and technologies.

Course Outcomes

COs	Description
CO1	Analyze real-world problems and decompose them into step-by-step solutions using algorithms and flowcharts.
CO2	Design structured solutions using appropriate data types, operators, and control flow constructs
CO3	Implement modular program logic using functions and basic data structures.
CO4	Evaluate program correctness and efficiency through systematic testing and debugging
CO5	Apply computational thinking principles to adapt and learn new programming constructs independently

CO-PO Mapping

PO								
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	0	0	0	1
CO2	3	3	3	2	0	0	0	1
CO3	3	2	3	2	0	0	0	1
CO4	2	3	2	2	0	0	2	1
CO5	2	1	2	2	0	0	0	3

Syllabus

Unit I

Introduction to Programming & Problem Solving. What is a program? Programming vs Problem-solving. Characteristics of a good program. Program development life cycle. Problem analysis and decomposition. Introduction to Algorithms. Characteristics of algorithms. Writing algorithms using pseudocode. Flowcharts: Symbols and conventions. Flowchart for simple problems.

Unit II

Basics of Programming Concepts. Overview of high-level languages. Structure of a simple program. Variables and Constants. Data Types. Integer, floating point, character, Boolean. Operators: Arithmetic, relational, logical, assignment. Expressions and type conversion. Input and output concepts.

Unit III

Control Structures. Need for control flow. Decision Making: if, if–else, nested if. switch/case. Looping Constructs: for loop, while loop, do–while loop. Loop control statements (break, continue – idea level). Common programming logic patterns.

Unit IV

Modular Programming. Need for modularization. Function concept. Function definition and call. Parameters and return values. Scope of variables. Advantages of functions. Recursion.

Unit V

Arrays: One-dimensional arrays, Two-dimensional arrays, Common operations on arrays. Strings: String representation, Basic string operations. Introduction to Files. Purpose of file handling. Reading and writing data (conceptual level). Debugging & Testing. Common programming errors. Logical vs syntax errors.

Textbooks/ References

1. Programming in ANSI C, by E. Balagurusamy. McGraw-Hill
2. Programming with C by Byron Gottfried. Schaums Outline

3. Programming in C, by Reema Thareja. Oxford University Press

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA181 PROGRAMMING FOUNDATION LAB L-T-P-C: 0-0-2-1

Course Objective(s)

- Provide hands-on experience in implementing programming logic using basic constructs.
- Enable students to translate algorithms and flowcharts into executable programs.
- Develop skills in modular programming and systematic problem solving.
- Introduce testing, debugging, and validation practices essential for reliable software development.
- Encourage independent learning and experimentation with programming tools and environments.

Course Outcomes

COs	Description
CO1	**Analyze** simple real-world problems and convert them into algorithms and flowcharts
CO2	**Implement** program logic using variables, operators, and control structures
CO3	**Design and develop** modular programs using functions and basic data structures
CO4	**Test and evaluate** programs for correctness, efficiency, and logical accuracy
CO5	**Apply** modern programming tools and debugging techniques to learn new program constructs independently

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	2	1	0	0	0	1
CO2	3	2	3	2	0	0	0	1
CO3	3	2	3	2	1	0	0	1
CO4	2	3	2	2	0	0	2	1
CO5	2	1	2	3	0	0	0	3

Syllabus

- Orientation to programming environment, IDE, program compilation & execution
- Writing simple programs – input/output and expressions
- Programs using operators and type conversion
- Conditional statements – if, if-else
- Nested decision making and logical conditions
- Looping constructs – for loop
- while and do-while loops (iteration problems)
- Problem solving using combinations of loops and decisions
- One-dimensional arrays – basic operations
- Searching and simple array applications
- String handling and basic string operations
- Functions – definition, calling, parameter passing
- Modular programs using functions
- Debugging, testing, and error handling

Textbooks/ References

1. Programming in ANSI C, by E. Balagurusamy. McGraw-Hill
2. Programming with C by Byron Gottfried. Schaums Outline
3. Programming in C, by Reema Thareja. Oxford University Press

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

26CSA182	LINUX PROGRAMMING LAB	L-T-P-C: 0-0-2-1

Course Objective(s)

To familiarize students with the architecture of Linux OS and the implementation of various applications in Operating Systems. Provides necessary skills for developing and debugging programs in Linux environment.

Course Outcomes

COs	Description
CO1	Experiment with basic Linux commands.
CO2	Working and demonstrate system and network management commands.
CO3	Build programs for process management using system calls
CO4	Build programs for systems management using system calls.
CO5	Working with shell programming for a given problem instance.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	1	1	1	-	-	-	-	-
CO2	1	1	1	-	-	-	-	-
CO3	1	1	1	-	-	-	-	-
CO4	1	1	1	-	-	-	-	-
CO5	1	1	1	1	1	-	-	-

Syllabus

Basic Linux and Windows DOS commands – System calls – fork, exec, getpid, exit, wait, close, stat, open, read, write. Implementation of systems calls in c programming. Linux directory structure, System management commands, Network management commands. Redirection-Input, Output redirection. Process related commands. Pipes. Shell scripting with syntax (if,while,until and for,switch case).

Textbooks

1: Operating Systems concepts, Silberschatz- alvinagne, ninth edition
2: S. Godbole-operating systems-Tata McGraw-Hil Publications

References

Operating System Lab Programs: Guide to Shell and Operating System Programs Kindle Edition by SYDHANI BEGUM (Author)

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

SEMESTER II

22ADM111	GLIMPSES OF GLORIOUS INDIA	L-T-P-C:2-0-1-2

Course Objective(s)

To introduce students to the depths and richness of the Indian culture and knowledge traditions, and to enable them to obtain a synoptic view of the grandiose achievements of India in diverse fields. To equip students witha knowledge of their country and its eternal values.

Course Outcomes

COs	Description
CO1	This part deals with two topics: The Need to Become Fearless in Life and the Role or Status of Women in India.
CO2	This part deals with three topics: Teachings and Principles of Chanakya, Difference between the terms God and Iswara and Contribution of Bhagavad Gita
CO3	This area handles two important concepts: Indian Soft powers and A portrayal of how nature was preserved through the medium of Faith. Inner power is about never giving up on your dreams. To manifest more of what you desire in life, you must be prepared to embrace your inner power. You must be persistent if you wantto succeed. Maintain your modesty and never stop learn-ing. Inner strength is an attitude to life. Faiths shape and direct how we think, act, and live our lives. However, faith's power is not solely spiritual. To preserve nature, our forefathers established systems andtraditions based on faith. Our culture and faith are intricately bound to nature.
CO4	Two important topics are discussed here: A Brief history of Ancient Indian Cultures and a Discussion on Practical Vedanta. Indian culture is the legacy of the ethno-linguistically diverse country's social norms, moral principles, traditional practices, belief systems, political systems, artefacts, and technologies. Fol-lowing every invasion or change of political control, new kingdoms carried their respective cultures with them, adding to the Indian culture. Vedanta is the philosophy of the Upanishads. Every soul possesses the potential to be divine. The objective is to manipulate thisinner divinity by invoking both internal and external natural forces.
CO5	From this part, a student gets an insight into the contribution that India has made to the world. Moreover,foreign powers have been trying to humiliate and degrade India in front of the world for so long. However, it should be recognized that many inventions that are considered beneficial to the world today havebeen contributed by the great men of India.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	-	1	-	-	-
CO2	-	-	-	-	1	-	-	-
CO3	-	-	-	-	1	-	-	1
CO4	-	-	-	-	1	-	-	-
CO5	-	-	-	-	1	-	-	-

Syllabus

1. Chapter 1 - Face the Brutes
2. Chapter 2 - Role of Women in India
3. Chapter 3 - Acharya Chanakya
4. Chapter 4 - God and Iswara
5. Chapter 5 - Bhagavad Gita: From Soldier to Samsarin to Sadhaka
6. Chapter 6 - Lessons of Yoga from Bhagavad Gita
7. Chapter 7 - Indian Soft Powers: A Solution For Many Global Challenges
8. Chapter 8 - Nature Preservation through faith
9. Chapter 9 - Ancient Cultures what happened to them.
10. Chapter 10 - Practical Vedanta
11. Chapter 11 - To the World from India
12. Chapter 12 - IndianApproach to Science

Textbooks/References

1. Glimpses Of Glorious India

Evaluation Pattern

Assessment	Weightage (%)
Midterm	30
Continuous Assessment	20
End Semester Exam	50
Total Marks	100

24ENG111	ENGLISH II	L-T-P-C: 1-0-2-2

Course Objectives

To train students to convey and document information in a formal environment; to facilitate them to acquire the skill of self-projection in professional circles; to inculcate critical and analytical thinking.

Course Outcomes

COs	Description
CO1	Illustrate comprehension of the fundamentals of writing
CO2	Analyse audio text focussing on English phonetics, pronunciation and meaning comprehension
CO3	Apply theoretical knowledge to write professional documents
CO4	Infer from current news to formulate ideas and opinions
CO5	Prepare appropriate content for mini project and make effective presentation

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2
CO3	-	-	-	-	2	-	-	2
CO4	-	-	-	-	2	-	-	2
CO5	-	-	-	-	2	-	-	2

SyllabusUnit I

Vocabulary Building: One-word substitutes; Antonyms and Synonyms; Words often Confused Error Analysis (Subject- Verb Agreement; Tense Sequence; Usage of Articles and Prepositions; Determiners; Redundancy); Modifiers (misplaced**,** dangling, etc.)

Unit II

Circulars; Memos; Formal Letter writing; e-Mail Etiquette; Instruction, Suggestion & Recommendation; Essay writing: Analytical and Argumentative

Unit III

Sounds of English: Stress, Intonation - Listening Comprehension (3 pieces – Women in Technology Panel discussion, IndiaQuestions Abdul Kalam, UPSC Topper Mock interview Akshat Jain) - Current News Awareness

Unit IV

Reports: Incident Report, Event Report Situational Dialogue; Group Discussion (Opinion)

Unit V

Mini Project and Presentation

References:

1. Felixa Eskey. Tech Talk, University of Michigan. 2005
2. Michael Swan. Practical English Usage, Oxford University Press. 2005
3. Anderson, Paul. Technical Communication: A Reader Centered Approach,
   V Edition, Hercourt, 2003.
4. Martinet, Thomson, A Practical English Grammar, IV Ed. OUP, 1986.
5. Raymond V. Lesikar and Marie E. Flatley. Basic Business Communication,
   TataMcGraw Hill Pub. Co. New Delhi. 2005. Tenth Edition.
6. Thampi, G. Balamohan. Meeting the World: Writings on Contemporary Issues. Pearson, 2013.
7. Lynch, Tony. Study Listening. New Delhi: CUP, 2008.
8. Kenneth, Anderson, Tony Lynch, Joan Mac Lean. Study Speaking. New Delhi: CUP, 2008.
9. Marks, Jonathan. English Pronunciation in Use. New Delhi: CUP, 2007.
10. Syamala, V. Effective English Communication for You (Functional Grammar, Oral and Written Communication): Emerald, 2002.
11. Sample Question Papers from Competitive Examinations

12. Women in Technology Panel discussion
https://youtu.be/T44XdGH5s-8?si=A1cDVEt777FH7vFR
13. India Questions Abdul Kalam
https://youtu.be/erg3CmVm6M4?si=WjP_SV1vy6FrsGHg
14. UPSC Topper Mock interview, Akshat Jain
https://youtu.be/lsJBGvyiAHI?si=L-u6kTadzJmghHLI

Evaluation Pattern

Assessment	Weightage (%)
Internal Assessment	80
External Assessment	20
Total Marks	100

24MAL111	MALAYALAM II	LTPC: 2 0 0 2

Course objective:

- To develop independent reading skills and reading for appreciating literary works.
- To develop elaboration and modernization of the vocabulary of a language
- To enable the students to plan, draft, edit & present a piece of writing.

Course outcomes:

COs	Description
CO1	Develop the ability to read and critically appreciate a given text
CO2	Develop fluency in communication
CO3	Develop interest in blending of language and Indian Spirituality
CO4	To enable the learners to understand the grammatical structures of classes of words

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2
CO3	-	-	-	-	2	-	-	2
CO4	-	-	-	-	2	-	-	2

UnitTopic

1 Memoirs-One of the Selecrtion from Chiudambara Smarana-Balachandran Chullikkadu-Critical analysis of his poetry)

2 Ancient Drama: Kerala Sakunthalam (Act 4), Kalidasan (Transilated by Attoor Krishna Pisharody).

3 Satire One of the Selection from Chemmanam Chacko,VKN Or Punathil Kunjabdulla- philosophical dimens of Satire

4 Part of an auto-biography/travelogue: Valarnnu varunna oratmavu(from Kanneerum Kinavum)-VT Bhattathirippad

5 Error-freeMalayalam: 1 Language; 2.Clarity of expression; 3.Punctuation-Thettillatha Malayalam – Writing-a. Expansion of ideas

Text books/Reference:

1) Hasa Sahithyam Kuttikrishna Mararu
2) Sakunthalam-Attoor/Kuttikrishna Marar
3) Kalidasa Hridayam-K.P.Narayana Pisharady
4) VKN-K.P.Appan
5) N.V.Krishna Warriar & Modern Poetry studies
6) Kanneerum Kinavum –V.T. Bhattathirippad
7) Adukkalayil Ninnu Arangatheykku-V.T.Bhattathirippadu
8) Nalla Malayalam- C.V.Vasudeva Bhattathiri
9) Tettum Sariyum-Prof. Panmana Ramachandran Nair

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	100

24HIN111	HINDI II	LTPC: 2 0 0 2

Course Objective:
The course will allow students to apply grammar in language structures, appreciate the literary compositions and provide them with a good command over translation techniques.

Course outcomes: By the end of the course the students will be able to:
1. Understand the postmodern trends of literature...
2. Explore tradition and culture through literature.
3. Apply ethical and professional translation strategies.
4. Demonstrate linguistic competence in written communication.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2
CO3	-	-	-	-	2	-	-	2
CO4	-	-	-	-	2	-	-	2

Syllabus
UNIT 1
Hindi Laghu Upanyas**: Mamatha Kaliya - 'Doud'**

UNIT 2
Hindi Natak**:** Swadesh Deepak- "Kort Marshal"

UNIT 3
Adhunik Hindi Kavya a.Jayashankar Prasad - (Lahar, Aah!Vedhana Mili Vidayi)., b.Suryakanth Tripathi "Nirala"-(Anamika - 4)., c.Subadhra Kumari, Chouhan - (Swadesh Ke Prathi, Smruthiyam), d.Gajanan Madhav Muktibodh- (ek swapna Katha)

UNIT 4
A) Sankshepan,
B) Anuvad: Paribhasha,Prakar,AnuvadKeLakshan,AnuvadKiAvashyakata,Passage (Translation)
C) Paragraph writing
D) Technical writing

REFERENCE

1. Prayojan Mulak Hindi Ke Naye Ayam	: Dr. Pandit Banne
2. Prayojan Mulak Hindi Ki Nayi Bhumika	: Kailash Nath Pandey
3. Prayojan Mulak Hindi Ke Vividh Roop	: Dr. Rajendra Mishra, Rakesh Sharma

4. "Adhunik Kavya Sangraha" Edited by. Dr. Urvashi Sharma (Printed and Published by Malik & Company, Jaipur)
5. Hindi Samay.com,/Hindikahani.com/exotic indiaart.com

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	100

24KAN111 **KANNADA II** **LTPC: 2 0 0 2**

Objectives:

- To develop the standard of orthography and spelling system.
- To develop independent reading skills and reading for appreciating literary works.
- To develop elaboration and modernization of the vocabulary of a language.
- To enable the students to plan, draft, edit & present a piece of writing.

Course Outcome

COs	**Description**
CO1	Develop the ability to read and critically appreciate a given text
CO2	Develop pattern of communication as required for different professional context
CO3	Develop fluency in speaking the language

CO-PO Mapping

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO								
CO1	**-**	**-**	**-**	**-**	2	-	-	2
CO2	**-**	**-**	**-**	**-**	2	-	-	2
CO3	**-**	**-**	**-**	**-**	2	-	-	2

Syllabus

UNIT – 1: Prabandhagalu

- Thotadacheya Bhoota – Kuvempu
- Bantu Bannada Holi – G. S. Shivarudrappa

UNIT – 2: Poems

- Ni hinga nodabayda Nanna – Da. Ra. Bendre
- Huttarihaadu – Panje Mangesh Rao
- Tungabadre – K.S.Narasimhaswamy
- Nanna Janagalu – Dr.Siddhalingaya

UNIT – 3: Novel

- Jugari Cross – Poornachandra Tejaswi

UNIT – 4

- Suttole
- Kadata
- prakatane
- Arjigalu
- Aadesha patraa

UNIT- 5

- Varadigalu
- Sanshikpta Baravanige
- Prabandhagalu: vaadaatmaka haagu vishleshanatmaka

References:

- Jugari Cross – Poornachandra Tejaswi – Pustaka Prakashana
- Shatamaanada Lalitha Prabandha – Gurulinga Kaapase - Karnataka Sahitya Academy
- N.Gopalkrishna Adiga – Kannada Vyakarana mattu Rachane – MCC Publications
- Maadhari Patragalu – S.R.Siddharaju – Kannada Saahitya Parishattu
- H.S.Krishnaswamy Iyangar – Adalitha Kannada – Chetana publication, Mysuru

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	100

24SAN111 SANSKRIT II LTPC: 2 0 0 2

Course Objective:
To introduce students to basic Sanskrit grammar, sentence construction, classical literature, and ethical texts, enabling effective communication, translation skills, and moral understanding.

Course outcomes: By the end of the course the students will be able to:

COs	Description
CO1	Apply basic Sanskrit grammar concepts to form correct words and sentences.
CO2	Comprehend and interpret Sanskrit verses, moral stories, and Subhāṣitas.
CO3	Identify major forms of Sanskrit classical literature, including Kavyas and Dramas.
CO4	Translate simple Sanskrit passages into English and vice versa with clarity and accuracy.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2
CO3	-	-	-	-	2	-	-	2
CO4	-	-	-	-	3	-	-	2

Syllabus

Module I
Seven cases, Avyayas, sentence making with Avyayas, Sapthakakaras.

Module II
Kthavathu Prathyaya, Upasargas, Kthvatha, Thumunnantha, LyabanthaPrathyaya. Three Lakaras – brief introduction, Lot lakara

Module III
New words and sentences for the communication, Slokas, moral stories, Subhashithas, riddles (Selected from the Pravesha Book)

Module IV
Introduction to classical literature, classification of Kavyas, classification of Dramas - Important five Mahakavyas

Module V
Translation of paragraphs from Sanskrit to English and vice versa

Module VI
Chanakya Neeti chapter III (Part II), Bhagavad Geeta chapter 14 (Part II)

Essential Reading:
1, Praveshaha; Publisher: Samskritabharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore -560 085
2, Sanskrit Reader I, II and III, R.S. Vadhyar and Sons, Kalpathi, Palakkad
3, PrakriyaBhashyam written and published by Fr. John Kunnappally
4, Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston
5, Sabdamanjari, R.S. Vadyar and Sons, Kalpathi, Palakkad
6, Namalinganusasanam by Amarasimha published by Travancore Sanskrit series
7, SubhashitaRatnaBhandakara by Kashinath Sharma, published by Nirnayasagarpress

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	100

24TAM111	TAMIL II	LTPC: 2 0 0 2

Course Objective:
The course will allow students to understand the writing competency in Tamil literature.

Course outcomes: By the end of the course the students will be able to:

COs	**Description**
CO1	Introduction to Tamil Folklore
CO2	Learning the nuances of Tamil spiritual literature
CO3	Exposure to the advanced aspects of Tamil grammar
CO4	Imbibing the spirit of language through familiarizing with linguistics, translation and creative writing

CO-PO Mapping

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO								
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2
CO3	-	-	-	-	2	-	-	2
CO4	-	-	-	-	2	-	-	2

அலகு 1: சிற்றிலக்கியங்கள்அறிமுகம்: கலிங்கத்துப்பரணி (பபோர்பபோடியது), முக்கூடற்பள்ளு 35. நோட்டுபுறவியல்: வரரவிலக்கணம், நோட்டுபுறப்போடல்கள், கரதகள், கரதப்போடல்கள், பழமமோழி, விடுகரதகள், கரலகள்.
Introduction to CiRRilakkiyam: Kalingaththupparani (Poor Padiyathu) - MukkdaRpallu 35. Folklore: Definition, Folksongs - Stories – kathaipPaadal - pazhamozhi - vidukathai - kalaikaL.

அலகு 2: பக்திஇலக்கியம்: ஆண்டோள்முழுவரலோறு, திருப்போரவ (1,2,3,4)

அலகு 3: மதோல்கோப்பியம்: மபோருளிலக்கணம் - மோல்லிலக்கணம்

அலகு 4: மமோழிமபயப்பு: மமோழிமபயப்புவரககள், மமோழிமபயர்ப்பின்முக்கியதுவமும்பதரவயும், இயந்திரமமோழிமபயர்ப்பு, மகோள்ரககள், இலக்கியமமோழிமபயர்ப்பு. மமோழியியல்அறிமுகம்: மமோழியும்மமோழியியலும், பயன்போடுமமோழியின்தன்ரமகள் ,மமோழியியல்துரறகள். பரடப்புஉருவோக்குதல் (கருத்துபரிமாற்றம் - கவிரதஇலக்கியம்- அறிமுகம், விடுதரலக்குமுன்னும்பின்னும் - நாடகம் - சிறுகதத).
Translation: Types of translation - Importance and need of translation - Machine translation - Principles - Literary translation.

Introduction to Linguistics: Language and Linguistics- Linguistics – Characteristics of applied language – Fields of Linguistics. Creation of creativity (Exchange of ideas - introduction to poetry literature, before and after liberation - drama - short story).

REFERENCES

மு.வரதரோன் “தமிழ்இலக்கியவரலோறு” ோஹித்யஅகமடமிபப்ளிபகஷன்ஸ் , 2012
மபோன்மணிமோறன் “அபடோன்தமிழ்இலக்கணம் “அபடோன்பப்ளிஷிங்குரூப், வஞ்சியூர், திருவனந்தபுரம், 2007. http:/www.tamilvu.org/libirary/libindex.htm.
http:/www.gunathamizh.com/2013/07/blog0post_24.html நோ.வோனமோமரல, “தமிழர்நோட்டுப்போடல்கள்” நியூமஞ்சுரிபுத்தகமவளியீட்டகம் 1964,2006
நோ.வோனமோமரல “பழங்கரதகளும், பழமமோழிகளும் ”நியூமஞ்சுரிபுத்தகமவளியீட்டகம், 1980,2008

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	100

24ENG110	Additional English – II	LTPC: 2 0 0 2

Course Objectives:

- To expose the students to various genres of English Literature.
- To expose the students to Indian English Writing of different timelines.
- To develop sensibility to read and understand literature and thereby encourage them to be sensitive to the whole spectrum of human experience.

Course Outcomes

COs	Course Outcomes
CO 1	To demonstrate an ability to critically appreciate any literary text
CO 2	To exhibit an ability to narrate and express their thoughts and idea.
CO 3	To be able to evaluate and relate to common human experiences

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	-	2	-	-	2
CO2	-	-	-	-	2	-	-	2
CO3	-	-	-	-	2	-	-	2
CO4	-	-	-	-	2	-	-	2

Syllabus

Unit-I: Introduction:

Drama: Tragedy & Comedy, Characters, Setting

Prose: Fiction and Non-Fiction

Life Writing.: Biography, Autobiography, Memoirs

Unit-II: **Essays:**

Shashi Tharoor - ***A Child's Reading in India***

Sarvepalli Radhakrishnan - ***Gandhian Outlook***

Unit-III: Play: ***Silence! The Court is in Session'*** by Vijay Tendulkar

Unit-IV: Non-Detail reading:

Karma – Khushwant Singh

Kailash Satyarthi's Nobel Lecture on 10 December 2014 at Oslo City Hall, Norway

Of Mothers, among other things. By A.K. Ramanujan

Unit-V: Critical Appreciation and Creative Writing: Class Activity

Core Reading

- Habib, M.A.R, ***Literary Studies, A Norton Guide***, Norton & Co, 2020
- Naik, M.K., ***A History of Indian English Literature,*** Sahitya Academy

References:

- Tendulkar, Vijay, ***Silence! The Court is in Session,*** Oxford University Press, 1982
- *Tharoor, Shashi,* ***A Child's Reading in India,*** Washington Post, Dec 1991
- *Gandhi Outlook and Techniques* - Ministry of Education, January 1, 1953
- Singh, Khushwant, ***Collected Short Stories***, Ravi Dayal Publishers, 1989
- **Nobel Lecture – Audio** [https://www.youtube.com/watch?v=UNZNbcf5Hd8]

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	20
Midterm	30
End Semester Exam	50
Total Marks	100

26CSA111 OBJECT ORIENTED PROGRAMMING USING JAVA L-T-P-C: 3-1-0-4

Course Objective(s)

The main objective of this course is to understand the basic concepts and techniques which form the object-oriented programming paradigm using Java Language.

Course Outcomes

COs	Description
CO1	Compose, compile, and run Java programs incorporating fundamental Java constructs.
CO2	Identify the necessary classes, objects, class attributes, and their relationships specifically designedto tackle a particular problem.
CO3	Utilizing the IO package and incorporating object-oriented design principles.
CO4	Develop multithreaded applications with synchronization and exception handling.
CO5	Utilize collection framework in java applications and build GUIs using Java AWT classes.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	3	2	-	-	-	-
CO2	3	3	3	2	-	-	-	-
CO3	3	3	3	2	1	-	-	-
CO4	3	3	3	2	1	-	-	-
CO5	3	3	3	3	1	-	-	-

Syllabus

Unit I: Java Environment, Introduction and Features of Java, JVM. Program Structure, Data types, Java Statements – Control and Looping, Type casting in Java programs - Types of Operators. Arrays – 1D, 2D.

Unit II: Introduction to object-oriented software design, Comparison of programming methodologies, Object Basics, Classes andObject, Data Members, Access Specifiers, Array of Objects, Constructors, Static Keyword.

Unit III: Overview of Streams, Bytes vs. Characters, File Object, Binary Input and Output, Reading and Writing Objects, MethodOverriding, Polymorphism, Super, Interfaces and Abstract Classes, Packages

Unit IV: Exception Handling, Introduction to Threads, Creating Threads, Thread States, Runnable Threads, Coordinating Threads,Interrupting Threads, Runnable Interface, Synchronization.

Unit V: Collection framework, Collection interfaces and classes, AWT, Event Handling.

Textbooks

- Herbert Scheldt, ―Java: The Complete Reference, Eleventh Edition‖, Oracle 2018
- Deitel PJ. Java how to program. Eleventh Edition, Pearson; 2018.

References

- Nino J, Hosch FA. Introduction to Programming and Object-oriented Design using Java. Wiley India Private Limited;2010. 4. Naughton P. and Schildt H. Java
- The Complete Reference. Eighth Edition, Tata McGraw- Hill; 2011.
- Bahrami A. Object Oriented Systems Development. Second Edition, McGraw-Hill; 2008.
- Booch G, Maksimchuk RA. Object-oriented Analysis and Design with Applications. Third Edition, Pearson Education;2009

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA112	COMPUTER ORGANIZATION AND ARCHITECTURE	L-T-P-C: 3-1-0-4

Course Objective(s)

1. Explore the architecture of modern processors, including the design of the central processing unit (CPU).
2. Acquire knowledge about different types of memory systems, including cache memory, and main memory (RAM).
3. Implement the phases involved in executing an instruction.
4. Illustrate concepts related to parallel processing and pipeline design, including superscalar and vector architectures.

Course Outcomes

COs	Description
CO1	Demonstrate understanding of modern processor architecture, including CPU design, andinstruction execution.
CO2	Exemplify how the memory organization is communicating with the processing unit.
CO3	Recognize the various I/O device communication methods and common I/O interfaces.
CO4	Comprehend ideas behind pipeline design and parallel processing, such as superscalar andvector architectures.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	1	-	-	-	-	-
CO2	3	2	1	-	-	-	-	1
CO3	3	2	2	1	-	-	-	1
CO4	3	2	2	1	-	2	-	1

Syllabus

Unit I

Fundamental concepts: Register transfers, fetching a word from memory, Storing a word in memory.
Execution of a complete instruction, Branch instructions, and A Complete processor.
Assembly language - Assembly language notation, Basic instruction types, Register Transfer Languages, Addressing modes, and subroutines.

Unit II

Memory Organization: Basic Concepts, Semiconductor RAMs, Read-Only Memories, Performance Analysis of memoryCache memory: Types of cache memory, Mapping functions, Replacement algorithms
Virtual memory: Address Translation, Secondary storage.

Unit III

Introduction to I/O Operations, Peripheral devices, and Input/output interfaces.
Modes of transfer: Programmed I/O, Interrupt initiated I/O, Direct Memory access.

Unit IV

Parallel Processing, Introduction to pipelining: Instruction pipelining and Arithmetic pipelining.
Hazards: Data hazards, Instruction hazards, Handling data hazards, and instruction hazards.
Embedded Systems: Examples of embedded systems

Textbooks

1. Carl Hamacher, Zvonks Vranesic, Safea Zaky (2002), Computer Organization, 5th edition, McGraw Hill, New Delhi, India.
2. M Morris Mano, Computer System Architecture (3rd Edition)

References

1. William Stallings (2010), Computer Organization and Architecture- designing for performance, 8th edition, Prentice Hall, New Jersey.
2. Andrew S. Tanenbaum (2006), Structured Computer Organization, 5th edition, Pearson Education Inc.
3. John P. Hayes (1998), Computer Architecture and Organization, 3rd edition, Tata McGraw Hill.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment (including lab)	25
End Semester Exam	50
Total Marks	100

26CSA113	DATABASE MANAGEMENT SYSTEMS	L-T-P-C: 3-0-0-3

Course Objective(s)

The objective of the course is to present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from a DBMS.

Course Outcomes

COs	Description
CO1	Students will have a full comprehension of database concepts and their applications, including their functionalities.
CO2	Students will be able to master basics of SQL and apply it to construct queries for any given databasesuch as create tables, applying constraints, insert/update/delete data, and building indexes on data RDBMS thereby building a successful application.
CO3	Students will be able to design entity relationship diagram, convert the entity relationship diagrams into RDBMS and formulate SQL queries on the data.
CO4	Implement the concept of normalization on the data and its usage in database design to complete an application with transaction properties such as concurrency control and recovery.

CO-PO Mapping

PO								
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	3	-	1	-	-	-	-	-
CO2	2	3	2	1	-	-	-	-
CO3	2	2	3	1	-	-	-	-
CO4	3	2	2	1	-	-	-	-

Syllabus

Unit I

Introduction – Need of Databases - Data Independence - The Three Levels of Architecture - The External Level - Conceptual

Level- Internal Level - Client/Server Architecture- System Structure, Instance and schema, Advantages and Disadvantagesof File Systems, Types of users in DBMS, Data Models and Overall System Architecture.

Unit II

Key Constraints - CODD's Rules, Design Issues -ER – Model –Attribute types- Weak Entity Sets - Extended ER Features –ER to Relational Mapping, Structure of Relational Databases, Concept of Normalization and Types of Anomalies.

Unit III

Functional Dependency: Armstrong's axioms- closure of a relation and closure of attribute– Lossy/ Lossless decomposition- 1NF, 2NF, 3NF, Boyce - Codd Normal Form. The Relational Algebra - Query Processing and Optimization: Evaluation ofRelational algebra Expressions Query Equivalence.

Unit IV

Transaction Processing: ACID properties, states of a transaction-Introduction to concurrency control-Deadlock-Recovery. Built in SQL functions- Set operations, Sub Queries-Joins-DCL – TCL- Views – Locks - Sequences – Index –PL/SQL Basics – Exceptions – Cursors - Stored Functions – Triggers

Textbooks

1. Silberschatz, Korth, "Data base System Concepts", 7th ed., McGraw hill, 2019.
2. Ivan Bayross: Sql- PL/SQL The Programming Language of Oracle – 4th Edition- Bpb Publications.

References

1. Data base Management Systems, Raghu Ramakrishnan, Johannes Gehrke, McGraw Hill Education (India) Private Limited, 3rd Edition.
2. Fundamentals of Database Systems" by Elmasri and Navathe.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA183	OBJECT ORIENTED PROGRAMMING USING JAVA LAB	L-T-P-C: 0-0-2-1

Course Objective(s)

The main objective of this course is to understand the basic concepts and techniques which form the object-oriented programming paradigm using Java Language.

Course Outcomes

COs	Description
CO1	Write, compile, and run Java programs incorporating fundamental Java constructs.
CO2	Design and implement classes, objects, and constructors to model real-world entities.
CO3	Utilize inheritance and polymorphism to create reusable and maintainable code with File Handling
CO4	Design and develop multithreaded applications to improve program performance with error handling mechanism.
CO5	Develop simple graphical user interfaces (GUIs) using AWT components.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	3	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-
CO3	3	3	3	-	1	-	-	-
CO4	3	3	3	-	1	-	-	-
CO5	3	3	3	-	1	-	-	-

Syllabus

1. Setting up Java development environment. Write and run simple Java programs using basic syntax.
2. Writing and compiling simple Java programs
3. Working with different data types and operators
4. Implementing conditional statements and loops
5. Work with arrays to store and manipulate collections of data
6. Creating classes and objects with Constructors
7. Exploring inheritance concepts
8. Utilizing polymorphism for code reusability using Abstract Class and Interface
9. Reading and writing data from files
10. Understanding multithreading concepts
11. Developing simple multithreaded applications
12. Implement exception handling mechanisms to manage errors effectively
13. Utilize built-in collections like ArrayList, HashMap, etc. to manage groups of objects efficiently.
14. Designing basic GUIs using AWT components with event handling in GUIs

Textbooks

- Herbert Scheldt, ―Java: The Complete Reference, Eleventh Edition‖, Oracle 2018
- Deitel PJ. Java how to program. Eleventh Edition, Pearson; 2018.

References

- Nino J, Hosch FA. Introduction to Programming and Object-oriented Design using Java. Wiley India Private Limited; 2010. 4. Naughton P. and Schildt H. Java
- The Complete Reference. Eighth Edition, Tata McGraw- Hill; 2011.
- Bahrami A. Object Oriented Systems Development. Second Edition, McGraw-Hill; 2008.
- Booch G, Maksimchuk RA. Object-oriented Analysis and Design with Applications. Third Edition, Pearson Education; 2009

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

26CSA184	DATABASE MANAGEMENT SYSTEMS LAB	L-T-P-C: 0-0-2-1

Course Objective(s)

1. The objective of this lab course is to understand the practical applicability of database management system concepts.
2. Working on existing database systems, designing of database, creating relational database, analysis of table design.

Course Outcomes

COs	Description
CO1	Students will have a comprehension on designing and creating relational database systems
CO2	Develop queries in SQL to retrieve any type of information from a database
CO3	Implement various advanced queries execution using relational constraints, joins, set operations, aggregate function etc.
CO4	Apply PL/SQL objects (functions, cursors, triggers etc.) for solving real life database problems.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	1	-	-	-	2	-
CO2	3	1	2	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-
CO4	3	2	2	-	-	-	1	-

Syllabus

Basics of SQL - Built in SQL functions: Create, Insert, Update. Operations – relational, logical, String operations and Aggregate Functions.
Alter – Joins – Types of Joins - Set operations, Sub Queries: Single row/ multiple row Sub queries -DCL – TCL Commands - Views – Sequences - Index and Locks
PL/SQL – Basic operations - Exceptions – Stored Functions and Triggers

Textbooks

Fundamentals of Data Base Management System, Mark Gillenson 3rd edition.

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

26CSA185	USER INTERFACE DESIGN	L-T-P-C: 0-0-2-1

Course Objective(s)

- To familiarize the fundamental concepts of UI design with their importance
- To introduce the tools for desgining user interface

Course Outcomes

COs	Description
CO1	Integrate UI design principles and tools to create a user-centric design.
CO2	Designing user interfaces (UI) involves using various design tools to create a visually appealing and functional design.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	3	1	-	1	2
CO2	-	-	-	3	2	-	1	2

Syllabus

Unit I

Fundamentals of User Interface Design

Introduction to User Interface (UI) Design - Definition and importance of user interface design, Evolution of user interfaces. Principles of UI Design - Clarity, efficiency, and usability, Visual hierarchy, and layout. Design Thinking - Understandingdesign thinking process, Empathy, and user-centered design. Tools and Technologies - Overview of UI design tools (Sketch,Adobe XD, Figma), Introduction to basic HTML and CSS for prototyping

Unit II

Practical Application of UI Design

Prototyping - Building wireframes and mockups, Interactive prototypes using tools like Figma or Adobe XD. User Researchand Testing - Techniques for user research, Conducting usability testing, and interpreting feedback. UI Design Standards and Guidelines - Accessibility standards, Responsive design principles.

Textbooks:

1. "Designing Interfaces: Patterns for Effective Interaction Design" by Jenifer Tidwell

References:

1. "Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability" by Steve Krug
2. "The Design of Everyday Things" by Don Norman
3. "About Face: The Essentials of Interaction Design" by Alan Cooper

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

SEMESTER III

26CSA201	DATA STRUCTURES	L-T-P-C:3-1-0-4

Course Objective(s)

- Understand the concept and importance of organizing data using appropriate data structures.
- Develop the ability to analyze and select suitable data structures for solving computational problems.
- Enable students to design and implement abstract data types (ADTs) and their operations.
- Build competence in applying linear and non-linear data structures for problem solving.

Course Outcomes

COs	Description
CO1	**Analyze** data handling requirements and classify problems based on appropriate data structure selection
CO2	**Design** abstract data types (ADTs) and represent data using structured and dynamic data types
CO3	**Implement** linear data structures such as arrays, stacks, queues, and linked lists to solve problems
CO4	**Apply** non-linear data structures like trees and graphs in computational problem solving
CO5	**Evaluate** the efficiency and suitability of data structures for real-world applications

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	2	2	0	0	0	1
CO2	3	2	3	2	0	0	0	1
CO3	3	2	3	2	0	0	0	1
CO4	2	2	3	2	0	0	0	1
CO5	2	3	2	2	0	0	1	2

Syllabus

Unit I: Introduction and Definition of Data Structure, Classification of Data Structures: Primitive and Non-primitive data structures. Linear and Non-linear data structures, Abstract Data Type (ADT). Introduction to implementation issues

Unit II: Enumerated, Structure, and Union Types– The Type Definition (typedef), Enumerated types, Structures – Declaration, initialization, accessing structures, operations on structures, structures, and functions, Passing structures through pointers. Introduction to Union

Unit III: Array ADT, Types of Arrays: 1-D, 2-D, and multi-dimension. Applications of Arrays: Linear Search, Binary Search and itsanalysis. Sorting: Bubble Sort, Insertion Sort, Selection Sort, and its analysis. Linked List, List as an ADT Types of LinkedList, and insertion and deletion operations of linked list: Singly, Circular, and Doubly.

Unit IV: Stacks ADT, Operations on Stack: Push, Pop, and Traversing. Applications of Stack: Expression conversion, PostfixEvaluation, Recursion: Tower of Hanoi, Merge Sort, Quick Sort. Analysis of Recursive Algorithms using Back Substitution and Masters Method. Queue ADT, Operations on Queue: Insertion, Deletion, and Traversing. Circular Queue.

Unit V: Graphs ADT, basic terminologies, types of graphs. Graph Representation: Adjacency Matrix, Incidence Matrix, AdjacencyList. Tree ADT, Basic Terminologies, Binary tree properties, Tree Traversal: Pre-order, In-order, and Postorder.

Textbooks

1. E. Horowitz & Sahni, Fundamental Data Structure, Galgotia Book Source, 1983.
2. A. Tannenbaum, Data Structure Using C, Pearson Education, 2003.

References

Classic Data Structures by D. Samanta, Second Edition.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA202	OPERATING SYSTEM	L-T-P-C: 3-0-0-3

Course Objective(s)

- Outlines the basic principles of Operating System.
- Implementation of the Process Management and CPU scheduling algorithms.
- Demonstrates the importance of Deadlock and its characterization.
- Articulates the need for memory management, page replacement algorithms, and File system interface.

Course Outcomes

COs	Description
CO1	Demonstrate the principles of Operating System, calls, services, and System programs.
CO2	Ability to apply different types of Scheduling algorithms and their evaluation.
CO3	Analyze the importance of Deadlock and its characterization.
CO4	Implement the concepts of Memory management, page replacement algorithms, and File system interface

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1	1	1	-	-	1	1
CO2	3	3	3	3	-	-	2	1
CO3	1	1	2	2	-	-	2	1
CO4	3	3	3	3	-	-	3	1

Syllabus

Unit I

Introduction to Operating Systems- Operating System Structures-Operating System Services-System Calls-System Programs- Operating Systems Generations

Unit II

Process Management- Process concepts, process states, process control block, Operations on processes, CPU Scheduling-Scheduling Criteria- scheduling algorithms and their Evaluation

Unit III

Deadlocks: System Model-Deadlock Characterization-Methods for handling Deadlocks-Deadlock Prevention- Deadlock Avoidance-Deadlock Detection-Recovery from deadlock

Unit IV

Memory Management: Background – Swapping – Contiguous memory allocation – Paging – Segmentation – Virtual Memory: Background – Demand paging- Page replacement algorithms.
File system interface- File Concept, Access Methods, Directory Structure, File System Structure, Allocation Methods, and Free-Space Management.

Textbooks

Silberschatz, Galvin, and Gagne, “Operating System Concepts”, 9th Edition, Wiley India Pvt Ltd, 2014.

References

1. Andrew S. Tanenbaum, “Modern Operating Systems”, 4th Edition, Pearson Education / PHI 2001.
2. Gary Nutt, “Operating Systems”, Third Edition, Pearson Education, 2009
3. Harvey M. Deital, “Operating Systems”, Third Edition, Pearson Education, 2004

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA203	INTRODUCTION TO PYTHON	L-T-P-C: 3-0-0-3

Course Objective(s)

- Introduce the fundamentals of Python programming as a high-level, versatile language.
- Enable students to analyze problems and design Python-based solutions using structured programming constructs.
- Develop skills in implementing programs using Python data types, control structures, and functions.
- Familiarize students with Python libraries and programming paradigms relevant to modern computing.

Course Outcomes

COs	Description
CO1	**Analyze** problem statements and model solutions using Python programming constructs
CO2	**Design** Python programs using appropriate data types, control structures, and functions
CO3	**Implement** modular Python programs using built-in data structures and standard libraries
CO4	**Evaluate** Python programs by debugging, testing, and improving code efficiency
CO5	**Apply** Python programming knowledge to independently learn advanced technologies and tools

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	0	0	0	1
CO2	3	3	3	2	0	0	0	1
CO3	3	2	3	2	0	0	0	1
CO4	2	3	2	2	0	0	1	1
CO5	2	1	2	2	0	0	0	3

Syllabus

Unit I

Introduction to Python Programming. Overview of Python. Features and applications of Python. Python programming environment. Basic syntax and indentation. Variables and keywords. Input and output statements

Unit II

Data Types and Operators. Built-in data types: int, float, string, and Boolean. Type casting and dynamic typing. Operators: Arithmetic, Relational, Logical, Assignment. Expressions and evaluation.

Unit III

Control Structures. Conditional statements: if, if-else, elif. Iterative statements: for loop, while loop. Loop control: break, continue, pass. Nested control structures.

Unit IV

Functions: Function definition and invocation. Parameters and return values. Scope of variables. Built-in data structures: Lists, Tuples, Sets, Dictionaries. Basic operations and applications.

Unit V

Introduction to Python modules. Importing built-in and user-defined modules. Overview of Python standard libraries. File handling: Reading and writing text files. Basic exception handling. Introduction to Python applications in modern computing.

Textbooks

1. "Python Crash Course, 2nd Edition: A Hands-On, Project-Based Introduction to Programming" Author: Eric MatthesPublisher: No Starch Press Year: 2019 ISBN-13: 978-1593279288
2. "Automate the Boring Stuff with Python: Practical Programming for Total Beginners" Author: Al Sweigart Publisher:No Starch Press Year: 2019 ISBN-13: 978-1593275990
3. "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, 2nd Edition" Author: Wes McKinney Publisher: O'Reilly Media Year: 2017 ISBN-13: 978-1491957660

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA204	WEB TECHNOLOGIES	L-T-P-C: 2-0-2-3

Course Objective(s)

- To understand the concepts and techniques underlying website creation with HTML, CSS.
- To create client scripting with JavaScript using loops and control statements.
- Able to create singe page web development applications in Angular JS and Server scripting.
- To create database applications with PHP and MYSQL.

Course Outcomes

COs	Description
CO1	Design basic web applications using HTML and CSS
CO2	Create interactive web applications using latest web technologies using JavaScript
CO3	Building single web page applications using various input methods
CO4	Database usage with interactive web applications using PHP and MYSQL

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	3	1	1	-	-	-
CO2	3	2	3	1	2	-	-	1
CO3	3	2	3	1	2	-	-	1
CO4	3	2	3	1	3	-	-	1

Syllabus

Unit I

HTML5 and CSS3: HTML5- Basic Tags, Tables, Forms.HTML5 Tags, HTML Graphics, HTML media, HTML Graphics,HTML, APIs.
CSS - Background, Borders, margin, Box model. Styling text, fonts, list, links, tables. CSS overflow, float, inline blocks, pseudo-classes, pseudo-elements. CSS border images, rounded corners.

Unit II

JavaScript - Client-side scripting using java script, Introduction to JavaScript, internal and external JavaScript files, variables, control statements, loops, Arrays, string handling, functions in JavaScript, inputting, and outputting from form elements to JavaScript. DOM concept, creating html elements using java script. Drawing 2D shapes, handling events. Introduction to AJAX

Unit III

Building Single page applications with Angular JS. Single page application – introduction, two-way data binding, MVC inangular JS, controllers, getting user inputs, loops, Client-side routing – accessing URL data, diverse ways to provide data in angular JS.

Unit IV

Server-side scripting, Difference between client side and server-side scripting languages. Introduction to PHP, variables, control statements, loops, Arrays, string handling, PHP forms, Global variables in PHP, Regular expression and pattern matching, Database programming: inputting and outputting data from MySQL using PHP, insertion, deletion and updating data.
State management in web applications, cookies, Application, and session state.

Lab Syllabus:

1. HTML5 Basics

- Create basic HTML pages
- Use headings, paragraphs, lists, images
- Internal & external CSS linking

2. HTML5 Tables, Forms & Media

- Create tables (row/column span)
- Build HTML forms
- Embed audio & video
- Basic canvas usage

3. HTML5 Semantic Tags & APIs

- Use semantic tags (header, section, etc.)
- Work with HTML5 APIs (local storage, geolocation – demo)
- Draw shapes using Canvas

4. CSS3 Fundamentals

- Apply selectors, classes, IDs
- Box model, borders, backgrounds
- Font & text styling

5. Advanced CSS3

- Style lists, tables, links
- Use floats, inline-block
- Apply pseudo-classes & pseudo-elements
- Rounded corners, border images
- Simple webpage layout

6. JavaScript Basics

- Internal & external JS
- Variables, datatypes, operators
- If/else & loops
- Taking input from user

7. JavaScript Arrays, Strings & Functions

- Array operations
- String handling
- User-defined functions
- Form validation
- DOM basics

8. DOM Programming & Events

- Creating & removing HTML elements using JS
- Accessing DOM elements
- Event handling (onclick, mouseover, etc.)
- 2D drawing with Canvas API

9. AJAX Introduction

- Asynchronous requests
- Updating webpage without reloading
- Simple AJAX form submission
- Handling JSON responses

10. AngularJS Basics

- AngularJS module creation
- Controllers
- Two-way data binding
- Directives (ng-model, ng-repeat)

11. AngularJS Routing & User Input

- Forms using AngularJS
- Handling user inputs
- Client-side routing
- Accessing URL parameters

12. PHP Basics (Server-Side Scripting)

- PHP syntax
- Variables, conditional statements, loops
- Arrays & string functions
- Handling form data with PHP ($_POST, $_GET)

13. PHP–MySQL Database Integration

- Connect PHP to MySQL
- Execute CRUD operations:
- Insert
- Update
- Delete
- Select
- Display DB results in HTML

14. State Management in Web Apps

- Cookies
- Sessions
- Simple login session handling

Textbooks:

1. The Complete Reference, HTML and CSS by Thomas A Powell latest edition

References:

1. XML: The Complete Reference Heather Williamson latest edition
2. Web Reference: w3schools.com

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA205 COMPUTER NETWORKS L-T-P-C: 3-0-2-4

Course Objective(s)

- Build an understanding of the fundamental concepts of computer networking.
- Familiarize the student with the basic taxonomy and terminology of the computer networking area.
- Students will be able to gain expertise in some specific areas of networking such as the design and maintenance of individual networks.

Course Outcomes

COs	Description
CO1	Analyze the services of OSI, TCP/IP model and design of network topologies
CO2	Develop error control, correction and error detection methods for data transmission
CO3	Implement networking protocols and technologies in practical network scenarios.
CO4	Apply knowledge of the transport and application layer to design and implement network applications.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	3	-	-		-	1
CO2	2	3	3	1	-	-	-	2
CO3	2	2	3	2	-	-	-	1
CO4	2	2	3	2	-	-	-	2

SyllabusUnit I

Evolution of Computer Networking - Types of Networks - networks topologies - Protocols Standards, World Wide Web

Network Devices-The OSI reference model- TCP/IP Reference Model. Physical Layer: transmission media- Analog Transmission- Digital transmission

Unit II

Data Link Layer Design Issues-Services provided to the Network Layer-Framing-Error Control-Flow Control- Error Detection and Correction- Elementary Data Link Protocols- Sliding Window Protocols- Multiple Access Protocols, MAC Address.

Unit III

Introduction to Network Layer – Services - Circuit Switching Vs Packet Switching-Packet Switched Networks-Types of Routing-routing algorithms- congestion control algorithms- Network Protocols-IP- IPV4, IPV6, Subnets, Gateways- Congestion Avoidance in Network Layer.

Unit IV

The Transport Services – Services provided to the upper layers –Elements of transport Protocols –Internet Transport Protocols- Congestion Controls in Transport Layer, Application Layer: Domain Name System, and Hyper Text TransferProtocol, Electronic mail, File Transfer Protocol, Remote login.

Lab syllabus

- Networking Commands & Basics — ping, traceroute, arp, ipconfig/ifconfig, netstat, nslookup, route; intro to WWW and protocols.
- Packet Sniffing with Wireshark — Capture & analyze Ethernet, ARP, IP, ICMP, TCP, UDP; observe 3-way handshake and DNS lookup.
- Topologies & Devices (Simulator) — Build bus/star/ring in Packet Tracer; hub vs switch vs router behavior.
- Physical Layer & Media — Compare UTP/STP/coax/fiber; attenuation/bandwidth demo; encoding overview (NRZ/Manchester).
- Framing Techniques (Code) — Implement character count, byte stuffing, and bit stuffing.
- Error Detection & Correction (Code) — CRC-16/32, Internet checksum, Hamming(7,4)/(12,8) with single-bit error correction.
- Flow Control Protocols (Sim/Code) — Stop-and-Wait; Sliding Window: Go-Back-N & Selective Repeat with timing diagrams.
- MAC Protocols (Sim) — CSMA/CD, CSMA/CA, token passing; collision/backoff observation.
- Routing Algorithms (Code) — Dijkstra (link-state) & Distance Vector; compute shortest paths and convergence behavior.
- IP Addressing & Subnetting — Design subnets/VLSM for a campus; subnet masks, gateways, route summarization.

- Router Config: Static & Dynamic (Simulator) — Static routes, RIP v2, OSPF single area; verify with show ip route/pings.
- IPv6 Configuration — Global/link-local, SLAAC, dual stack; simple inter-VLAN + routing verification.
- Congestion Control (Sim/Trace) — Leaky/Token Bucket, RED/WRED concepts; observe TCP throughput under loss/latency.
- Socket Programming — TCP and UDP client/server; file transfer over TCP; measure RTT/throughput.
- Application Layer Protocols — DNS (nslookup/dig), HTTP (requests, headers), SMTP/IMAP/POP3 (telnet demo), FTP & SSH.

Textbooks / References

1. Computer Networks (Fifth Edition) – Andrew S. Tanenbaum (Prentice Hall of India)
2. Computer Networking a Top-Down Approach (Fifth Edition)-James F. Kurose-Keith W. Ross (Pearson)
3. Computer Networks - Protocols, Standards and Interfaces (Second Edition) – Uyless Black (Prentice Hall of India Pvt.Ltd.)
4. Data communication and Networking (Fourth Edition)- Behrouz A Forouzan (Tata Mcgraw Hill)

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA281	DATA STRUCTURES LAB	L-T-P-C: 0-0-2-1

Course Objective(s)

- To gain knowledge about the fundamental concepts of algorithms, flowcharts, and performance analysis of the algorithms.
- To comprehensively understand different types of data structures used for problem-solving**.**

Course Outcomes

COs	**Description**
CO1	Devise algorithms using structures and unions
CO2	Utilization of both static and dynamic data structures in the design of algorithms
CO3	Implementing stack and queue data structures for various applications
CO4	Implement the concepts of non-linear data structures like graphs and trees to solve real-time problems

CO-PO Mapping

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO								
CO1	3	3	3	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-
CO4	3	3	3	-	-	-	-	-

Lab Cycle:

1. Write a program to demonstrate linear search and perform the analysis.
2. Write a program to demonstrate structures.
3. Write a program to demonstrate unions.
4. Write a program to demonstrate structures and functions with pointers.
5. Write a program to illustrate a 1D array.
6. Write a program to illustrate a 2D array.
7. Write an algorithm to perform binary search and perform the comparison of linear and binary search.
8. Write an interactive program to perform sorting algorithms – Bubble sort, Insertion sort, Selection Sort, and its analysis.
9. Write an interactive program to illustrate insertion and deletion operations on a singly linked list.
10. Write an interactive program to illustrate insertion and deletion operations on a circular linked list.
11. Write an interactive program to illustrate insertion and deletion operations on a doubly linked list.
12. Write a program to illustrate stack operations.
13. Write a program to perform infix to postfix conversion.
14. Write a program to perform postfix evaluation.
15. Write a program to perform Merge sort.
16. Write a program to perform Quick sort.
17. Write a program to operate on a queue.
18. Write a program to perform operations on a circular queue.
19. Write a program to represent the graph using an adjacency matrix.
20. Write a program to represent the graph using an adjacency list.
21. Write an interactive program to perform binary tree traversal – Pre-order, In-order and Post-order.

Textbooks:

1. E. Horowitz & Sahni, Fundamental Data Structure, Galgotia Book Source, 1983.
2. A. Tannenbaum, Data Structure Using C, Pearson Education, 2003.

References:

Classic Data Structures by D. Samanta, Second Edition.

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

26CSA282	PYTHON PROGRAMMING LAB	L-T-P-C: 0-0-2-1

Course Objective(s)

- Gain hands-on experience in writing and executing Python programs.
- Translate algorithmic and problem-solving concepts into Python implementations.
- Develop the ability to design and implement modular programs using Python functions and data structures.
- Acquire proficiency in debugging, testing, and validating Python programs.

Course Outcomes

COs	Description
CO1	**Analyze** problem statements and design Python-based solutions
CO2	**Implement** Python programs using control structures and built-in data types
CO3	**Develop** modular Python programs using functions and data structures
CO4	**Test and evaluate** Python programs for correctness and efficiency
CO5	**Apply** Python programming skills to learn advanced tools and technologies independently

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	0	0	0	1
CO2	3	2	3	2	0	0	0	1
CO3	3	2	3	3	0	0	0	1
CO4	2	3	2	2	0	0	1	1
CO5	2	1	2	3	0	0	0	3

Syllabus

- Introduction to Python environment, IDE, and basic program execution
- Python syntax, variables, input/output programs
- Programs using operators and expressions
- Conditional statements (if, if-else, elif)
- Iterative constructs (for and while loops)
- Nested loops and control statements
- Lists and list operations
- Tuples, sets, and dictionary operations
- Functions—definition, parameters, return values
- Modular programming using functions
- String processing and applications
- File handling—reading and writing files
- Exception handling and error management
- Mini problem / case study using Python

Textbooks

1. "Python Crash Course, 2nd Edition: A Hands-On, Project-Based Introduction to Programming" Author: Eric Matthes Publisher: No Starch Press Year: 2019 ISBN-13: 978-1593279288
2. "Automate the Boring Stuff with Python: Practical Programming for Total Beginners" Author: Al Sweigart Publisher: No Starch Press Year: 2019 ISBN-13: 978-1593275990
3. "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, 2nd Edition" Author: Wes McKinney Publisher: O'Reilly Media Year: 2017 ISBN-13: 978-1491957660

References

1. "Introduction to Computation and Programming Using Python: With Application to Understanding Data, 2nd Edition"Author: John V. Guttag Publisher: The MIT Press Year: 2016 ISBN-13: 978-0262529624

"Learning Python, 5th Edition" Author: Mark Lutz Publisher: O'Reilly Media Year: 2013 ISBN-13: 978-1449355739

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

SEMESTER IV

26CSA211	FULL STACK FRAMEWORKS	L-T-P-C: 3-0-0-3

Course Objective(s)

1. Explain the foundational concepts of web development and the MEARN stack, comprising MongoDB, Express.js, React.js, and Node.js.
2. Describe the significance of RESTful APIs (Application Programming Interfaces) and illustrate their construction using Node.js and Express.js to facilitate communication between front-end and back-end systems.
3. Evaluate and discuss CRUD (Create, Read, Update, Delete) operations, and demonstrate their implementation using MongoDB as the primary database management system.
4. Discuss and apply industry best practices in software development, emphasizing code modularity, scalability, and error handling techniques, to conceptualize and design robust and maintainable full stack applications.

Course Outcomes

COs	Description
CO1	Apply fundamental concepts of HTML, CSS, and JavaScript to design interactive and visually appealing web interfaces.
CO2	Create single-page applications (SPAs) utilizing React.js to ensure efficient client-side rendering.
CO3	Manage HTTP requests and responses proficiently using Node.js for server-side scripting and backend development.
CO4	Construct RESTful APIs employing Express.js to develop robust backend services.
CO5	Execute CRUD operations and efficiently handle data persistence by integrating MongoDB into MEARN stack applications.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	1	2	1	2	-	-	2	3
CO2	1	2	1	2	-	-	-	3
CO3	1	2	1	2	-	-	-	3
CO4	1	2	1	2	-	-	-	3
CO5	1	2	1	2	-	-	-	3

SyllabusUnit I

Introduction to MERN Stack Introduction to Web Development Overview of MERN Stack, Setting up Development
Environment, Basics of HTML, CSS, and JavaScript Introduction to MongoDB

Unit II

Introduction to React.js, JSX Syntax and Components, State Management with Hooks, Routing and Navigation, HandlingForms and User Input

Unit III

Introduction to Node.js and npm, Building RESTful APIs with Express.js
CRUD Operations with MongoDB and Mongoose, Authentication and Authorization, Deployment and Hosting Option

Unit IV

Introduction to Express.js, Setting Up a Server, Routing and Middleware, Request and Response Handling, Error Handling and Debugging Techniques

Unit V

Introduction to MongoDB, Basic CRUD Operations, Data Modeling with MongoDB, Aggregation Framework, Indexingand Performance Optimization

Text Books:

1. "Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node" by Vasan Subramanian
2. Simon Holmes, "Getting MEAN with Mongo, Express, Angular, and Node, Second Edition, Manning Publications;

1edition (31 October 2015)

References:

1. Jeff Dickey, “Write Modern Web Apps with Mean Stack, Peachpitpress, 015
2. Ken Williamson, “Learning Angular JS”, O′Reilly; 1 edition (24 March 015)
3.MithunSatheesh, “Web development with MongoDBand Node JS”, Packt Publishing Limited; 2nd Revised edition (30October 2015).

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA212	SOFTWARE ENGINEERING & UML	L-T-P-C: 2-0-2-3

Course Objective(s)

- Understand the principles, processes, and methodologies involved in software development.
- Analyze customer requirements and convert them into structured software specifications.
- Design software systems using Unified Modeling Language (UML) diagrams.
- Apply modern software engineering tools and practices throughout the software life cycle.
- Develop awareness of professional ethics, teamwork, and project practices in software projects.

Course Outcomes

COs	Description
CO1	**Analyze** software requirements and formulate problem statements using standard software engineering practices
CO2	**Design** software architectures and detailed models using appropriate UML diagrams
CO3	**Apply** suitable software development life cycle models and agile practices for project execution
CO4	**Evaluate** software quality using verification, validation, and testing concepts
CO5	**Demonstrate** ethical responsibility, teamwork, and adaptability in software development activities

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	3	2	2	0	0	0	1
CO2	2	3	3	3	1	0	0	1
CO3	1	2	3	2	2	1	0	1
CO4	1	3	2	2	1	0	2	1
CO5	0	1	1	1	3	2	3	2

Syllabus

Unit I

Introduction to Software Engineering. Software and Software Engineering concepts. Software characteristics and challenges. Software Development Life Cycle (SDLC). Generic process framework. Software engineering ethics and professionalism.

Unit II

Software Process Models. Waterfall model. Incremental and Iterative models. Spiral model. Agile methodologies – Scrum overview. Comparison of process models.

Unit III

Requirements Engineering. User requirements vs system requirements. Functional and non-functional requirements. Requirements elicitation techniques. Software Requirement Specification (SRS). Requirement validation and management.

Unit IV

Software Design and UML. Introduction to design concepts. Architectural design. UML fundamentals
UML diagrams: Use Case diagram, Class diagram, Sequence diagram, Activity diagram.

Unit V

Software quality concepts. Verification and Validation. Levels of testing. Testing techniques (black-box and white-box overview). Introduction to software maintenance

Lab Syllabus

- CASE tool / UML tool introduction
- Problem identification and requirement analysis
- Preparation of Software Requirement Specification (SRS)
- Use Case modeling using UML
- Class diagram design

- Sequence diagram modeling
- Activity diagram modeling
- Architecture modeling
- Agile artifacts – user stories and backlog
- Software design review and documentation
- Test case design
- Verification and validation exercises
- Mini project – requirement to design
- Mini project – UML evaluation

Text Books:

1. Software Engineering: A Practitioner's Approach, 8th Edition, by Roger S. Pressman and Bruce R. Maxim. McGraw-Hill Education, 2015.
2. Software Engineering, by Ian Sommerville. 10th Edition, Pearson Education, 2016.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA213	FUNDAMENTALS OF AI	L-T-P-C: 3-0-0-3

Course Objective(s)

- Familiarize the basic concepts, principles, and techniques of artificial intelligence.
- Identify the various features of AI, further studies in AI-related fields or for careers in industries where AI technologies are increasingly prevalent.

Course Outcomes

COs	Description
CO1	Exhibit a comprehensive comprehension of the fundamental principles, theories, and frameworks thatform the basis of artificial intelligence.
CO2	Expertise in the implementation and application of an extensive array of AI methodologies, including machine learning algorithms & search techniques.
CO3	Acquire robust analytic and evaluative proficiencies in order to assess AI models and systems withregard to their performance, limitations, and ethical ramifications; this includes taking into accountfairness, transparency and bias.
CO4	Appraise the practical experience by actively participating in AI projects during the course and implementing acquired knowledge and skills to create viable solutions, conduct data analysis, andinterpret outcomes.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	1	1	-	-	-	1
CO2	3	3	-	1	-	-	-	1
CO3	3	-	-	1	-	-	-	1
CO4	3	1	-	1	-	-	-	1

Syllabus

Unit I: AI problems, the foundation of AI and history of AI intelligent agents: Agents and Environments, Strategies - Control Strategy - State, Space, Search, - Stages of AI - Tasks in AI - AI Problem formulation with assumptions.

Unit II: Searching for solutions - Tic-Toc-Toe - Uniformed search strategies - Breadth-first search - Depth-first Search - Search with
partial information (Heuristic search) Hill climbing - A* - AO* - Means-End Analysis

Unit III: Knowledge representation issues - predicate logic - logic programming, semantic nets - frames and inheritance - Constraint propagation - Representing knowledge using rules - Rules-based deduction systems. Reasoning under uncertainty - Review of probability in AI - Baye's probabilistic - Maximum Likelihood Estimation - Interferences and Dempstershafer theory.

Unit IV: First-order logic - Resolution method - Inference in first-order logic - Propositional knowledge vs. first-order inference - Unification & lifts - Forward chaining - Backward chaining - Resolution - Learning from observation Inductive learning Classification: Decision trees - Explanation-based learning - Statistical Learning methods - Reinforcement Learning, fundamentals of neural networks.

Textbooks:

1. Artificial Intelligence (Second Edition) – Elaine Rich, Kevin knight (Tata McGraw-Hill)

References:

1. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", SecondEdition, Pearson Education
2. David Poole, Alan Mackworth, Randy Goebel, "Computational Intelligence: a logical approach", Oxford University Press.
3. G. Luger, "Artificial Intelligence: Structures and Strategies for complex problemsolving", Fourth Edition, PearsonEducation.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA283	FULL STACK FRAMEWORKS LAB	L-T-P-C: 0-0-2-1

Course Objective(s)

1. Understand the foundational concepts of web development and the MEARN stack, including MongoDB, Express.js, React.js, and Node.js.
2. Construct RESTful APIs (Application Programming Interfaces) using Node.js and Express.js for seamless communication between front-end and back-end.
3. Analyze and implement CRUD (Create, Read, Update, Delete) operations using MongoDB as the database managementsystem.
4. Apply best practices in software development, including code modularity, scalability, and error handling, to create robust and maintainable full stack applications.

Course Outcomes

COs	Description
CO1	Implement fundamental concepts of HTML, CSS, and JavaScript to create interactive and visually appealing web interfaces.
CO2	Develop single-page applications (SPAs) using React.js for efficient client-side rendering.
CO3	Handle HTTP requests and responses using Node.js for server-side scripting and backend development.
CO4	Construct RESTful APIs using Express.js for building robust backend services.
CO5	Perform CRUD operations and manage data persistence efficiently by integrating MongoDB intoMEAN stack applications.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	1	2	1	2	-	-	-	3
CO2	1	2	1	2	-	-	-	3
CO3	1	2	1	2	-	-	-	3
CO4	1	2	1	2	-	-	-	3
CO5	1	2	1	2	-	-	-	3

Syllabus

Unit 1: Basics of Web Development

1. Create a simple webpage layout that includes a header, a navigation bar, a main content area with two columns, anda footer.
2. Apply basic CSS styling to make the webpage visually appealing, including background colors, font styles, andmargins.
3. Write a JavaScript function to validate a contact form. Ensure that the name, email, and message fields are not emptybefore allowing form submission. Display error messages if any field is left blank.
4. Create an HTML table with headers for each column and populate it with sample data. Use attributes like colspan and rowspan to merge cells for more complex layouts.

Unit 2: React.js Lab Programs

1. Set up a React.js project using Create React App.
2. Create functional and class based React components for a simple UI.
3. Implement state management using React's useState and useContext hooks.
4. Integrate React Router for client-side routing in a React.js application.
5. Fetch data from a RESTful API and display it dynamically in a React.js application

Unit 3: Node.js Lab Programs

1. Create a simple HTTP server using Node.js.
2. Implement basic file I/O operations (read/write) using Node.js fs module.
3. Implement a program to read the query string using Node JS(Using URL Module)
4. Set up routing and request handling using the built-in HTTP module in Node.js.
5. Implement email service using NodeJS nodemailer service**.**
6. Integrate third-party APIs (e.g., weather API) into a Node.js application

Unit 4: **Express.js Lab Programs**

1. Set up an Express.js project structure with routing.
2. Create RESTful APIs for a simple to-do list application using Express.js.
3. Implement middleware functions for authentication and error handling in an Express.js application.
4. Integrate Express.js with MongoDB using Mongoose for CRUD operations.

Unit 5: MongoDB Lab Programs

1. Install MongoDB and set up a local database server.
2. Create a MongoDB database and define collections.
3. Perform CRUD operations (Create, Read, Update, Delete) on MongoDB collections using the MongoDB shell.
4. Connect a Node.js application to MongoDB using the official MongoDB Node.js driver.
5. Implement basic data validation and schema definition using Mongoose in a Node.js application.

Textbooks:

1. https://www.sites.google.com/site/amritaevs/home
2. R. Rajagopalan, Environmental Studies: From Crisis to Cure. Oxford University Press, 2011, 358 pages. ISBN: 9780198072089.
3. Daniel D. Chiras, Environmental Science. Jones & Bartlett Publishers, 01-Feb-2012, 669 pages. ISBN: 9781449645311.

References:

1. Andy Jones, Michel Pimbert and Janice Jiggins, 2011. Virtuous Circles: Values, Systems, Sustainability. IIED and IUCN CEESP, London. URL:http://pubs.iied.org/pdfs/G03177.pdf
2. Annenberg Learner, The Habitable Planet, Annenberg Foundation 2015. URL: http://www.learner.org/courses/envsci/unit/pdfs/textbook.pdf

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

SEMESTER V

26CSA301 MOBILE APPLICATION DEVELOPMENT L-T-P-C: 0-1-2-2

Course Objective(s)

To make the student understand the basic concepts of mobile application development, be aware of the characteristics of mobile applications, User-interface design, and the basics of graphics and multimedia. To gain knowledge about the testing and publishing of mobile applications.

Course Outcomes

COs	Description
CO1	Demonstrate a foundational understanding of the Android development environment, tools, and basic programming concepts.
CO2	Design and implement user interfaces for iOS applications using essential UI components and event handling.
CO3	Design and implement user interfaces with activities, fragments, navigation drawers, and notifications in Android applications.
CO4	Utilize SQLite for data persistence in Android applications

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	3	3	-	1	-	-	1
CO2	2	3	3	-	1	-	-	1
CO3	2	3	3	-	2	-	-	1
CO4	2	3	3	1	2	-	2	1

Syllabus

Unit 1: Introduction

Overview of Android & iOS, Dalvik/ART runtime, APK structure & Android API levels, Introduction to Android Studio, Project structure, Gradle basics, Creating & running the first Android app

Unit 2: UI/UX

Views, Layouts, Input Controls, Drawable resources, Toasts and basic input events, Advanced UI components: ListView, GridView, Menus: options, context, sub-menus, Pickers (date/time), Spinners

Unit 3: Navigation and Notifications

Activities, Activity lifecycle, Fragments & Fragment lifecycle, Intents: explicit & implicit, Passing data between activities, Navigation Drawer (concepts + workflow), Notifications, Toast, Dialogs (Alert, Date, Time, Progress), Notification Manager, Push notification concept

Unit 4: Database

Introduction to SQLite database, SQLiteOpenHelper, Creating database & tables, CRUD operations using SQLite, Insert, Update, Delete, Select, Using Cursors, Using SQLite in simple apps.

Lab

1. Setting Up the Development Environment
2. Create a basic Android project in Android Studio
3. Write simple Java code to display a message on the screen
4. Run the app on an emulator and understand the debugging process
5. Experiment with different layout components like buttons, text fields, images, etc.
6. Build simple app screens using linear layouts and relative layouts
7. Implement layouts like Grid View and List View
8. Create menus (option menu, context menu)
9. Use pickers (date and time pickers) and spinners
10. Develop a simple app with multiple activities to understand the activity lifecycle
11. Introduce fragments and explore their lifecycle methods

12. Implement communication between activities using explicit and implicit intents
13. Integrate a navigation drawer into an app
14. Display simple notifications using Toast messages
15. Create dialogs with pickers (date/time) and progress bars
16. Explore push notifications (requires additional setup)
17. Set up a local SQLite database using SQLite Open Helper
18. Practice basic database operations: creating tables, inserting data, querying data, updating, and deleting data

Textbooks:

Head first Android Development.

References:

Android Programming: Pushing the Limits, Wiley By Erik Hellman
Android Application Development Black Book, Dreamtech Press, Pradeep Kothari, KLSI

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

26CSA302	ALGORITHMS	L-T-P-C:3-0-0-3

Course Objective(s)

- Introduce algorithmic thinking and problem-solving strategies.
- Develop the ability to analyze algorithm efficiency using complexity measures.
- Enable students to design algorithms using standard paradigms.
- Train students to evaluate and compare algorithms based on performance and applicability.

Course Outcomes

COs	Description
CO1	**Analyze** computational problems and express solutions using algorithms and flowcharts
CO2	**Evaluate** algorithms using time and space complexity and asymptotic notations
CO3	**Design** efficient algorithms using iterative and recursive approaches
CO4	**Apply** searching and sorting algorithms and compare their performance
CO5	**Assess** algorithmic strategies to select optimal solutions for given problems

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	2	2	0	0	0	1
CO2	3	3	2	2	0	0	0	1
CO3	2	3	3	2	0	0	0	1
CO4	2	2	3	2	0	0	0	1
CO5	2	3	2	2	0	0	1	2

Syllabus

Unit I

Algorithms vs Flowcharts, Characteristics of algorithms, Algorithm representation techniques, Time and Space Complexity Best, Average, and Worst-case analysis, Asymptotic Notations: Big-O, Big-Ω, Big-Θ.

Unit II

Algorithm analysis methodology. Analyzing iterative programs. Simple algorithm analysis examples. Comparative analysis of algorithms. Performance measurement techniques

Unit III

Introduction to recursion. Examples: Tower of Hanoi. Factorial, Fibonacci. Analysis of recursive algorithms. Back Substitution method. Master's Theorem. Divide and Conquer approach.

Unit IV

Searching algorithms: Linear Search (analysis), Binary Search (analysis). Sorting algorithms: Bubble Sort, Insertion Sort, Selection Sort, Merge Sort, Quick Sort. Comparative analysis of sorting algorithms.

Unit V

Brute Force technique. Divide and Conquer strategy. Greedy method (introductory examples). Limitations of algorithms and trade-offs.

Text Books

1. Analysis of Algorithms, Jeffrey J McConnel, Jones and Bartlett Publishers, Inc, 2nd Revised edition, 2 November 2007
2. Introduction to the Design and Analysis of Algorithms, Anany Levitin, Third Edition, Pearson Education, 2012
3. Introduction to Algorithms, Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, and Clifford Stein. Third Edition, Prentice-Hall of India Private Limited; 2009.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

23LSK201 LIFE SKILLS – I L-T-P-C: 1-0-2-2

Pre-requisite: An open mind and the urge for self-development, basic English language skills, knowledge of high school level mathematics.

Course Objective: To assist students in inculcating soft skills, developing a strong personality, empowering them to face life's challenges, improving their communication skills and problem-solving skills.

Course Outcomes

COs	Descriptions
CO1	**Soft Skills -** To develop greater morale and positive attitude to face, analyze, and manage emotions in real life situations, like placement process.
CO2	**Soft Skills -** To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews.
CO3	**Aptitude –** To analyze, understand and solve questions in arithmetic and algebra by employing the most suitable methods.
CO4	**Aptitude -** To investigate and apply suitable techniques to solve questions on logical reasoning.
CO5	**Verbal –** To infer the meaning of words & use them in the right context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.
CO6	**Verbal -** To identify the relationship between words using reasoning skills. To develop the capacity to communicate ideas effectively. **Skills:** Communication, self-confidence, emotional intelligence, presentation skills and problem-solving Skills.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	-	2	-	-	3
CO2	-	-	-	-	3	-	-	2
CO3	-	-	-	-	3	-	-	-
CO4	-	-	-	-	3	-	-	-
CO5	-	-	-	-	3	-	-	-
CO5	-	-	-	-	3	-	-	2

Syllabus

Soft Skills

Soft Skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. New-age challenges and distractions. Learning to benefit from constructive criticisms and feedback. Need for change in mindset and up-skilling to keep oneself competent in the professional world.

Managing Self: Knowing oneself, Self-perception, Importance of positive attitude, Building and displaying confidence, Avoiding being overconfident, Managing emotions, stress, fear. Developing Resilience and handling failures. Self-motivation, Self-learning, and continuous knowledge up-gradation / Life-long learning. Personal productivity - Goal setting and its importance in career planning, Self-discipline, Importance of values, ethics and integrity, Universal Human Values.

Communication: Process, Language Fluency, Non-verbal, Active listening. Assertiveness vs. aggressiveness. Barriers in communication. Digital communication

Aptitude

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.

Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.

Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership.

Averages: Basics, and Weighted Average.

Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.

Logical Reasoning I: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding \& Decoding, Cryptarithmetic Problems and Input - Output Reasoning.

Verbal Skills

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misused words, commonly confused words and wrong form of words in English.

Grammar (Basics): To learn the usage of grammar and facilitate students to identify errors and correct them.

Reasoning: Stress the importance of understanding the relationship between words through analogy questions. Emphasize the importance of avoiding the gap (assumption) in the argument/ statements/ communication.

Speaking Skills: Make students conscious of the relevance of effective communication in today's world through individual speaking activities.

Writing Skills: Introduce formal written communication and keep the students informed about the etiquette of email writing.

References:

1. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
2. The hard truth about Soft Skills, by Amazon Publication.
3. Verbal Skills Activity Book, CIR, AVVP
4. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
5. The BBC and British Council online resources
6. Owl Purdue University online teaching resources
7. www.thegrammarbook.com online teaching resources
8. www.englishpage.com online teaching resources and other useful websites
9. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
10. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
11. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
12. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
13. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
14. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
15. A Modern Approach to Logical Reasoning, R S Aggarwal.
16. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	**Internal**	**External**
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests.**

26CSA381	ALGORITHMS LAB	L-T-P-C:0-0-2-1

Course Objective(s)

- Provide hands-on experience in implementing standard algorithms.
- Enable students to analyze time and space complexity through practical experimentation.
- Develop skills in designing and comparing algorithmic solutions.
- Reinforce recursive and iterative problem-solving techniques.

Course Outcomes

COs	Description
CO1	**Implement** searching and sorting algorithms and analyze their performance
CO2	**Analyze** iterative and recursive algorithms using empirical and theoretical methods
CO3	**Design and implement** algorithms using standard design paradigms
CO4	**Evaluate** algorithm efficiency using asymptotic notation and complexity analysis
CO5	**Apply** algorithmic problem-solving skills to learn advanced computing techniques independently

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	3	2	0	0	0	1
CO2	3	3	2	2	0	0	0	1
CO3	2	3	3	2	1	0	0	1
CO4	3	3	2	2	0	0	1	1
CO5	2	1	2	2	0	0	0	3

Syllabus

- Introduction to algorithm lab environment and problem analysis
- Linear search and binary search – implementation and comparison
- Bubble sort – performance analysis
- Insertion sort and selection sort
- Comparative study of simple sorting algorithms
- Divide and conquer – merge sort
- Quick sort and performance comparison
- Recursion fundamentals – factorial, Fibonacci
- Tower of Hanoi – recursive analysis
- Analysis of iterative vs recursive algorithms
- Back substitution method for recurrence relations
- Master's theorem – practical validation
- Greedy algorithm (basic problems)
- Algorithm optimization case study

Text Books

1. Analysis of Algorithms, Jeffrey J McConnel, Jones and Bartlett Publishers, Inc, 2nd Revised edition, 2 November 2007
2. Introduction to the Design and Analysis of Algorithms, Anany Levitin, Third Edition, Pearson Education, 2012
3. Introduction to Algorithms, Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, and Clifford Stein. Third Edition, Prentice-Hall of India Private Limited; 2009.

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

26CSA303	COMPETITIVE PROGRAMMING	L-T-P-C:0-1-2-2

Course Objective(s)

- Develop strong algorithmic problem-solving skills through continuous practice.
- Apply efficient algorithms and data structures for solving time-constrained problems.
- Enhance the ability to analyze problem constraints and select optimal solutions.
- Familiarize students with online competitive programming platforms and tools.

Course Outcomes

COs	Description
CO1	**Analyze** problem statements to identify constraints and suitable algorithmic strategies
CO2	**Design** efficient algorithms for computational problems under time and space constraints
CO3	**Implement** optimized solutions using appropriate programming languages and techniques
CO4	**Evaluate** solution efficiency and correctness by testing against diverse input cases
CO5	**Demonstrate** independent learning and adaptability by solving progressively complex problems

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	0	0	0	1
CO2	2	3	3	2	0	0	0	1
CO3	3	2	3	2	0	0	0	1
CO4	2	3	2	2	0	0	0	1
CO5	2	1	2	2	0	0	0	3

Syllabus

Introduction to competitive programming and online judges, Input/output optimization and constraints handling Implementation of basic problem-solving patterns, Searching problems (binary search applications), Simple sorting-based problems, Mathematical and number-theory basics, Greedy strategy problems, Recursion and backtracking problems, Divide and conquer problem solving, Two-pointer and sliding window techniques, Basic dynamic programming problems, String-processing challenges, Timed contest / mock competition, Problem discussion and optimization techniques

Text Books

1. Competitive Programming 4, Volumes 1 & 2, Competitive Programming Community, 2020 by Steven Halim and Felix Halim.
2. Guide to Competitive Programming: Learning and Improving Algorithms Through Contests, by Antti Laaksonen. Springer, 2017.

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

26CSA396	MINOR PROJECT	4 Credits

Course Objectives

- The main objective of the Project is for the students to learn and experience all the major phases andprocesses involved in solving real-life problems.

Course Outcomes

The major outcome of the minor project must be well-trained students. More specifically, students must haveacquired the following skills:

COs	Description
CO1	Able to practice acquired knowledge within the chosen area of technology for project development.
CO2	Identify, discuss, and justify the technical aspects of the chosen project with a comprehensive andsystematic approach.
CO3	Reproduce, improve, and refine technical aspects for the projects.
CO4	Work as an individual or in a team in development of technical projects.
CO5	Communicate and report effectively project related activities and findings.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	-	2	3	1	3
CO2	1	2	2	-	2	1	3	2
CO3	2	2	3	3	2	3	2	3
CO4	1	2	2	-	3	1	2	2
CO5	-	-	-	-	3	-	3	-

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	60
End Semester Exam	40
Total Marks	100

SEMESTER VI

26CSA311	AUTOMATA THEORY AND COMPILER DESIGN	L-T-P-C: 3-1-0-4

Course Objective(s)

- Provide an overview of computer science theoretical foundations focusing on formal languages and Automata Theory.
- Introduce the role and importance of compilers in converting computer programs into executable formats.
- Cover the essential areas of computer science required for compiler design, including logic, formalism, mathematics, datastructures, algorithms, and programming.
- Outline the stages involved in the design of standard compilers, starting from front-end compilation to back-endprocesses.

Course Outcomes

COs	Description
CO1	To Demonstrate a comprehensive understanding of kinds of finite automata and their capabilities.
CO2	Design Finite Automata for different Regular Expressions and Languages, construct context-free grammar for various languages.
CO3	Develop stages of compilation, and lexical Analysis, compare different types of parsers (Bottom-up and Top-down) and construct a parser for a given grammar.
CO4	Perform analysis of syntax directed translation and representations of intermediate code, describe type checking.
CO5	Illustrate code optimization and code generation techniques in the compilation

CO-PO Mapping

PO								
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	2	3	3	-	1	-	-	2
CO2	2	3	3	-	1	-	-	2
CO3	2	3	3	-	1	-	-	1
CO4	2	3	3	-	1	-	-	1
CO5	2	3	3	-	1	-	-	1

SyllabusUnit I

Finite Automata (FA): Introduction, Deterministic Finite Automata (DFA) -Formal definition, simpler notations (state
transition diagram, transition table), the language of a DFA. Nondeterministic Finite Automata (NFA)- Definition of the FA, language of an NFA, Equivalence of Deterministic and Nondeterministic Finite Automata, Applications of Finite Automata, Minimization of Deterministic Finite Automata.

Unit II

Regular Expressions (RE): Introduction, Identities of Regular Expressions, Finite Automata and Regular Expressions- Converting from DFA's to Regular Expressions, Converting Regular Expressions to Automata, Context Free Grammar (CFG): Derivation Trees, Sentential Forms, Rightmost and Leftmost derivations of Strings.

Unit III

Introduction To Compilers: Definition of compiler, interpreter and its differences, the phases of a compiler, role of lexical analyzer, regular expressions, finite automata, from regular expressions to finite automata. Parsing: Parsing, the role the ofparser, context free grammar, derivations, parse trees, elimination of left recursion, left factoring, predictive parsers, LL(1)grammars. Bottom Up Parsing: Definition of bottom-up parsing, LR grammars, LR parsers-simple LR, canonical LR(CLR)and Look Ahead LR (LALR) parsers, error recovery in parsing, parsing ambiguous grammars.

Unit IV

Syntax Directed Translation: Syntax directed definition, construction of syntax trees, S-attributed and L-attributed definitions, translation schemes. Intermediate Code Generation: intermediate forms of source programs– abstract syntax tree, polish notation and three address code, Type Checking: Definition of type checking, type expressions, type systems.

Unit V

Code Optimization: Organization of code optimizer, basic blocks and flow graphs, optimization of basic blocks, the principal sources of optimization, the directed acyclic graph (DAG) representation of basic block, and global data flowanalysis. Code Generation: Machine dependent code generation, object code forms, the target machine, a simple code generator, register allocation and assignment, peephole optimization.

Textbooks:

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman (2007), Introduction to Automata Theory Languages and Computation, 3rdedition, Pearson Education, India.
2. Alfred V.Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, "Compilers: Principles, Techniques and Tools", Prentice Hall, Second Edition, 2006.

References:

1. Martin, John C., Introduction to Languages and the Theory of Computation, 3rd ed., Tata McGraw Hill Education Private Limited.
2. Keith Cooper and Linda Torczon, "Engineering a Compiler", Second Edition, Morgan Kauffmann, 2011.
3. Andrew W. Appel and Jens Palsberg, "Modern Compiler Implementation in Java", Cambridge University Press, Second Edition, 2002.
4. Tremblay and Sorenson, The Theory and Practice of Compiler Writing, Tata McGraw Hill & Company.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA399	MAJOR PROJECT	6 Credits

Course Objectives

- To allow students to develop their own ideas and get experienced in industrial and research projects.
- It provides an opportunity in solving a real-life problem by applying the knowledge gained through various courses of study and an exposure on different phases of software /system development life cycle.

Course Outcomes

The major outcome of the major project must be well-trained students. More specifically students must have acquired the following skills:

COs	Description
CO1	Able to practice acquired knowledge within the chosen area of technology for project development.
CO2	Identify, discuss, and justify the technical aspects of the chosen project with a comprehensive andsystematic approach.
CO3	Reproduce, improve, and refine technical aspects for the projects.
CO4	Work as an individual or in a team in development of technical projects.
CO5	Communicate and report effectively project related activities and findings.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	-	2	3	1	3
CO2	1	2	2	-	2	1	3	2
CO3	2	2	3	3	2	3	2	3
CO4	1	2	2	-	3	1	2	2
CO5	-	-	-	-	3	-	3	-

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	60
End Semester Exam	40
Total Marks	100

MATHEMATICS FOR COMPUTING

26MAT131	ALGEBRA AND NUMBER THEORY	L-T-P-C: 3-1-0-4

Course Objective(s)

- Understand the fundamentals of group theory.
- Familiarize yourself with the theorems of divisibility, congruence, Fermat and Wilson.
- Learn the concepts of vector spaces, linear transformations, eigen values, and eigen vectors.
- Learn to implement the concepts of eigen values, diagonalization, inner product space, orthogonality, projection, anddecomposition.

Course Outcomes

COs	Description
CO1	Develop the concepts of group theory.
CO2	Analyze divisibility theory, basic properties of congruences, and different theorems on modular algorithms.
CO3	Acquire the knowledge of vector spaces and subspaces to implement linear transformation rules.
CO4	Implement diagonalization using eigen values and vectors.
CO5	Apply the concept of inner product spaces, projection, and decomposition to determine orthogonality andreduce dimensionality.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	-	-	-	-	1
CO2	3	3	3	-	-	-	-	1
CO3	3	3	3	-	-	-	-	1
CO4	3	3	3	-	-	-	-	1
CO5	3	3	3	-	-	-	-	1

Syllabus

Unit I: Definition of Groups, Basic Examples - Symmetric Groups, Matrix Groups, Subgroups, Cyclic Group and Factor Groups; Normal Subgroups; Quotients of Groups; Homomorphisms, Automorphisms; Cayley’s Theorem, Permutation Groups.

Unit II: Divisibility theory and congruences: Division algorithm, Greatest Common Divisor, Euclidean algorithm, Extended Euclidean algorithm. Basic propertiesof congruences, Binary and decimal representation of integers, Linear congruences and Chinese Remainder Theorem. Fermat’s Theorem and its Generalization, Fermat’s Little theorem, Wilson’s theorem.

Unit III: Vector space - Vector spaces, Sub spaces, Linear independence, Basis, Dimension, Finite dimensional vector space, null and column space; Linear Transformations

Unit IV: Problems in Eigen Values and Eigen Vectors, Diagonalization, Orthogonal Diagonalization, Quadratic Forms, Diagonalizing Quadratic Forms.

Unit V: Inner Products, Angle and Orthogonality in Inner Product Spaces, Length of a Vector, Schwarz Inequality, Orthogonal Vectors, Orthogonal Complement, Orthogonal Bases: Gram-Schmidt Process; Decomposition-LU-Decompositions-The Power Method- QR method- SVD- Data Compression Using Singular Value Decomposition

Textbooks:

1. Gilbert Strang,’ Linear Algebra and its Applications, Fourth Edition, Cengage Learning, 2014
2. Howard Anton and Chris Rorres, ‘Elementary Linear Algebra’, 9th Edition, Wiley, 2005.
3. David M. Burton, Elementary Number Theory (7th edition), McGraw Hill Education (India)

References:

1. John B. Fraleigh, ‘A First Course in Abstract Algebra’, Narosa Publishing House, 2003.
2. Joseph A. Gallian, ‘Contemporary Abstract Algebra’, Cengage Learning, 2013.
3. David C. Lay, Linear Algebra and its Applications, Pearson

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26MAT132	MATHEMATICAL FOUNDATION	L-T-P-C: 3-1-0-4

Course Objective(s)

- Understand the preliminary concept of operation on sets and mathematical logic.
- Understand the fundamental aspects of number theory.
- Learn different types of matrices, their properties, and operations.
- Familiarize yourself with the fundamentals of differential equations.
- Familiarize yourself with the fundamentals of differential calculus.

Course Outcomes

COs	Description
CO1	Implement set theory, mathematical logic, and different types of statements.
CO2	Develop the concepts of number theory.
CO3	Apply various matrix operations and Caley Hamilton theorem on different types of matrices to determine the rank.
CO4	Apply the concept of separations of variables to determine first and second-order differential equations.
CO5	Develop the basic concepts of limits and derivatives.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	3	-	-	-	-	1
CO2	3	3	3	-	-	-	-	1
CO3	3	3	3	-	-	-	-	1
CO4	3	3	3	-	-	-	-	1
CO5	3	3	3	-	-	-	-	1

Syllabus

Unit 1: Basic concepts of set theory and operations on sets - Mathematical logic – statements – connectives - negation, conjunction, disjunction - conditional and bi-conditional statements –Truth tables - tautology – contradiction – equivalence law – Predicates, Quantifiers, & Arguments.

Unit 2: Matrix Algebra-Introduction-Types of matrices-matrix operations- transpose of a matrix -determinant of matrix - inverse of a matrix- Cramer's rule - normal form-echelon form- finding rank of a matrix -Cayley Hamilton theorem.

Unit 3: Number theory: Divisibility- Primality Testing. GCD- Properties of the Greatest Common Divisor- Euler's Theorem - Euclid's Algorithm-Extended Euclid's Algorithm. The Fundamental Theorem of Arithmetic. The Prime Number Theorem. Modular Arithmetic- Congruence - Arithmetic with a Prime Modulus- Multiplicative Inverses- Fermat's Little Theorem- Chinese Remainder Theorem.

Unit 4: Differential calculus - Functions and limits - Simple Differentiation of Algebraic Functions — Evaluation of First and Second Order Derivatives – Maxima and Minima

Unit 5: Differential Equations: Introduction to differential equations – Separation of Variables – First order differential equations - Second order constant coefficient homogeneous linear equations.

Textbooks:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw- Hill Publishing Company Limited, New Delhi, Sixth Edition, 2007.
2. P.R.Vittal-Business Mathematics and Statistics, Margham, Publications, Chennai.
3. Stewart 2015, CALCULUS: Early Transcendentals, 8th Edition, Cengage learning, India.

References:

1. Liu, "Elements of Discrete Mathematics", Tata McGraw- Hill Publishing Company Limited, 2004.
2. Gilbert Strang, "Linear Algebra and its Applications", Third Edition, Harcourt College Publishers, 1988.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26MAT133	ADVANCED MATHEMATICAL FOUNDATION	L-T-P-C: 3-1-0-4

Course Objective:

- Learn different types of relations, functions, and their properties.
- Familiarize yourself with the advanced counting techniques and graph theory.
- Understand the fundamentals of group theory.
- Learn to implement the concepts of linear transformation, eigenvalues, diagonalization, and inner product.

Course Outcomes:

COs	Description
CO1	Implement various relations, functions, and their properties.
CO2	Solve linear recurrence relations using the divide and conquer algorithm and inclusion-exclusion principle.
CO3	Determine the basic characteristics of graph theory and its real-life applications.
CO4	Develop the concepts of group theory.
CO5	Implement linear transformation rules and the concept of inner product.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	-	2	-	-	1
CO2	3	3	3	-	2	-	-	1
CO3	3	3	3	-	2	-	-	1
CO4	3	3	3	-	1	-	-	1
CO5	3	3	3	-	2	-	-	1

Syllabus:

Unit 1: Relations and Their Properties - Representing Relations, Closure of Relations, Partial Ordering, Equivalence Relations and partitions, Functions- definition, types, and composition.

Unit 2: Counting Techniques: Basic countings, Permutation and Combination – Advanced Countings, Recurrence Relations, Generating Functions, Solving linear homogeneous Recurrence Relations, Divide and Conquer algorithm, Inclusion-Exclusion.

Unit 3: Graph Theory - Graphs and subgraphs, isomorphism, matrices associated with graphs, degrees, walks, connected graphs, Euler and Hamilton Graphs: Graph coloring, shortest path algorithm, Chinese-postman problem, approximate solutions of traveling salesman problem.

Unit 4: Group theory: Binary Operations, Definition of Groups, Properties of Groups, Basic Examples, Subgroups, Cyclic Group, Lagrange's Theorem.

Unit 5: Linear Transformations: Reflection, Dilation, Shearing, Eigen values and vectors, Inner Products.

Textbooks:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw- Hill Publishing Company Limited, New Delhi, Sixth Edition, 2007.
2. I N. Herstein, 'Topics in Algebra', Second Edition, John Wiley and Sons, 2000.
3. Gilbert Strang,' Linear Algebra and its Applications, Fourth Edition, Cengage Learning, 2014
4. Howard Anton and Chris Rorres, 'Elementary Linear Algebra', 9th Edition, Wiley, 2005.

References:

1. R.P. Grimaldi, "Discrete and Combinatorial Mathematics", Pearson Education, Fifth Edition, 2007.
2. Liu, "Elements of Discrete Mathematics", Tata McGraw- Hill Publishing Company Limited, 2004.
3. John B. Fraleigh, 'A First Course in Abstract Algebra', Narosa Publishing House, 2003.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26MAT134	LINEAR ALGEBRA	L-T-P-C: 3-1-0-4

Course Objective(s)

- Understand matrix operations, system of linear equations, and the solution mechanisms.
- Familiarize yourself with the basic concepts of vector spaces, subspaces, basis, and dimension.
- Apply linear transformation rules in different aspects related to kernel, range, and change of basis.
- Learn to implement the concepts of eigen values, diagonalization, inner product space, orthogonality, projection, anddecomposition.

Course Outcomes

COs	Description
CO1	Develop the concepts of system of linear equations, rank of matrix, and solution methods for a system of linear equations.
CO2	Learn vector spaces and subspaces to determine basis, dimension, and linear independency.
CO3	Implement linear transformation rules to obtain kernel and range of a transformation.
CO4	Implement diagonalization using eigen values and vectors.
CO5	Apply the concept of inner product spaces and projection to determine orthogonality.

CO-PO Mapping

PO								
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	-	-	-	-	1
CO2	3	3	2	-	-	-	-	1
CO3	3	3	2	-	-	-	-	1
CO4	3	3	2	-	-	-	-	1
CO5	3	3	2	-	-	-	-	1

Syllabus

Unit 1: Linear Systems and Matrix Operations - System of Linear equations, Row reduction and echelon form, Rank of a mixby row echelon form, Gauss elimination, Inverse of a matrix by Gauss Jordan, LU decomposition

Unit 2: Vector space - Vector spaces, Sub spaces, Linear independence, Basis, Dimension, Finite dimensional vector space, nulland column space

Unit 3: Linear Transformations - Linear transformation, Relation between matrices and linear transformations, Kernel and range,Change of basis, Nilpotent transformations

Unit 4: Eigen values and Eigen vectors - Eigen Values and Eigen Vectors, Diagonalization, Orthogonal Diagonalization, Quadratic Forms, Diagonalizing Quadratic Forms; Similarity of linear transformations -Diagonalization and its applications.

Unit 5: Inner Product Spaces - Inner products, Orthogonality, Orthogonal complements, Orthonormality, Projection on subspace, Gram Schmidt Process, Least Square Principle, QR Decomposition

Textbooks:

1. Howard Anton and Chris Rorrs, “Elementary Linear Algebra”, Ninth Edition, John Wiley & Sons, 2000.
2. D C Lay, S R Lay and JJ McDonald, Linear Algebra and its Applications, Pearson India, Fifth edition.

References:

1. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
2. Gilbert Strang, “Linear Algebra and its Applications”, Third Edition, Harcourt College Publishers, 1988.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26MAT135	STATISTICAL AND NUMERICAL METHODS	L-T-P-C: 3-1-0-4

Course Objective(s)

- Understand the basic measures of central tendency and dispersion.
- Learn the fundamentals of correlation and regression analysis.
- Understand the preliminary concept of probability and different types of probability distribution.
- Familiarize yourself with different interpolation methods and various numerical techniques to find the solution of equation and simultaneous linear equations.

Course Outcomes

COs	Description
CO1	Develop the concepts of descriptive statistics by employing measures of central tendency and dispersion.
CO2	Apply the concepts of correlation and regression in various problems.
CO3	Develop the fundamental concept of probability theory and distribution functions.
CO4	Implement different interpolation methods.
CO5	Determine the solutions of an equation by bisection and Newton Raphson method and simultaneous linear equations by Gauss Elimination methods.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	3	2	-	-	1	-
CO2	3	3	3	2	-	-	1	-
CO3	3	3	3	2	-	-	1	-
CO4	3	3	3	2	-	-	1	-
CO5	3	3	3	2	-	-	1	-

Syllabus

Unit 1: Statistics-Introduction - Measures of central tendency – AM, Median, Mode, Measures of dispersion and its coefficients –range, QD, SD, MD.

Unit 2: Correlation- Karl Pearson’s and Spearman’s rank correlation, Regression- regression equations, regression coefficients,Method of least squares – fitting of a straight line.

Unit 3: Introduction to Probability - addition theorem, multiplication theorem, independent events, conditional probability, Baye’stheorem, Probability distribution - Binomial, Poisson, Normal.

Unit 4: Interpolation- Newton’s forward &backward method- Lagrange’s Method.

Unit 5: Solutions of Numerical, Algebraic and transcendental methods- bisection method, Newton Raphson method, Simultaneouslinear equations -Gauss elimination.

Textbooks:

1. P.R.Vittal-Business Mathematics and Statistics, Margham Publications, Chennai,
2. M.K.Venkataraman: Numerical methods in Science and Engineering-National Publishing Company, Chennai

References:

1. Ross S.M., Introduction to Probability and Statistics for Engineers and Scientists, 3rd edition, Elsevier AcademicPress.
2. S.A. Mollah, Numerical Analysis and Computational Procedures, 5th edition, Books & Allied Ltd

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

Electives – 3 Credits

AI & DS STREAM

26CSA331	PYTHON FOR AI AND DS	L-T-P-C:2-0-2-3

Course Objective(s)

- Equip students with Python workflows for AI/DS: environments, notebooks, packages, and reproducibility.
- Analyze and transform real-world datasets using NumPy/pandas for downstream ML.
- Design and implement EDA and visualization using matplotlib/seaborn to derive insights.
- Construct preprocessing pipelines (scikit-learn) for robust model-ready datasets; use baseline models at API level.

Course Outcomes

COs	Description
CO1	Analyze AI/DS tasks and design Python-based data workflows
CO2	Implement data ingestion, cleaning, reshaping, and feature engineering with NumPy/pandas.
CO3	Develop insightful EDA and visualize patterns using matplotlib/seaborn.
CO4	Construct preprocessing pipelines and evaluate baseline models using standard metrics

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	2	3	1	0	0	2
CO2	3	2	2	3	0	0	1	1
CO3	2	2	2	2	1	0	0	1
CO4	2	3	3	3	0	0	1	1

Syllabus

Unit I

Python DS Foundations. Environments (venv/conda), Jupyter/VS Code, reproducibility (seeds), notebooks as reports. Python refresher (brief): iterables, comprehensions, functions, modules. NumPy arrays: vectorization, broadcasting, indexing, performance notes.

Unit II

Data Wrangling with pandas. DataFrames/Series; read/write (CSV/Excel/JSON); datetime and categorical data. Cleaning: missing values, outliers (IQR/percentiles), type conversion, joins/merge, reshape (melt/pivot)Feature engineering: binning, scaling (concept), encoding (one-hot/ordinal at API level).

Unit III

EDA & Visualization. Descriptive statistics, distributions, correlations, groupby/aggregation. matplotlib & seaborn: hist, kde, box/violin, pairplot, heatmap, catplots. Communicating insights: labeling, aesthetics, dashboards.

Unit IV

Preprocessing Pipelines & Baselines. Train/test split; leakage pitfalls. scikit-learn: Pipeline, ColumnTransformer, scalers, encoders. Baseline models (API-level only; no theory): Linear/Logistic (fit/predict), k-NNMetrics usage (definitions only): MAE/MSE/R^2; accuracy, precision, recall, F1, ROC-AUC.

Lab Syllabus

- Setup env + notebook hygiene + Git; NumPy warm-up
- pandas I/O & data cleaning (missing, types)
- pandas transform (merge, reshape, groupby)
- Feature engineering (encoding, binning, scaling via API)
- EDA I: distributions, summary stats, correlation heatmaps
- EDA II: categorical vs numeric visualizations, pairplots
- Train/test split; data leakage demo

- Pipelines & ColumnTransformer (numeric + categorical)
- Baseline regression (fit/predict; residual plots; MAE/MSE/R^2)
- Baseline classification (confusion matrix; precision/recall/F1/ROC)
- Model selection via simple CV (API use only)

Text Books

1. Wes McKinney, Python for Data Analysis, 3e, O'Reilly.
2. Jake VanderPlas, Python Data Science Handbook, O'Reilly.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA332	INTRODUCTION TO NEURAL NETWORKS	L-T-P-C:3-0-0-3

Course Objective(s)

- Introduce the biological inspiration and mathematical foundations of neural networks.
- Develop an understanding of basic neuron models and learning rules.
- Enable students to analyze single-layer and multi-layer neural network architectures.
- Explain training mechanisms, convergence issues, and limitations of neural networks.
- Provide a conceptual foundation for advanced neural and deep learning courses

Course Outcomes

COs	**Description**
CO1	**Analyze** the biological and mathematical basis of artificial neural networks
CO2	**Explain and evaluate** neuron models and learning rules
CO3	**Analyze** single-layer and multi-layer neural network architectures
CO4	**Evaluate** training algorithms, convergence behavior, and generalization issues
CO5	**Assess** the suitability and limitations of neural networks for real-world problems

CO-PO Mapping

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO								
CO1	3	2	1	1	0	0	0	1
CO2	3	3	2	1	0	0	0	1
CO3	3	3	2	2	0	0	0	1
CO4	2	3	3	2	0	0	0	1
CO5	2	2	2	1	0	0	1	2

Syllabus

Unit I

Biological neurons and brain inspiration. Artificial neuron concept. McCulloch–Pitts neuron model. Threshold logic units. Linear separability.

Unit II

Learning paradigms: Supervised learning, Unsupervised learning. Hebbian learning rule. Perceptron learning algorithm. Adaline and LMS rule. Limitations of single-layer perceptrons.

Unit III

Multi-Layer Neural Networks. Need for hidden layers. Multi-Layer Perceptron (MLP) architecture. Activation functions: Sigmoid, Tanh, ReLU (conceptual introduction only). Network capacity and representation power.

Unit IV

Training Neural Networks. Error functions. Backpropagation algorithm (conceptual and mathematical overview). Gradient descent learning. Learning rate, momentum. Convergence behavior. Overfitting and generalization.

Unit V

Pattern classification. Function approximation. Associative memory. Hopfield networks (intro). Limitations of neural networks: Local minima. Interpretability. Data dependency. Ethical considerations in neural decision systems.

Text Books

1. Neural Networks and Learning Machines, 3rd Edition by Simon Haykin. Pearson, 2009.
2. Artificial Neural Networks by B. Yegnanarayana. PHI Learning, 2009.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA333	FUNDAMENTALS OF DATA SCIENCE	L-T-P-C:2-0-2-3

Course Objective(s)

- Introduce students to data-centric thinking and the end-to-end data science lifecycle.
- Develop the ability to understand, interpret, and contextualize data from multiple sources.
- Enable learners to prepare, explore, and validate data quality for downstream analytics.
- Build skills in communicating insights using data narratives and visual reasoning.
- Create awareness of ethical, legal, and societal aspects of data usage.

Course Outcomes

COs	Description
CO1	**Analyze** real-world problems to identify data requirements, sources, and constraints
CO2	**Examine and validate** datasets for structure, quality, and suitability for analysis
CO3	**Apply** data preparation and exploratory reasoning techniques to derive meaningful insights
CO4	**Evaluate** data-driven findings and communicate them effectively using visual and narrative methods
CO5	**Assess** ethical, legal, and societal implications in the collection and use of data

CO-PO Mapping

PO / **CO**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	1	0	0	0	1
CO2	2	3	2	1	0	0	1	1
CO3	2	3	3	2	1	0	0	1
CO4	1	2	2	2	2	0	0	1
CO5	1	2	1	1	0	0	3	2

Syllabus

Unit I

What is Data Science? Data-driven decision-making vs intuition. Roles in a data science team. Data science lifecycle: Problem framing, Data understanding, Insight generation, Action and feedback. Use cases across domains (health, finance, cyber, governance).

Unit II

Types of data: Structured, semi-structured, unstructured. Data formats: Tabular, text, logs, time-series, images (conceptual). Data sources: Sensors, surveys, transactions, APIs, open data. Data acquisition challenges. Data ownership and provenance.

Unit III

Importance of data quality. Common data quality issues: Missing values, Inconsistencies, Duplicates, Noise and bias. Data cleaning concepts (logic-level, not coding-heavy). Data labeling and annotation. Data documentation and metadata.

Unit IV

Exploratory reasoning vs confirmatory analysis. Pattern recognition in data (non-statistical). Correlation vs causation (conceptual pitfalls). Data visualization principles: Choosing the right chart, Misleading visualizations.

Unit V

Data privacy and consent. Personal Identifiable Information (PII). Algorithmic bias from data. Fairness, transparency, accountability. Legal and regulatory awareness (intro level). Responsible use of data in AI systems.

Lab Syllabus

- Understanding datasets and problem contexts
- Identifying data types and data sources
- Exploring dataset structure and metadata

- Data quality assessment (missing, duplicates)
- Data cleaning strategies (logical steps)
- Dataset versioning and documentation
- Basic exploratory summaries (non-statistical)
- Visualization for understanding data patterns
- Identifying misleading visualizations
- Correlation vs causation case studies
- Data storytelling exercise
- Ethics case study: biased datasets
- Privacy and anonymization discussion

Text Books:

1. Data Literacy: A User's Guide, Routledge, 2020 by Kathy Schrock
2. Doing Data Science, O'Reilly Media, 2013, by Cathy O'Neil and Rachel Schutt

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA334	APPLIED STATISTICS FOR DATA SCIENCE	L-T-P-C: 3-0-0-3

Course Objective(s)

- Understand the basic mechanisms of descriptive statistics
- Familiarize yourself with inferential statistics by studying the estimation theory and hypothesis testing

Course Outcomes:

COs	Description
CO1	Implement various methods of descriptive statistics using central tendency, dispersion, skewness, kurtosis, correlation and regression analysis, and least squares.
CO2	Apply the estimation theory to obtain maximum likelihood estimator, moments, and confidence interval.
CO3	Explain the importance of estimating the parameters and testing of hypotheses for both small and large samples.
CO4	Apply statistical testing for various data sets.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	3	2	-	0	0	0	1
CO2	2	3	2	-	0	0	1	1
CO3	2	3	3	-	1	0	0	1
CO4	1	2	2	-	2	0	0	1
CO5	1	2	1	-	0	0	3	2

Syllabus:

Unit 1

Introduction to Statistics: Definition, importance in ML, and types of data (Nominal, Ordinal, Interval, Ratio), Measures of Central Tendency (Mean, Median, Mode), Measures of Dispersion (Range, Quartile Deviation, Variance, Standard deviation,), skewness and kurtosis, Correlation and Regression analysis, Method of least squares, Coefficient of determination

Unit 2

Estimation theory - Point Estimation: criteria of point estimation, method of maximum likelihood estimation and method of moments, Interval Estimation: Introduction – confidence Interval for mean of a Normal Distribution with Variance known and unknown – Confidence Interval for the two means of a Normal Distribution with Variance known and unknown, Confidence interval for one and two Population Proportions

Unit 3

Hypothesis testing – large sample tests for single mean and two means – large sample tests for single proportion and two proportions, small sample tests for single mean and two means – paired t-test – test for single variance – test for equality of two variances

Unit 4

Chi-square goodness of fit for Binomial, Poisson and Normal distributions, Independence of attributes

Textbooks:

1. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, John Wiley and Sons Inc., 2005
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8th Edition, Pearson Education Asia, 2007.
3. Gupta, S. C. and Kapoor, V.K., Fundamentals of Applied Statistics, 4th Edition (Reprint), Sultan Chand & Sons, 2008

References:

1. Ross S.M., Introduction to Probability and Statistics for Engineers and Scientists, 3rd edition, Elsevier Academic Press.
2. Ravichandran, J. Probability and Statistics for engineers, First Reprint Edition, Wiley India, 2012.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA335	COMPUTER VISION BASICS	L-T-P-C:2-0-2-3

Course Objective(s)

- Introduce the fundamental principles of computer vision and image understanding.
- Explain digital image representation, acquisition, and transformations.
- Enable students to analyze and apply classical image processing techniques.
- Develop understanding of feature extraction and traditional vision algorithms.

Course Outcomes

COs	Description
CO1	**Analyze** the process of image formation and digital image representation
CO2	**Apply** image enhancement and transformation techniques to improve visual information
CO3	**Analyze and extract** meaningful features from images using classical methods
CO4	**Evaluate** traditional computer vision techniques for detection and recognition tasks
CO5	**Assess** the limitations, ethical concerns, and real-world challenges of computer vision systems

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	1	0	0	0	1
CO2	3	3	2	2	0	0	0	1
CO3	3	3	2	2	0	0	0	1
CO4	2	3	3	2	0	0	1	1
CO5	1	2	1	1	0	0	3	2

Syllabus

Unit I: Introduction to Computer Vision and Image Representation. What is Computer Vision? Human vision vs computer vision. Applications of computer vision. Image acquisition and sensors.
Digital image representation: Pixels, Resolution, Bit depth. Color models: Grayscale, RGB, HSV. Image file formats.

Unit II: Image enhancement: Contrast stretching, Histogram equalization. Image filtering: Mean, median filters, Gaussian smoothing. Noise models (conceptual): Salt & pepper, Gaussian noise. Image transformations: Scaling, Rotation.

Unit III: Edge detection: Gradient concept, Sobel and Prewitt operators, Canny edge detection (conceptual). Thresholding techniques. Region-based segmentation. Morphological operations: Dilation, Erosion.

Unit IV: Feature detection and description. Template matching. Shape representation and contours
Object detection using classical techniques (rule-based).

Unit V: Classical vision applications: Face detection (Haar-like features – overview). Motion detection (frame differencing) Challenges in computer vision: Illumination, Occlusion, Scale and viewpoint, Privacy, surveillance, and ethical issues, Limitations of traditional computer vision.

Lab Syllabus

- Image reading, display, and pixel operations
- Color space conversions
- Image enhancement techniques
- Noise addition and filtering
- Histogram analysis and equalization
- Spatial transformations
- Edge detection using Sobel/Prewitt
- Canny edge detection
- Thresholding and segmentation
- Morphological operations

Text Books

1. Computer Vision: Algorithms and Applications, by Richard Szeliski. Springer.
2. Digital Image Processing, 4th Edition, by Rafael C. Gonzalez and Richard E. Woods. Pearson

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA336 ETHICS AND DATA PRIVACY L-T-P-C: 3-0-0-3

Course Objective(s)

1. Understand the foundational ethical theories, including utilitarianism, deontology, and virtue ethics, and apply them to analyze ethical considerations in handling personal and sensitive data.
2. Analyze the ethical implications of various data collection methods, such as surveillance and data mining, and assess the privacy concerns arising from data processing techniques like profiling and data analytics.
3. Examine the legal and regulatory frameworks governing data privacy, including international and national data protection laws, and evaluate the compliance requirements for organizations handling personal data.
4. Develop ethical decision-making skills in data-driven environments by exploring ethical frameworks for decision making in data science and analytics and assessing the ethical implications of artificial intelligence and machine learningtechnologies.

Course Outcomes

COs	**Description**
CO1	Understand ethical theories such as utilitarianism, deontology, and virtue ethics.
CO2	Evaluate the ethical implications of various data collection methods like surveillance and data mining.
CO3	Apply ethical frameworks to guide decision-making in data science and analytics.
CO4	Recognize the importance of ethics and corporate social responsibility in data-driven organizations.

CO-PO Mapping

PO **CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	3	2	-	-	-	-	2	-
CO2	3	3	-	-	-	-	2	-
CO3	3	3	2		-	-	-	-
CO4	3	3	-	2	-	-	-	-

Syllabus

Unit-1 Introduction to Ethics and Data Privacy: Overview of ethical theories -utilitarianism, deontology, virtue ethics, Introduction to data privacy concepts and regulations-GDPR, CCPA, Ethical considerations in handling personal and sensitive data.

Unit: 2 Ethical Issues in Data Collection and Processing: Ethical implications of data collection methods-surveillance, data mining, Privacy concerns in data processing-profiling, data analytics. **Legal and Regulatory Frameworks:** Overview of international and national data protection laws, Compliancerequirements for organizations handling personal data.

Unit 3: Ethical Decision Making in Data-Driven Environments and Privacy Engacing Practices: Ethical frameworks for decision making in data science and analytics, Ethical considerations in algorithm development and deployment Ethical implications of artificial intelligence and machine learning technologies. **Privacy-Enhancing Technologies and Practices-** Overview of privacy-enhancing technologies (PETs), Best practices forimplementing privacy-by-design principles

Unit 4: Ethical Leadership, Corporate Responsibility, Emerging Issues and Future Trends: Role of ethics and corporate social responsibility (CSR) in data-driven organizations, Ethical leadership in promoting transparency, accountability, and trust. Exploration of emerging ethical issues in data privacy in IoT and biometrics, Ethical considerations in the era of big data, IoT, and ubiquitous computing.

Textbook

1. "Ethics for the Information Age" by Michael J. Quinn
2. "Data and Goliath: The Hidden Battles to Collect Your Data and Control Your World" by Bruce Schneier
3. "Privacy in Context: Technology, Policy, and the Integrity of Social Life" by Helen Nissenbaum

Reference

1. "Privacy on the Ground: Driving Corporate Behavior in the United States and Europe" by Kenneth A. Bamberger and Deirdre K. Mulligan
2. "The Ethics of Information Technology and Business" edited by Richard T. De George and Joseph R. Varner
3. "Privacy in the Age of Big Data: Recognizing Threats, Defending Your Rights, and Protecting Your Family" by Theresa M. Payton and Ted Claypoole

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA337	DATA GOVERNANCE	L-T-P-C: 3-0-0-3

Course Objective(s)

- Delving into Data Governance aids individuals in comprehending the laws and regulations dictating data management. It enables them to devise and execute policies and procedures ensuring adherence to compliance standards.
- Engaging in Data Governance empowers individuals with the expertise required to effectively manage data across its lifecycle, encompassing collection, utilization, and disposal phases. Furthermore, it equips them with data managementtools and methodologies aimed at enhancing data quality and consistency.

Course Outcomes

COs	Description
CO1	Comprehend the necessity of Data Governance within organizations and analyse how organizational culture influences Data Governance practices and articulate the challenges associated with implementing Data Governance
CO2	Identify the various types of assets that require governance and assess different data models and their implications on Data Governance.
CO3	Analyze the relationship between data stewardship and Data Governance and understand the types of data stewardship roles and responsibilities within organizations.
CO4	Develop a framework for successful Data Governance strategies and understand the importance of information exchanges in Data Governance implementations.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	-	2	-	2	-
CO2	3	-	-	-	-	-	2	2
CO3	-	3	-	-	-	-	2	2
CO4	-	-	3	-	-	-	2	-

Syllabus

Unit 1

Data Governance -The Need for Data Governance - How Data Governance fits into Organizational Strategy Data Governance Maturity Models -Data Governance Life Cycle - how to Manage Risk with Data Governance - Organizational Culture Affects Data Governance - Articulate the Challenges of Data Governance

Unit 2

Metadata Framework - Evaluate and Explain Master Data Management - Types of Assets that Require Governance - Analyze and Describe Metadata Use for Data Governance - Evaluate the Varying Data Models and Their Bearing on Governance Regulatory and Operational Risk Through Data Governance - The Relationship Between IT and Business in an Organization - Information Governance Framework Optimize Performance with Data Governance - Formal Structure Impacts Data Governance - Create a Data Governance Document that Describes the Business Need for Data Governance

Unit 3

Data Stewardship and Governance – How they fit together – Types of data stewardship – Roles and responsibilities

Unit 4

Application of Data Governance in Business - Challenges of Data Governance in a Big Data world - Frame- work for successful Data Governance strategies - Information Exchanges

References

1. Data Governance: Creating Value from Information Assets, Neera Bhansali, 2013. Auerbach Publications, ISBN: 978-1439879139.
2. Data Governance: Perspectives and Practices, Harkish Sen, Technics Publications, 2019
3. Data stewardship: an actionable guide to effective data management and data governance, David Plotkin, Amsterdam: Elsevier, 2014

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA338	BIG DATA FOUNDATIONS	L-T-P-C:3-0-0-3

Course Objective(s)

- Introduce the characteristics and challenges of big data in modern computing systems.
- Explain the architectural principles behind distributed data storage and processing.
- Familiarize students with the big-data ecosystem and frameworks at a conceptual level.
- Develop understanding of data ingestion, storage, and processing workflows at scale.
- Build awareness of security, governance, and ethical aspects of big data systems.

Course Outcomes

COs	Description
CO1	**Analyze** the characteristics and challenges of big data in real-world applications
CO2	**Explain and evaluate** distributed architectures for big-data storage and processing
CO3	**Examine** big-data frameworks and ecosystem components used in large-scale systems
CO4	**Assess** data ingestion, management, and processing workflows for scalability and reliability
CO5	**Evaluate** security, governance, and ethical issues associated with big-data platforms

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	1	0	0	0	1
CO2	3	3	2	2	0	0	0	1
CO3	2	3	2	2	0	0	0	1
CO4	2	3	3	2	0	0	1	1
CO5	1	2	1	1	0	0	3	2

Syllabus

Unit I: Introduction to Big Data. Evolution of data storage and processing. Limitations of traditional data systems. Big Data definitions and 5 Vs. Big data use cases (industry, government, cyber). Challenges of big data systems. Big data vs data analytics vs data science.

Unit II: Distributed System Foundations. Basics of distributed computing. Cluster and cloud computing overview. CAP theorem (conceptual understanding). Fault tolerance and replication. Scalability and availability. Data locality concept.

Unit III: Big Data Storage and Processing Models. Distributed file systems: HDFS architecture (conceptual). Data models: Key-value stores, Column-oriented stores, Document stores. Batch vs stream processing.

Unit IV: Big Data Ecosystem. Hadoop ecosystem overview: Hadoop Common, HDFS, YARN, MapReduce (conceptual model only).
NoSQL databases (architecture-level): HBase, MongoDB. Data ingestion tools (conceptual): Flume, Sqoop, Kafka (overview).

Unit V: Data governance and stewardship. Data quality in large data systems. Privacy and compliance (intro): Data anonymization concepts. Security challenges in big data: Access control, Data integrity, Auditing. Ethical issues in big-data usage. Future trends in big-data systems.

Text Books

1. Big Data: A Revolution That Will Transform How We Live, Work, and Think, by Viktor Mayer-Schönberger and Kenneth Cukier. Houghton Mifflin Harcourt.
2. Hadoop: The Definitive Guide, by Tom White. O’Reilly Media.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

CYBER SECURITY STREAM

26CSA341	INTRODUCTION TO CYBER SECURITY	L-T-P-C: 3-0-0-3

Course Objectives:

- To introduce the core principles and practices of modern cybersecurity.
- To develop an understanding of common attacks, threats, and vulnerabilities.
- To explain basic security mechanisms used to protect systems and networks.
- To familiarise students with authentication, authorisation, and access control.
- To provide awareness of cyber laws, ethics, and digital rights.

Course Outcomes

COs	Description
CO1	Explain the fundamental concepts and terminology of cybersecurity.
CO2	Identify various types of cyber threats and vulnerabilities.
CO3	Understand basic network security mechanisms and defensive strategies.
CO4	Describe authentication, authorisation, and access control models.
CO5	Demonstrate awareness of cyber laws, ethical issues, and legal frameworks.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	1	1	1	1	-	2	2
CO2	2	2	1	1	1	-	2	2
CO3	2	2	1	2	1	-	2	2
CO4	1	2	1	1	1	-	3	2
CO5	2	3	2	2	2	1	2	2

Syllabus

Unit I: Foundations of Cybersecurity: Definition and importance of cybersecurity, Security goals: Confidentiality, Integrity, Availability (CIA Triad). Security Challenges in the Modern Digital World. Terminology: Threats, vulnerabilities, exploits, risks. Overview of cybersecurity domains (network, application, cloud, IoT, mobile). Basics of security governance and policies.

Unit II: Cyber Threats, Attacks & Vulnerabilities: Types of threats: Internal vs external. Types of attacks: Malware (virus, worm, trojan, ransomware, spyware), Social engineering attacks, Phishing, spear-phishing, DoS, DDoS attacks, Man-in-the-middle attacks. Software vulnerabilities: buffer overflow, injection, and misconfigurations. Zero-day vulnerabilities (conceptual overview).

Unit III: Network security concepts: perimeter, defence-in-depth. Firewalls: purpose, types, rule filtering basics. Intrusion Detection and Prevention Systems (IDS/IPS). Virtual Private Networks (VPNs) – basic idea. Secure communication basics: HTTPS, TLS, SSL. Wi-Fi security (WEP, WPA, WPA2/WPA3 – conceptual comparison).

Unit IV: Authentication: Passwords, OTPs, biometrics, multifactor authentication (MFA). Authorization: Role-based access control (RBAC), rule-based, attribute-based (ABAC). Access control policies & models. Identity & access management (IAM) basics. Password attacks and password hygiene.

Unit V: Overview of cybersecurity standards: ISO 27001, NIST (brief introduction). Indian Cyber Laws: IT Act 2000 & Amendments. Intellectual property rights related to IT. Digital evidence and forensics basics. Cyber ethics: responsible behaviour online. Privacy principles and data protection basics (GDPR overview).

Textbooks/ References

1. Computer Security: Principles and Practice. Authors: William Stallings & Lawrie Brown. Edition: 5th Edition (2023). Publisher: Pearson.
2. Security in Computing. Authors: Charles P. Pfleeger, Shari Lawrence Pfleeger, Lizzie Coles-Kemp. Edition: 6th Edition (2023). Publisher: Addison-Wesley / Pearson.
3. CompTIA Security+ Guide to Network Security Fundamentals. Author: Mark Ciampa. Edition: 8th Edition (2024/2025). Publisher: Cengage Learning / Course Technology

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA342	NETWORK SECURITY BASICS	L-T-P-C: 3-0-0-3

Course Objectives:

- To explain the fundamentals of network security and threat models.
- To introduce key network security technologies and protocols.
- To describe defensive mechanisms such as firewalls, IDS/IPS, and VPNs.
- To understand basic secure communication and encryption in networks.
- To develop awareness of wireless security standards and vulnerabilities.

Course Outcomes

COs	Description
CO1	Define basic network security concepts and threat types.
CO2	Identify and explain vulnerabilities in common network architectures.
CO3	Describe how firewalls, IDS/IPS, and VPNs function.
CO4	Understand secure communication mechanisms (TLS, HTTPS).
CO5	Evaluate basic wireless security measures and limitations.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	1	-	-	-	2	2
CO2	2	3	2	1	1	-	2	2
CO3	2	2	3	1	1	-	2	2
CO4	3	2	2	1	1	1	3	2
CO5	3	2	2	1	1	1	3	2

Syllabus

Unit I: Introduction to Network Security. Role of network security in organizations. Basic network architecture (LAN, WAN, Internet). Network attack surface. Types of threats: intrusions, spoofing, scanning, sniffing. Security policies and principles (least privilege, defense in depth).

Unit II: Network Protocols & Vulnerabilities. OSI & TCP/IP models: where security fits. Common protocol vulnerabilities (ARP spoofing, DNS poisoning). Port scanning basics. Secure vs insecure protocols (HTTP vs HTTPS, Telnet vs SSH). Basics of packet filtering and inspection.

Unit III: Firewalls: purpose, types (packet-filtering, stateful, application-level). Firewall rule design (conceptual, non-config oriented). Network Address Translation (NAT) and its role in security. IDS vs IPS. Signature-based vs anomaly-based detection systems. Use cases and limitations.

Unit IV: Basics of encryption in networks. Public key infrastructure (concept only). TLS/SSL and HTTPS. Digital certificates (conceptual only). VPN fundamentals. Tunneling & encapsulation basics. IPsec overview (very high level).

Unit V: Wi-Fi basics: SSID, access points, authentication models. Wireless threats: rogue AP, eavesdropping, evil-twin attacks. Wireless encryption standards: WEP, WPA, WPA2, WPA3. Secure Wi-Fi configuration principles (UG-level best practices). Introduction to mobile and IoT network security risks (overview only).

Textbooks/ References

1. Computer Security: Principles and Practice. Authors: William Stallings, Lawrie Brown. Edition: 5th Edition (2023). Publisher: Pearson.
2. Security in Computing. Authors: Charles P. Pfleeger, Shari L. Pfleeger, Lizzie Coles Kemp. Edition: 6th Edition (2023). Publisher: Addison Wesley / Pearson
3. CompTIA Security+ Guide to Network Security Fundamentals. Author: Mark Ciampa. Edition: 8th Edition (2024/2025). Publisher: Cengage Learning.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA343 CRYPTOGRAPHY FUNDAMENTALS L-T-P-C: 2-0-2-3

Course Objectives:

- Understand core concepts and evolution of cryptography.
- Explain how classical and modern ciphers work.
- Distinguish symmetric and asymmetric encryption.
- Understand the purpose of hashing, message integrity, and digital signatures.
- Learn how cryptography is applied in authentication, HTTPS, email security, and real-world systems.

Course Outcomes

COs	Description
CO1	Describe the goals, principles, and fundamental terminology of cryptography.
CO2	Explain the operation and weaknesses of classical ciphers (substitution and transposition).
CO3	Distinguish between symmetric and asymmetric encryption and describe commonly used algorithms (AES, RSA) at a conceptual level.
CO4	Explain the role of hashing, MACs, and digital signatures in ensuring integrity and authentication.
CO5	Analyze basic real-world scenarios to select appropriate cryptographic techniques and recommend safe practices.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	1	1	1	1	-	2	2
CO2	2	2	1	1	1	-	2	2
CO3	2	2	1	2	1	-	2	2
CO4	2	3	2	2	1	-	2	2
CO5	2	3	2	3	2	1	2	2

Syllabus

Unit I: Foundations of Cryptography: Need for cryptography; CIA + authentication + non-repudiation. Terminology: plaintext, ciphertext, keys, entropy. Types of cryptanalytic attacks.

Unit II: Classical Encryption Techniques. Caesar cipher, monoalphabetic substitution Vigenère cipher. Transposition ciphers. Frequency analysis.

Unit III: Modern Symmetric & Asymmetric Cryptography. Symmetric key concepts. DES overview; AES structure (conceptual rounds). Asymmetric encryption basics. RSA and Diffie–Hellman at high level. Applications: secure communication, storage.

Unit IV: Hashing, MACs & Digital Signatures. Cryptographic hash functions, SHA-2 / SHA-3. MACs: purpose and usage. Digital signatures: conceptual process. Certificates & PKI basics.

Unit V: Password storage (hashing + salting). HTTPS basics. Email signing. Choosing the right cryptographic tool. Simple risk-based scenarios.

Textbooks/ References

1. Computer Security: Principles and Practice – William Stallings & Lawrie Brown. 5th Edition, Pearson (2023).
2. Security in Computing – Pfleeger, Pfleeger & Coles Kemp. 6th Edition, Addison Wesley/Pearson (2023).
3. Cryptography and Network Security – William Stallings. 8th Edition, Pearson.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA344	CYBER LAWS & DIGITAL FORENSICS	L-T-P-C: 3-0-0-3

Course Objectives:

- To familiarize students with Indian and global cyber laws.
- To explain the legal implications of cybercrimes and digital evidence.
- To introduce fundamental concepts of digital forensics.
- To explain the forensic investigation process and reporting principles.
- To promote ethical and legally compliant use of digital technologies.

Course Outcomes

COs	Description
CO1	Describe major cyber laws, legal frameworks, and IT Act provisions relevant to cybersecurity and digital data.
CO2	Identify various categories of cybercrimes and understand their legal implications under national and international frameworks.
CO3	Explain the fundamentals of digital forensics, types of evidence, and chain of custody principles.
CO4	Describe the digital forensic investigation process, including acquisition, preservation, analysis, and reporting.
CO5	Analyze simple case scenarios and recommend legally compliant and ethical actions in cybersecurity and forensic contexts.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	1	1	1	1	1	-	3	2
CO2	1	3	1	1	1	-	3	2
CO3	2	2	1	1	1	-	3	2
CO4	2	2	2	2	1	1	2	2
CO5	2	3	2	2	2	1	3	2

Syllabus

Unit I: Introduction to Cyber Laws. Need for cyber legislation. Indian IT Act 2000 and Amendments (2008). Legal definitions: electronic documents, digital signatures. Regulatory bodies and enforcement mechanisms.

Unit II: Cybercrimes & Legal Response: Types of cybercrimes: identity theft, phishing, cyberstalking, fraud, data breaches. Legal implications and penalties under IT Act. Overview of global cyber laws (US, EU, GDPR). Case studies from CERT-In advisories.

Unit III: Foundations of Digital Forensics: Definition and scope of digital forensics. Types of digital evidence (volatile vs non-volatile). Chain of custody: documentation, integrity, and admissibility. Roles & responsibilities of forensic investigators.

Unit IV: Digital Forensics Process: Forensic process models. Acquisition: imaging concepts, write blockers, preservation & documentation. Analysis & reporting principles. Common tools overview (FTK Imager, Autopsy – conceptual only).

Unit V: Case Studies & Ethical Considerations. Real-world case scenarios: financial fraud, online harassment, data theft. Ethical issues in investigation. Privacy rights & data protection principles. Responsible reporting and compliance.

Textbooks/ References

1. Niranjan Reddy & Pavan Duggal – The Information Technology Act, 2000: A Handbook.
2. Eoghan Casey – Digital Evidence and Computer Crime.
3. Nelson, Phillips & Steuart – Guide to Computer Forensics and Investigations.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA345	LINUX SECURITY & HARDENING	L-T-P-C: 2-0-2-3

Course Objectives:

- Understand core Linux security concepts and the importance of system hardening.
- Learn how Linux file permissions, users/groups, and privilege separation enhance security.
- Explore authentication, password policies, and pluggable authentication modules.
- Understand system hardening techniques and secure service configuration.
- Develop the ability to analyze simple system-level security issues and recommend mitigations.

Course Outcomes

COs	Description
CO1	Explain fundamental concepts of Linux security, privilege separation, and the need for system hardening.
CO2	Describe Linux permission models, user/group management, and access control mechanisms.
CO3	Explain authentication mechanisms, password policies, and basic PAM concepts.
CO4	Describe Linux system hardening techniques, including service management, firewall basics, and configuration security.
CO5	Analyze simple Linux security scenarios and recommend appropriate hardening steps or best practices.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	1	1	1	1	-	2	2
CO2	2	2	1	2	1	-	2	2
CO3	2	2	1	2	1	-	2	2
CO4	2	2	2	3	1	-	2	2
CO5	2	3	2	3	2	1	2	2

Syllabus

Unit I

Introduction to Linux Security: Principles of Linux security, Threat landscape for Linux servers, Principle of least privilege, User vs root vs sudo, Why Linux needs hardening (misconfiguration, default services, weak authentication).

Unit II

Users, Groups & File Permissions. Linux file permissions: rwx, user/group/others. Permission modification (chmod, chown, chgrp), Special permissions: SUID, SGID, Sticky Bit (conceptual at UG level), User and group, management fundamentals, Understanding /etc/passwd, /etc/shadow (conceptual only).

Unit III

Authentication & Account Security. Password policy basics. Account lockout strategies. Introduction to PAM (concept only). SSH security basics (password vs key-based authentication), Disabling root login, restricting access.

Unit IV

System Hardening & Secure Configuration. Hardening approach: disable unnecessary services, patching, updates, Basics of systemd service control, Firewall basics (UFW/Firewalld – conceptual usage), Log monitoring using syslog/journalctl, Introduction to AppArmor and SELinux (concept only; MCA covers advanced SELinux).

Unit V

Case Studies & Best Practices. Common misconfigurations (world-writable directories, exposed SSH, open ports), File integrity checks: Tripwire (concept only), Simple audit scenarios: "identify risk + recommend mitigation", Security checklists for Linux servers, Ethical and responsible system administration.

Lab syllabus

- Baseline System Security Assessment – Create non-root user, analyze running services, identify default risks.
- Users, Groups & Least-Privilege Configuration – Group creation, sudo configuration with visudo, checking privileges.
- File Permissions Management (rwx, chmod, chown) – Modify permissions, secure file/directory access, configure umask.
- Special Permissions: SUID, SGID, Sticky Bit – Identify SUID binaries, evaluate risks, secure shared directories.
- Understanding /etc/passwd and /etc/shadow – Analyze fields, differentiate system vs human accounts, lock/unlock accounts.

- Password Policy & Account Aging – Configure login.defs, set password expiry with chage, enforce minimum password days.
- Account Locking & Basic PAM Demonstration – Implement simple login lockout using pam_tally2 or faillock.
- SSH Hardening – Key-based authentication, disable password logins, restrict users, disable root login.
- System Hardening with systemd & Updates – Disable unnecessary services, manage units, apply updates.
- Firewall Configuration (UFW or Firewalld) – Default deny, allow essential services, verify rules and connectivity.
- Log Monitoring with syslog & journalctl – Filter authentication logs, detect failed SSH attempts, generate summaries.
- Introduction to AppArmor/SELinux (Concept + Light Hands-on) – Inspect profiles, switch modes, observe denials.
- Misconfiguration Hunt – Identify world-writable locations, exposed SSH, unnecessary listening services.
- File Integrity Checking (Tripwire Concept Demo) – Initialize baseline, modify files, run checks, interpret the report.

Textbooks/ References

1. Mastering Linux Security and Hardening (Third Edition, 2023) by Donald A. Tevault.
2. Linux Security and Administration: Safeguarding Your Linux System with Proactive Administration Practices (2024 Guide for Beginners) by Randall Blair.
3. Mastering Linux Security and Hardening, 3rd Edition by Tevault, Donald A, Packt Publishing, 2023.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA346	WIRELESS & MOBILE SECURITY	L-T-P-C: 3-0-0-3

Course Objectives:

- Understand security issues unique to wireless and mobile environments
- Learn wireless security standards and protocols
- Identify vulnerabilities and attack vectors targeting mobile and wireless systems
- Understand mobile operating system security models
- Apply best practices for securing wireless networks and mobile devices

Course Outcomes

COs	Description
CO1	Explain the fundamentals of wireless and mobile security, including threat models and risk factors.
CO2	Describe wireless network security standards, protocols, and common attacks.
CO3	Explain mobile operating system security architectures and permission models.
CO4	Describe security risks, attacks, and protection mechanisms in mobile devices and wireless communication.
CO5	Analyze basic wireless/mobile security scenarios and recommend appropriate mitigation strategies and best practices.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	1	1	1	1	-	2	2
CO2	2	2	1	2	1	-	2	2
CO3	2	2	1	2	1	-	2	2
CO4	2	2	2	2	1	-	2	2
CO5	2	3	2	3	2	1	2	2

Syllabus

Unit I: Fundamentals of Wireless & Mobile Security. Characteristics of wireless and mobile environments. Differences between wired v/s wireless security. Threat Models for Wireless and Mobile Systems. Risk assessment fundamentals. Security challenges in mobility and roaming.

Unit II: Wireless Network Security. Wi-Fi architecture and components. Wireless security protocols: WEP, WPA, WPA2, WPA3. Authentication methods: PSK, Enterprise (conceptual). Wireless attacks: eavesdropping, rogue AP, evil twin, de-authentication. Secure Wi-Fi configuration best practices

Unit III: Cellular & Mobile Communication Security. Overview of cellular networks (2G–4G conceptual). SIM-based authentication concepts. Mobile communication threats: IMSI catching (high-level), spoofing. Security in mobile data transmission. Limitations of mobile communication security.

Unit IV: Mobile Operating System Security. Mobile OS architecture overview. Android & iOS security models (sandboxing, permissions). App lifecycle and permission control. Secure app installation and updates. Mobile Device Management (MDM) Concepts.

Unit V: Mobile Threats, Privacy & Case Studies. Mobile malware types: spyware, adware, trojans (intro level). Mobile phishing and SMS attacks. Data privacy concerns and location tracking. Case studies: insecure Wi-Fi usage, malicious apps. Security best practices for users and organizations.

Textbooks/ References

1. CompTIA Security+ Guide to Network Security Fundamentals, 8th Edition, by Mark Ciampa. Cengage Learning, 2024.
2. Computer Security: Principles and Practice, 5th Edition, by William Stallings. Pearson, 2023
3. Hacking Exposed Wireless, Latest Edition, by Joshua Wright. McGraw-Hill.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA347	DIGITAL FORENSICS	L-T-P-C: 3-0-0-3

Course Objectives:

- To introduce the scope and importance of digital forensics in cybersecurity
- To understand types of digital evidence and forensic principles
- To explain standardized forensic investigation processes
- To familiarize students with basic forensic techniques and tools (conceptual)
- To develop ethical reasoning and legal awareness in handling digital evidence

Course Outcomes

COs	Description
CO1	Explain the objectives, scope, and principles of digital forensics and its role in cybercrime investigation.
CO2	Identify different types of digital evidence and explain principles such as integrity, authenticity, and chain of custody.
CO3	Describe the standard digital forensic investigation process and documentation requirements.
CO4	Explain basic techniques and tools used in computer, network, and mobile forensics at a conceptual level.
CO5	Analyze simple forensic case scenarios and recommend appropriate investigative steps while ensuring ethical and legal compliance.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	1	1	1	-	2	2
CO2	2	2	1	1	1	-	3	2
CO3	2	2	2	2	1	1	2	2
CO4	2	2	1	3	1	-	2	2
CO5	2	3	2	2	2	1	3	2

Syllabus

Unit I: Introduction to Digital Forensics. Evolution and scope of digital forensics. Role of digital forensics in cybersecurity and law enforcement. Branches of digital forensics (computer, network, mobile, cloud). Challenges in digital forensic investigations. Overview of forensic standards and best practices.

Unit II: Digital Evidence & Legal Considerations. Types of digital evidence. Volatile vs non-volatile data. Rules of evidence and admissibility. Chain of custody and documentation. Introduction to cyber laws and forensic relevance.

Unit III: Forensic Investigation Process. Common forensic process models (conceptual). Evidence identification and acquisition. Preservation techniques. Analysis overview. Reporting and expert testimony basics

Unit IV: Forensic Tools & Techniques. Disk and file system forensics (conceptual overview). Log analysis fundamentals. Network traffic evidence basics. Mobile device forensics overview. Common forensic tools: FTK, EnCase.

Unit V: Case Studies, Ethics & Emerging Trends. Financial fraud investigation. Data breach scenario. Ethical issues in digital forensics. Privacy and compliance considerations. Emerging trends: cloud forensics, IoT forensics (overview).

Textbooks/ References

1. Digital Evidence and Computer Crime, 3rd Edition, by Eoghan Casey. Academic Press (Elsevier)
2. Guide to Computer Forensics and Investigations, 6th Edition, by Nelson, Phillips & Steuart. Cengage Learning
3. Cybercrime and Forensics, Latest Edition, Pearson by Bill Nelson

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

IOT & EMBEDDED SYSTEMS STREAM

26CSA371	INTRODUCTION TO IOT	L-T-P-C: 3-0-0-3

Course Objective(s)

- To provide hands-on experience in IoT concepts such as sensing, actuation, and communication.
- To develop program skills in Arduino and Raspberry-PI programming for IoT applications.
- To introduce the process of interfacing actuators and sensing devices to Arduino and Raspberry PI.
- To impart the knowledge of networking concepts that enable wired and wireless communication among devices for IoT applications.
- To introduce cloud platforms for storing and implementing IoT applications

Course Outcomes

COs	Description
CO1	Familiarize with the fundamental concepts of Internet of Things. .
CO2	Develop skills in programming and hardware platform like Arduino and Raspberry-PI for IOT applications.
CO3	Familiarize with the design and implementation of IOT protocols and connecting devices for IOT application.
CO4	Analyse and integrate the IOT applications to cloud service.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	1	1	1	1	1	1
CO2	2	3	2	2	2	1	2	2
CO3	2	3	1	3	2	1	1	2
CO4	2	3	2	2	2	1	2	2

Syllabus

Unit 1: Introduction to IOT Overview of machine-to-machine communication – Sensing – Actuations-Basics of Networking Introduction to Micro-Controllers-Introduction to Embedded systems.

Unit 2: Basics of networking for device-to-device communication, Communication Protocols – wired and wireless communication – Network Topology-Sensor Networks-Introduction to Arduino and Raspberry-PI-Introduction to IOT protocols-MQTT-COAP-Wi-Fi and Bluetooth connections in Arduino-Raspberry-PI Ethernet and Wi-Fi connectivity

Unit 3: Programming Arduino and Raspberry-PI Introduction to Arduino programming – Arduino GPIO's – Arduino Digital and Analog Input & Output – Interfacing Sensors to Arduino – Interfacing communication devices to Arduino – Configuring Raspberry-PI-Introduction to python-Programming Raspberry-PI using python-Raspberry-PI GPIO's-Interfacing sensors to Raspberry-PI- Communicating Arduino and Raspberry-PI using ethernet / Bluetooth/ Wi-Fi-Remote Actuation and control of motors, LED's and Relays using Arduino and Raspberry-PI.

Unit 4: Introduction to cloud and IOT cloud Services – Cloud services for IOT storage-Introduction to cloud services to visualize IOT data- Streaming IOT data to cloud-Plot and Visualize data using cloud tools- Adding IOT devices to cloud- Integrating Arduino and Raspberry-PI to ThingSpeak /IBM Watson.

Text Books / References

1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press).
2. Singh, R., Gehlot, A., Gupta, L. R., Singh, B., & Swain, M. (2019).?Internet of things with Raspberry Pi and Arduino. CRC Press.
3. Strickland, James R. "Raspberry Pi for Arduino Users."?Raspberry Pi for Arduino Users?-Building IoT and Network Applications and Devices,(2018).
4. Singh, Rajesh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, and Mahendra Swain.?Internet of things with Raspberry Pi and Arduino. CRC Press, 2019.
5. Banzi, Massimo, and Michael Shiloh.?Getting started with Arduino. Maker Media, Inc., 2022.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA372	IOT PROGRAMMING	L-T-P-C: 2-0-2-3

Course Objective(s)

- To understand the architecture and programming models of IoT systems
- To develop programs for embedded platforms used in IoT applications
- To interface sensors and actuators with IoT devices
- To implement IoT communication protocols and cloud integration

Course Outcomes

COs	Description
CO1	Explain IoT architectures, components, and programming paradigms
CO2	Develop embedded programs for sensor data acquisition and actuator control
CO3	Implement communication between IoT devices using standard protocols
CO4	Build and deploy basic cloud-enabled IoT applications

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	–	–	1	–	1	–
CO2	3	3	2	–	3	–	1	–
CO3	2	3	2	–	3	1	1	–
CO4	2	2	3	–	3	1	1	1

Syllabus

Unit I: Introduction to IoT and Embedded Platforms

Overview of Internet of Things, IoT system architecture, IoT building blocks, sensing and actuation, embedded computing platforms for IoT, microcontrollers vs single-board computers, development environments, programming challenges in resource-constrained devices.

Unit II: Embedded Programming for IoT Devices

Arduino platform overview, Arduino programming model, digital and analog I/O, GPIO programming, timers and interrupts, interfacing sensors (temperature, humidity, motion) and actuators (LED, relay, motor), serial communication (UART, I2C, SPI), power management basics.

Unit III: IoT Communication and Networking

IoT networking concepts, device-to-device and device-to-cloud communication models, wireless technologies for IoT (Wi-Fi, Bluetooth Low Energy, Zigbee – overview), application layer protocols: MQTT, HTTP/REST, CoAP, publish–subscribe vs request–response models, data formats (JSON, XML).

Unit IV: Cloud Integration and IoT Applications

Cloud architecture for IoT, device registration and management, data ingestion and storage, dashboards and visualization, REST APIs for IoT, introduction to edge computing, security basics in IoT (authentication, authorization, secure communication), case studies of IoT applications.

Text Books

1. Arshdeep Bahga, Vijay Madisetti, *Internet of Things: A Hands-On Approach*, Universities Press, 2015.
2. Rajkumar Buyya, Amir Vahid Dastjerdi, *Internet of Things: Principles and Paradigms*, Morgan Kaufmann, 2016.

Reference Books

1. Adrian McEwen, Hakim Cassimally, *Designing the Internet of Things*, Wiley, 2014.
2. Documentation of Arduino, Raspberry Pi, MQTT, and REST APIs.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA373	IOT NETWORK BASICS	L-T-P-C: 3-0-0-3

Course Objective(s)

- To understand basic networking concepts in the context of IoT systems
- To study IoT communication models and network architectures
- To learn IoT networking protocols and standards
- To understand wireless communication technologies used in IoT
- To develop the ability to design basic IoT networking solutions

Course Outcomes

COs	Description
CO1	Explain IoT networking concepts, architectures, and communication models
CO2	Analyze IoT communication protocols and protocol stacks
CO3	Apply appropriate networking technologies for IoT applications
CO4	Design basic IoT network architectures for real-world scenarios

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	–	–	2	–	1	–
CO2	3	3	2	–	3	–	1	–
CO3	2	3	2	–	3	1	1	–
CO4	2	2	3	–	3	1	1	1

Syllabus

Unit I: Fundamentals of Networking for IoT

Basics of data communication, network types, IoT communication models (device-to-device, device-to-gateway, device-to-cloud), IoT network architecture layers, addressing in IoT, IPv4 vs IPv6, 6LoWPAN, constraints in IoT networking.

Unit II: IoT Communication Protocol Stack

IoT protocol stack overview, physical and data link layers for IoT, network layer protocols, transport layer protocols (UDP, TCP), application layer protocols, protocol interoperability and gateways.

Unit III: Wireless Communication Technologies for IoT

Wireless communication fundamentals, short-range technologies (Bluetooth Low Energy, Zigbee, Z-Wave), medium-range technologies (Wi-Fi, Thread), long-range technologies (LoRaWAN, NB-IoT, Sigfox), comparison of IoT wireless technologies.

Unit IV: Routing, Security, and Network Management

Routing in IoT networks, mesh and star topologies, routing protocols for IoT (RPL), quality of service (QoS), network reliability, IoT network security basics, secure communication, authentication, network management and monitoring, case studies of IoT networking deployments.

Text Books

1. Arshdeep Bahga, Vijay Madisetti, *Internet of Things: A Hands-On Approach*, Universities Press, 2015.
2. Rajkumar Buyya, Amir Vahid Dastjerdi, *Internet of Things: Principles and Paradigms*, Morgan Kaufmann, 2016.

Reference Books

1. Perry Lea, Internet of Things for Architects, Packt Publishing.
2. Adrian McEwen, Hakim Cassimally, Designing the Internet of Things, Wiley.
3. Al-Fuqaha et al., Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications, IEEE Communications Surveys & Tutorials.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA374	IoT SECURITY FUNDAMENTALS	L-T-P-C: 3-0-0-3

Course Objective(s)

- To understand the security challenges and threat models in IoT systems
- To learn cryptographic techniques suitable for resource-constrained IoT devices
- To analyze vulnerabilities, attacks, and defense mechanisms in IoT environments
- To design secure IoT architectures and communication mechanisms

Course Outcomes

COs	Description
CO1	Identify and analyze security threats and vulnerabilities in IoT systems
CO2	Apply cryptographic and authentication mechanisms for IoT security
CO3	Evaluate secure communication protocols and access control mechanisms
CO4	Design basic secure IoT architectures considering privacy and ethics

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	–	–	–	2	1	–
CO2	3	2	2	–	2	3	1	–
CO3	2	3	2	–	2	3	1	–
CO4	2	2	3	–	2	3	1	1

Syllabus

Unit I: Introduction to IoT Security

IoT security overview, characteristics of IoT environments, threat landscape, attack surface in IoT systems, security requirements for IoT, IoT security architecture, challenges in securing resource-constrained devices.

Unit II: Cryptography and Authentication for IoT

Basics of cryptography, symmetric and asymmetric encryption, hashing and message authentication codes, key management in IoT, lightweight cryptographic algorithms, authentication mechanisms, identity management for IoT devices.

Unit III: Secure Communication and Access Control

Secure communication protocols for IoT (TLS/DTLS), secure MQTT and HTTP, access control models, authorization frameworks, role-based and attribute-based access control, trust management, secure firmware updates.

Unit IV: Privacy, Attacks, and Secure IoT Design

IoT privacy issues, data protection and privacy preservation techniques, common IoT attacks (DoS, spoofing, replay, malware), intrusion detection for IoT, secure IoT architecture design, case studies and best practices.

Text Books

1. Alrawais, Alhothaily, Hu, Cheng, Fog Computing for Cyber-Physical Systems: Security and Privacy Perspectives, Springer, 2018.
2. Sicari et al., Security, Privacy and Trust in Internet of Things, Springer, 2015.

Reference Books

1. David Linthicum, Cloud Computing and SOA Convergence in Your Enterprise, Addison-Wesley.
2. NISTIR 8259 – Foundational Cybersecurity Activities for IoT Device Manufacturers.
3. OWASP IoT Top 10 Documentation.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA375	FUNDAMENTALS OF EDGE COMPUTING	L-T-P-C: 3-0-0-3

Course Objective(s)

- Introduces edge computing concepts for cyber-physical systems (CPS).
- Explains real-time system characteristics and the role of RTOS in CPS.
- Covers RTOS design aspects, scheduling, synchronization, communication, and memory management.
- Develops skills in performance analysis, testing, and evaluation of RTOS for CPS applications**.**

Course Outcomes

COs	Description
CO1	Understand the fundamental concepts of edge computing and its significance in the context of distributed systems.
CO2	Ability to design edge computing solutions, including architectures, models, and platforms.
CO3	Develop knowledge of resource management techniques in edge computing, including task scheduling algorithms, resource allocation algorithms, and load balancing algorithms.
CO4	Apply performance analysis and optimization techniques to evaluate the effectiveness and efficiency of edge computing solutions.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	–	–	–	–	–	–
CO2	3	3	2	–	–	–	–	–
CO3	3	3	2	–	–	–	–	–
CO4	3	3	1	–	–	–	–	–

Syllabus

Unit I: Overview of edge computing and its significance in distributed systems. Edge computing architectures, models, and platforms. Comparison of edge computing with cloud computing and fog computing. Case studies of edge computing applications

Unit II: Resource management in edge computing and its challenges. Resource management techniques for edge computing, including task scheduling algorithms, resource allocation algorithms, and load balancing algorithms. Case studies and applications of resource management in edge computing, such as mobile edge computing, and autonomous vehicles.

Unit III: Metrics for measuring performance in edge computing: latency, throughput, and energy efficiency. Case studies of performance analysis and optimization in edge computing, such as edge-based video streaming, smart transportation systems, and healthcare IoT devices. Emerging trends in edge computing: edge intelligence, serverless computing, edge security, and hybrid cloud and edge architectures.

Text Books / References

Textbook(s)

1. Anitha Kumari, G. Sudha Sadasivam, D. Dharani and M. Niranjanamurthy,"Edge Computing Fundamentals, Advances and Applications", CRC Press, 2022.

Reference(s)

1. Xin Sun and Amin Vahdat, "Edge Computing: A Primer", CRC Press, 2019.
2. Daniel Situnayake, Jenny Plunkett, "AI at the Edge", O'Reilly Media, Inc, 2023.
3. Rajkumar Buyya and Satish Narayana Srirama, "Fog and Edge Computing Principles and Paradigms", John Wiley & Sons, Inc.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA376	INDUSTRIAL INTERNET OF THINGS	L-T-P-C: 3-0-0-3

Course Objective(s)

- To understand the fundamentals and architecture of Industrial IoT systems
- To learn industrial sensors, controllers, and communication protocols
- To analyze data acquisition and monitoring systems used in industries
- To study industrial use cases such as smart manufacturing and predictive maintenance

Course Outcomes

COs	Description
CO1	Explain IIoT concepts, architectures, and industrial requirements
CO2	Analyze industrial sensors, controllers, and communication protocols
CO3	Design basic IIoT-based monitoring and control systems
CO4	Evaluate industrial IoT applications and real-world case studies

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	–	–	1	–	1	–
CO2	3	3	2	–	2	–	1	–
CO3	2	3	3	–	3	–	1	1
CO4	2	2	2	–	2	1	1	1

Syllabus

Unit I: Introduction to Industrial Internet of Things

Overview of IIoT, evolution from traditional automation to Industry 4.0, differences between IoT and IIoT, IIoT reference architecture, industrial requirements such as reliability, latency, scalability, and safety.

Unit II: Industrial Sensors and Communication Protocols

Industrial sensors and actuators, programmable logic controllers (PLCs), supervisory control and data acquisition (SCADA), industrial communication protocols (Modbus, PROFIBUS, CAN, OPC UA), real-time data acquisition systems.

Unit III: IIoT System Design and Industrial Analytics

Edge computing in IIoT, data acquisition and preprocessing, integration of IIoT with cloud platforms, industrial data analytics, condition monitoring, predictive maintenance, digital twins.

Unit IV: Industrial Applications and Case Studies

Smart manufacturing systems, industrial automation, energy management, asset tracking, safety and security in IIoT, challenges and future trends, real-world industrial case studies.

Text Books

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.
2. Rajkumar Buyya, Amir Vahid Dastjerdi, Internet of Things: Principles and Paradigms, Morgan Kaufmann, 2016.

Reference Books

1. Shrouf, Ordieres, Miragliotta, *Smart Factories in Industry 4.0*, Elsevier.
2. Documentation on OPC UA, Modbus, and SCADA systems.
3. IEEE and NIST reports on Industrial IoT.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

Regular Stream

26CSA361 CLIENT SERVER COMPUTING L-T-P-C: 3-0-0-3

Course Objective(s)

The objective of this course is to familiarize with client server computing concepts, to understand the components of client server application, client server system development and the data storage concepts in client server computing.

Course Outcomes

COs	Description
CO1	Explore the concept of client server computing.
CO2	Analyze the components of client server application.
CO3	Design the client server network.
CO4	Develop Client Server System applications.
CO5	Explore the data Storage concepts in client server computing.

CO-PO Mapping

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO								
CO1	3	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	2
CO4	-	2	3	2	-	-	-	-

Syllabus

Unit1

Client/Server Computing: DBMS concept and architecture, Single system image, Client Server architecture, mainframe-centric client server computing, downsizing and client server computing, preserving mainframe applications investment through porting, client server development tools, advantages of client server computing.

Unit-2

Components of Client/Server application: The client: services, request for services, RPC, windows services, fax, print services, remote boot services, other remote services, Utility Services. Dynamic Data Exchange (DDE), Object Linking and Embedding (OLE), Common Object Request Broker Architecture (CORBA). The server: Detailed server functionality, thenetwork operating system, available platforms, the network operating system, available platform, the server operating system.

Unit-3

Client/Server Network: connectivity, communication interface technology, Interposes communication, wide area network technologies, network topologies (Token Ring, Ethernet, FDDI, CDDI) network management, Client-server systemdevelopment: Software, Client–Server System Hardware: PC-level processing unit, Macintosh, notebooks, pen, UNIX workstation, x-terminals, server hardware.

Unit-4

Client Server Systems Development: Services and Support, system administration, Availability, Reliability, Serviceability,Software Distribution, Performance, Network management, Help Disk, Remote Systems Management Security, LAN and Network Management issues. Training, Training advantages of GUI Application, System Administrator training, Database Administrator training, End-user training.

Textbooks/ References

1. Patrick Smith & Steave Guengerich, ―Client / Server Computing‖, PHI
2. Dawna Travis Dewire, ―Client/Server Computing‖, TMH

References

1. Robert Orfali, Dan Harkey, and Jeri Edwards, ―Client / Server Survival Guide, Third Edition, JOHN WILEY & SONS. INC.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA362	E-COMMERCE TECHNOLOGIES	L-T-P-C:3-0-0-3

Course Objective(s)

- Introduce the fundamental concepts and evolution of electronic commerce systems.
- Explain the architectures and technologies enabling e-commerce platforms.
- Develop an understanding of electronic payment systems and transaction processing.
- Familiarize students with security, privacy, and trust mechanisms in e-commerce.
- Provide awareness of legal, ethical, and societal aspects of e-commerce technologies.

Course Outcomes

COs	Description
CO1	**Analyze** the structure and operation of electronic commerce systems
CO2	**Explain and evaluate** e-commerce architectures and enabling technologies
CO3	**Assess** electronic payment models and transaction processing mechanisms
CO4	**Evaluate** security, privacy, and trust requirements for e-commerce platforms
CO5	**Analyze** legal, ethical, and emerging trends in electronic commerce

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	2	1	0	0	0	1
CO2	3	3	2	2	0	0	0	1
CO3	2	2	3	2	0	0	1	1
CO4	2	3	2	2	0	0	3	1
CO5	1	2	1	1	0	0	3	2

Syllabus

Unit I: Introduction to electronic commerce. Evolution of e-commerce. Traditional commerce vs e-commerce
Types of e-commerce: B2C, B2B, C2C, G2C. E-commerce business models (technology perspective). Features and components of an e-commerce system.

Unit II: E-Commerce Architecture and Technologies. E-commerce system architecture. Client–server and multi-tier architectures. Web and application servers. Role of databases in e-commerce. Middleware and integration technologies. APIs and service-based architectures.

Unit III: Fundamentals of electronic payment systems. Online transaction processing
Payment models: Credit and debit cards, Net banking, Digital wallets, UPI and mobile payments (conceptual). Payment gateways and intermediaries. Risks and challenges in electronic payments.

Unit IV: Security requirements in e-commerce: Confidentiality, Integrity, Authentication, Non-repudiation. Encryption and digital signatures (overview). Secure Socket Layer (SSL/TLS). Public Key Infrastructure (PKI). Trust models and certification authorities. Fraud and cyber threats in e-commerce.

Unit V: Legal issues in e-commerce: Electronic contracts, Digital signatures. Consumer protection (overview). Privacy and data protection concerns. Ethical issues in online commerce. Emerging technologies: Mobile commerce (m-commerce), Social commerce, Blockchain in e-commerce (conceptual). Future trends and challenges.

Text Books

1. Electronic Commerce by Gary P. Schneider. Cengage Learning
2. E-Commerce: Business, Technology, Society, by Kenneth C. Laudon and Carol Guercio Traver. Pearson Education

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA363	KNOWLEDGE MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objective(s)

- Acquire the knowledge on basics of knowledge management and knowledge management cycle.
- Explore the various knowledge management models and their roles in business strategies'
- Develop understanding in using tools and technology for KM implementation and its use cases

Course Outcomes

COs	Description
CO1	Recognize the basic concepts of knowledge management, thematic analysis and dynamics
CO2	Role of knowledge Management models in business strategies.
CO3	Focus on knowledge transfer and organization learning
CO4	Interpret the tools and technology for KM implementation and survey the business case illustrations

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	-	-	-	-	-	-	-
CO2	1	-	-	-	-	-	-	-
CO3	1	2	2	3	-	-	-	-
CO4	-	2	2	3	-	-	-	-

Syllabus

UNIT- 1

Focuses on Knowledge Economy - Context and Relevance of KM in the Business and Paradigm Shift, Emergence of Knowledge Economy - Demanding Knowledge Driven Strategic approach to Business. Focuses on Data, Information, Knowledge, attributes of knowledge, ethics, Types of Knowledge - Tacit and Explicit Knowledge, evolution, Knowledge: A Driver for Creativity and Innovation, Knowledge a Strategic Resource.

Focuses on Management of Knowledge - Knowledge Management, Knowledge Development and Management Cycle, Thematic Analysis of Knowledge Management, Knowledge Transformation and its Dynamics, Business Case for Knowledge Management

UNIT- 2

Focuses on KM Design and Architecture- Generic Model of Knowledge Management System, Challenges in Developing KMS, KM System Design and Architecture.

Focuses on KM for Business strategy - KM, Business Strategy and Knowledge Link, A Knowledge Strategy Framework, Validation of Knowledge through Knowledge Models, Creation and Acquisition of Knowledge, Knowledge Acquisition Techniques (KAT)

UNIT- 3

Focuses on KM to Transfer, Measure, Capitalize and Control - Knowledge Transfer and Sharing, Knowledge Mapping, Knowledge Asset, Intellectual Capital and Property.

Focuses on Organization Learning and Learning Organization - The Concept and Building of a learning organization, File Core Disciplines of a Learning Organization, Organization Learning

UNIT - 4

Focuses on Tools and Technology for Successful KM Implementation - ICT, UCT, WiMAX Technology, Groupware Technology, Data Warehouse and Data Mining for Knowledge Search. Focuses on Case Illustrations of Knowledge Management and Making a Business Case for Knowledge, Management where following Tools and Technology are Used - Data Warehousing and Data Mining, Knowledge Portal, Knowledge Products, Intelligent Agents

Textbooks / References

1. Knowledge Management –Waman S Jawadekar, Tata McGraw Hill Education Private Limited-2011
2. Knowledge Management –E Sudhir Warier, Vikas Publishing House Pvt. Ltd. -2009
3. Measuring and Managing Knowledge: Tom Housel and Arthur Bell 2001, International Edition, Tata, McGraw-Hill
4. Knowledge Management: Ganesh Natarajan, President & CEO Aptech

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA364	SOFT COMPUTING	L-T-P-C: 3-0-0-3

Course Objective(s)

1. Identify the characteristics of Soft computing systems and explore various applications of Soft computing techniques
2. Investigate applications of Neural Networks including Associative Memory, Adaptive Resonance theory, and SelfOrganizing Maps.
3. Analyse applications of Fuzzy Logic in decision-making, control systems, and classification.
4. Explore applications of hybrid Soft computing techniques and Analyze the convergence of GA and its multi-leveloptimization capabilities.

Course Outcomes

COs	Description
CO1	Demonstrate an understanding of the characteristics of Soft computing systems and their advantages over traditional computing paradigms.
CO2	Use Neural Networks for various domains such as pattern recognition, associative memory, and optimization, and evaluate their performance.
CO3	Optimize Fuzzy Logic-based systems for improved performance in different application domains.
CO4	Critically evaluate hybrid Soft computing approaches and Genetic Algorithms to solve real-world optimization problems

CO-PO Mapping

PO								
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-
CO4	3	3	3	2	-	-	-	-

Syllabus

Unit 1: Introduction to Soft Computing: Concept of computing systems, "Soft" computing versus "Hard" computing, Characteristics of Soft computing, Some applications of soft computing techniques.

What is Neural Network, Learning rules and various activation functions, Single layer Perceptron, Back Propagation networks, Architecture of Backpropagation (BP)Networks, Backpropagation Learning, to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications.

Unit 2: Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Minmax Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule-based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.

Unit 3: Hybrid Soft Computing Techniques and Applications: Neuro-fuzzy hybrid systems, Genetic neuro hybrid systems, Genetic fuzzy hybrid and fuzzy genetic hybrid systems, simplified fuzzy ARTMAP – Applications: A fusion approach of multispectral images with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing-based hybrid fuzzy controllers.

Unit 4: Genetic Algorithm: -History of Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function, GA Operators- Reproduction, Crossover, Mutation, Convergence of GA, Bitwise operation in GA, Multi-level Optimization.

Textbooks:

1. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI
2. S.N.Sivanandam and S.N.Deepa, ―Principles of Soft Computing‖, Wiley India Pvt Ltd, 2011.

References

1. J.S.R.Jang, C.T.Sun, and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education 2004.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, International Editions, Electrical Engineering Series, Singapore.
3. Stamatios V. Kartalopoulos "Understanding Neural Networks and Fuzzy Logic Basic Concepts & Applications", IEEE Press, PHI, New Delhi.
4. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA365 SYSTEMS AND NETWORK ADMINISTRATION L-T-P-C: 3-0-0-3

Course Objective(s)
The main aim of this course is to provide basic ideas to manage and administer computer systems as well as networks. Students are trained with practical sessions

Course Outcomes

COs	Description
CO1	Analyze the role of a System and Network administrator.
CO2	Explore the basic software commands for managing and administering the Systems and networks.
CO3	Develop skills in doing subnets, routing, and VPN installation.
CO4	Develop the skill to test the security vulnerabilities and their countermeasures.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	-	-	-	-	-	-	1
CO2	1	1	1	-	-	-	-	1
CO3	1	-	1	-	-	-	1	1
CO4	1	-	1	-	-	-	-	1

Syllabus
Unit 1: Understanding System Administration – Importance of Port Number, Tracking Services and processes. Monitoring your System, Network Operating System - Admin User - Administration Tools – Commands - Configuration Files – Log Files - Backup and Restore Files.

Unit 2: User Management - Issues - Registration – Account Policy – Login environment – Setting up and Supporting Users – Disk Quotas.

Unit 3: Network Administration – Topologies – Network Devices - Network Configuration – Static and Dynamic-Routing, Switching, VPN and other security Protocols-Firewall administration

Unit 4: Introduction to File Server – Setting Up a File Server – Network File Systems - SAMBA – Web Server. Understanding Directory Services- Active Directory

Textbooks/ References
1. Red Hat Linux - System Administration
2. Windows Server 2016 Administration Fundamentals by Bekim Dauti
3. UNIX and Linux System Administration Handbook, 4thEd., by Nemeth, Snyder, Hein and Whaley (Prentice Hall,2010)
4. The Practice of System and Network Administration, 2nd Ed., by Limoncelli, Hogan and Chalup (Addison Wesley, 2007)
5. Mark Burgess – Principles of Network and System Administration –2nd Edition - John Wiley & Sons 6. Essential System Administration: Tools and Techniques for Linux and Unix Administration, 3rd Edition 3rd Edition by Æleen Frisch
7. LDAP System Administration: Putting Directories to Work 1st Edition by Gerald Carter
8. TCP/IP Network Administration (3rd Edition; O'Reilly Networking) Third Edition by Craig Hunt
9. Network Troubleshooting Tools (O'Reilly System Administration) 1st Edition by Joseph D Sloan
10. Linux Cookbook: Essential Skills for Linux Users and System & Network Administrators 2nd Edition by CarlaSchroder

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA366	MULTIMEDIA APPLICATIONS	L-T-P-C: 3-0-0-3

Course Objective(s)

1. Understand the concept and evolution of multimedia, including its history, early computing, and the principles ofhypermedia and hypertext.
2. Develop skills in photo editing using Photoshop, including cropping, adjusting tone/color/brightness/contrast, retouching, and saving images appropriately.
3. Learn about graphic design principles, including types of graphic design, image-based and type-based design, symboland logo design, and the graphic design process.
4. Gain proficiency in video and animation techniques, including visual representation, digitalizing video, and utilizinganimation tools to create engaging multimedia content.

Course Outcomes

COs	Description
CO1	Understand multimedia's evolution and diversity, differentiate between linear and interactive formats, and integrate varied media to communicate effectively.
CO2	Apply audio and video principles, mastering techniques such as digitization and signal processing, to create dynamic multimedia presentations.
CO3	Acquire expertise in photo editing and graphic design, demonstrating skills in image manipulation, color correction, and the creation of visually compelling graphics and logos.
CO4	Analyze the components and functionalities of multimedia systems, evaluating the roles of perception, representation, storage, and transmission mediums in multimedia content delivery

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-
CO3	1	1	3	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-

Syllabus

Unit-1 Introduction to Multimedia: Introduction to multimedia, a concise history of multimedia, early multimedia computing, hypermedia and hypertext, combining content from various media, linear VS. Interactive multimedia, nonlinear interactive multimedia, kinds of multimedia.

Unit: 2 Audio fundamentals and Video and Animation: Audio fundamentals, sound waves, sound transducer, signal fundamentals, measurement of sound, sound wave and signal, analog/ digital conversion, quantizes sound signal, Fourier transform.

Video and Animation: Introduction to video animation, visual representation, video resolution, digitalizingvideo, video capture cards, video formats, animation, controlling animation, animation tools.

Unit 3: Photo editing and Graphic Designing: Photoshop- image editing, create a copy of your original image, crop and straighten your picture, check your image size and resolution, fix tone, color, brightness, contrast, retouch as necessary, sharpen your image, save your image appropriately.

Graphic Designing: Types of graphic design, image-based design, type-based design, image and type design, symbols, logosand logo types, the graphic design process, briefing, design, art work, production.

Unit 4: Media and data streams: Multimedia: media and data streams, main properties of a multimedia system, the perception medium, the representation medium, the storage medium, the transmission medium, representation values and representation spaces, representation dimensions.

Textbook

1. Introduction to Multimedia Communications: Applications, Middleware, Networking" by Kamisetty Rao andFeng Wu
2. "Audio in Media" by Stanley Alten
3. Understanding Animation" by Paul Wells

Reference

1. "The Adobe Photoshop CC Book for Digital Photographers" by Scott Kelby

2. "Graphic Design School: The Principles and Practice of Graphic Design" by David Dabner, Sandra Stewart, and Abbie Vickress
3. "Multimedia: Making It Work" by Tay Vaughan

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA367 SOFTWARE TESTING AND QUALITY ASSURANCE L-T-P-C:2-0-2-3

Course Objective(s)

- Introduce the fundamental concepts and objectives of software testing and quality assurance.
- Explain testing principles, levels, and methodologies used in the software life cycle.
- Develop the ability to analyze software requirements and design effective test cases.
- Familiarize students with quality models, standards, and process improvement frameworks.
- Promote awareness of ethical responsibility, reliability, and customer trust in software products.

Course Outcomes

COs	Description
CO1	**Analyze** the role of testing and quality assurance in the software development life cycle
CO2	**Design and evaluate** test cases using appropriate functional and structural test design techniques
CO3	**Analyze** different testing levels, strategies, and life-cycle models
CO4	**Evaluate** software quality using models, metrics, and international standards
CO5	**Assess** ethical, reliability, and risk-related issues in software testing and quality assurance

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	3	2	1	0	0	1	1
CO2	3	3	3	2	0	0	1	1
CO3	2	3	2	1	0	0	1	1
CO4	2	2	3	2	0	0	2	1
CO5	1	2	1	1	0	0	3	2

Syllabus

Unit I: Introduction to Software Testing and QA. Need for software testing. Software testing vs debugging. Verification vs validation. Objectives and principles of software testing. Role of testing in SDLC. Quality assurance vs quality control. Cost of software defects

Unit II: Software Testing Life Cycle (STLC). Test planning and test strategy. Levels of testing: Unit testing, Integration testing, System testing, Acceptance testing. Alpha and beta testing. Regression testing.

Unit III: Test Design Techniques. Black-box testing techniques: Equivalence class partitioning, Boundary value analysis, Decision table testing. White-box testing techniques: Control flow testing, Statement, branch, and path coverage. Grey-box testing (conceptual). Test case design and documentation.

Unit IV: Software quality concepts. Software quality models: McCall's model, ISO/IEC 25010 quality model. Software metrics: Product metrics, Process metrics. Defect management and reporting. Introduction to standards: ISO 9001, CMMI (overview).

Unit V: Static testing: Reviews and inspections. Risk-based testing. Software reliability concepts. Introduction to non-functional testing: Performance, Security. Usability testing. Ethical issues in testing: Data privacy, Responsible disclosure. Future trends in software testing.

Textbooks

1. Software Testing: Principles and Practice, by Srinivasan Desikan and Gopalaswamy Ramesh. Pearson Education.
2. The Art of Software Testing, by Glenford J. Myers, Corey Sandler, and Tom Badgett. 3rd Edition, Wiley.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

Electives – 4 Credits
AI & DS Stream

26CSA231	MACHINE LEARNING BASICS	L-T-P-C:3-0-2-4

Course Objective(s)

- Introduce the fundamental concepts and paradigms of machine learning.
- Develop the ability to formulate problems as suitable machine learning tasks.
- Enable students to select, apply, and compare classical ML algorithms.
- Build competence in model evaluation, validation, and performance trade-offs.
- Create awareness of limitations, bias, and ethical issues in ML systems.

Course Outcomes

COs	Description
CO1	**Analyze** real-world problems and **formulate** them as supervised or unsupervised learning tasks
CO2	**Design and apply** classical machine learning models for regression and classification
CO3	**Evaluate and compare** machine learning models using appropriate metrics and validation techniques
CO4	**Apply** clustering and dimensionality-reduction techniques for exploratory analysis
CO5	**Assess** limitations, bias, and ethical concerns in machine-learning-based decision systems

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	2	2	0	0	1	2
CO2	3	3	2	2	0	0	1	1
CO3	2	2	3	2	1	0	0	1
CO4	2	3	3	2	0	0	1	1
CO5	2	3	3	2	1	0	2	2

Syllabus

Unit I

What is Machine Learning? ML vs Programming vs AI. Types of Learning: Supervised learning, Unsupervised learning. Learning workflow: Data → Model → Prediction → Evaluation. Applications of classical ML. Limitations of ML systems.

Unit II

Regression problem formulation. Linear Regression. Assumptions and interpretation. Error functions (MSE, MAE). Regularization. Ridge and Lasso (conceptual understanding). Model performance evaluation. Overfitting and underfitting.

Unit III

Classification problem formulation. Logistic Regression. k-Nearest Neighbour (k-NN). Decision Tree Classifier. Information gain / Gini (conceptual). Performance metrics: Confusion matrix, Accuracy, Precision, Recall, F1-score, ROC curve (interpretation).

Unit IV

Clustering. k-Means algorithm. Hierarchical clustering. Cluster evaluation: Inertia, silhouette score. Dimensionality Reduction. Principal Component Analysis (PCA). Variance interpretation. Applications in data analysis.

Unit V

Training, validation, and test sets. Cross-validation (k-fold). Hyperparameter tuning (grid/random – idea level). Bias–variance trade-off. Class imbalance issues. Ethics in Machine Learning. Bias, fairness, transparency. Responsible ML practices.

Lab Syllabus

- Problem formulation & metrics selection; baselines
- Linear regression: bias–variance, residuals, regularization paths (ridge/lasso)
- Logistic regression: decision boundaries, threshold tuning, PR/ROC curves

- k-NN: distance metrics; effect of k; scaling sensitivity
- Model selection: CV & grid/random search; nested CV (concept demo)
- Clustering (k-means): choosing k;
- Compare models using metrics

Text Books

1. *An Introduction to Statistical Learning (ISLR)*, 2nd Edition, by Gareth James et al. Springer.
2. Introduction to Machine Learning with Python, by Andreas C. Müller & Sarah Guido, O'Reilly.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA232 COMPUTATIONAL INTELLIGENCE L-T-P-C: 3-0-2-4

Course Objective(s)

- Provide a comprehensive understanding of core CI paradigms like Neural Networks, Fuzzy Logic, and Evolutionary Computation.
- Implement basic CI algorithms using Python libraries.
- Analyze, evaluate and compare different CI approaches for specific tasks.

Course Outcomes

COs	Description
CO1	Gain an understanding of the core concepts, scope, and historical development of Computational Intelligence techniques. Explore the relationship between CI, Artificial Intelligence, and Machine Learning and the difference by evaluating a real-world application.
CO2	Analyze the biological inspiration behind Artificial Neural Networks. Explore different network architectures, learning algorithms, impact of activation functions on network performance and learn various training techniques.
CO3	Acquire knowledge about fuzzy sets, components of fuzzy inference systems, rule-based systems and their applications in decision-making and control.
CO4	Explore the principles of evolutionary algorithms and their role in optimization and search problems. Delve into Genetic Algorithms, including selection, crossover, mutation operators and implement various evolutionary algorithms

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	2	1	1	1	-	2
CO2	2	2	3	2	1	1	-	1
CO3	2	2	3	2	1	1	-	1
CO4	2	2	3	2	1	1	-	1

Syllabus

Unit 1: Introduction to Computational Intelligence

Definition, scope, and applications of Computational Intelligence (CI) - Historical development of CI techniques - Relationship of CI to Artificial Intelligence (AI) and Machine Learning (ML) - Types of CI: Neural Networks, Fuzzy Logic, Evolutionary Computation

Unit 2: Artificial Neural Networks

Biological inspiration and neuron models - Network architectures (Perceptron, Multi-Layer Perceptron) - Learning algorithms (Backpropagation, Gradient Descent) - Activation functions and their impact - Training techniques: Gradient Descent, Stochastic Gradient Descent, Mini-batch Gradient Descent - Applications of neural networks

Unit 3: Fuzzy Logic Systems

Fuzzy sets and fuzzy logic concepts: Fuzzy Logic - Fuzzy rules - Fuzzy inference - Membership functions and fuzzy reasoning - Fuzzy rule-based systems and their design - Applications of fuzzy logic systems

Unit 4: Evolutionary Computation

Introduction to evolutionary algorithms (EAs) - Genetic Algorithms (GAs): Selection, Crossover, Mutation - Applications of GAs (optimization, search problems) - Introduction to other EAs (Particle Swarm Optimization, Ant Colony Optimization)

Lab syllabus:

1. Install and explore Python libraries for CI: TensorFlow, scikit-fuzzy, DEAP.
2. Write simple Python scripts to perform basic mathematical operations using these libraries.
3. Implement a Perceptron algorithm in Python to perform binary classification on a sample dataset.
4. Explore different activation functions (e.g., Sigmoid, ReLU) and analyze their impact on network performance.
5. Implement a Multi-Layer Perceptron (MLP) network with backpropagation for a more complex classification task.
6. Analyze the effect of hidden layers and the number of neurons on the performance of the MLP.
7. Implement fuzzy sets and membership functions in Python for a given variable.

8. Design a simple fuzzy rule-based system for decision-making.

9. Implement the fuzzy reasoning process using Python to evaluate the system's output for different inputs.

10. Analyze the impact of changing membership functions on the system's behavior.

11. Implement a basic Genetic Algorithm (GA) in Python to solve a simple optimization problem.

12. Analyze the impact of different selection methods on the performance of the GA.

13. Explore crossover and mutation operators and their effect on the diversity of the population.

14. Implement a simple Particle Swarm Optimization (PSO) algorithm and compare its performance to GA for a chosen problem.

Textbooks

1. Stuart Russell, Peter Norvig, ―Artificial Intelligence: A Modern Approach‖, Third Edition, Pearson Education / Prentice Hall of India, 2010.
2. Elaine Rich and Kevin Knight, ―Artificial Intelligence‖, Third Edition, Tata McGraw Hill, 2010.

References

1. Patrick H. Winston. "Artificial Intelligence", Third edition, Pearson Edition, 2006.
2. Dan W.Patterson, ―Introduction to Artificial Intelligence and Expert Systems‖, PHI, 2006.
3. Nils J. Nilsson, ―Artificial Intelligence: A new Synthesis‖, Harcourt Asia Pvt. Ltd., 2000.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA233	TIME SERIES ANALYSIS	L-T-P-C: 3-0-2-4

Course Objective(s)

- Enhance the ability to analyze the timely data with trend estimation and seasonal forecasting.
- Pre-requisite: Probability and statistics,

Course Outcomes

COs	Description
CO1	Introduce the overview of time series analysis and importance of its properties.
CO2	Describe the regression, type and importance of regression and role of model selection in time series
CO3	Analyze the data about its covariance and prediction about time series data and its models.
CO4	Classify different types of spectral representation and estimation of time series analysis.
CO5	Building the multivariate and spatial time series and its higherapplications.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	1	1	-	-	-	-
CO2	3	1	2	3	-	-	-	-
CO3	3	2	2	3	-	-	-	-
CO4	3	3	2	2	-	-	-	-
CO5	3	2	2	-	-	-	-	-

Syllabus

Unit 1

Introduction to Time Series Analysis- Signal Vs Noise - Graphics - Stationary Process - Ensemble methods - Random walk Vs trend - Periodicity - Linear Process - Estimators: Mean, ACF, PACF and Variorum. Properties of Covariance and Normality.

Unit 2

Regression Models - Trend - Difference of time - Backshift operator - Harmonic regression - Periodogram - Signal processing, novel asymptote theory - Nonparametric regression - smoothening - Periodic functions; Model selection-AIC, BIC, SIC, bias-variance trade-of; ARMA models-polynomial approximation, causality, notation.

Unit 3

Covariances-identification Prediction - recursion; Estimation - MLE, LS, forward-backward State - space models - Kalman filter Properties -equivalence with ARMA, nonlinear models - Switching models-hidden Markov models (HMM).

Unit 4

Hilbert spaces-infinite dimension, L2, martingale; Spectral representation-integral representation, Woldde composition; Periodogram-discrete Fourier transform (DFT); Spectral estimation-linear filters.

Unit 5

Multivariate time series-VAR, cross-correlation, trans function, spectral regr; Cointegration- principal components; Seasonality-X-11, Dynamic multiple regression models, Quasi variant step regression models, seasonal differencing; Wavelets- multi resolution analysis; Spatial time series-kriging, spatial AR models

Textbooks:

1. R. H. Shumway and D. S. Stoffer (2006), Time series analysis and its applications (With R Examples, Second Edition). Springer, New York.

References:

1. "The Analysis of Time Series: An Introduction" by Chris Chatfield.
2. "Forecasting: Principles and Practice" by Rob J. Hyndman and George Athanasopoulos.
3. "Introduction to Time Series Analysis and Forecasting" by Douglas C. Montgomery, Chery L. Jennings, and Murat Kulahci.

List of Experiments:

1. Use time series analysis techniques to forecast future inventory needs and optimize stock levels. This can help to reduce stockouts and holding costs.
2. Build a time series model to predict future stock prices. It is important to remember that this is a complex task and theresults should not be used for financial decision-making.
3. To forecast future website traffic and identify patterns in user behavior. This information can be used to improve website design and content marketing strategies.
4. Use time series analysis to identify trends in social media activity and understand how different factors can impact these metrics.
5. Focus to predict the temperature in the near future in any geo location with an multi variate trend estimation.
6. Use time series analysis to forecast future sales and identify factors that can impact sales.
7. Analyse the data Trend using exponential smoothening technique.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA234	NON-RELATIONAL DATABASES	L-T-P-C: 3-0-2-4

Course Objective(s)

- Gain a foundational understanding of Exploratory Data Analysis (EDA) concepts.
- Learn how to import and manipulate data using Python libraries (e.g., Pandas, NumPy).
- Perform data cleaning and pre-processing techniques.
- Create informative data visualizations using Python libraries (e.g., Matplotlib, Seaborn).
- Summarize and describe data using statistical methods.

Course Outcomes

COs	Description
CO1	Students will have a neat comprehension of how NoSQL databases differ from relational databases from a practical perspective.
CO2	Students will be able to master the basics concepts of designing NoSQL database management system.
CO3	Students will be familiar with selecting a particular NoSQL database for specific use cases.
CO4	Students will be able to apply all types of NoSQL database to implement based on business requirements.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	1	1	-	-	1	-	-
CO2	2	1	1	-	-	2	-	-
CO3	1	2	2	-	-	-	-	-
CO4	2	1	1	-	-	-	-	-

Syllabus

Unit 1

Database Management System – introduction, history of database, management systems characteristics of dbms, definition, objectives, merits and demerits, entity relationship model, concurrency control. Data Models – definition, designing databases, hierarchical data model, network data model.

Unit 2

RDBMS – relational data model, techniques & components of relational data model, definition of relational terms, features, 12 rules for a fully RDBMS.

Unit 3

NOSQL Systems-Introduction to NoSQL, Disadvantages of NoSQL technology, NOSQL Systems, weakness of RDBMS, Key-value database-Key values database, more elements of key values database, Properties of Key-value store.

Unit 4

Columnar Databases - Characteristics of a columnar database. Document databases with MongoDB - Implement a document database with Mongo DB. Graph Databases - Graph databases, properties of graph model, graph traversal problems and adjacency matrix.

Lab Syllabus

- Explore DBMS features, objectives, limitations; compare hierarchical, network, and relational data models.
- Draw ER diagrams, identify entities, attributes, relationships, and convert real-world scenarios into ER models.
- Convert ER diagrams into relational schemas, define keys, constraints, relations, and practice normalization basics.
- Hands-on SQL for Understanding RDBMS Concepts
- Create tables, insert data, define keys, and run basic queries to reinforce relational model fundamentals.
- Evaluate an RDBMS installation (MySQL/PostgreSQL) against Codd’s rules; check where relational systems fall short.
- Analyze NoSQL characteristics, CAP theorem concepts (conceptual), identify scenarios where RDBMS is weak.
- Install Redis or similar; perform basic SET, GET, DEL operations; explore data persistence modes.
- Work with Redis lists, sets, hashes; understand key-value store properties and performance features.

- Implement a session store, caching scenario, or user-preference storage using Redis key-value patterns.
- Explore Cassandra / Click House concepts; inspect column families, partitioning, and primary key design.
- Create column families, insert sample data, retrieve data using typical columnar access patterns.
- Install MongoDB; create databases and collections; insert JSON documents; retrieve and filter data.
- Implement embedded documents, references, arrays; perform CRUD operations and aggregation pipeline queries.

Textbooks:

1. Advanced Data Management: For SQL, NoSQL, Cloud and Distributed Databases By Lena Wiese
2. Getting Started with Nosql by Gaurav Vaish.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA235	R PROGRAMMING	L-T-P-C: 3-0-2-4

Course Objective(s)

- Understand the core syntax, data structures (vectors, matrices, data frames) and how to navigate the R environment.
- Learn to import data from various sources, clean and transform datasets, handle missing values and outliers, andeffectively structure data for analysis.
- Gain the ability to summarize data with descriptive statistics, create informative visualizations (histograms, scatterplots,boxplots) and identify patterns and relationships within datasets.
- Develop an understanding of foundational statistical concepts like hypothesis testing (p-values) and perform simplelinear regression analysis.
- Learn to write basic R scripts to streamline data manipulation and analysis processes.

Course Outcomes

COs	Description
CO1	Apply the R programming fundamental to setup environment, write basic R scripts, and utilize core programming constructs to effectively.
CO2	Develop expertise in importing data from various formats, cleaning and manipulating datasets, and efficiently structuring data for further analysis.
CO3	Perform exploratory data analysis (EDA), including summarizing data with descriptive statistics, creating informative data visualizations, and identifying patterns and trends within datasets.
CO4	Develop a solid understanding of fundamental statistical concepts like hypothesis testing and be able to perform basic statistical analysis methods, such as simple linear regression, using R.
CO5	Equipped to write basic R scripts to automate data analysis tasks, improving efficiency and streamlining the data analysis workflow.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	-
CO2	3	-	-	3	-	-	-	-
CO3	-	3	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-
CO5	-	2	2	2	-	-	2	-

Syllabus

Unit 1

Introduction to R: Introduction to R programming and its applications. Setting up R environment and basic syntax. Working with data objects (vectors, matrices, data frames). Importing data from various sources (CSV, Excel). Hands-on practice: Basic data manipulation in R.

Unit 2

Data Manipulation and Wrangling: Data cleaning & transformation techniques. Handling missing values and outliers. Working with dates and times in R. Merging and reshaping data sets. Hands-on practice: Data cleaning and wrangling exercises.

Unit 3

Exploratory Data Analysis (EDA): Descriptive statistics and data visualization fundamentals. Creating informative visualizations (histograms, scatterplots, boxplots). Summarizing data with tables and charts. Identifying patterns and relationships in data. Hands-on practice: Conducting EDA on real-world data.

Unit 4

Introduction to Data Analysis: Basic statistical concepts (hypothesis testing, p-values), Simple linear regression analysis,Introduction to data modelling in R. Hands-on practice: Performing statistical analysis on data.

Lab Syllabus

- Write an R program to create and manipulate vectors, matrices, and data frames.
- Write an R program to import data from CSV and Excel files and display basic information.
- Write an R program to filter, subset, and modify data frame columns (basic data manipulation).
- Write an R program to clean data by handling missing values (remove/replace NA).

- Write an R program to detect and treat outliers using summary statistics and boxplot method.
- Write an R program to work with dates and times using the lubridate package.
- Write an R program to merge two data sets using different join types.
- Write an R program to reshape data using pivot_longer() and pivot_wider().
- Write an R program to compute descriptive statistics (mean, median, mode, variance).
- Write an R program to create visualizations—histogram, scatterplot, and boxplot using ggplot2.
- Write an R program to perform Exploratory Data Analysis (EDA) on a real-world dataset.
- Write an R program to generate summary tables and correlation plots.
- Write an R program to perform hypothesis testing (t-test or chi-square test).
- Write an R program to perform simple linear regression using lm() and visualize the fitted line.

TEXTBOOKS:

1. Data Science with R: A Step-by-Step Guide with Visual Illustrations & Examples, Andrew Oleksy.
2. Practical Data Science with R, Nina Zumel and John Mount, Dreamtech/Manning, 2014
3. R Programming for Data Science, Roger D. Peng, Lean publishing, 2015.

REFERENCES:

1. "R for Data Science", Hadley Wickham and Garett Grolemund, O'Reilly, 2017
2. "Data Mining for Business Analytics: Concepts, Techniques and Applications in R", GalitShmueli, et al, Wiley India,2018.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA236 PROBABILITY AND STATISTICS FOR MACHINE LEARNING L-T-P-C: 3-1-0-4

Course Objective(s)

- Understand the basic mechanisms of descriptive statistics
- Understand the preliminary concept of probability and different types of probability distribution
- Learn different types of two-dimensional probability distributions and correlation analysis
- Familiarize yourself with inferential statistics by studying the estimation theory and hypothesis testing

Course Outcomes:

COs	Description
CO1	Implement various methods of descriptive statistics using central tendency, dispersion, skewness, kurtosis, correlation and regression analysis, and least squares.
CO2	Develop the fundamental concept of probability theory.
CO3	Develop the concept of probability distribution functions.
CO4	Learn two-dimensional probability distribution theory for discrete case.
CO5	Apply the estimation theory to obtain maximum likelihood estimator, moments, and confidence interval and hypothesis testing for both large and small samples.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	-
CO2	3	-	-	3	-	-	-	-
CO3	-	3	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-
CO5	-	2	2	2	-	-	2	-

Syllabus:

Unit 1: Introduction to Statistics: Definition, importance in ML, and types of data, Measures of Central Tendency and Dispersion, skewness and kurtosis, Correlation and Regression analysis, Coefficient of determination.

Unit 2: Introduction to Probability, Probability, Conditional Probability, Multiplication and Total Probability rules, Independence, Bayes theorem

Unit 3: Random variables, Probability Distributions. Mathematical expectation and variance, Uniform, Binomial, Poisson, Exponential, and Normal distributions

Unit 4: Two-dimensional random variables - Joint, marginal and conditional probability distributions for discrete case only, correlation analysis

Unit 5: Estimation theory - Point Estimation: criteria of point estimation, method of maximum likelihood estimation and method of moments, Hypothesis testing, large and small sample tests for single mean and two means, paired t-test, Chi-square goodness of fit, Independence of attributes

Textbooks:

1. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, John Wiley and Sons Inc., 2005
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8th Edition, Pearson Education Asia, 2007.

References:

1. Ross S.M., Introduction to Probability and Statistics for Engineers and Scientists, 3rd edition, Elsevier Academic Press.
2. Ravichandran, J. Probability and Statistics for engineers, First Reprint Edition, Wiley India, 2012.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment (including lab)	25
End Semester Exam	50
Total Marks	100

CYBER SECURITY STREAM

26CSA241	BLOCKCHAIN & WEB3	L-T-P-C: 3-0-2-4

Course Objective(s)

- To introduce the fundamentals of blockchain and *decentralised* systems
- To explain blockchain architecture, consensus mechanisms, and transactions
- To understand smart contracts and *decentralised* applications (DApps)
- To explore Web3 concepts and real-world use cases
- To provide practical exposure to blockchain development basics

Course Outcomes

COs	Description
CO1	Analyze centralized and decentralized system models to justify the need for blockchain-based solutions.
CO2	Evaluate blockchain architectures, transaction flows, and consensus mechanisms for suitability in different application contexts.
CO3	Apply cryptographic concepts, wallets, and key management techniques to secure blockchain transactions and identities.
CO4	Design and implement basic smart contracts and decentralized applications using blockchain development tools.
CO5	Analyze real-world blockchain and Web3 use cases and identify suitable application scenarios.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	1	1	1	-	2	2
CO2	2	2	1	2	1	-	2	2
CO3	2	2	1	2	1	-	2	2
CO4	2	2	3	3	2	1	2	2
CO5	2	3	3	2	2	1	2	2

Syllabus

Unit I

Introduction to Blockchain & Distributed Ledgers. Evolution from centralized to decentralized systems. Need for trust less systems. Blockchain definition and characteristics. Distributed ledger technology (DLT). Types of blockchains: public, private, consortium. Benefits and limitations of blockchain.

Unit II

Blockchain Architecture & Consensus. Block structure and hash chaining. Transactions and Merkle trees (conceptual). Consensus mechanisms: PoW, PoS, PBFT (high-level). Nodes, miners, validators. Transaction validation and finality.

Unit III

Blockchain & Cryptography Essentials. Hash functions and digital signatures in blockchain. Public/private keys and wallets. Addresses and key management. Introduction to cryptocurrency (Bitcoin, Ethereum overview). Gas, fees, and incentives (concepts only)

Unit IV

Smart Contracts & Ethereum Platform. What are smart contracts? Ethereum architecture. Smart contract lifecycle. Intro to Solidity programming language (syntax & structure). Advantages and risks of smart contracts.

Unit V

Web3, DApps & Use Cases. Web1 vs Web2 vs Web3. Decentralized applications (DApps). Web3 components: wallets, smart contracts, front-ends. Use cases: supply chain, finance, healthcare, identity, NFTs. Legal, ethical, and environmental considerations.

Lab Syllabus

1. Introduction to Remix IDE, MetaMask wallet, and Ethereum test networks.
2. Create and manage a wallet using MetaMask; explore public/private keys.
3. Perform and observe transactions on a test network; understand gas fees.
4. Write and deploy a simple Solidity smart contract.

5. Create a contract to store and retrieve data on blockchain.
6. Implement a simple token (ERC-20 style – simplified).
7. Read/write data from deployed smart contracts using Remix.
8. Create a simple front-end to interact with a smart contract.
9. Observe common risks (e.g., improper access control).
10. Design a simple blockchain use case (e.g., voting, student record, supply chain demo).

Textbooks/ References

1. Mastering Blockchain, 3rd Edition, by Imran Bashir. Packt Publishing
2. Blockchain Basics, by Daniel Drescher. Apress

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA242 INTRUSION DETECTION & PREVENTION SYSTEMS L-T-P-C: 3-0-2-4

Course Objective(s)

- To analyze the nature of cyber intrusions and attack patterns
- To evaluate different IDS and IPS architectures and detection techniques
- To understand rule-based, signature-based, and anomaly-based detection
- To implement basic IDS/IPS solutions using open-source tools
- To evaluate alerts, false positives, and system limitations ethically and responsibly

Course Outcomes

COs	Description
CO1	Analyze cyber-attack patterns and intrusion techniques to determine detection requirements in networked systems.
CO2	Evaluate host-based and network-based intrusion detection and prevention architectures for different security environments.
CO3	Design rule-based and signature-based detection strategies using IDS/IPS concepts and traffic characteristics.
CO4	Implement and demonstrate basic IDS/IPS solutions using open-source tools to detect and prevent simulated attacks.
CO5	Analyze and assess IDS/IPS alerts to differentiate true attacks from false positives and recommend appropriate response actions.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	1	1	1	-	2	2
CO2	2	3	1	2	1	-	2	2
CO3	2	2	3	3	2	1	2	2
CO4	2	2	3	3	2	1	2	2
CO5	2	3	2	2	2	1	3	2

Syllabus

Unit I

Intrusions, Threats & Detection Requirements. Nature of cyber intrusions and attack lifecycle. Threat actors and intrusion techniques. Detection vs prevention – conceptual distinctions. Limitations of traditional security controls. Need for IDS and IPS in modern networks.

Unit II

IDS/IPS Architectures & Deployment Models. Host-based IDS (HIDS). Network-based IDS (NIDS). Inline IPS vs passive IDS. Centralized vs distributed architectures. Deployment challenges and performance considerations.

Unit III

Detection Techniques & Analysis Methods. Signature-based detection. Anomaly-based detection. Rule-based detection systems. Heuristics and threshold analysis. Strengths, weaknesses, and evasion techniques.

Unit IV

IDS/IPS Technologies & Tools. Overview of IDS/IPS tools: Snort, Suricata, Zeek (conceptual + practical orientation). Rule structure and alert generation. Log and alert analysis basics. Integration with firewalls and access controls. Ethical and legal considerations in monitoring.

Unit V

Alert Management, Response & Case Studies. Intrusion alert classification. False positives vs false negatives. Incident response basics for detected intrusions. Case studies: scan detection, brute-force attacks, DoS indicators. IDS/IPS limitations and future trends.

Lab Syllabus

1. Installation and overview of IDS tools and lab setup.
2. Capturing and analyzing basic traffic for intrusion indicators.
3. Configure Snort in IDS mode and understand rule structure.
4. Create and test simple Snort rules for port scanning and ICMP alerts.

5. Observe traffic deviations and anomaly indicators using IDS output.
6. Analyze IDS logs and classify alerts based on severity.
7. Demonstrate prevention concepts using inline or blocking rules.
8. Distinguish benign traffic from malicious alerts.
9. Detect brute-force or scan activity in a controlled environment.
10. Design and demonstrate an IDS/IPS deployment for a small organization, including rules and response logic.

Textbooks/ References

1. Guide to Intrusion Detection and Prevention Systems, by Scarfone & Mell. NIST (SP 800-94) – Conceptual foundation.
2. Intrusion Detection Systems, by Bace & Mell. Macmillan Technical Publishing
3. Intrusion Detection & Prevention by Carl Endorf et al. McGraw-Hill

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA243	IOT SECURITY	L-T-P-C: 3-0-2-4

Course Objective(s)

- To analyze security risks specific to IoT architectures and deployment environments
- To evaluate vulnerabilities in IoT devices, communication protocols, and data flows
- To design secure mechanisms for device authentication, communication, and updates
- To implement basic IoT security controls and protections in simulated environments
- To assess IoT security practices considering ethical, privacy, and sustainability concerns

Course Outcomes

COs	Description
CO1	Analyze IoT architectures and threat models to identify security risks at device, network, and application layers.
CO2	Evaluate vulnerabilities in IoT communication protocols and data handling mechanisms.
CO3	Design secure authentication, authorization, and data protection mechanisms suitable for constrained IoT devices.
CO4	Implement and demonstrate basic security controls for IoT devices and gateways using appropriate tools and configurations.
CO5	Assess and recommend IoT security solutions for real-world scenarios considering privacy, ethics, and sustainability requirements.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	3	1	1	1	0	2	2
CO2	2	3	1	2	1	0	2	2
CO3	2	2	3	3	2	1	2	2
CO4	2	2	3	3	2	1	2	2
CO5	2	3	3	2	2	1	3	2

Syllabus

Unit I

IoT Architecture & Threat Landscape. IoT ecosystem components: devices, gateways, cloud, applications. IoT reference architectures. Attack surface in IoT environments. IoT-specific threat models and risk vectors. Constraints in securing IoT systems (power, memory, connectivity).

Unit II

IoT Device & Hardware Security. Device identity and trust. Secure boot concepts. Firmware security & OTA updates. Physical attacks and tampering risks. Secure device provisioning.

Unit III

IoT Communication & Network Security. IoT communication protocols: MQTT, CoAP, HTTP (security aspects). Transport-level security for IoT. Gateway security concepts. Network segmentation for IoT. Threats: replay, spoofing, man-in-the-middle.

Unit IV

Data, Cloud & Application Security in IoT. Data lifecycle in IoT systems Access control and authentication mechanisms. Secure APIs and IoT cloud platforms (conceptual). Privacy risks and data leakage. Logging and monitoring basics for IoT systems.

Unit V

IoT Security Management & Case Studies. IoT security best practices and frameworks. Case studies: smart home, healthcare IoT, smart city. Ethics, privacy, and regulatory considerations. Incident response for IoT environments. Future challenges in IoT security.

Lab Syllabus

1. Introduction to IoT devices, gateways, and lab tools.
2. Configure basic authentication for an IoT device or simulator.
3. Publish and subscribe using secure MQTT (TLS simulation).
4. Capture and analyze IoT protocol traffic using Wireshark.

5. Study firmware update process and identify security weaknesses.
6. Configure basic firewall rules for IoT gateway device.
7. Implement role-based access control for IoT data access.
8. Observe effects of replay or spoofing attacks in controlled environment.
9. Implement basic device and gateway logging.
10. Design and demonstrate a secure IoT use case (e.g., smart home or sensor network) with identified risks and mitigations.

Textbooks/ References

11. Practical Internet of Things Security, by Brian Russell & Drew Van Duren. Packt Publishing
12. Security and Privacy in Internet of Things (IoTs), by Fei Hu. CRC Press

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA244	SECURE SOFTWARE DEVELOPMENT	L-T-P-C: 3-0-2-4

Course Objective(s)

- To analyze security risks throughout the software development lifecycle
- To design software systems using secure design principles and patterns
- To implement secure coding practices in common programming languages
- To apply testing and analysis techniques to detect software vulnerabilities
- To evaluate software systems for compliance with security and ethical standards

Course Outcomes

COs	Description
CO1	Analyze software security requirements and threats across different phases of the SDLC.
CO2	Design secure software architectures using security principles and design patterns.
CO3	Implement secure coding practices to mitigate common software vulnerabilities.
CO4	Apply and demonstrate software security testing techniques to identify and fix vulnerabilities.
CO5	Evaluate and recommend improvements to software systems considering security, ethics, and compliance requirements.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	1	1	1	0	2	2
CO2	2	2	3	2	2	1	2	2
CO3	2	2	3	3	2	1	2	2
CO4	2	3	2	3	2	1	2	2
CO5	2	3	2	2	2	1	3	2

Syllabus

Unit I

Secure Software Development Lifecycle & Threat Analysis. Security in SDLC: requirements, design, implementation, testing, deployment. Security requirements engineering. Threat modeling fundamentals (STRIDE – conceptual). Risk assessment and attack surface analysis. Aligning security with business and ESG goals.

Unit II

Secure Design Principles & Architecture. Security design principles (least privilege, defense-in-depth, fail-safe defaults). Secure architecture patterns. Authentication and authorization models. Secure session and state management. Design reviews and architectural risk analysis.

Unit III

Secure Coding Practices & Vulnerabilities. Input validation and output encoding. Secure error handling and logging. Memory and resource management (conceptual). OWASP Top 10 vulnerabilities (high-level). Safe use of cryptographic APIs.

Unit IV

Software Security Testing & Analysis. Static Application Security Testing (SAST) – overview. Dynamic Application Security Testing (DAST) – overview. Code review techniques. Secure dependency and library management. Introduction to DevSecOps concepts.

Unit V

Secure Deployment, Maintenance & Case Studies. Secure configuration and deployment practices. Patch management and vulnerability disclosure. Secure APIs and microservices (intro level). Legal, ethical, and compliance considerations. Case studies: insecure applications and breaches.

Lab Syllabus

1. Analyze a simple application and identify security risks in each SDLC phase.
2. Create a basic threat model for a given application using STRIDE principles.
3. Implement input validation to prevent injection vulnerabilities.
4. Implement role-based access control in a sample application.
5. Modify an application to handle errors securely without information leakage.

6. Use a static analyzer to detect security issues in source code.
7. Map application vulnerabilities to OWASP Top 10 categories.
8. Identify and fix vulnerable third-party dependencies.
9. Perform peer code review and apply security fixes.
10. Design, implement, and harden a secure software application with documented security controls.

Textbooks/ References

11. Writing Secure Code, 2nd Edition, by Michael Howard & David LeBlanc. Microsoft Press.
12. Secure Coding: Principles and Practices, by Mark G. Graff & Kenneth R. Van Wyk. O’Reilly Media.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA245	CYBER RISK MANAGEMENT	L-T-P-C: 3-1-0-4

Course Objective(s)

- To analyse cyber threats, vulnerabilities, and impacts from a risk management perspective
- To apply cyber risk assessment frameworks and methodologies
- To design cyber risk mitigation and treatment strategies aligned with organizational goals
- To evaluate governance, compliance, and regulatory requirements related to cyber risk
- To develop informed decision-making capabilities for managing cyber risk ethically and responsibly

Course Outcomes

COs	Description
CO1	Analyze cyber threats, vulnerabilities, and impacts to identify organizational cyber risks.
CO2	Apply cyber risk assessment frameworks to evaluate likelihood and impact of cyber incidents.
CO3	Design cyber risk treatment and mitigation strategies aligned with organizational objectives.
CO4	Evaluate governance, compliance, and regulatory requirements influencing cyber risk decisions.
CO5	Assess and justify cyber risk management decisions considering ethics, finance, and sustainability.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	3	1	1	1	0	2	2
CO2	2	3	2	2	1	1	2	2
CO3	2	2	3	2	2	2	2	2
CO4	2	2	2	1	2	2	3	2
CO5	2	3	2	1	2	3	3	2

Syllabus

Unit I

Cyber Risk Fundamentals & Threat Landscape. Evolution of cyber risk. Difference between cyber threats, vulnerabilities, and risks. Cyber-attack surfaces and threat actors. Business impact of cyber incidents. Introduction to qualitative vs quantitative risk.

Unit II

Cyber Risk Assessment Frameworks & Methodologies. Cyber risk lifecycle. Risk identification techniques. Risk analysis and evaluation. Risk matrices and scoring models. Introduction to NIST Cybersecurity Framework and ISO/IEC 27005.

Unit III

Cyber Risk Mitigation & Treatment Strategies. Risk treatment options: mitigate, transfer, accept, avoid. Control selection and prioritization Technical, administrative, and legal controls. Role of cybersecurity investments. Cost-benefit analysis in cyber risk decisions.

Unit IV

Cyber Governance, Compliance & Regulatory Risk. Cyber risk governance structures. Roles and responsibilities (CISO, Risk Officer, Board). Compliance standards: ISO 27001, GDPR, IT Act (India). Audits, assurance, and reporting. Cyber risk metrics and key risk indicators (KRIs).

Unit V

Incident Response, Ethics & Strategic Risk Decisions. Cyber incidents as risk events. Incident response planning (risk perspective). Cyber insurance (introductory concepts). Ethical decision-making in cyber risk. Case studies: ransomware, data breach, supply-chain risk.

Textbooks/ References

1. Principles of Information Security, by Michael E. Whitman & Herbert J. Mattord. Cengage Learning
2. How to Measure Anything in Cybersecurity Risk, by Hubbard & Seiersen. Wiley
3. Guide for Conducting Risk Assessments. NIST Special Publication 800-30.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA246	CYBERCRIME & CRIMINOLOGY	L-T-P-C: 3-1-0-4

Course Objective(s)

- To analyse cybercrime using criminological theories and behavioural models
- To examine different categories of cybercrimes and offender typologies
- To evaluate legal, policing, and judicial responses to cybercrime
- To assess the social, psychological, and economic impacts of cybercrime
- To promote ethical reasoning and preventive strategies in combating cybercrime

Course Outcomes

COs	Description
CO1	Analyze traditional and cyber-specific criminological theories to explain cybercriminal behavior and motivations.
CO2	Classify and evaluate different types of cybercrimes based on offender methods, victim profiles, and impact severity.
CO3	Assess legal, law-enforcement, and judicial mechanisms used to prevent, investigate, and prosecute cybercrimes.
CO4	Analyze social, psychological, and economic impacts of cybercrime on individuals, organizations, and society.
CO5	Design and justify preventive strategies and awareness programs to reduce cybercrime risks ethically and responsibly.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	1	1	1	0	2	2
CO2	2	3	1	1	1	0	2	2
CO3	2	2	2	1	1	1	2	2
CO4	2	1	1	1	3	2	2	1
CO5	2	3	3	2	2	1	3	2

Syllabus

Unit I

Foundations of Criminology & Cybercrime. Fundamentals of criminology. Crime causation theories (classical, positivist, sociological). Transition from traditional crime to cybercrime. Cyberspace as a criminogenic environment. Evolution and trends of cybercrime.

Unit II

Cybercriminal Behaviour & Offender Typologies. Cyber offender profiles and motivations. Organized cybercrime groups and lone actors. Hacking cultures and underground communities. Insider threats and socio-technical factors. Radicalization and cyber extremism (overview).

Unit III

Cybercrime Types & Modus Operandi. Financial cybercrimes (fraud, ransomware, scams). Crimes against individuals (cyberstalking, harassment). Crimes against organizations (data breaches, APTs). Crimes against society and state (cyber terrorism – overview). Emerging cybercrime trends

Unit IV

Legal, Policing & Judicial Response to Cybercrime. Cyber law enforcement mechanisms. Cyber policing and digital investigations (conceptual). Jurisdictional challenges and transnational crime. Evidentiary issues in cybercrime prosecution. Role of national and international agencies.

Unit V

Impact, Ethics & Cybercrime Prevention. Psychological and social impact on victims. Economic consequences of cybercrime. Victimology in cybercrime. Ethics and digital responsibility. Prevention strategies: policy, awareness, education.

Textbooks/ References

1. Cybercrime and Digital Forensics, by Thomas J. Holt, Adam M. Bossler, Kathryn C. Seigfried-Spellar. Routledge.
2. Cybercrime and Society, by Majid Yar. Sage Publications
3. Digital Evidence and Computer Crime, by Casey E. Academic Press

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

IOT & EMBEDDED SYSTEMS STREAM

26CSA271	INTRODUCTION TO EMBEDDED SYSTEM	L-T-P-C: 3-1-0-4

Course Objective(s)

- Introduces fundamentals of embedded systems and basic electronics.
- Covers digital electronics, integrated circuits, and controller programming.
- Explains interfacing of sensors, actuators, and communication protocols.
- Introduces RTOS concepts for embedded and IoT applications.

Course Outcomes

COs	Description
CO1	Understand embedded systems components, design challenges and applications.
CO2	Understand design of Digital & Integrated circuits.
CO3	Understand application of program on chip peripherals for single purpose controller.
CO4	Apply the different sensors, actuators (off chip peripherals) and communication protocols for developing embedded systems.
CO5	Understand the software architectures, task communication, and identify tasks related issues in RTOS.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	0	0	0	0	0	1
CO2	3	2	2	0	0	0	0	1
CO3	2	2	3	0	0	0	0	1
CO4	2	3	3	0	0	0	0	1
CO5	2	3	2	2	0	0	2	1

Syllabus

Unit 1: Topic: INTRODUCTION

Basic Electronics - R, L, C, Laws, Semiconductor, Diode & Transistors; Basic Electronic Circuits - R, L, C, Diodes & Transistors.

Unit 2: Topic: DIGITAL ELECTRONICS & INTEGRATED CIRCUITS

Logic Gates; Boolean Algebra; Number Systems; Registers and RAM; CPU vs Microprocessors; Design circuits using Kicad

Unit 3: Topic: SINGLE PURPOSE CONTROLLER

Program on chip peripherals for single purpose controller-Timers, Counter, Watchdog, USART controller, PWM, LCD Controller,Keypad Controller.

Unit 4: Topic: APPLICATION FOR DEVELOPING EMBEDDED SYSTEMS

Sensors, actuators (off chip peripherals)- Temperature, Humidity, Accelerometer, RFID, LCD interface; Communication protocols for developing embedded systems – UART protocol, I2C protocol, SPI protocol.

Unit 5: Topic: RTOS IN EMBEDDED SYSTEMS

Software architectures; Task communication; Identify tasks related issues in RTOS; Stack; Threads and Thread Communication;Context Switching;Scheduler; Development of IoT Applications

Text Books (Sample Format)

- Designing Embedded Hardware, John Catsoulis. 2nd edition. Shroff Publishers and Distributors. ISBN-10: 9788184042597.

Reference Book

- Embedded System Design: A Unified Hardware / Software Introduction. Tony Givargis and Frank Vahid. Wiley. ISBN-10: 812650837X.
- Introduction to Embedded Systems, Shibu K V.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA272	EMBEDDED C PROGRAMMING I	L-T-P-C: 3-1-0-4

Course Objective(s)

- Introduce fundamental concepts and structure of C programming.
- Develop logical thinking and problem-solving skills using C.
- Enable modular program development using functions and libraries.
- Build competence in memory handling, pointers, and data structures.
- Apply C programming for basic communication and hardware interfacing (UART).

Course Outcomes

COs	Description
CO1	Understand the basic Components of C Programming
CO2	Understand the basic logical & analysis structure of C
CO3	Understand the splitting of large programs into modules
CO4	Understand the nuancess of C programing with memory
CO5	Apply UART Interface & Library Implementation in C

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	0	0	0	0	0	1
CO2	2	3	0	0	0	0	0	1
CO3	2	2	2	0	0	0	0	1
CO4	2	3	**2**	0	0	0	0	1
CO5	2	3	**3**	0	0	0	2	1

Syllabus

Unit 1: Topic: INTRODUCTION

History of C; C standardization; Introduction to VIM editor; Introduction to C programing- printf, scanf and Hello World, escape sequences in C, Commenting in C; Data types and variables; Adress Variables; Type Qualifiers-const, volatile; C Preprocessor.

Unit 2: Topic: OPERATORS, CONDITIONAL & ITERATIVE STATEMENTS

Classification of operators – Unary, Binary, Ternary; Types of operators – Arithmetic, Relational, Logical, Bitwise, Assignment, Misc Operators - (sizeof(), &, *, ?:); if, if..else, nested if..else, switch; Looping Conditional – while, do..while, for; Unconditional – goto, break, continue, return.

Unit 3: Topic: FUNCTIONS, STORAGE CLASSES & ARRAYS

Types of functions – Library, User defined; Rules for calling a specific function;4 types of user defined functions, Function call by value & call by address; Local & Global Variables; Storage Classes; Command Line Arguments, Arrays-array declaration & initialization, array elements, array length & size, 2D array, Make file.

Unit 4: Topic: POINTERS, STRINGS, STRUCTURES & UNIONS

Pointers – Declaration & initialization, pointer type & name, NULL pointer, void pointer, pointer arithmetic, Array & Pointers, Dynamic Memory Allocation; Storage classes, Strings; Structures; Bitfields; Unions.

Unit 5: Topic: LIBRARY IMPLEMENTATION & COMMUNICATION MODULE WITH C

Multiple file compilation; Library Implementation – Static & Dynamic; Communication module with C - UART Interface, Terminal Programing.

Text Books (Sample Format)

- Michael J Pont, "Embedded C", Addison-Wesley, An imprint of Pearson Education, 2002.

Reference Book

- Paul Deitel and Harvey Deitel, “C How to Program”, 8th Edition, Pearson Education Limited, 2016.
- Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA273	FIRMWARE DEVELOPMENT	L-T-P-C: 3-1-0-4

Course Objective(s)

- Introduce embedded systems fundamentals and Cortex-M architecture.
- Enable Cortex-M development using IDEs and architectural analysis.
- Develop skills in GPIO, UART, timers, PWM, ADC, and peripheral interfacing.
- Build embedded firmware using SPI and I2C for integrated applications.

Course Outcomes

COs	Description
CO1	Understand the fundamentals of embedded systems, explain the significance of Cortex-M architecture, and differentiate between SoC, MPU, and MCU
CO2	Set up and utilize Integrated Development Environments (IDEs) for Cortex-M development, and analyze Cortex-M architecture and its features through block diagrams.
CO3	Configure and program GPIOs, and implement UART communication by understanding their internal architecture, registers, and interfacing techniques.
CO4	Implement timer-based applications, generate PWM signals, perform ADC conversions, and interface RTC and EEPROM devices using appropriate registers and protocols.
CO5	Develop embedded firmware to interface peripherals using SPI and I2C protocols, and perform device programming for integrated embedded applications.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1								
CO2								
CO3								
CO4								

Syllabus

Unit 1

Topic: CORTEX-M ARCHITECTURE AND EMBEDDED SYSTEMS

Introduction to Embedded Systems and their significance - Understanding the Cortex-M Architecture and Internals - Introduction to Emsys (Embedded Systems) and its applications - System-on-Chip (SoC). Introduction and components - Difference between MPU (Microprocessor Unit) and MCU (Microcontroller Unit

Unit 2

Topic: DEVELOPMENT ENVIRONMENT AND CORTEX-M FEATURES

Introduction to Integrated Development Environments (IDEs) and their significance - Features and Usage of IDEs for Cortex-M development - Cortex-M Features, Block Diagram, Architecture

Unit 3

Topic: GPIO, UART, AND COMMUNICATION MODULES

General Purpose Input / Output (GPIO) - GPIO Internals, Features, Block Diagram and Architecture, Registers - Peripheral Interface UART and Communication Modules - UART Internals, Features, Block Diagram and Architecture, Registers.

Unit 4

Topic: TIMERS, PWM, ADC, AND REAL-TIME CLOCK (RTC)

Understanding Timers, their Internals, and Application - Pulse Width Modulation (PWM): Registers, and Applications - Analog-to-Digital Converter (ADC): Registers, and Applications - Real-Time Clock (RTC) - DS1307, EEPROM - AT24C512

Unit 5

Topic: SPI INTERNALS AND DEVICE PROGRAMMING

Modules SPI and I2C - Serial Peripheral Interface (SPI) Internals - Device Programming and Integration of Peripherals and its Applications

Text Books (Sample Format)

- Embedded Systems: Real-Time Operating Systems for Arm Cortex M Microcontrollers by Jonathan Valvano

Reference Book

1. "The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors" by Joseph Yiu

2. "Embedded Systems: Introduction to ARM Cortex-M Microcontrollers" by Jonathan Valvano

3. “Mastering Microcontroller: TIMERS, PWM, CAN, RTC, LOW POWER" by B.A. Borisov

4. "The 8051 Microcontroller and Embedded Systems" by Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay

5. "Programming Embedded Systems: With C and GNU Development Tools" by Michael Barr and Anthony Massa

6. Embedded Systems Design with the Atmel AVR Microcontroller" by Steven Barrett

7. "Microcontroller Based Embedded Systems" by Raj Kamal

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

26CSA274	WIRELESS SENSOR NETWORKS	L-T-P-C: 3-1-0-4

Course Objective(s)

- To To introduce the fundamentals, applications, and challenges of Wireless Sensor Networks
- To provide knowledge of sensor node hardware components and network architectures
- To study different WSN deployment scenarios, sources, sinks, and gateway concepts
- To understand MAC and routing protocols designed for energy-efficient sensor networks
- To enable students to analyze protocol choices for specific WSN applications

Course Outcomes

COs	Description
CO1	Explain the concepts, applications, constraints, and emerging technologies of Wireless Sensor Networks
CO2	Describe sensor node hardware components and analyze WSN architectures and deployment scenarios
CO3	Compare and evaluate MAC protocols and their suitability for low-power wireless sensor networks
CO4	Analyze and select appropriate routing protocols for different WSN communication requirements

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	–	–	–	–	1	–
CO2	2	3	2	–	–	–	–	–
CO3	2	3	2	1	–	–	–	–
CO4	2	3	3	2	1	–	–	–

Syllabus

Unit 1

Overview of WSN: Introduction, Sensor network applications – Habitat Monitoring –Tracking chemical plumes – Smart transportation. Constraints and Challenges, Emerging technologies for wireless sensor networks – Advantages of sensor networks.

Unit 2

Architectures: Hardware components – sensor node overview – controller- memory – communication device – sensors and actuators – power supply of sensor nodes – Network architecture – Sensor network scenarios – types of sources and sinks – single hop Vsmulti hop – multiple sources and sinks – mobility – Gateway Concepts.

Unit 3

Protocols: MAC Protocols for Wireless Sensor Networks – Low duty cycle protocol: SMAC – Contention Based Protocol: CSMA, Scheduling Based Protocol – Routing Protocol: AODV, DSDV, optimized Linked State Routing, DSR and Reactive routing: Flooding, Hierarchical routing, Location based Routing – Unicast and Multicast.

Text Books

- Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2005.

Resources

1. Feng Zhao and Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach”, Elsevier, 2007.
2. Kazem Sohraby, Daniel Minoli, and Taieb Znati, “Wireless Sensor Networks -Technology, Protocols and Applications”, John Wiley, 2007.
3. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	**100**

REGULAR ELECTIVES

26CSA261 IOT ARCHITECTURES AND PROGRAMMING L-T-P-C: 3-0-2-4

Course Objective(s)

- Gain a foundational understanding of machine learning concepts, including supervised learning, unsupervised learning, and reinforcement learning.

Pre-requisite: Linear algebra, Probability and statistics

Course Outcomes

COs	Description
CO1	Acquire the core concepts and principles behind the Internet of Things (IoT), including sensors, actuators, connectivity protocols, and IoT architectures.
CO2	Develop proficiency in programming languages commonly used in IoT development, such as Python, C/C++, or JavaScript, with a focus on their application in IoT contexts.
CO3	Learn techniques for collecting, processing, and analyzing data from IoT devices, including sensor data fusion, real-time data streaming, and data visualization.
CO4	Explore various networking and communication protocols used in IoT ecosystems, including Wi-Fi,Bluetooth, MQTT, CoAP, and HTTP, and their application in different IoT scenarios.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	-	1	1	-	-	-	-
CO2	3	3	3	3	-	-	-	-
CO3	2	2	2	2	-	-	-	-
CO4	3	2	2	2	-	-	-	-

Syllabus

Unit 1

Introduction to Internet of Things- Definition and Characteristics of IoT, Sensors, Actuators, Physical Design of IoT – IoTProtocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies – Wireless Sensor Networks,Cloud Computing, Embedded Systems, IoT Levels and Templates, Domain Specific IoTs – Home, City, Environment, Energy, Agriculture and Industry.

Components in IoT: Control Units - Sensors - Communication modules - Power Sources - Communication Technologies -RFID - Bluetooth - Zigbee - Wifi - Rflinks - Mobile Internet - Wired Communication.

Unit 2

IoT and M2M: M2M - Difference between IoT and M2M - Software Defined Networks - Network Function virtualization - IoT System Management with NETCONF - YANG - Need for IoT systems management - SNMP - Network Operator requirements - IoT systems management. Developing IoT: IoT Design Methodology: Purpose & Requirements Specification - Process Specification - Domain Model Specification - Information Model Specification - Service Specifications - IoT Level Specifications - Functional View Specification - Operational View Specification - Device & Component Integration - Application Development - Case study on IoT for Weather Monitoring.

Unit 3

Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C). IoT Physical Devices and Endpoints: Motivation for using Python, Python Packages of Interest for IoT, Building blocks of an IoT Device, Exemplary device: Raspberry Pi, Linux on Raspberry Pi, Raspberry Pi Interfaces - Serial, SPI, I2C, Programming Raspberry Pi with Python -Other IoT Devices. Controlling Hardware- Connecting LED, Buzzer, Switching High Power devices with transistors, Controlling AC Power devices with Relays, Controlling servo motor, speed control of DC Motor, unipolar and bipolar Stepper motors

Unit 4

The IoT building Blocks - IoT Application Enablement Platforms - Characterizing IoT or M2M Application Platforms - IoT AEPs - Azure IoT Hub - Amazon Web service IoT Platform - the Axeda IoT Platform - IoT data Analytics Platforms -IoT Data Virtualization Platforms - IoT Data Visualization Platform - IoT Edge Data Analytics. The Next generation Clouds for IoT Applications and Analytics - Motivation for Cloud Enabled Environments - IoT and cloud Inspired Smarter environments - Hybrid Clouds - Emergence of Edge/Fog Clouds - Building Blocks of Software Defined Networking - Software Defined Storage. Purpose of Cloud in IoT - Expounding the Edge/Fog Computing paradigm:

Introduction to Edge/Fog Computing - Fog Computing Concepts - Use Cases of Fog/Edge Computing - Edge Analytics.

List of Experiments: (Platform: Rasspian / Arduino / Python)

1. Experiment with integrating various sensors (e.g., temperature, humidity, motion, light) with IoT devices. Collect real-time data from sensors using IoT protocols such as MQTT or CoAP.
2. Set up edge computing nodes to process data locally before transmitting it to the cloud. Experiment with lightweight machine learning algorithms for edge analytics (e.g., anomaly detection, predictive maintenance).
3. Evaluate the performance of different wireless communication protocols (e.g., Zigbee, LoRaWAN, NB-IoT) in termsof range, data rate, and power consumption.
4. Experiment with mesh networking techniques to extend network coverage and improve reliability.
5. Conduct penetration testing to identify vulnerabilities in IoT devices and networks. Implement encryption techniques (e.g., SSL/TLS, AES) to secure data transmission and storage.
6. Explore privacy-preserving techniques such as differential privacy and data anonymization.

Textbooks:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A Hands of Approach” , Arshdeep Bagha & Vijay Madisetti, 1st Edition, 2014.
2. Pethuru Raj, Anupama C.Raman ,“The Internet of Things: Enabling Technologies, Platforms, and use cases”, CRC Press, 1st Edition, 2017.
3. Charalampos Doukas, “Building Internet of Things with the Arduino”, Volume 1, Create Space Independent Publishing Platform, 2012.

References:

1. Adrian McEwen, Hakim Cassimally, “Designing the Internet things”, John Wiley and Sons, 1st Edition, 2014.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA262	COMPUTER GRAPHICS AND VISUALIZATION	L-T-P-C: 3-0-2-4

Course Objective(s)

- Compare and contrast physical and synthetic images and explain the role of a graphics pipeline.
- Utilize the Matlab library for basic 2D and 3D object creation and rendering.
- Implement common geometric transformations (translation, rotation, scaling, shear) using homogeneous coordinates.
- Differentiate between classical and computer viewing systems and apply perspective and parallel projections.
- Explain the various animation and visualization techniques.

Course Outcomes

COs	Description
CO1	Apply the fundamental concepts and principles of computer graphics and visualization.
CO2	Explore basic rendering techniques such as rasterization and ray tracing.
CO3	Develop 3D models using appropriate techniques and tools.
CO4	Apply animation techniques to create dynamic visualizations.
CO5	Analyze and critique various visualization techniques and their effectiveness in conveying information

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-
CO3	-	-	3	3	-	-	-	-
CO4	3	3	1	3	-	-	-	-
CO5	2	2	2	-	-	-	-	-

Syllabus

Unit 1

Introduction to Computer Graphics: Overview of computer graphics, Graphics systems and models, Graphics pipeline, Basics of raster graphics and vector graphics, Graphics APIs and libraries. Rendering Techniques: Introduction to rendering,Rasterization algorithms, Ray tracing basics, Shading models and lighting techniques, Texture mapping.

Unit 2

Introduction to Matlab: Points, Lines. Specifying a 2D World Coordinate Reference Frame in Matlab- Matlab Point Functions, Line Functions Polygon Fill Area Functions, Vertex Arrays. Line Drawing Algorithms, Circle Generation Algorithm Filled Area Primitives Matlab fill Area Functions, Scan Line Polygon Filling Algorithms, Boundary Fill, FloodFill Algorithms Attributes of Output Primitives. Geometric Transformations: Basic 2D transformations-Other Transformations: Reflection and Shearing. Matlab Geometric Transformation Functions.

Unit 3

3D Object Representation: Fractals, Geometrical Transformation for 3D Objects, Viewing and Clipping 2D Viewing Functions Clipping Operations. Three-Dimensional Viewing: Viewing Pipeline, Viewing Coordinates. Projections: ParallelProjections, Perspective Projections. Matlab Two-Dimensional and Three-Dimensional Viewing Functions.

Unit 4

Visible Surface Detection and Illumination Models: Visible Surface Detection Methods, Illumination Methods and SurfaceRendering, Polygon. Rendering Methods: Constant Intensity Shading, Grouard Shading, Phong Shading. Matlab Illumination and Surface Rendering Functions, GUI – Matlab Interactive Input Device Functions. The User Dialog Interactive Picture Construction Techniques, Colour Models. Computer Animation: Animation principles, Keyframing andinterpolation, Skeletal animation, Procedural animation, Motion capture techniques.

Lab:

1. Introduction to computer graphics concepts and setting up the MATLAB environment for graphics.
2. Implement basic 2D graphics primitives (lines, circles, polygons) using MATLAB functions.
3. Implement functions to draw lines by slope-intercept or Bresenham's line algorithm.
4. Create a function to draw filled circles using parametric equations and the Midpoint circle algorithm.
5. Apply geometric transformations (translation, rotation, scaling) in 2D.

6. Generate a square and triangle, and apply translation, rotation, and scaling transformations using matrix multiplicationin 3D.
7. Visualize a 3D coordinate system using lines and labels.
8. Create 3D plots of lines and surfaces using plot3 and surf functions.
9. Implement functions to adjust camera position (e.g., view) and orientation for different viewing perspectives.
10. Create a function to generate a cube mesh with vertices and faces using fill3 or patch.
11. Develop a function to generate a sphere mesh with appropriate subdivisions using parametric equations.
12. Create a function to generate a cylinder mesh using points along a circle and extruded lines.
13. Implement flat shading for basic colouring of objects based on face Normals.
14. Employ different shading and lighting models to enhance visual realism.
15. Create basic animations to visualize dynamic scenes or processes.

Textbook:

1. Adams, Richard S., and Richard E. Hall. Fundamentals of Computer Graphics (4th ed.). Addison-Wesley Professional,2016.
2. Gonzalez, Rogelio, Richard E. Woods, and Steven L. Eddins. MATLAB Graphics Programming (3rd ed.). Pearson Education Limited, 2009.
3. Roy A. Plastock and Gordon Kalley, “Schaum’s Outline Series – Theory and Problems of Computer Graphics”, SecondEdition, Tata McGraw-Hill, 2000.
4. Foley J.D, Van Dam A, Eiener S.K. and Hughes J.F., “Computer Graphics Principles and Practice”, Second Edition, Pearson Education, 1996.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA263 ARCHITECTURE AND DEPLOYMENT OF SECURE AND SCALABLE WAN L-T-P-C: 3-0-2-4

Course Objective(s)

This course offers an introductory overview of secure and scalable Wide Area Network (WAN) setups, including the configuration of Wireless Local Area Networks (WLANs) and WAN technologies. Additionally, it introduces students to various network protocols and methodologies for troubleshooting network issues using a range of tools.

Course Outcomes

COs	Description
CO1	Employ the importance of scaling networks in modern IT infrastructure by implementing LAN redundancy solutions to enhance network reliability.
CO2	Demonstrate proficiency in configuring secure wireless LANs and troubleshoot OSPF routing issues in single and multiarea OSPF environments
CO3	Design hierarchical network architectures for scalability and implement first-hop redundancy protocols to ensure network availability.
CO4	Troubleshoot WAN connectivity issues using systematic troubleshooting methods and configure NAT and troubleshoot NAT-related issues to ensure proper network address translation.
CO5	Device and configure site-to-site connectivity and VPNs to ensure secure network communication and monitor network performance using Syslog, SNMP, and Netflow tools.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-
CO4	-	-	3	2	-	-	-	2
CO5	-	-	3	2	-	-	-	2

Syllabus

Unit 1:

Introduction to Scaling Networks, implementing a Network Design, LAN Redundancy, Spanning Tree Concepts and protocols.

Unit 2:

Link Aggregation Concepts and Configuration, Wireless LAN Concepts, operations and Security, Wireless LAN Configuration, Troubleshoot Single-Area OSPF, Multiarea OSPF

Unit 3:

Operation and configuration. Hierarchical Network Design, WAN Technologies, Spanning Tree Configuration, First-HopRedundancy Protocols, Point-to-Point Connections.

Unit 4:

PPP Operation and Configuration, HDLC protocol, Troubleshoot WAN Connectivity, Frame Relay concepts and Configurations, NAT Operation & Configuration, Troubleshooting NAT

Unit 5:

Tele working, Broadband Solutions, Configuring xDSL Connectivity, Securing Site-to-Site Connectivity, VPNs, Site-to-Site GRE Tunnels, IPsec, Monitoring the Network – Syslog, SNMP, Netflow, Network Troubleshooting with a Systematic Approach.

Lab Exercises:

1. Design and implement a basic network topology using Packet Tracer or GNS3.
2. Configure LAN redundancy using redundant links and protocols such as HSRP or VRRP.
3. Implement Spanning Tree Protocol (STP) on a network topology to prevent loops and ensure network stability.
4. Configure link aggregation (EtherChannel) between switches to increase bandwidth and provide redundancy.
5. Set up a wireless LAN (WLAN) with appropriate security measures such as WPA2 encryption.
6. Troubleshoot a single-area OSPF network by identifying and resolving routing issues.
7. Configure multiarea OSPF routing to improve scalability and efficiency in a network.
8. Design and implement a hierarchical network structure with core, distribution, and access layers.

9. Configure WAN technologies such as PPP or HDLC for point-to-point connections between routers.
10. Set up Frame Relay connections between routers and troubleshoot connectivity issues.
11. Configure Network Address Translation (NAT) to enable private IP addresses to access the internet.
12. Troubleshoot NAT translation issues and ensure proper communication between internal and external networks.
13. Implement teleworking solutions by configuring remote access VPNs for off-site employees.
14. Configure broadband solutions such as xDSL connectivity for high-speed internet access.
15. Secure site-to-site connectivity by implementing VPN tunnels using IPsec encryption.
16. Configure GRE tunnels between remote sites to create a virtual private network (VPN).
17. Monitor network performance using syslog to collect and analyze system logs.
18. Set up Simple Network Management Protocol (SNMP) to monitor network devices and performance metrics.
19. Capture and analyze network traffic using Wireshark to troubleshoot connectivity and performance issues.
20. Implement a systematic approach to network troubleshooting, including identifying symptoms, isolating the problem, and resolving issues.

Suggested Softwares: Packet Tracer, Wireshark, Putty, NetFlow Analyzer

References:

1. Youlu Zheng and ShakilAkhtar, Networks for Computer Scientists and Engineers.
2. Peterson & Davie, "Computer Networks, A Systems Approach", 5th Edition, Morgan Kaufmann, 2011. 3.Scaling Networks - Course Booklet - Cisco Press.
3. 4.Switched Networks - Course Booklet - Cisco Press.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA264 BIG DATA ANALYTICS L-T-P-C: 3-0-2-4

Course Objective(s)

- This course comprehends the fundamentals of Big Data, including its importance, characteristics, and applications invarious domains.
- Gain proficiency in working with Hadoop and its ecosystem, including HDFS, MapReduce paradigm, YARN, andZookeeper, for managing and processing large-scale datasets efficiently.
- Develop skills in utilizing advanced tools and technologies such as Hive, Pig, Spark, and MongoDB for data querying,processing, and analysis, enabling effective decision-making and insights extraction from diverse data sources.

Course Outcomes

COs	Description
CO1	Employ the concept of Big Data, its applications and its impact on decision-making processes.
CO2	Acquire in-depth knowledge of the Hadoop MapReduce paradigm and its role in distributed data processing
CO3	Gain proficiency in hive and pig for data processing tasks in Hadoop environments.
CO4	Explore the concept of Resilient Distributed Datasets (RDDs) in Spark and their significance in distributed data processing.
CO5	Develop skills in creating and querying indexes for efficient data retrieval through MongoDB JavaScriptShell.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-
CO3	-	3	1	-	-	-	-	2
CO4	-	-	3	2	-	-	-	2
CO5	-	-	-	1	2	-	-	-

Syllabus

Unit 1: Introduction to Big Data

Introduction to Big Data and its importance, 3 Vs and more, Big data analytics, Big data applications. Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop, Inputs and outputs of MapReduce, Hadoop Architecture, HDFS, Common Hadoop Shell commands, NameNode, Secondary NameNode, and DataNode,

Unit 2: Hadoop, Map Reduce and YARN

Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers , Algorithms using map reduce, Examples of Map Reduce (Word count problem, Matrix-Vector Multiplication), YARN & Zookeeper, Hadoop Cluster Setup & Hadoop Configuration, HDFS Administration: Monitoring & Maintenance

Unit 3: Hive and PIG

Hive Architecture, Comparison with Traditional Database, HiveQL - Querying Data - Sorting And Aggregating, Map Reduce Scripts, Joins & Subqueries, HBase concepts, Advanced Usage, Schema Design & Indexing - PIG, Zookeeper

Unit 4: Spark

Spark: RDD's in Spark, Data Frames & Spark SQL, Spark Streaming

Unit 5: Mongo DB

Introduction to MongoDB key features, Core Server tools, MongoDB through the JavaScript's Shell, Creating and Querying through Indexes, Document-Oriented, principles of schema design, Constructing queries on Databases, collections and Documents, MongoDB Query Language.

Lab syllabus

- Write a program to explore Hadoop HDFS: create, list, copy, move, and delete files using Hadoop shell commands.
- Write a program to demonstrate basic MapReduce: implement the Word Count example.
- Write a program to implement MapReduce for counting maximum/minimum/average values from a dataset.
- Write a program to implement Matrix–Vector Multiplication using MapReduce.
- Write a program to demonstrate Hadoop YARN: submitting, monitoring, and killing YARN jobs.

- Write a program to configure and run a simple Hadoop cluster (pseudo-distributed mode).
- Write a Hive program to create databases and tables, load data, and run basic HiveQL queries.
- Write a Hive program to perform sorting, grouping, aggregation, joins, and subqueries.
- Write a PIG program to load, filter, transform, group, and aggregate large datasets.
- Write a program to query data from HBase: create tables, insert data, retrieve data using shell commands.
- Write a Spark program to create RDDs and perform map, filter, reduce, and aggregate operations.
- Write a Spark SQL program to create DataFrames, run SQL queries, and perform aggregations.
- Write a Spark Streaming program to read live data streams (e.g., socket stream) and compute word counts.
- Write a MongoDB program using JavaScript shell to create databases, collections, and insert/query documents.

References:

1. Understanding Big data, Chris Eaton, Dirk Deroos et al McGraw Hill, 2012
2. Big Data and Analytics, Seema Acharya, Subhashini Chellappan, Wiley Publication, 2015.
3. Hadoop: The Definitive Guide, Tom White, O'Reilly Publications
4. 4.Data Analytics with Spark Using Python, Aven Jeffrey, Pearson Paperback 2018
5. Mongo DB in Action, Kyle Banker, Manning Publications Company

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA265	C# AND ASP.NET	L-T-P-C: 3-0-2-4

Course Objective(s)

- Understand the foundation of CLR execution.
- Learn technologies of .NET framework and know OOP aspects in C#.
- Able to develop desktop-based applications using C#.
- Able to develop web-based applications using C#. (ASP.NET)

Course Outcomes

COs	Description
CO1	Understand .NET framework and architecture
CO2	Design and build console applications using the basic and OOP in C#
CO3	Build desktop-based applications using Windows forms in C#
CO4	Design and develop web-based applications using C#

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	3	-	1	2	-	-
CO2	3	2	3	-	1	2	-	-
CO3	3	2	3	-	1	2	-	-
CO4	3	2	3	-	1	2	-	-

Syllabus

Unit 1

Introduction: The C# language, The .Net Architecture and .Net Framework, The Common Language Runtime (CLR), Microsoft Intermediate Language (MSIL) Code, Just In Time Compilers (JITers), The Common Languages Specification (CLS), The Common Type System (CTS), Garbage Collection (GC), The .Net Framework, Working with Visual Studio.Net. **C# Basics:** Data Types, Variables & Constants, Operators in C#, Arithmetic Operators, Prefix and Postfix notation, Assignment Operators, Relational Operators, Other Operators, Operators precedence, Flow Control and Conditional Statements if-else statement, switch statement, Loops in C#, for loop, do-while loop, Array in C#, foreach Loop.

Unit 2

Object and Classes: Concept of a class, Objects, Fields, Methods, Instantiating the class, Accessing the members of a class, Access modifiers, Properties, Static members of the class, Constructors, Desturctors, Overloading Constructors, Value types (out & ref keywords). **Inheritance & Polymorphism:** Implementing inheritance in C#, The base keyword, ProtectedAccess Modifier, sealed keyword, Polymorphism, using the reference of the base type for referencing the objects of the child class, using methods with the same name in the base and Sub-class, Overriding the methods, the new keywords, Typecasting, is and as keywords, Boxing and Un-boxing.

Unit 3

Exceptions in C# and .Net: Handling Exceptions using the try-catch-finally blocks, Delegates Basics, Delegates in the .Net Framework, Passing delegates to methods, Multicast Delegates, Events and Events, handling in C#, Multicast events.**Windows Form Applications:** Controls- The Button Control, Adding the Event Handlers, The Label and LinkLabel Controls, The TextBox Control, Adding the Event Handlers, The RadioButton and CheckBox Controls, The ListBox and CheckedListBox Controls, ListBox Properties, The ComboBox Control. ADO.NET.

Unit 4

ASP.NET: Overview of ASP.NET framework, Stages in Web Forms Processing, Introduction to Server Controls, HTML Controls, Validation Controls, User control, Data Binding Controls, Configuration, Personalization, Session State, Addingcontrols to a web form, Buttons, Text Box, Labels, Checkbox, Radio Buttons, ListBox, etc.

Lab Syllabus

- Write a C# program to demonstrate data types, variables, constants, and basic operators.
- Write a C# program using conditional statements (if–else, switch) and loop structures (for, while, do-while).
- Write a C# program to create and manipulate one-dimensional and multi-dimensional arrays, including foreach loop.
- Write a C# program to define a class with fields and methods, create objects, and access class members.

- Write a C# program to demonstrate constructors, overloaded constructors, static members, and destructors.
- Write a C# program to illustrate the use of ref and out parameters.
- Write a C# program to implement single-level and multi-level inheritance, using base and protected members.
- Write a C# program to demonstrate method overriding, runtime polymorphism, and use of new, is, and as keywords.
- Write a C# program to demonstrate boxing and unboxing with value types and reference types.
- Write a C# program to handle exceptions using try-catch-finally blocks, including multiple exception types.
- Write a C# program to demonstrate delegates, multicast delegates, and events.
- Write a Windows Forms application demonstrating basic controls (Button, Label, TextBox) with event handling.
- Write a Windows Forms application using ListBox, ComboBox, RadioButton, and CheckBox controls.
- Write a C# program using ADO.NET to connect to a database, insert, update, delete, and retrieve records.

Textbooks:

1. Faraz Rasheed “Programmer Heaven C# School”.

References:

1. Stephen Walthert “ASP.NET 3.5 unleased”, SAMS
2. Shibi Panikkar and Kumar Sanjeev, “C# with .NET Frame Work”, Firewall Media.
3. Jeffrey Richter, “Applied Microsoft .Net Framework Programming”, (Microsoft)
4. Balagurusamy, “Programming with C#”, TMHom

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA266	CLOUD COMPUTING	L-T-P-C: 3-0-2-4

Course Objective(s)

- To understand the principles of cloud architecture, models and infrastructure.
- To understand the concepts of virtualization and virtual machines.
- To gain knowledge about virtualization Infrastructure.
- To explore and experiment with various Cloud deployment environments.
- To learn about the security issues in the cloud environment.

Course Outcomes

COs	Description
CO1	Identify the design challenges inherent in cloud computing, including scalability, resource management, and data security considerations
CO2	Apply the concept of virtualization and its various types, such as full virtualization, para-virtualization, and hardware-assisted virtualization.
CO3	Experiment with virtualization of hardware resources and explore ocker for lightweight application deployment.
CO4	Develop and deploy services on the cloud platforms demonstrating proficiency in setting up and managing a cloud environment.
CO5	Analyze the security challenges posed by cloud computing to develop robust security strategies and protocols.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	1	-	-	1	-	-	-
CO2	3	1	-	2	1	-	-	-
CO3	3	2	1	2	1	-	-	-
CO4	3	2	2	3	1	-	-	-
CO5	3	3	2	3	1	-	-	-

SyllabusUNIT I

Cloud Architecture: System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture – Cloud deployment models – Cloud service models; Cloud Infrastructure: Architectural Design of Compute and Storage Clouds – Design Challenges.

UNIT II

Virtual Machine Basics – Taxonomy of Virtual Machines – Hypervisor – Key Concepts –Virtualization structure – Implementation levels of virtualization – Virtualization Types: Full Virtualization – Para Virtualization – Hardware Virtualization – Virtualization of CPU, Memory and I/O devices.

UNIT III

Desktop Virtualization – Network Virtualization – Storage Virtualization – System-level of Operating Virtualization – Application Virtualization – Virtual clusters and Resource Management – Containers vs. Virtual Machines – Introduction to Docker – Docker Components – Docker Container – Docker Images and Repositories.

UNIT IV

Google App Engine – Amazon AWS – Microsoft Azure; Cloud Software Environments – Eucalyptus – OpenStack.

UNIT V

Virtualization System-Specific Attacks: Guest hopping – VM migration attack – hyper jacking. Data Security and Storage;Identity and Access Management (IAM) - IAM Challenges - IAM Architecture and Practice.

Lab Experiments:

1. Install Virtualbox/VMware/ Equivalent opensource cloud Workstation with different flavours of Linux or Windows OS on top of windows 8 and above.
2. Install a C compiler in the virtual machine created using a virtual box and execute Simple Programs.
3. Install Google App Engine. Create a hello world app and other simple web applications using python/java.
4. Use the GAE launcher to launch the web applications.

5. Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.
6. Find a procedure to transfer the files from one virtual machine to another virtual machine.
7. Install Hadoop single node cluster and run simple applications like wordcount.
8. Creating and Executing Your First Container Using Docker.
9. Run a Container from Docker Hub.

Text books:

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, “Distributed and Cloud Computing, From Parallel Processing to the Internet of Things”, Morgan Kaufmann Publishers, 2012.
2. James Turnbull, “The Docker Book”, O’Reilly Publishers, 2014.
3. Krutz, R. L., Vines, R. D, “Cloud security. A Comprehensive Guide to Secure Cloud Computing”, Wiley Publishing, 2010.

References:

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

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA267	WEB MINING	L-T-P-C: 3-0-2-4

Course Objective(s)

- Familiarize students with fundamental principles and methods in Information Retrieval, Web Search, Data Mining, andMachine Learning, specifically tailored for knowledge extraction from web sources.
- Enhance proficiency in utilizing contemporary data mining tools to address real-world challenges in Web Mining.
- Cultivate self-directed learning and research capabilities through hands-on experience and independent study.

Course Outcomes

COs	Description
CO1	Students will demonstrate the ability to pre-process and clean web data, including handling missing values, dealing with noise and outliers, and transforming data into appropriate formats for analysis.
CO2	Students will be able to employ various web crawling and scraping techniques to effectively extract structured and unstructured data from web sources.
CO3	Students will gain a deep understanding of different web mining techniques, including content mining, structure mining, and usage mining, and will be able to apply these techniques to extract actionable insights from web data.
CO4	Students will develop the ability to critically evaluate web mining results, interpret findings, and make informed decisions based on the insights derived from web data analysis.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	2	-	-	-	-
CO2	3	3	3	2	-	-	-	-
CO3	3	3	3	2	-	-	-	-
CO4	3	3	2	2	-	-	-	-

Syllabus

Unit 1

Information Retrieval and Web Search: Information Retrieval Models, Text and Web Page Pre-Processing -Stopword Removal, Stemming, Web Page Pre-Processing, Inverted Index and Its Compression - Inverted Index, Search Using an Inverted Index. Latent Semantic Indexing, Web Search, Web Spamming. Link Analysis: Social Network Analysis, Co-Citation and Bibliographic Coupling, PageRank, HITS, Community Discovery- Bipartite Core Communities, Maximum Flow Communities, Email Communities Based on Betweenness

Unit 2

Web Crawling: A Basic Crawler Algorithm - Breadth-First Crawlers, Preferential Crawlers. Implementation Issues, Universal Crawlers, Focused Crawlers, Topical Crawlers, Evaluation, Crawler Ethics and Conflicts. Structured Data Extraction: Wrapper Induction, Automatic Wrapper Generation, String Matching and Tree Matching, Multiple Alignment, Extraction Based on a Single List Page and Multiple pages.

Unit 3

Information Integration: Introduction to Schema Matching, Pre-Processing for Schema Matching, Schema-Level Match, Domain and Instance-Level Matching, Combining Similarities, Integration of Web Query Interfaces. Opinion Mining: Sentiment Classification, Feature-Based Opinion Mining and Summarization, Comparative Sentence and Relation Mining, Opinion Search, Opinion Spam.

Unit 4

Web Usage Mining: Data Modeling for Web Usage Mining, Discovery and Analysis of Web Usage Patterns - Session and Visitor Analysis, Cluster Analysis and Visitor Segmentation, Analysis of Sequential and Navigational Patterns.

Lab Exercises:

1. Web Crawling and Scraping: Building a web crawler to collect data from a specific website.
2. Text Mining: Analyzing the content of web pages to extract keywords and perform sentiment analysis.
3. Link Analysis: Implementing algorithms like PageRank to analyze the link structure of the web.
4. Web Usage Mining: Analyzing user behavior on a website to identify patterns and trends
5. Recommender Systems: Building a simple recommender system using web mining techniques.
6. Final Project: Applying web mining techniques to a real-world dataset and presenting findings.

Textbooks / References:

1. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data (Data-Centric Systems and Applications) by Bing Liu, Springer Publisher.
2. Mining The Web: Discovering Knowledge From Hypertext Data by Chakrabarti Soumen, Elsevier Science
3. Web Mining: Applications and Techniques, Anthony Scime (State University of New York at Brockport, USA) Release Date: August, 2004|Copyright: © 2005 |Pages: 442 ISBN13:
4. "Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data" by Bing Liu
5. "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, GitHub, and More" by Matthew A. Russell
6. "Introduction to Information Retrieval" by Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze
7. Research papers and online resources relevant to web mining and related topics.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

SEMESTER VII

26CSA401 ADVANCED DATA STRUCTURES L-T-P-C: 3-0-0-3

Course Objective(s)

- Understand the basic principles and operations of data structures
- Understand different types of queues and hashing mechanism
- Learn various algorithms for text processing
- Familiarize yourself with the advanced data structures in graphs and trees

Course Outcomes

COs	Description
CO1	Identify the appropriate basic data structure for solving problems.
CO2	Apply different types of queues and implementation of hashing techniques.
CO3	Develop algorithms for text-processing applications.
CO4	Apply the concepts of graphs and advanced trees to solve computational problems.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO												
CO1	3	3	3	-	-	-	3	-	1	-	1	-
CO2	3	3	3	-	-	-	1	-	1	-	1	-
CO3	3	3	3	2	-	-	1	-	1	-	1	-
CO4	3	3	3	3	-	-	3	-	1	-	1	-

Syllabus

Unit I: Overview of basic Data Structures: Arrays: types of arrays, Memory Representation, applications of arrays. Stack: Operations, Expression Conversion, Recursion. Queue, Operations, Circular Queue, Applications of Queue. Linked List Types and Operations: Singly, Circular, and Doubly linked list.

Unit II: Priority Queue, Double-ended queue, Binomial queue, and its operations. Hashing: Introduction, hash function, hash tables. Collision Handling: Linear probing, quadratic probing, double hashing, rehashing, chaining.

Unit III: String Matching – The naive string-matching algorithm, Pattern Matching, The Rabin-Karp algorithm, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding

Unit IV: Graph traversal: BFS, DFS. Topological sort. Types of Trees: Binary Tree, Threaded Binary Tree, Heap: Introduction, Hearp Sort, Expression Tree, AVL Tree – Rotations, B Tree – Insertion and Deletion. Red Black Tree – Insertion and Deletion. K-dimensional tree, Splay tree.

Textbooks:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002
3. Advanced Data Structures, Reema Thareja, S. Rama Sree, Oxford University Press, 2018

References:

1. Fundamentals of Computer Algorithms, Ellis Horowitz, Satraj Sahani and Rajasekharam, 2nd Edition, 2009, University Press Pvt. Ltd.
2. Introduction to Algorithms, Thomas H Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, 3rd Edition, 2009, The MIT Pres.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment (including lab)	25
End Semester Exam	50
Total Marks	100

26CSA402	ADVANCED JAVA AND J2EE	L-T-P-C: 3-0-0-3

Course Objective(s)
The main Objective of the course is to enable students to understand the concepts underlying technologies in JAVA Enterprise edition with Swings and multithreading, configuring Apache tomcat server, Java beans and Enterprise Java Beans.

Course Outcomes

COs	Description
CO1	Develop applications utilizing TCP/IP socket programs, swing controls with JDBC API.
CO2	Able to develop server-side programming with java Servlets
CO3	Develop web pages using JSP
CO4	Able to efficiently manage user sessions for stateful interactions using sessions and cookies
CO5	Demonstrate the use of JavaBeans and Advanced J2EE Frameworks.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	-	-	-	-	2	-	3	2
CO2	3	3	3	2	-	-	-	-	2	-	3	3
CO3	2	2	2	2	-	-	-	-	2	-	2	2
CO4	2	3	3	3	-	-	-	-	2	-	3	2
CO5	3	3	3	3	-	-	-	-	2	-	3	3

Syllabus
Unit I: Networking: Classes to be covered Socket, ServerSocket, IPAddress, URL connections – Swing controls – JDBC - Writing JDBC applications using select, insert, delete, update**.**

Unit II: Introduction to J2EE: J2EE Architecture, Standard Services of J2EE, Introduction to Web servers
SERVLETS: Introduction to Servlets - Life cycle of servlets, Deployment Descriptor (web.xml). The servlet API: javax. servlet package. Reading the servlet Parameters, Reading Initialization parameter. The javax.servlet.http. Request Dispatcher

Unit III: JAVA SERVER PAGES: Advantage of JSP technology. JSP Architecture, JSP Access Model. JSP Syntax Basic (Declarations, Expression, Scriplets, Comments), JSP directives page, include and taglib, JSP Implicit Objects, Exception Handling.

Unit IV: Package Handling HTTP Request and Response (GET/ POST Request), Using Cookies, Session Tracking.

Unit V: Introduction to EJB – Understanding MVC – Building Controllers, models, and views – Integrating hibernate with spring.

Textbooks:
1. Deitel & Deitel, "Java How to program", Prentice Hall, 2017.

References:
Gary Cornell and Cay S. Horstmann, "Core Java Vol 1 and Vol 2", Sun Microsystems Press, Eleventh Edition, 2018.
Java EE 8 Development with Eclipse: Develop, Test, and Troubleshoot Java Enterprise Applications Rapidly with Eclipse, 3rd Edition

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment (including lab)	25
End Semester Exam	50
Total Marks	100

26CSA403	PROGRAMMING FOR PROBLEM SOLVING	L-T-P-C: 3-0-0-3

Course Objective

To develop students' logical reasoning and programming skills through hands-on problem solving, preparing them for coding assessments and technical interviews.

Course Outcomes

COs	Description
CO1	Apply fundamental programming constructs such as loops, conditionals, functions, and recursion to solve basic computational problems.
CO2	Analyze problems using decomposition techniques and implement solutions using arrays, strings, and hashing.
CO3	Solve algorithmic challenges using techniques like sliding window, two-pointer, and frequency maps.
CO4	Demonstrate proficiency in solving coding problems from online platforms under time constraints.
CO5	Develop clean, efficient, and optimized code for real-world applications, considering constraints and edge cases.
CO6	Design and implement a mini-project using command-line interface (CLI) tools that integrates learned programming concepts.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	1	-	-	1	-
CO2	3	3	2	1	-	-	1	-
CO3	2	3	3	2	-	-	2	-
CO4	2	3	3	2	2	-	2	-
CO5	1	2	2	2	2	-	1	-
CO6	1	2	2	3	2	-	2	-

Syllabus

Unit 1: Foundations of Programming

Introduction to logic building, Control structures: loops, conditionals, Functions and modular programming, Recursion basics, Input/output operations, Debugging and error handling.

Unit 2: Problem-Solving Techniques

Pattern recognition and problem decomposition, Mathematical problems (number theory, combinatorics), String manipulation techniques, Array-based problem solving, Hashing and frequency maps, Sliding window and two-pointer techniques.

Unit 3: Programming Challenges

Daily coding problems (easy to medium level), solving problems from platforms like HackerRank, LeetCode, CodeChef, Group coding sessions and peer reviews, Timed coding tests and contests.

Unit 4: Real-World Applications

Writing clean and efficient code, understanding constraints and edge cases, optimizing solutions. Mini-project: Build a simple CLI tool or game (e.g., quiz app, calculator, to-do list).

Textbooks/References:

1. Let Us C" by Yashavant Kanetkar – A classic book for foundational programming concepts and exercises.
2. Introduction to Algorithms" by Cormen, Leiserson, Rivest, and Stein – For deeper understanding of algorithmic techniques (selected chapters).
3. Cracking the Coding Interview" by Gayle Laakmann McDowell – Excellent for preparing students for coding interviews and challenges.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment (including lab)	25
End Semester Exam	50
Total Marks	100

26CSA404 ADVANCED DBMS L-T-P-C: 3-0-0-3

Course Objective(s)

- The course provides explores emerging trends and technologies in the field of database management, including object-oriented database, parallel databases, active databases and understand their potential applications and impact.
- Students can apply theoretical concepts and practical skills acquired throughout the course to real-world projects, case studies, and problem-solving exercises to gain practical experience in advanced database management.

Course Outcomes

COs	Description
CO1	Demonstrate proficiency in advanced SQL concepts and comprehend the fundamentals of parallel databases
CO2	Implement object-relational database concepts to manipulate complex data types in queries.
CO3	Implement and Integrate JSON with PHP for storing, querying data and evaluate their usage in different scenarios
CO4	Design and implement active databases with event-driven triggers and rules to automate data management tasks and enforce complex constraints.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO												
CO1	1	2	3	2	-	-		-	-	-	-	-
CO2	1	3	3	2	-	-		1	-	-	-	-
CO3	1	2	3	2	-	-		1	-	-	-	-
CO4	1	2	2	1	2	-		-	-	-	-	-

Syllabus

Unit I: Advanced SQL – Sub queries, Joins, views, With clause – Recursion in SQL, PL-SQL.
Introduction to Parallel database and I/O Parallelism, Interquery Parallelism, Intraquery Parallelism. Intraoperation Parallelism, Interoperation Parallelism – Introduction to Distributed Databases.

Unit II: Introduction to object-relational database - Complex Data Types, Structured Types and Inheritance in SQL, Table Inheritance, Array and multiset, Object Query Languages, Query planning, Evaluation and Optimization Techniques

Unit III: JSON – syntax, datatypes, stringify, objects, schema
XML Databases: XML Data Model – DTD – XML Schema – XML Querying
Comparison of JSON with XML, Comparing the usage of JSON and XML; Use JSON with PHP/ Python

Unit IV: Intelligent Databases-Active Databases- Taxonomy- Applications- Design Principles for Active Rules- Events, Conditions, Actions. Temporal Databases: Overview of Temporal Databases: Introduction to Temporal Database: Time ontology, structure, and granularity, Temporal data models, Spatial Databases - Types of spatial data, Geographical Information Systems (GIS), Deductive Databases-Introduction to recursive queries, Datalog Notation, Clause Form and Horn Clauses.

Textbooks / References:

1. Database Systems Concepts; Silberschatz, Abraham, Henry F. Korth, and S.Sudarshan.
2. Principles of Distributed Database Systems; Ozsu, M. Tamer and Patrick Valduriez.
3. C. S. R. Prabhu, “Object Oriented Database Systems: Approaches and Architectures”, Third Edition, PHI Learning Pvt. Ltd.
4. RamezElmasri and ShamkantNavathe, “*Fundamentals of Database Systems*”, Sixth Edition, Addison Wesley, 2010
5. Hector Garcia-Molina, Jeffrey Ullman and Jennifer Widom, “*Database Systems: The Complete Book*”, Second Edition, Prentice Hall, 2008
6. Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T.Snodgrass, V.S.Subrahmanian, Roberto Zicari, ―Advanced Database Systems‖, Morgan Kaufmann publishers,2006.
7. Henry F Korth, Abraham Silberschatz, S. Sudharshan, ―Database System Concepts‖, Sixth Edition, McGraw Hill, 201

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment (including lab)	25
End Semester Exam	50
Total Marks	100

26CSA481 ADVANCED DATA STRUCTURE LAB L-T-P-C: 0-0-2-1

Course Objective(s)

- Understand the basic principles and operations of data structures
- Understand different types of queues and hashing mechanism
- Learn various algorithms for text processing
- Familiarize yourself with the advanced data structures in graphs and trees

Course Outcomes

COs	Description
CO1	Identify the appropriate basic data structure for solving problems.
CO2	Apply different types of queues and implementation of hashing techniques.
CO3	Develop algorithms for text-processing applications.
CO4	Apply the concepts of graphs and advanced trees to solve computational problems.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	-	3	-	1	-	1	-
CO2	3	3	3	-	-	-	1	-	1	-	1	-
CO3	3	3	3	2	-	-	1	-	1	-	1	-
CO4	3	3	3	3	-	-	3	-	1	-	1	-
CO5	3	3	3	-	-	-	3	-	1	-	1	-

Syllabus

1. Implement searching algorithms: Linear & Binary Search
2. Implement basic sorting algorithms: Bubble sort, Insertion sort, Selection sort
3. Interactive program to implement stack operations
4. Interactive program to implement queue operations
5. Implement insertion and deletion operations on singly, circular, and doubly linked list
6. Perform insertion and deletion operations on the double-ended queue
7. Implement hashing techniques with a collision mechanism
8. Implement a program for String Matching using the Boyer-Moore Algorithm on a text file content
9. Implement a program for String Matching using Knuth-Morris-Pratt Algorithm on a text file content
10. Implement Huffman-Coding Method. Show the result with suitable example
11. Implement BFS and DFS
12. Implement heap sort
13. Implement B Tree
14. Implement red black tree
15. Implement splay tree

Textbooks:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002
3. Advanced Data Structures, Reema Thareja, S. Rama Sree, Oxford University Press, 2018

References:

1. Fundamentals of Computer Algorithms, Ellis Horowitz, Satraj Sahani and Rajasekharam, 2nd Edition, 2009, University Press Pvt. Ltd.
2. Introduction to Algorithms, Thomas H Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, 3rd Edition, 2009, The MIT Pres.

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment (including lab)	70
End Semester Exam	30
Total Marks	100

26CSA482	ADVANCED JAVA AND J2EE LAB	L-T-P-C: 0-0-2-1

Course Objective(s)

The main Objective of the course is to enable students to understand the concepts underlying technologies in JAVA Enterprise edition with Swings and multithreading, configuring Apache tomcat server, Java beans and Enterprise Java Beans.

Course Outcomes

COs	Description
CO1	Develop applications utilizing TCP/IP socket programs, swing controls with JDBC API.
CO2	Able to develop server-side programming with java Servlets
CO3	Develop web pages using JSP
CO4	Able to efficiently manage user sessions for stateful interactions using sessions and cookies
CO5	Demonstrate the use of JavaBeans and Advanced J2EE Frameworks.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	-	-	-	-	2	-	3	2
CO2	3	3	3	2	-	-	-	-	2	-	3	3
CO3	2	2	2	2	-	-	-	-	2	-	2	2
CO4	2	3	3	3	-	-	-	-	2	-	3	2
CO5	3	3	3	3	-	-	-	-	2	-	3	3

Syllabus

1. Program to display IP Address and local host.
2. Program to demonstrate few methods of Inetaddress class
3. Client Server Socket Programming.
4. Program to Implement chat application
5. Program to demonstrate datagram
6. Program to fetch a particular Website tag when an URL is specified.
7. Program to implement JButton with image and ActionListerner
8. Program to implement JTextField, JLabel, JTextArea and JButton.
9. Program to implement JCheckBox and JRadioButton
10. 1rogram to implement JList and JComboBox
11. Program to implement Address Book using swing component
12. Program to implement JTabbed pane
13. Program to implement JTree
14. Program to implement JTable
15. Program to implement JMenu
16. Establish Database connection from a java program.
17. Insert / Update a table from java program.
18. Load a table data in Swing components.
19. Delete a record from a table.
20. Program which shows use of statement, prepared Statement and Callable statement.
21. Write a program to implement a simple servlet which writes a Welcome HTML page in the web browser.
22. A servlet should receive a parameter from JSP page and process it.
23. Servlet program to implement parameter handling.

24. Servlet program to handle GET and POST request.

25. Configure Apache Tomcat and write a hello world JSP page.

26. Create a JSP page to demonstrate scriplets.

27. Create a JSP Page to demonstrate include tag

28. Create a JSP Page to demonstrate action elements include

29. Create a JSP Page to demonstrate action elements forward

30. Create a login page and authenticate a user in a JSP page using database.

31. A website hit counter data which has to be saved in a cookie.

32. Implement a Java Beans to set and get values.

33. Program to illustrate the procedure of handling session and print a Hello world using Java Bean.

34. Program to demonstrate exception handling using servlets/JSP.

35. An application named account using stateful session bean. The purpose of account is to perform transaction operations (deposit and withdraw) for the customer.

Textbooks:
Deitel & Deitel, "Java How to program", Prentice Hall, 2017.

References:
Gary Cornell and Cay S. Horstmann, "Core Java Vol 1 and Vol 2", Sun Microsystems Press, Eleventh Edition, 2018.
Java EE 8 Development with Eclipse: Develop, Test, and Troubleshoot Java Enterprise Applications Rapidly with Eclipse, 3rd Edition

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment (including lab)	70
End Semester Exam	30
Total Marks	100

26CSA483	PROGRAMMING FOR PROBLEM SOLVING LAB	L-T-P-C: 0-0-2-1

Course Objective

To develop students' logical reasoning and programming skills through hands-on problem solving, preparing them for coding assessments and technical interviews.

Course Outcomes

COs	Description
CO1	Apply fundamental programming constructs such as loops, conditionals, functions, and recursion to solve basic computational problems
CO2	Analyze problems using decomposition techniques and implement solutions using arrays, strings, and hashing
CO3	Solve algorithmic challenges using techniques like sliding window, two-pointer, and frequency maps
CO4	Demonstrate proficiency in solving coding problems from online platforms under time constraints
CO5	Develop clean, efficient, and optimized code for real-world applications, considering constraints and edge cases
CO6	Design and implement a mini-project using command-line interface (CLI) tools that integrates learned programming concepts

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	1	-	-	1	-
CO2	3	3	2	1	-	-	1	-
CO3	2	3	3	2	-	-	2	-
CO4	2	3	3	2	2	-	2	-
CO5	1	2	2	2	2	-	1	-
CO6	1	2	2	3	2	-	2	-

Syllabus

1 **Structured I/O Parser:** Read N student records from stdin (format: name, dept, marks1, marks2, marks3) and output a rank list with average, standard deviation, and top-3.

2 **Conditionals:** Electricity billing with tiered rates and a night rebate.

3 **Loops—Patterns & Frequency**
Pascal Row (Iterative)
Integer Frequency & Histogram

4 Program to illustrate functions of all types

5 Problem Decomposition (Strings)

6 Debugging strategies

7 Arrays—Prefix / Two-Pointer / Sliding Window
Longest Subarray with Sum = K (Non-Negative)
Two-Sum (Sorted) & 3-Sum

8 String palindrome using two pointers

9 Daily coding challenges discussion

10 Daily coding challenges discussion

11 Daily coding challenges discussion

12 Clean coding principles and best practices

13 Time coding practice

Textbooks/References:

1. Let Us C" by Yashavant Kanetkar – A classic book for foundational programming concepts and exercises.
2. Introduction to Algorithms" by Cormen, Leiserson, Rivest, and Stein – For deeper understanding of algorithmic techniques (selected chapters).
3. Cracking the Coding Interview" by Gayle Laakmann McDowell – Excellent for preparing students for coding interviews and challenges.

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment (including lab)	70
End Semester Exam	30
Total Marks	100

26CSA484	ADVANCED DBMS LAB	L-T-P-C: 0-0-2-1

Course Objective(s)

- The course provides explores emerging trends and technologies in the field of database management, including object-oriented database, parallel databases, active databases and understand their potential applications and impact.
- Students can apply theoretical concepts and practical skills acquired throughout the course to real-world projects, case studies, and problem-solving exercises to gain practical experience in advanced database management.

Course Outcomes

COs	Description
CO1	Demonstrate proficiency in advanced SQL concepts and comprehend the fundamentals of parallel databases
CO2	Implement object-relational database concepts to manipulate complex data types in queries.
CO3	Implement and Integrate JSON with PHP for storing, querying data and evaluate their usage in different scenarios
CO4	Design and implement active databases with event-driven triggers and rules to automate data management tasks and enforce complex constraints.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO												
CO1	1	2	3	2	-	-		-	-	-	-	-
CO2	1	3	3	2	-	-		1	-	-	-	-
CO3	1	2	3	2	-	-		1	-	-	-	-
CO4	1	2	2	1	2	-		-	-	-	-	-

Syllabus

1. Write advanced SQL queries using subqueries, nested subqueries, and correlated subqueries.

2. Implement and apply joins (inner, outer, natural, self joins) and set operations (UNION, INTERSECT, EXCEPT) on multi-table databases.

3. Develop SQL queries using EXISTS, WITH clause (CTE), and recursive queries for hierarchical data representation.

4. Create and manipulate views, including updatable views, and analyze their role in logical data abstraction.

5. Develop PL/SQL programs using variables, control structures, procedures, functions, cursors, and exception handling.

6. Simulate transaction processing, demonstrating ACID properties, transaction states, serializability, and locking mechanisms.

7. Implement case studies illustrating concurrency control issues such as lost updates, dirty reads, non-repeatable reads, and phantom reads.

8. Design SQL queries to demonstrate parallel execution plans and observe query behavior using database explain/analysis tools.

10. Implement object-relational database features:
    - Creation of complex data types
    - Structured user-defined types
    - Methods and inheritance in SQL

11. Create and manipulate databases using table inheritance and array data types, and write queries on inherited tables.

12. Create and manipulate JSON data in databases:
    - JSON syntax and datatypes
    - Storing JSON objects
    - Querying JSON attributes

13. Design and query XML databases using:
    - XML schema / DTD
    - XPath / XQuery

- Storage and retrieval of XML data

14. Comparative case study:
    - Compare JSON vs XML for data representation
    - Use JSON with PHP or Python to interact with the database
    - Demonstrate a small integrated application

Textbooks / References:

1. Database Systems Concepts; Silberschatz, Abraham, Henry F. Korth, and S.Sudarshan.
2. Principles of Distributed Database Systems; Ozsu, M. Tamer and Patrick Valduriez.
3. C. S. R. Prabhu, "Object Oriented Database Systems: Approaches and Architectures", Third Edition, PHI Learning Pvt. Ltd.
4. RamezElmasri and ShamkantNavathe, "*Fundamentals of Database Systems*", Sixth Edition, Addison Wesley, 2010
5. Hector Garcia-Molina, Jeffrey Ullman and Jennifer Widom, "*Database Systems: The Complete Book*", Second Edition, Prentice Hall, 2008
6. 6. Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T.Snodgrass, V.S.Subrahmanian, Roberto Zicari, ―Advanced Database Systems‖, Morgan Kaufmann publishers,2006.
7. Henry F Korth, Abraham Silberschatz, S. Sudharshan, ―Database System Concepts‖, Sixth Edition, McGraw Hill, 201

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26LSK211	LIFE SKILLS - II	L-T-P-C: 0-0-2-2

Course Objectives

- Develop effective communication and listening skills for professional environments
- Build assertiveness, self-confidence, and positive self-perception
- Apply goal-setting and time-management strategies for personal and professional growth
- Enhance presentation and public speaking skills
- Strengthen verbal ability, grammar, and written communication
- Improve logical reasoning and quantitative aptitude for competitive assessments

Course Outcomes (COs)

COs	Description
CO1	Communicate effectively using verbal, non-verbal, listening, and presentation skills in professional environments
CO2	Demonstrate self-confidence, assertiveness, ethical behavior, and effective interpersonal skills
CO3	Apply logical reasoning and quantitative aptitude skills to solve analytical problems
CO4	Use professional writing, data interpretation, and time-management skills for workplace effectiveness

CO–PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	3	2	3	1	2	3
CO2	2	2	2	3	3	1	3	3
CO3	2	3	1	1	1	3	2	2
CO4	2	2	3	2	2	2	3	3

Soft Skills

Introduction to 'Campus to Corporate Transition':

Communication and listening skills: Communication process, barriers to communication, verbal and non-verbal communications, elements of effective communication, listening skills, empathetic listening, role of perception in communication.

Assertiveness Skills: The concept, assertiveness and self-esteem, advantages of being assertive, assertiveness and organizational effectiveness.

Self-perception and Self-confidence: The locus of control (internal v/s external), person perception, social perception, attribution theories-self presentation and impression management, the concept of self and self-confidence, how to develop self-confidence.

Goal Setting: The concept, personal values and personal goals, goal setting theory, six areas of goal setting, process of goal setting: SMART goals, how to set personal goals.

Time Management: The value of time, setting goals/ planning and prioritizing, check the time killing habits, procrastination, tools for time management, rules for time management, strategies for effective time management.

Presentation Skills: The process of presentation, adult learning principles, preparation and planning, practice, delivery, effective use of voice and body language, effective use of audio-visual aids, dos and don'ts of effective presentation.
Public speaking-an art, language fluency, the domain expertise (Business GK, Current affairs), self-confidence, the audience, learning principles, body language, energy level and conviction, student presentations in teams of five with debriefing

Verbal Skills

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misspelt words, commonly confused words and wrong form of words in English.

Grammar: Train students to understand the nuances of English Grammar and thereby enable them to spot grammatical errors and punctuation errors in sentences.

Reasoning: Stress the importance of understanding the relationship between words through analogy questions and learn logical reasoning through syllogism questions. Emphasize the importance of avoiding the gap (assumption) in arguments/

statements/ communication.

Oral Communication Skills: Aid students in using the gift of the gab to improve their debating skills.

Writing Skills: Introduce formal written communication and keep the students informed about the etiquettes of email writing. Make students practice writing emails specially composing job application emails.

Aptitude Skills

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.

Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.

Ratio, Proportion & Variation:
Basics, Alligations, Mixtures, and Partnership, Averages and Weighted Average.

Time and Work: Basics, Pipes & Cistern, and Work Equivalence.

Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.

Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.

Data Interpretation: Tables, Bar Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, and other forms of data representation.

Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.

References:

1. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
2. The hard truth about Soft Skills, by Amazon Publication.
3. Verbal Skills Activity Book, CIR, AVVP
4. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
5. The BBC and British Council online resources
6. Owl Purdue University online teaching resources
7. www.thegrammarbook.com online teaching resources
8. www.englishpage.com online teaching resources and other useful websites
9. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
10. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
11. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
12. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
13. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
14. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
15. A Modern Approach to Logical Reasoning, R S Aggarwal.
16. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	**Internal**	**External**
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests.**

SEMESTER VIII

26CSA411 DESIGN AND ANALYSIS OF ALGORITHMS L-T-P-C: 3-1-0-4

Course Objective(s)

- To introduce algorithms as a precise mathematical concept, teach algorithm design, establish their correctness, and study their efficiency and memory usage.
- To provide a clear understanding of algorithmic design paradigms such as Divide-and-Conquer, Dynamic Programming, Greedy, Branch and Bound, etc.

Course Outcomes

COs	Description
CO1	Able to compare functions using asymptotic analysis and describe the relative merits of worst-case, average-case, and best-case analysis
CO2	Derive and solve recurrences describing the performance of divide-and-conquer algorithms
CO3	Apply greedy strategy to solve problems
CO4	Find optimal solution using dynamic programming
CO5	Design algorithms using backtrack and branch and bound to solve complex problems and performance analysis of non-deterministic problems

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	1	-	1	-	1	-
CO2	3	3	3	2	-	-	1	-	1	-	1	-
CO3	3	3	3	3	-	-	1	-	1	-	1	-
CO4	3	3	3	3	-	-	1	-	1	-	1	-
CO5	3	3	3	3	-	-	2	-	1		1	-

Syllabus

Unit I: Notion of an Algorithm – Fundamentals of Algorithmic Problem Solving – Important Problem Types – Fundamentals of the Analysis of Algorithmic Efficiency –Asymptotic Notations and growth rate. Sorting Algorithms and analysis: Bubble sort, Selection sort, Insertion sort, Shell sort. Recurrence Relations- substitution & master's method.

Unit II: Divide and conquer strategy – finding minimum and maximum, integer multiplication, binary search, binary search tree. Merge sort, Quick sort, heap sort, and its analysis. Strassen's algorithm for matrix multiplication, maximum subarray.

Unit III: Greedy Method – Knapsack problem, Job sequencing with deadlines, optimal merge pattern. Minimum spanning tree – Prim's and Kruskal's algorithm. Single source shortest path – Dijkstra's algorithm, Bellman-Ford algorithm. Huffman Coding.

Unit IV: Dynamic programming – Principle of optimality, knapsack problem, matrix chain multiplication, longest common subsequence problem, optimal binary search tree, traveling salesman problem. All pair shortest path – Floyd Warshal algorithm.

Unit V: Backtracking and Branch and Bound – Queen's problem, sum of subset, graph coloring, Hamiltonian cycle, job sequencing with deadline, 0 or 1 knapsack problem, TSP. The class P and NP, polynomial reduction, NP–completeness problem, and NP-Hard problem.

Textbooks:

1. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, PHI
2. Design and Analysis of Algorithms, Dave and Dave, Pearson
3. Introduction to Design and Analysis of Algorithms, Anany Levitin, Pearson

References:

1. Fundamental of Algorithms by Gills Brassard, Paul Bratley, PHI
2. Analysis of Algorithms, Jeffrey J McConnel, Jones and Bartlett Publishers, Inc, 2nd Revised edition, 2 November 2007

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA412 PRINCIPLES AND IMPLEMENTATION OF DESIGN PATTERNS L-T-P-C: 3-0-2-4

Course Description

This course introduces the intent, structure, and application of design patterns, followed by in-depth study of creational (Abstract Factory, Factory Method, Prototype, Singleton), structural (Adapter, Bridge, Composite, Decorator, Façade, Proxy), and behavioral (Command, Iterator, Mediator, Observer, State, Template Method) patterns with comparative analysis and case studies to support reusable, robust software design. It covers core software engineering principles and object-oriented design patterns for building scalable and maintainable systems. It also deals with software classification, layered architecture, SDLC, generic and agile process models (Scrum, XP), process assessment, design engineering, and reengineering.

Course Objective(s)

- To understand the idea of software engineering process models by analyzing SDLC, layered architecture, agile methods (Scrum, XP), and reengineering techniques for systematic software development.
- To identify, compare, and implement object-oriented design patterns including creational, structural, and behavioral patterns to produce scalable, reusable, and maintainable software architectures.
- To develop robust software designs using pattern-based solutions through case studies and practical analysis to improve flexibility, performance, and quality in real-world applications.

Course Outcomes

COs	Description
CO1	Understand and apply software engineering methods, layered technology, process frameworks, and requirements analysis with design engineering using agile methodology along with reengineering.
CO2	Understand the concept of Design patterns and its importance in gaining behavioral knowledge of the problem and its solutions using Creational, Structural design patterns.
CO3	Understand and apply common creational design patterns to incremental and iterative development, and identify appropriate object creation mechanisms to design and propose effective solutions for given problems.
CO4	Understand and apply common design patterns to incremental/iterative development. To identify appropriate behavioral patterns for the design to propose solutions to the given problem.
CO5	Understand the need for programming by using basic design principles in solving real-life problems or case studies.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	2	3	1	1	1	3	3
CO2	-	2	3	2	2	1	3	3
CO3	3	2	3	2	3		3	
CO4	3	3	3	3	3		3	
CO5	3	2	2	2	3		3	

Prerequisites

- Object oriented programming languages

Syllabus

Unit I: Software Engineering – Introduction - Software Classification - Layered Technology - SDLC - Generic Process Model, Perspective Models - Agile Process Models – Scrum and Extreme Programming (XP) - Design Engineering - Reengineering

Unit II: Introduction: What Is a Design Pattern? Describing Design Patterns, The Catalogue of Design Patterns, Organizing the Catalogue, How Design Patterns Solve Design Problems, How to Select a Design Pattern, How to Use a Design Pattern.

Unit III: Creational Patterns: Abstract Factory, Factory Method, Prototype, Singleton – Comparisons of various creational patterns – Discussion of Case studies – ex: Cross-Platform UI Framework – Banking solution - Cloud Notification Service etc.,

Unit IV: Structural Patterns: Adapter, Bridge, Composite, Decorator, Façade, and Proxy – Comparisons of various structural patterns - Discussion of Case studies – ex: Payment gateways, ERP migrations etc.,

Unit V: Behavioral Patterns: Command, Iterator, Mediator, Observer, State and Template Method. Comparisons of various behavioral patterns - Discussion of Case studies – ex: smart homes, Smart Factory Automation etc.,

Textbooks / References:

1. Roger S. Pressman, “Software Engineering-A Practitioner’s Approach”, Seventh Edition, Tata McGraw-Hill, 2010.
2. Richard Fairley, “Software Engineering concepts”, Tata McGraw-Hill Publishing Company Pvt. Ltd., Ninth Edition
3. Patterns in JAVA Vol-I By Mark Grand, Wiley Dream Tech.
4. Head First Design Patterns by Eric Freeman-O’Reilly-spd

Evaluation Pattern

sment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA487 PROBLEM FORMULATION & RESEARCH TOOLS L-T-P-C: 0-0-2-1

Course Objective(s)

1. Familiarize with different types of research methodologies and their applications.
2. Gain proficiency in identifying, selecting, and formulating research problems and questions.
3. Analyze ethical issues related to research, including copyright, intellectual property rights, and plagiarism.
4. Acquire skills in writing a research report, including proper citation and acknowledgment of sources.
5. Apply knowledge gained through a case study by conducting a literature review on a chosen research topic, preparing a review report, and presenting findings in a seminar format.

Course Outcomes

COs	Description
CO1	Apply various research methodologies and techniques to address research problems effectively in different academic and professional contexts.
CO2	Evaluate and critique research literature using traditional and internet-based sources to identify gaps, trends, and areas for further investigation.
CO3	Assess ethical considerations related to research, including issues of plagiarism, copyright, intellectual property rights, and data confidentiality.
CO4	Conduct a literature review on a chosen research topic, synthesizing and presenting findings effectively in both written and oral formats.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO												
CO1	-	3	-	1	3	1	-	3	-	-	2	1
CO2	3	-	-	1	-	2	-	-	1	1	-	-
CO3	-	-	-	1	-	3	-	-	-	3	-	1
CO4	-	3	3	1	2	-	-	-	3	-	3	1

Syllabus

Research: Meaning, Purpose, Types of Research, Steps in Research, Identification, Selection and Formulation of Research Problem, Research Questions, Research Design, Review of Literature.
Internet as a source in identifying gap areas from literature reviews and emerging trends.
Research Report writing. Ethical Issues, Copyright, Royalty, Intellectual Property Rights and Patent Law, Reproduction of Published Material, Citation and Acknowledgement.
Case study: Conduct a literature review on a chosen research topic, prepare a review report, and present a seminar.

Textbooks:

CR Kothari: Research Methodology-Methods and Techniques, New Age International Publishers, 2004.

References:

1. Jacques Barzun, Henry F. Graff: The Modern Researcher‖ Edition 6, Wadsworth Inc Fulfilment, 2003.
2. Carlo Lastrucci, The Scientific Approach: Basic Principles of the Scientific Method (Cambridge, Mass.: Schenkman, 1967).
3. Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age, 2016.

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

26CSA414	ADVANCED PROGRAMMING USING PYTHON	L-T-P-C: 3-0-0-3

Course Objective

To equip students with strong programming foundations using Python, focusing on core logic building, object-oriented programming, advanced features like decorators and generators, file handling, regular expressions, and problem-solving patterns using Python.

Course Outcomes

COs	Description
CO1	Apply core and object-oriented programming principles in Python.
CO2	Use advanced Python features such as iterators, generators, decorators, and context managers.
CO3	Develop robust Python applications using modules, error handling, and unit testing. CO4: Implement algorithmic problem-solving techniques using Python.
CO4	Handle text data using regular expressions and work with file systems efficiently

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	-	-	-	1	-
CO2	3	3	3	1	-	-	1	-
CO3	2	3	3	2	1	-	2	-
CO4	3	3	3	2	1	-	2	-
CO5	1	1	1	2	2	-	1	-

Syllabus

Unit 1: Introduction & Object-Oriented Programming

Python syntax and semantics, data types, control flow, functions, modules, packages, recursion and lambda functions, file handling, exception handling, and debugging techniques. Classes and Objects, Constructors, inheritance, p olymorphism, Magic methods (__init__, __str__,__len__, etc.), Composition vs Inheritance, class and static methods.

Unit 2: Advanced Python Programming Concepts, Iterators and Generators, Decorators and closures, Context managers (with statement), Modules and packages (standard & custom), Dynamic typing and introspection.

Unit 3: File and Text Processing

Text, binary file handling, Directory handling using os, shutil, glob, working with JSON and CSV, Regular Expressions using the re module (search, match, replace, extract patterns), Use- case: Log file analyzer

Unit 4: Problem-**Solving Patterns in Python**

Sorting, searching, recursion, Hashing, frequency counters, sliding window, Backtracking problems, Basic graph and tree problems using dictionaries/lists, Competitive programming style challenges (Leetcode-style)

Unit 5: Testing and Best Practices

Writing testable code, Unit testing with unittest or pytest, Code documentation and style (PEP8), Error logging and debugging, Packaging Python applications. Git and GitHub basics, writing clean, maintainable code, and creating a portfolio of Python projects.

Text Books/ References

1. Python Programming: An Introduction to Computer Science by John Zelle
2. Fluent Python by Luciano Ramalho
3. Test-Driven Development with Python by Harry J.W. Percival

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment (including lab)	50
End Semester Exam	30
Total Marks	100

26CSA485	DESIGN AND ANALYSIS OF ALGORITHMS LAB	L-T-P-C: 0-0-2-1

Course Objective(s)

- To provide a strong foundation in basic algorithmic concepts and problem-solving techniques
- To implement and analyze common sorting and searching algorithms
- To understand and apply Divide and Conquer techniques
- To implement Greedy and Dynamic Programming approaches for optimization problems
- To develop practical skills in algorithm implementation and complexity analysis

Course Outcomes

COs	**Description**
CO1	Analyze and compute the time complexity of basic algorithms
CO2	Implement and apply sorting and searching algorithms
CO3	Solve problems using Divide and Conquer techniques
CO4	Solve optimization problems using Greedy methods
CO5	Implement solutions using Dynamic Programming and Backtracking

CO-PO Mapping

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO												
CO1	3	2	–	–	–	–	–	–	3	2	–	–
CO2	2	3	2	–	–	–	–	–	2	3	2	–
CO3	3	2	2	–	–	–	–	–	3	2	2	–
CO4	2	3	2	–	–	–	–	–	2	3	2	–
CO5	3	2	2	–	–	–	–	–	3	2	2	–

Syllabus

1. Program to perform operation count for a given pseudocode
2. Program to read *N* numbers and find the largest and smallest elements
3. Programs to count the number of basic operations in a simple loop
4. Programs to analyze time complexity of simple algorithms using loop structures
5. Program to implement Bubble Sort
6. Program to implement Insertion Sort
7. Program to implement Quick Sort
8. Program to find Maximum and Minimum of a given set of numbers
9. Program to implement Merge Sort
10. Program to perform Binary Search (recursive and non-recursive)
11. Program to solve Knapsack problem using Greedy method
12. Program to find Minimum Cost Spanning Tree using Prim's Algorithm
13. Program to find Minimum Cost Spanning Tree using Kruskal's Algorithm
14. Program to solve Single Source Shortest Path problem
15. Program to solve Job Sequencing with Deadlines problem
16. Program to solve All-Pairs Shortest Path problem

Textbook

- Ellis Horowitz, Sartaj Sahni, and Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, Universities Press.

References

- Thomas H. Cormen et al., Introduction to Algorithms, MIT Press
- Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson
- Brassard and Bratley, Fundamentals of Algorithmics, Prentice Hall

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

26CSA486	ADVANCED PROGRAMMING USING PYTHON LAB	L-T-P-C: 0-0-2-1

Course Objective

To equip students with strong programming foundations using Python, focusing on core logic building, object-oriented programming, advanced features like decorators and generators, file handling, regular expressions, and problem-solving patterns using Python.

Course Outcomes

COs	Description
CO1	Apply core and object-oriented programming principles in Python.
CO2	Use advanced Python features such as iterators, generators, decorators, and context managers.
CO3	Develop robust Python applications using modules, error handling, and unit testing.
CO4	Implement algorithmic problem-solving techniques using Python.
CO5	Handle text data using regular expressions and work with file systems efficiently

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	3	-	-	-	1	-
CO2	3	3	3	1	-	-	1	-
CO3	2	3	3	2	1	-	2	-
CO4	3	3	3	2	1	-	2	-
CO5	1	1	1	2	2	-	1	-

Syllabus

Unit 1: Introduction & Object-Oriented Programming

1. **Student Record Management System:** Implement a menu-driven program using data types, control flow, functions, file handling, and exception handling.
2. **Recursive and Lambda Utilities:** Write programs using recursion (factorial, Fibonacci) and lambda functions for sorting and filtering data.
3. **File Handling and Exception Management:** Read from and write to text files, handle exceptions, and implement debugging using try–except blocks.
4. **Object-Oriented Programming in Python:** Design a class-based application demonstrating classes, objects, constructors, inheritance, polymorphism, and magic methods (__init__, __str__, __len__)..

Unit 2: Advanced Python Programming Concepts

5. **Iterator and Generator Implementation:** Create custom iterators and generators for processing large datasets efficiently.
6. **Decorators and Closures:** Develop decorators for logging execution time and closures for data encapsulation.
7. **Context Manager for Resource Handling**: Implement custom context managers using the with statement for file or database resource management.
8. **Dynamic Typing and Introspection Tool:** Build a utility using type(), dir(), getattr(), and hasattr() to inspect objects dynamically.

Unit 3: File and Text Processing

9. **Directory Automation Tool:** Use os, shutil, and glob modules to organize files based on extensions and dates.
10. **CSV and JSON Data Processor:** Read, write, and transform data between CSV and JSON formats.
11. **Log File Analyzer using Regular Expressions:** Analyze server log files using the re module to extract IP addresses, timestamps, and error messages.

Unit 4: Problem-**Solving Patterns in Python**

12. **Algorithmic Problem Set – Sorting and Searching:** Implement and compare sorting and searching algorithms using different input sizes.
13. **Sliding Window and Frequency Counter Problems:** Solve problems such as longest substring without repetition and anagram detection.
14. **Graph and Tree Problems in Python:** Implement BFS, DFS, and basic tree traversals using dictionaries and lists.

Unit 5: Testing and Best Practices

15. **Develop a mini-project with:**
    - Modular code structure
    - Unit tests using unittest or pytest
    - Logging and documentation (PEP8)
    - GitHub repository setup and project packaging

Text Books/ References

1. Python Programming: An Introduction to Computer Science by John Zelle
2. Fluent Python by Luciano Ramalho
3. Test-Driven Development with Python by Harry J.W. Percival

Evaluation Pattern

Assessment	Weightage (%)
Continuous Assessment	70
End Semester Exam	30
Total Marks	100

23LSK301	LIFE SKILLS – III	L-T-P-C:1-0-2-2

Course Objectives

- Develop effective communication and listening skills for professional environments
- Build assertiveness, self-confidence, and positive self-perception
- Apply goal-setting and time-management strategies for personal and professional growth
- Enhance presentation and public speaking skills
- Strengthen verbal ability, grammar, and written communication
- Improve logical reasoning and quantitative aptitude for competitive assessments

Course Outcomes (COs)

COs	Description
CO1	Communicate effectively using verbal, non-verbal, listening, and presentation skills in professional environments
CO2	Demonstrate self-confidence, assertiveness, ethical behavior, and effective interpersonal skills
CO3	Apply logical reasoning and quantitative aptitude skills to solve analytical problems
CO4	Use professional writing, data interpretation, and time-management skills for workplace effectiveness

CO–PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	3	2	3	1	2	3
CO2	2	2	2	3	3	1	3	3
CO3	2	3	1	1	1	3	2	2
CO4	2	2	3	2	2	2	3	3

Syllabus

Soft Skills

Interpersonal Skills: Ability to manage conflict, flexibility, empathetic listening, assertiveness, stress management, problem solving, understanding one’s own interpersonal needs, role of effective teamwork in organizations.

Group Problem Solving: The process, the challenges, the skills and knowledge required for the same.

Conflict Management: The concept, its impact and importance in personal and professional lives, (activity to identify personal style of conflict management, developing insights that helps in future conflict management situations.)

Team Building and Working Effectively in Teams: The concept of groups (teams), different stages of group formation, process of team building, group dynamics, characteristics of effective team, role of leadership in team effectiveness. (Exercise to demonstrate the process of emergence of leadership in a group, debrief and reflection), group discussions.

Interview Skills: What is the purpose of a job interview, types of job interviews, how to prepare for an interview, dos and don’ts of interview, One on one mock interview sessions with each student

Verbal Skills

Vocabulary: Help students understand the usage of words in different contexts. Stress the importance of using refined language through idioms and phrasal verbs.

Grammar: Enable students to identify poorly constructed sentences or incorrect sentences and improvise or correct them.

Reasoning: Facilitate the student to tap her/his reasoning skills through critical reasoning questions and logical ordering of sentences.

Reading Comprehension: Enlighten students on the different strategies involved in tackling reading comprehension questions.

Public Speaking Skills: Empower students to overcome glossophobia and speak effectively and confidently before an audience.

Writing Skills: Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style.

Aptitude Skills
Sequence and Series: Basics, AP, GP, HP, and Special Series.

Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.

Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.

Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.

Logical Reasoning I: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives, Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.

Logical Reasoning II: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding & Decoding, Cryptarithmetic Problems and Input - Output Reasoning.

Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency. Campus recruitment papers: Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.

Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.

References:

17. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
18. The hard truth about Soft Skills, by Amazon Publication.
19. Verbal Skills Activity Book, CIR, AVVP
20. Nova’s GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
21. The BBC and British Council online resources
22. Owl Purdue University online teaching resources
23. www.thegrammarbook.com online teaching resources
24. www.englishpage.com online teaching resources and other useful websites
25. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
26. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
27. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
28. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
29. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
30. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
31. A Modern Approach to Logical Reasoning, R S Aggarwal.
32. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests.**

SEMESTER IX

26CSA501 GENERATIVE AI AND INTELLIGENT SYSTEMS L-T-P-C: 3-1-0-4

Course Objectives

- To develop a strong understanding of the mathematical and computational foundations of generative modeling and its real-world applications.
- To introduce and analyze key generative AI techniques including variational autoencoders, generative adversarial networks, Transformers, normalizing flow models, and information lattice learning.
- To equip students with skills in neural text decoding, prompt programming, and detection of AI-generated content for responsible and effective use of generative AI systems.

Course Outcomes

COs	Description
CO1	Explain the fundamental concepts of Generative Artificial Intelligence and analyze the representational power of autoencoders and variational autoencoders for dimensionality reduction and feature learning.
CO2	Design and evaluate Generative Adversarial Networks and autoregressive models, and apply them to real-world problems such as anomaly detection and intrusion detection systems
CO3	Understand and implement Transformer-based architectures, analyze scaling laws, and apply large language models for sequence modeling and text generation tasks.
CO4	Analyze structured probabilistic models using graphical representations, perform inference and sampling from graphical models, and apply Restricted Boltzmann Machines to generative learning problems.
CO5	Evaluate advanced generative models, address ethical and societal challenges, and apply responsible Generative AI techniques to practical applications across multiple domains.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	1	1	-	-	-	-
CO2	2	3	3	-	-	-	-	-
CO3	2	2	3	1	-	-	-	-
CO4	3	3	1	-	-	-	-	-
CO5	1	2	2	2	-	-	-	-

Unit I – Introduction to Generative Models and Autoencoders

Introduction to Generative Artificial Intelligence and its evolution, generative vs discriminative models, applications of generative models. Autoencoders: representational power, effect of layer size and depth, undercomplete autoencoders, regularized autoencoders, denoising autoencoders, contractive autoencoders. Variational Autoencoders (VAEs), Case study: Applications of autoencoders in dimension reduction.

Unit II - Generative Adversarial Networks and Autoregressive Models

Generative Adversarial networks (GAN) – structure and training algorithm, Deep Convolutional GAN, Autoregressive models – Finite memory, long range memory through RNN and CNN, Transformers – Encoder, decoders, scaling laws, Case study: Generative Adversarial Networks-aided Intrusion Detection System.

Unit III - Transformers and Large Language Models

Limitations of sequential models, attention mechanisms, self-attention, multi-head attention, positional encoding. Transformer architecture: encoder, decoder, encoder–decoder models. Scaling laws in large models, pre-training and fine-tuning strategies. Overview of large language models (BERT, GPT, T5). Applications in text generation, summarization, and sequence modeling.

Case Study: Transformer-based text generation systems.

Unit IV – Structured Probabilistic Models and Graphical Models

Issues with unstructured generative models. Structured probabilistic models: directed and undirected graphical models. Bayesian Networks and Markov Random Fields. Partition function, marginalization and inference. Separation and D-separation, conversion between directed and undirected graphs.

Unit V – Advanced Generative Models, Ethics, and Applications

Energy-based models, diffusion models and denoising diffusion probabilistic models. Multimodal generative models combining text, image, and audio. Evaluation metrics for generative models. Ethical considerations: bias, fairness, deepfakes, data privacy, intellectual property issues. Social impact of generative AI and responsible deployment. Case Study: Generative AI applications in healthcare, cybersecurity, and creative industries.

Textbook(s)

1. Goodfellow, Y. Bengio, and A. Courville, "Deep Learning", MIT Press, 2016.

Reference(s)

1. Raut, R., Pathak, P. D., Sakhare, S. R., & Patil, S. (Eds.), "Generative Adversarial Networks and Deep Learning: Theory and Applications". CRC Press, 2023.
2. M. Tomcsak, "Deep Generative Modeling", Springer, 2022.
3. Langr J, Bok V. "GANs in action: deep learning with generative adversarial networks". Manning. 2019.
4. Papoulis and S. U. Pillai, "Probability – Random Variables, and Stochastic Processes", Fourth Edition, McGraw-Hill, 2017.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment (including lab)	25
End Semester Exam	50
Total Marks	100

26CSA598 DISSERTATION PHASE I 6 Credits

Course Objectives

- Identify relevant research problems in emerging computing domains
- Conduct a systematic and critical review of research literature
- Apply appropriate research methodologies and ethical practices
- Analyze system requirements and design suitable solution frameworks
- Prepare feasibility studies and structured research documentation

Course Outcomes (COs)

COs	Description
CO1	Identify and define research problems and formulate objectives
CO2	Review, analyze, and synthesize research literature
CO3	Apply ethical research practices and appropriate methodologies
CO4	Analyze system requirements and design solution models
CO5	Prepare structured technical and research documentation

Syllabus

1 Orientation – Introduction to research areas, dissertation guidelines, awareness of research tools

2 Topic Finalization – Selection of project domain and finalization of dissertation title

3 Research Platforms – Usage of Google Scholar, ResearchGate, citation management tools

4 Literature Survey – Techniques and strategies for conducting an effective literature review

5 Review Paper – Review paper analysis, understanding structure, and presentation

6 Gap Identification – Identification of research gaps and novelty in the chosen domain

7 Review Preparation – Preparation and presentation for Review I

8 Problem Definition – Formulation of problem statement, objectives, and research questions

9 Research Methodology – Quantitative, qualitative, and experimental research methods

10 Ethics – Research ethics, plagiarism issues, data privacy, and responsible research practices

11 System Analysis – Requirement analysis, functional and non-functional modeling

12 System Design – UML diagrams, OOAD / SSAD design approaches

13 Feasibility Study – Technical, economic, and operational feasibility analysis

14 Documentation – Dissertation report structure, formatting, and standard guidelines

15 Final Review – Preparation for Review II and submission of documentation

Evaluation Pattern

Assessment	Weightage (%)
Review I	40
Review II	40
Continuous Assessment (including lab)	20
Total Marks	100

SEMESTER X

26CSA599 **DISSERTATION PHASE II** **12 Credits**

Course Objectives

- Implement the proposed research solution identified in Phase I
- Integrate system modules and refine the developed model or application
- Conduct experiments and evaluate results using appropriate metrics
- Analyze, interpret, and validate experimental outcomes
- Prepare a research paper suitable for conference or journal submission
- Document the complete dissertation work and present findings effectively

Course Outcomes

COs	**Description**
CO1	Implement the proposed system or model using appropriate computing tools and technologies
CO2	Integrate system modules and perform functional and performance testing
CO3	Conduct experiments and analyze results using suitable evaluation metrics
CO4	Compare proposed solutions with existing approaches and validate outcomes
CO5	Prepare a complete dissertation report and communicate research findings effectively

Syllabus

1. Environment setup and configuration of tools, libraries, and frameworks required for implementation
2. Algorithm / model implementation based on the proposed methodology
3. Module-wise development of the system and integration of individual components
4. Code optimization, version control practices, and technical documentation of implementation
5. Functional testing and debugging of the developed system
6. Performance testing and refinement of system parameters
7. Review I – Evaluation of implementation progress, testing, and experimental results
8. Experimental design and preparation of datasets for evaluation
9. Selection and application of appropriate evaluation metrics
10. Result analysis and interpretation of experimental outcomes
11. Comparative analysis with existing or baseline approaches, validation of results, and discussion of advantages and limitations
12. Research paper preparation: structure, abstract, methodology, results, citation style, and plagiarism checking
13. Dissertation report writing: formatting standards, results discussion, conclusion, and future scope
14. Review II – Final review including research paper, dissertation documentation, system demonstration, and viva-voce

Evaluation Pattern

Assessment	Weightage (%)
Review I	40
Review II	40
Continuous Assessment (including lab)	20
Total Marks	100

ELECTIVES – 3 Credits

AI & DS STREAM

26CSA530 DEEP LEARNING L-T-P-C: 3-0-0-3

Course Description

This course builds from a one node neural network to a multiple feature, multiple output neural networks. After an understanding of how neural networks work and the parameters that control deep learning systems, building of deep learning neural networks and various applications.

Course Objectives

- Understand the context of neural networks and deep learning
- Know how to use a neural network
- Understand the data needs of deep learning
- Have a working knowledge of neural networks and deep learning.
- Explore the parameters for neural networks

Course Outcomes

Cos	Description
CO1	Identify the roles of neural networks in deep learning
CO2	Design of different Convolutional Neural Networks for problem solving
CO3	Implement various unsupervised deep learning techniques
CO4	Design convolution networks for various Computer Vision problems

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	3	-	-	-	-	-
CO2	3	3	1	-	1	-	-	-
CO3	2	3	2	-	1	-	-	-
CO4	3	1	3	1	1	-	-	-

Syllabus

Unit I

Introduction to Deep Neural Networks: Feed forward Neural networks. Gradient descent and the back propagation algorithm, Intuition of Neural Networks Loss functions, Optimization, Unit saturation, aka the vanishing gradient problem, and ways to mitigate it.

Unit II

Convolutional Neural Networks, Training Neural Networks, Understanding Neural Networks Through Deep Visualization and Recurrent Neural Networks: Architectures, convolution / pooling layers, LSTM, Encoder Decoder architectures.

Unit III

Deep Unsupervised Learning: Auto encoders (standard, sparse, denoising, contractive, etc), variational Auto encoders, denoising encoders, Adversarial Generative Networks.

Unit IV

Deep Belief Networks: Energy Based Models, Restricted Boltzmann Machines, Sampling in an RBM. Applications of deep neural networks in handwritten character recognition, face recognition, semantic web, social networks.

Textbooks / References:

1. Domingos, Pedro. "A few useful things to know about machine learning." Communications of the ACM 55.10 (2012): 78-87.
2. Li Fei-Fei (Stanford), Rob Fergus (NYU), Antonio Torralba (MIT), “Recognizing and Learning Object Categories” (Awarded the Best Short Course Prize at ICCV 2005).
3. Baydin, AtilimGunes, Barak A. Pearlmutter, and Alexey AndreyevichRadul. "Automatic differentiation in machine

learning: a survey." arXiv preprint arXiv:1502.05767 (2015).

4. Bengio, Yoshua. "Practical recommendations for gradient-based training of deep architectures." Neural Networks: Tricks of the Trade. Springer Berlin Heidelberg, 2012. 437-478.
5. LeCun, Yann A., et al. "Efficient backprop." Neural networks: Tricks of the trade. Springer Berlin Heidelberg, 2012. 9-48.
6. Simonyan, Karen, Andrea Vedaldi, and Andrew Zisserman. "Deep inside convolutional networks: Visualising image classification models and saliency maps." arXiv preprint arXiv:1312.6034 (2013).
7. Zeiler, Matthew D., and Rob Fergus. "Visualizing and understanding convolutional networks." Computer vision–ECCV 2014. Springer International Publishing, 2014. 818- 833.
8. Springenberg, Jost Tobias, et al. "Striving for simplicity: The all convolutional net." arXiv preprint arXiv:1412.6806 (2014).
9. Russakovsky, Olga, et al. "Imagenet large scale visual recognition challenge." International Journal of Computer Vision 115.3 (2015): 211-252.

Evaluation Pattern

sment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA531	LINEAR ALGEBRA AND APPLICATIONS	L-T-P-C: 3-0-0-3

Course Description

This is a graduate level course which provides a platform for students to dig deeper into modern operating system technology, implementation techniques and research issues. The course enables the students to specialize in Operating Systems by exposing the recent developments and research in the area. This course covers broad range of topics which includes Unix architecture, design of modern operating systems, resource sharing and scheduling, software and hardware interaction, memory management, distributed and real time system behaviors etc.

Course Objectives

- To understand how physical nature, as described by quantum physics, can lead to algorithms that imitate human behavior.
- To explore possibilities for the realization of artificial intelligence by means of quantum computation
- To learn computational algorithms as described by quantum computation

Course Outcomes

Cos	Description
CO1	Understand the basic concepts of vector space, Basis and Dimension
CO2	Understand linear transformation and its applications
CO3	Understand the concepts of inner products, orthogonality and projections
CO4	Understand the concepts of Eigen Values, Eigen Vectors & Diagonalization.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	1	2	1	-	-	-	-	2
CO2	2	3	2	-	-	-	-	2
CO3	1	3	2	1	-	-	-	-
CO4	2	3	3	1	-	-	-	-

Syllabus

Unit I : Vector space

Vectors, Vector spaces - Sub spaces, Four fundamental subspaces, Linear independence, Basis and Dimensions,

Unit II: Linear Transformations

Linear Transformations, Matrix representation, Kernel, Range, Characteristic Roots, Characteristic Vector, Matrix of a Linear Transformation. Rank Nullity Theorem, Relation between matrices and linear transformations - Kernel and range of a linear transformation

Unit III: Norms, Inner product and Orthogonality

Vector Norms, Matrix Norms, Inner product, Orthogonal vectors, Gram-Schmidt procedure, Orthogonal projection.

Unit IV: Eigen values and Eigen vectors

Elementary properties of Eigen Systems, Diagonalization, Orthogonal Diagonalization, Functions of diagonalizable matrices, Normal Matrices

Textbooks/References:

1. Carl. D. Meyer, ‘Matrix Analysis and Applied Linear Algebra’, SIAM publications
2. David C. Lay, Linear Algebra and its Applications, Pearson.
3. Gilbert Strang, “Linear Algebra and Its Applications”, Fourth Edition, Cengage, 2006.

Evaluation Pattern

sment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA532	ARTIFICIAL INTELLIGENCE	L-T-P-C: 3-0-0-3

Course Description

Gain a historical perspective of AI and its foundations. Become familiar with basic principles of AI toward problem solving and intuitive understanding of approaches of inference, perception, knowledge representation, and learning.

Course Objectives

- Illustrate the reasoning on Uncertain Knowledge
- Explore the explanation-based learning in solving AI problems
- Demonstrate the applications of soft computing and Evolutionary Computing algorithms
- To gain the aptitude to apply knowledge representation and reasoning to real-world problems.
- To understand AI Ethics.

Course Outcomes

COs	Description
CO1	Be aware of the basics of AI and its need along with the issues in designing search problems.
CO2	Understand and apply various search algorithms in real world problems.
CO3	Get a thorough idea about the fundamentals of knowledge representation, inference and theorem proving.
CO4	Express and comprehend the working knowledge of reasoning in the presence of incomplete and/or uncertain information.
CO5	Understand AI Ethics.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	2	2	-	1	-	-	-
CO2	2	1	1	-	1	2	1	-
CO3	3	2	1	-	-	-	-	-
CO4	1	2	1	-	1	2	1	1
CO5	2	-	-	-	-	-	1	-

Prerequisites

- Machine Learning
- Programming languages
- Probability

Syllabus

Unit I: Artificial Intelligence – Basics, The AI Problems – The Underlying Assumption – What is an AI technique – Criteria for Success. Problems, Problem Spaces and Search – Defining Problem as a State Space Search – Production Systems – Problem Characteristics – Production System Characteristics – Issues in the design of Search Programs.

Unit II: Heuristic Search Techniques - Generate – and – Test – Hill Climbing – Best-First Search – Problem Reduction – Constraint Satisfaction - Game Playing - The Minimax Search Procedure – Adding Alpha-Beta Cut-offs. Means - Ends Analysis. Knowledge Representation issues – Representations and Mapping - Approaches to knowledge Representation – Issues in knowledge Representation – The Frame Problem.
Case study based on search algorithms (to be considered as part of continuous assessment).

Unit III: Using Predicate Logic – Representing simple facts in Logic – Representing Instance and Isa Relationship – Computable Functions and Predicates – Resolution – Natural Deduction. Representing Knowledge Using Rules – Procedural versus Declarative knowledge – Logic Programming – Forward versus Backward Reasoning – Matching – Control Knowledge.
Case study based on reasoning (to be considered as part of continuous assessment).

Unit IV: Reasoning under Uncertainty – Introduction to Non-monotonic Reasoning – Augmenting a Problem Solver – Implementation: Depth - First Search, Fuzzy Logic.
Applications of artificial intelligence, DNA sequencing using AI techniques.
AI Ethics- Algorithmic bias and fairness, Explainability and transparency, Privacy and robustness

Textbooks / References:

1. Artificial Intelligence (Second Edition) – Elaine Rich, Kevin knight (Tata McGraw-Hill)
2. Artificial Intelligence: A Modern Approach (3rd Edition) - Stuart Russell and Peter Norvig(Pearson)
3. A Guide to Expert Systems – Donald A. Waterman (Addison-Wesley)
4. Principles of Artificial Intelligence – Nils J. Nilsson (Narosa Publishing House)
5. Introduction to Artificial Intelligence – Eugene Charnaik, Drew McDermott (Pearson Education Asia).

Evaluation Pattern

sment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA533	DATABASE ADMINISTRATION	L-T-P-C: 3-0-0-3

Course Description

Gain a historical perspective of AI and its foundations. Become familiar with basic principles of AI toward problem solving and intuitive understanding of approaches of inference, perception, knowledge representation, and learning.

Course Objectives

- The course's objective is to present an introduction to database management systems, emphasizing how to organize, maintain and retrieve - efficiently, and effectively - information from a DBMS.
- This course focuses on the administration of a DBMS including creation, management, maintenance, and operation of a database management system.

Course Outcomes

Cos	Description
CO1	Establish and in-depth understanding of Database Administration using the Oracle DBMS interfaces.
CO2	Analyze and model requirements and constraints for installing, configuring, and tuning a DBMS.
CO3	Develop methods for implementing security, back-up and recovery measures.
CO4	Develop methods for creating and Managing Database Storage Structures and understand network responsibilities for DBA.
CO5	Apply the knowledge and skills required to Monitoring the Performance of the Database computing.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	2	-	-	1	-	-
CO2	2	2	2	-	-	-	-	-
CO3	1	3	2	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-
CO5	2	3	3	-	-	-	-	-

Prerequisites

- Database Management Systems
- Structured Query Languages

Syllabus

Unit I

Introduction: DBMS architecture-data independence-Users- DBA roles-SQL *PLUS Overview: Producing more readable outputs, accepting values at runtime, Using iSQL *Plus-Introduction to DML Statements, Truncating a table, Transaction control language, Managing Views: Creating and modifying views, Using views, Inserting, Updating and deleting data through views.

Unit II

User Access and Security: Creating and modifying use accounts, creating and using roles, granting and revoking privileges, managing user groups with profiles-Oracle Overview and Architecture: storage structures, Oracle memory structures, Oracle background processes, connecting to oracle instance.

Unit III

Managing Oracle: starting up the oracle instance, managing sessions, shutting down the oracle instance, instances messages -instance alerts. Control and Redo Log Files: Managing the control files, Maintaining and monitoring log files. Managing tables, indexes and constraints: Storing data (create, alter, analyzing, querying table information).

Unit IV

Introduction to Network Administration: Network design considerations, network responsibilities for the DBA, network configuration, Overview of oracle Net features, Oracle Net Stack Architecture.

Unit V

Backup and Recovery Overview: Database backup, restoration and recovery, Types of failure in oracle environment, defining a backup and recovery strategy, Testing the backup and recovery plan. Introduction to performance tuning: brief overview of Tuning methodology, General tuning concepts.

Textbooks / References:

1. Craig S. Mullins, ―Database Administration: The Complete Guide to DBA Practices and Procedures, Second Edition, Addison Wesley, 2012.
2. C.J. Date, ―Introduction to Database Systems, Eighth Edition, Addison Wesley, 2003.
3. Chip Dawes, Biju Thomas, ―Introduction to Oracle 9i SQL‖, BPB, 2002.
4. Bob Bryla, Biju Thomas, ―Oracle 9i DBA Fundamental I‖, BPB, 2002.
5. Kevin Loney,"Oracle Database 10g: The Complete Reference", McGraw-Hill

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA534	INFORMATION RETRIEVAL	L-T-P-C: 3-0-0-3

Course Description

This course's main goal is to offer scientific support in information search and retrieval. The course also covers both fundamental and sophisticated strategies for developing text-based information systems. Information retrieval techniques for the web, including crawling, link-based algorithms, and metadata usage, document clustering and classification are part of the course.

Course Objectives

- To understand and comprehend the highlighted IR-related issues
- To gain the skills required to build and deploy real-world applications leveraging information retrieval methods.
- To learn advanced multimodal information system approaches

Course Outcomes

Cos	Description
CO1	Familiarize with the basic methods for information extraction and retrieval of textual data.
CO2	Understand the concept of apply text processing techniques to prepare documents for statistical modelling.
CO3	Evaluate the performance of machine learning models for textual data.
CO4	Master the concept of machine learning models for analyzing textual data and correctly Interpreting the results.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	2	1	-	-	-	-
CO2	2	2	2	2	-	-	-	-
CO3	3	3	1	3	-	-	2	3
CO4	1	1	2	1	-	-	3	3

Syllabus

Unit I: Boolean Expression Based Retrieval: Vocabulary and Postings –Lists –Dictionaries and Tolerant Retrieval –Index Construction and Compression -Scoring and Vector Space Model–Score Computation.

Unit II: Evaluating Information Retrieval Systems. Relevance Feedback and Query Expansion –XML Based Retrieval–Probabilistic Models –Language Models-Text Classification –Vector Space Classification –SVM Based Document. Data Fusion -Metasearch Data fusion, early and late fusion, Metasearch engines of retrieval.

Unit III: Latent Semantic Indexing –Web Search –Web Crawlers –Link Analysis –Unstructured Data Retrieval Semantic Web.

Unit IV: Ontology -Implementations using Natural Language Toolkit. Distributed Information Retrieval: A theoretical Model of Distributed retrieval, web search.

Textbooks / References:

1. C. Manning, P. Raghavan and H. Schütze, "Introduction to Information Retrieval", Cambridge University Press, 2008.
2. R. Baeza-Yates and B. Ribeiro Neto, "Modern Information Retrieval: The Concepts and Technology Behind Search", Second Edition, Addison Wesley, 2011.
3. David A. Grossman and Ophir Frieder "Information Retrieval: Algorithms and Heuristics", Second Edition, Springer 2004.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA535 INFORMATION SCIENCE AND ETHICS L-T-P-C: 3-0-0-3

Course Description

Course Overview Ethics is, simply put, the question of how to live. Information ethics, then, examines living with information technology. This course presents the philosophical foundations of information ethics (including computing, data and management), focusing on the uses and abuses of information, human moral agency in relation to new information and communication technologies, and the meaning of social responsibility in the global information society.

Course Objectives

- To create an awareness on Engineering Ethics and Human Values.
- To understand Moral and Social Values and Loyalty
- To appreciate the rights of others.
- To create awareness on assessment of safety and risk.

Course Outcomes

Cos	Description
CO1	Identify and analyze current ethical issues facing the information professions.
CO2	Use major and alternative traditions of ethics to engage contemporary dilemmas.
CO3	Evaluate and articulate arguments regarding professional decision making.
CO4	Interpret the professional and scholarly literature of information ethics.
CO5	Recognize the ethical challenges of contemporary information trends and extrapolate the future direction of the information ethics field.

CO-PO Mapping

PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO								
CO1	1	1	-	-	1	1	2	1
CO2	2	1	-	-	1	-	2	1
CO3	3	3	3	-	1	1	2	1
CO4	-	4	3	-	1	1	3	1
CO5	2	3	2	-	1	-	3	1

Syllabus

Unit I: Introduction to Information Ethics

Introduction: a unified model of information ethics, First stage: IE as an ethics of informational resources, Second stage: IE as an ethics of informational products, Third stage: IE as an ethics of the informational environment, Fourth stage: IE as a macro ethics. Information ethics as environmental ethics: The foundationalist problem, Classic macro ethics and ICTs ethical problems, An informational model of macro ethics, From computer ethics to information ethics, Information ethics as a patient-oriented and onto centric theory, The normative aspect of information ethics: four ethical principles, Information ethics as a macro ethics.

Unit II: Information ethics and the foundationalist debate:

Looking for the foundations of computer ethics, The ‘no resolution approach’: CE as not a real discipline. Distributed morality: Introduction: the basic idea of distributed morality, The old ethical scenario without distributed morality, The new ethical scenario with distributed morality, Some examples of distributed morality.

Unit III: Information business ethics:

Introduction: from information ethics to business ethics, The informational analysis of business, The WHI ethical questions: what, how, and impact, The ethical business. Global information ethics: Introduction: from globalization to information ethics, Globalizing ethics, Global-communication ethics vs. global-information ethics, Global-information ethics and the problem of the lion, Global information-ethics and its advantages, the cost of a global-information ethics: postulating the ontic trust.

Unit IV: Ethics for IT workers and IT users, IT security incidents:

A major concern, implementing trustworthy computing, privacy: privacy protection and the law, intellectual property: what is intellectual property, Copyrights, Patents, Trade Secrets, Key Intellectuals property issues. In defense of information ethics: Introduction: addressing the sceptic, IE is an ethics of news, IE is too reductivist, IE fails to indicate what information constitutes an individual, IE’s de-anthropocentrization of the ethical discourse is mistaken, IE’s measure of intrinsic moral value is insufficiently clear and specific.

Textbooks / References:

1. Handbook of research on Machine and Deep Learning Applications for Cyber Security, Padmavathi Ganapathi and D. Shanmugapriya, IGI Global.
2. The Ethics of Information, Luciano Floridi, Oxford
3. Ethics in information technology, George W. Reynolds, 5th Editions.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA536	PATTERN RECOGNITION	L-T-P-C: 3-0-0-3

Course Description

Automated systems that increase their own performance via experience are designed using pattern recognition algorithms. This course examines statistical pattern identification from several aspects, including techniques, tools, and algorithms. Students will learn various techniques like Bayesian Decision Theory, Estimation Theory, Linear Discrimination Functions, Nonparametric Techniques, Support Vector Machines, Neural Networks, Decision Trees, and Clustering Algorithms.

Course Objectives

- To understand the fundamentals of pattern recognition.
- To explore the most cutting-edge algorithms and techniques used in pattern recognition research.
- To learn pattern recognition theories such as Bayes classifier and linear discriminant analysis and to use the techniques to solve real-world challenges.

Course Outcomes

Cos	Description
CO1	Implement the concepts of Tree classifiers and decision trees on patterns
CO2	Design both supervised and unsupervised classification methods to develop classifiers for real-world data.
CO3	Apply advanced techniques like Dimensionality Reduction for different features
CO4	Compare various techniques used by different clustering algorithms

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	2	-	-	-	-	-
CO2	3	2	2	2	-	-	-	-
CO3	2	2	3	2	1	-	-	-
CO4	2	2	3	2	2	-	2	2

Syllabus

Unit I: Introduction to Pattern Recognition-Tree Classifiers Getting our feet wet with real classifiers, Decision Trees: CART, C4.5, ID3-Random Forests-Bayesian Decision Theory Grounding our inquiry-Linear Discriminants Discriminative Classifiers: the Decision Boundary, Separability, Perceptron.

Unit II: Support Vector Machines, Parametric Techniques Generative Methods grounded in Bayesian Decision Theory, Maximum Likelihood Estimation-Bayesian Parameter Estimation. Non-Parametric Techniques-Kernel Density Estimators-Nearest Neighbor Methods, Unsupervised Methods.

Unit III: Exploring the Data for Latent Structure -Component Analysis and Dimension Reduction-The Curse of Dimensionality, Principal Component Analysis, Fisher Linear Discriminant, Locally Linear Embedding.

Unit IV: Clustering, K-Means. Expectation Maximization, Mean Shift, Classifier Ensembles, Bagging, Boosting / AdaBoost.

Textbooks / References:

1. Duda, Hart and Stork, Pattern Classification, Second Edition, Wiley, 2001.
2. T.M. Mitchell, Machine learning, McGraw-Hill, New York, 1997.
3. S. Theodoridis, K. Koutroumbas, Pattern recognition, Academic Press, 1999.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA537	RECOMMENDATION SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- To develop state-of-the-art recommendation systems that automate a variety of choice-making strategies with the goal of providing affordable, personal, and high-quality Recommendations and focusing on theory as well as on the practical use and applications of Recommender systems.

Course Outcomes

Cos	Description
CO1	Understand basic idea of Recommendation system and its applications in various fields.
CO2	Explore the various recommendation system, analyse the content based and collaborative filtering methods
CO3	Understand Hybrid approaches and its applications in recommender systems
CO4	Apply different methods to build and evaluate recommender systems on historical datasets, conceive the various recommendation metrics.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	2	2	-	-	-	-
CO2	3	3	3	2	-	-	-	-
CO3	2	3	3	2	-	-	-	-
CO4	3	2	3	2	2	-	-	-

Prerequisites

- Data mining
- Machine learning

Syllabus

Unit I: Introduction and basic taxonomy of recommender systems (RSs). Traditional and non-personalized RSs. Overview of data mining methods for recommender systems, Applications of recommendation systems, Issues with recommender system.

Unit II: Content-based recommendation: High level architecture of content-based systems, Advantages and drawbacks of content-based filtering, Basic components of content-based RSs. Feature selection. Item representation Methods for learning user profiles.
Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders.
Collaborative Filtering: User-based nearest neighbour recommendation, Item-based nearest neighbour recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems

Unit III: Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.

Unit IV: Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centered metrics.

Textbooks / References:

1. C.C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
2. F. Ricci, L Rokach, B. Shapira and P.B. Kantor, Recommender systems handbook, Springer 2010.
3. J. Leskovec, A. Rajaraman and J. Ullman, Mining of massive datasets, 2nd Ed., Cambridge, 2012. (Chapter 9).
4. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press (2011), 1st ed.
5. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer (2011), 1st ed.
6. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems for Learning, Springer (2013), 1st ed.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA538	WEB MINING	L-T-P-C: 3-0-0-3

Course Description

Web mining aims to discover useful information and knowledge from the Web hyperlink structure, page contents and usage logs. It has direct applications in e-commerce, Web analytics, information retrieval/filtering, personalization, and recommender systems. Employees knowledgeable about Web mining techniques and their applications are highly sought by major Web companies such as Google, Amazon, Yahoo, MSN and others who need to understand user behavior and utilize discovered patterns from terabytes of user profile data to design more intelligent applications.

Course Objectives

- Introduce students to the basic concepts and techniques of Information Retrieval, Web Search, Data Mining, and Machine Learning for extracting knowledge from the web.
- Develop skills of using recent data mining software for solving practical problems of Web Mining.
- Gain experience of doing independent study and research

Course Outcomes

Cos	Description
CO1	Perceive Information Retrieval Models, explore web preprocessing and community discovery
CO2	Design and implement a crawler application to collect and index documents from the web and analyze structured data extraction.
CO3	Analyze text to determine the reliability of the information including potential bias. Explore web usage mining and opinion mining with case studies.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	2	1	2	-	-	2
CO2	2	2	3	3	2	-	-	1
CO3	2	2	3	3	2	-	-	1

Prerequisites

- Data Mining concepts

Syllabus

Unit I: Information Retrieval and Web Search: Information Retrieval Models, Text and Web Page Pre-Processing - Stopword Removal, Stemming, Web Page Pre-Processing, Inverted Index and Its Compression - Inverted Index, Search Using an Inverted Index. Latent Semantic Indexing, Web Search, Web Spamming. Link Analysis: Social Network Analysis, Co-Citation and Bibliographic Coupling, PageRank, HITS, Community Discovery- Bipartite Core Communities, Maximum Flow Communities, Email Communities Based on Betweenness.

Unit II: Web Crawling: A Basic Crawler Algorithm - Breadth-First Crawlers, Preferential Crawlers. Implementation Issues, Universal Crawlers, Focused Crawlers, Topical Crawlers, Evaluation, Crawler Ethics and Conflicts. Structured Data Extraction: Wrapper Induction, Automatic Wrapper Generation, String Matching and Tree Matching, Multiple Alignment, Extraction Based on a Single List Page and Multiple pages.

Unit III: Information Integration: Introduction to Schema Matching, Pre-Processing for Schema Matching, Schema-Level Match, Domain and Instance-Level Matching, Combining Similarities, Integration of Web Query Interfaces. Opinion Mining: Sentiment Classification, Feature-Based Opinion Mining and Summarization, Comparative Sentence and Relation Mining, Opinion Search, Opinion Spam. Web Usage Mining: Data Modeling for Web Usage Mining, Discovery and Analysis of Web Usage Patterns - Session and Visitor Analysis, Cluster Analysis and Visitor Segmentation, Analysis of Sequential and Navigational Patterns.

Textbooks / References:

1. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data (Data-Centric Systems and Applications) by Bing Liu, Springer Publisher.
2. Mining The Web: Discovering Knowledge from Hypertext Data by Chakrabarti Soumen, Elsevier Science
3. Web Mining: Applications and Techniques, Anthony Scime (State University of New York at Brockport, USA) Release Date: August, 2004|Copyright: © 2005 |Pages: 442 ISBN13: 9781591404149|ISBN10: 1591404142|EISBN13: 9781591404163, IGI Global Publisher.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA539	BUSINESS ANALYTICS AND VISUALIZATION	L-T-P-C: 3-0-0-3

Course Objectives:

- To promote the ability to critically analyze and solve data-oriented real-world decision problems.
- To utilize the theories of statistics and probabilities in business analytics.
- To gain familiarity with an array of modeling techniques used to solve data-oriented decision problems.
- To learn best practices in visualization.
- To understand time series modeling of historical data.

Course Outcomes:

Cos	Description
CO1	Design visualizations like charts and advanced dashboard for various types of data
CO2	Evaluate statistical inferences of the classification and clustering techniques used using different case studies
CO3	Implement the smoothing techniques for real time problems for better forecasting

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	3	2	-	1	-	1
CO2	2	3	2	2	1	1	-	1
CO3	2	3	2	3	2	1	1	1

Syllabus

Unit I: Introduction to Business Analytics, Descriptive Statistics – Types of Data and its Measures, Data cleansing. Data Visualization-Design Techniques, Tables, Charts, Advanced data Visualization, Dashboards, Case Studies.

Unit II: Inferential Analysis – Statistical Inference, Descriptive Data mining - Clustering and Association Rules. Performance Evaluation, Overview of key Classification and prediction techniques, Case studies.

Unit III: Introduction to Forecasting, Time Series – Level, Trend, and Seasonality, Smoothing Techniques – Moving Average and Exponential Smoothing, Determining the best forecasting model to use. Case Study.

Textbooks / References:

1. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, Dennis J. Sweeney, Thomas A. Williams 'Business Analytics',3/e, Cengage Learning,2019.
2. GalitShmueli, Kenneth C. Lichtendahl Jr., 'Practical Time Series Forecasting with R: A Hands-On Guide', 2/e, Axelrod Schnall Publishers, 2016.
3. Joel Grus, 'Data Science from Scratch: First Principles with Python', 2/e, O'Reilly Media, 2019.
4. Cole Nussbaumer Knaflic, 'Storytelling with Data: A Data Visualization Guide for Business Professionals', John Wiley& Sons, 2015.
5. Claus O. Wilke, "Fundamentals of Data Visualization: A primer for making informative and compelling figures", O'Reilly, 2019.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA540 COMPUTATIONAL INTELLIGENCE L-T-P-C: 3-0-0-3

Course Objectives

- The Objective of the course is to make students familiar with basic principles of various computational methods of data processing that can commonly be called computational intelligence. This course introduces the fundamentals of key intelligent systems technologies including knowledge-based systems, neural networks, fuzzy systems, and evolutionary computation.

Course Outcomes

COs	**Description**
CO1	Understand the need for and importance of Computational intelligence.
CO2	Understand the concepts of neural networks and backpropagation learning.
CO3	Implement associative memory using neural networks.
CO4	Understand the idea of fuzzy logic in real-world problems.
CO5	Understand hybrid approaches to solve real-world problems.

CO-PO Mapping

PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO								
CO1	3	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	-
CO3	3	2	3	-	-	-	-	-
CO4	2	3	3	-	-	-	-	
CO5	2	3	3	-	-	-	-	-

Prerequisites

- Machine Learning
- Programming languages
- Probability

Syllabus

Unit I: Artificial Intelligence – a Brief Review – Pitfalls of Traditional AI – Need for Computational Intelligence – Importance of Tolerance of Imprecision and Uncertainty – Overview of Artificial Neural Networks - Fuzzy Logic – Evolutionary Computation.

Unit II: Neural Network: Biological and Artificial Neuron, Neural Networks, Supervised and Unsupervised Learning. Single Layer Perceptron - Multilayer Perceptron – Backpropagation Learning.

Unit III: Neural Networks as Associative Memories - Hopfield Networks, Bidirectional Associative Memory. Topologically Organized Neural Networks – Competitive Learning, Kohonen Maps.

Unit IV: Fuzzy Logic: Fuzzy Sets – Properties – Membership Functions - Fuzzy Operations. Fuzzy Logic and Fuzzy Inference - Applications. Evolutionary Computation – Constituent Algorithms.

Unit V: Swarm Intelligence Algorithms - Overview of other Bio-inspired Algorithms - Hybrid Approaches (Neural Networks, Fuzzy Logic, Genetic Algorithms etc.). Case Studies: Prediction Models, Optimization Models.

Textbooks / References:

1. Laurene Fausett, Fundamentals of Neural Networks, 2nd edition, Pearson, 1993
2. Ross T J, ―Fuzzy Logic with Engineering Applications‖, McGraw Hill, 1997.
3. Eiben A E and Smith J E, ―Introduction to Evolutionary Computing‖, Second Edition, Springer, Natural Computing Series, 2007.
4. Kumar S, ―Neural Networks - A Classroom Approach‖, Tata McGraw Hill, 2004.
5. Engelbrecht, A.P, ―Fundamentals of Computational Swarm Intelligence‖, John Wiley & Sons, 2006.
6. Konar. A, ―Computational Intelligence: Principles, Techniques and Applications‖, Springer Verlag, 2005.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

CYBER SECURITY STREAM

26CSA550	ESSENTIALS OF CYBER SECURITY	L-T-P-C: 3-0-0-3

Course Description

This course introduces the basics of cyber security.

Course Objectives

Gain an understanding of digital security, access control mechanisms, browser security keywords and jargon, network basics and security protocols, and awareness of cyber-attacks and data privacy.

Course Outcomes

COs	Description
CO1	Develop a solid foundation in digital security and implement measures to protect devices from threats
CO2	Learn access control mechanisms and understand how to secure servers
CO3	Comprehend the fundamentals of networking and gain a brief introduction to the security of network protocols
CO4	Understand cyber-attacks, learn about data privacy issues, and explore preventive measures

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	-	-	-	1	-
CO2	3	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	1	-

Syllabus

Unit I

Basics of digital security, protecting personal computers and devices, Types of malwares, protecting devices from Virus and Malware, Identity, Authentication and Authorization, need for strong credentials, keeping credentials secure,

Unit II

protecting servers using physical and logical security, World Wide Web (www), the Internet and the HTTP protocol, security of browser to web server interaction,

Unit III

Networking basics, Networking concepts (CIDR, subnets), and protocols (DNS, DHCP, IP). Security of protocols, sample application hosted on-premises,

Unit IV

Introduction to cyber-attacks, application security (design, development and testing), operations security, monitoring, identifying threats and remediating them, Principles of data security - Confidentiality, Integrity and Availability.

Textbooks / References:

1. Sammons, John, and Michael Cross. The basics of cyber safety: computer and mobile device safety made easy. Elsevier, 2016.
2. Charles P. Pfleeger, Shari Lawrence, Pfleeger Jonathan Margulies; Security in Computing, Pearson Education Inc. 5th Edition, 2015
3. Brooks, Charles J., Christopher Grow, Philip Craig, and Donald Short. Cybersecurity essentials. John Wiley & Sons, 2018

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA551	MALWARE ANALYSIS	L-T-P-C: 3-0-0-3

Course Objectives

- This course aims to identify malware types based on static and behavioral analysis, determine malware capabilities and persistence vectors and evaluate potential threat from malware activity on the network.

Course Outcomes

After completing this course, students will be able to:

COs	Description
CO1	Possess the skills necessary to carry out independent analysis of modern malware samples using both static and dynamic analysis techniques.
CO2	Understand executable formats, Windows internals and API, and analysis techniques.
CO3	Extract investigative leads from host and network-based indicators associated with a malicious program.
CO4	Apply techniques and concepts to unpack, extract, decrypt, or bypass new anti-analysis techniques in future malware samples.
CO5	Achieve proficiency with industry standard tools including IDA Pro, OllyDbg, WinDBG, PE Explorer, ProcMon etc.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	3	-	-	-	2
CO2	3	1	-	-	-	-	-	-
CO3	3	1	-	1	-	-	-	-
CO4	3	2	-	1	-	-	-	-
CO5	3	1	-	3	1	-	-	-

Syllabus

Unit I: Introduction to malware, Basic Static and Dynamic Analysis,

Unit II: Overview of Windows file format, PEView.exe, Patching Binaries, Disassembly (objdump, IDA Pro),

Unit III: Introduction to IDA, Introduction to Reverse Engineering, Extended Reverse Engineering using GDB and IDA, Advanced Dynamic Analysis - debugging tools and concepts, Malware Behavior - malicious activities and techniques, Analyzing Windows programs – Win API, Handles, Networking, COM, Data Encoding, Malware Countermeasures, Covert Launching and Execution,

Unit IV: Anti Analysis - Anti Disassembly, VM, Debugging -, Packers – packing and unpacking, Intro to Kernel – Kernel basics, Windows Kernel API, Windows Drivers, Kernel Debugging,

Unit V: Rootkit Techniques- Hooking, Patching, Kernel Object Manipulation, Rootkit Anti-forensics, Covert analysis.

Textbooks / References:

1. Michael Sikorski and Andrew Honig, “Practical Malware Analysis”, No Starch Press,2012
2. Jamie Butler and Greg Hoglund, “Rootkits: Subverting the Windows Kernel”, Addison-Wesley, 2005
3. Dang, Gazet and Bachaalany, “Practical Reverse Engineering”, Wiley,2014
4. Reverend Bill Blunden, “The Rootkit Arsenal: Escape and Evasion in the Dark Corners of the System” Second Edition, Jones& Bartlett, 2012.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA552	BLOCKCHAIN AND DECENTRALIZED APPLICATIONS	L-T-P-C: 3-0-0-3

Course Objectives

- Students will be exposed to blockchains and decentralized applications. They will understand the fundamental algorithms supporting this modern technology and its place in the security setting of the modern technology era.

Course Outcomes

COs	Description
CO1	Understand the fundamental characteristics of Blockchain and cryptocurrency
CO2	Understand the basics concepts of Bitcoin and Ethereum Blockchain
CO3	Develop smart contracts using Solidity and Remix IDE
CO4	Understand the architecture of distributed applications
CO5	Develop DApps for real-life use cases

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-
CO3	2	-	1	3	-	-	-	-
CO4	3	-	-	-	-	-	-	-
CO5	2	-	2	3	-	-	-	-

Syllabus

Unit I

Need for Distributed Record-Keeping, distributed ledger technology, Modeling faults and adversaries, Byzantine Generals problem, Nakamoto’s concept with Blockchain-based cryptocurrency, Transaction: - syntax, structure and validation, Blocks- Structure, Genesis block, and Merkle tree. Mining: -target, hash rates, Consensus mechanisms, forking. Byzantine fault-tolerant distributed computing,

Unit II

coins, wallets, Bitcoin scripting language, Ethereum smart contract architecture, contract transactions, comparing Bitcoin scripting vs. Ethereum Smart Contracts,

Unit III

Remix IDE, Solidity: - variables, data types, addresses and balances, strings in Solidity, global Msg-Object, mapping, structure, array, require, assert revert, constructor, fallback functions, View/Pure Getter functions. modifier, inheritance, importing of Files, events and return variables, ABI array, debugging libraries

Unit IV

DApps architecture, blockchain server, Truffle suite: setup and test cases, Web3 SDK, Web3 provider, Ganache, MetaMask integration with web3, channel concept and micropayment channel, web interface for DApps, Deployment to public testnet and mainnet, Network ID, Infura API, private Blockchain, Go-Ethereum, Type of DApps, Oracles, Ethereum improvement proposal(EIP) framework, standard ERC 20 for token Dapps, ERC 721 for non-fungible tokens, RES4

Textbooks / References:

1. Ramamurthy, Bina. *Blockchain in action*. Manning Publications, 2020.
2. https://web3js.readthedocs.io/en/v1.7.3/
3. Merunas Grincalaitis, “Mastering Ethereum: Implement Advanced Blockchain Applications Using Ethereum-supported Tools, Services, and Protocols”, Packt Publishing.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA553	FUNDAMENTALS OF CYBERSECURITY OPERATIONS	L-T-P-C: 3-0-0-3

Course Objectives

- The course teaches students security concepts, common network and application operations and attacks, and the types of data needed to investigate security incidents. Students will learn how to monitor alerts and breaches and become a contributing member of a Cybersecurity Operations Center (SOC) including understanding the IT infrastructure, operations, and vulnerabilities.

Course Outcomes

COs	Description
CO1	Understand the functionalities of various SOC generations.
CO2	Understand different data collection, data analysis, and security analysis techniques as part of SOC technologies.
CO3	Understand vulnerability management techniques and threat intelligence methodologies.
CO4	Assess the SOC capabilities using different SOC tools and techniques.
CO5	Learn how SOC helps in business continuity and disaster recovery plan.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-
CO4	3	-	1	-	-	-	-	-
CO5	2	-	-	-	-	-	-	-

Syllabus

Unit I: Information security incident management (Incident detection, triage and incident categories, Incident severity, resolution, Closure, Post-incident), Security Operations Center (SOC) Generations (First-generation, second, third and fourth generation SOC), SOC Maturity models (Introduction to maturity models, and applying maturity models in SOC),

Unit II: SOC Technologies-1 (Data collection and analysis, syslog protocol), SOC Technologies-2 (Telemetry Data, Security analysis, Data enrichment),

Unit III: Vulnerability Management (Broad introduction), Threat intelligence (Broad introduction)

Unit IV: Assessment of SOC capabilities (Business and IT Goals, Assessing capabilities & IT processes), SOC - Business Continuity, Disaster recovery (Importance of BCP and DR processes, and its interface to SOC), Security event generation and collection (Cloud Security, IDPS, Breach Detection), SOC and SIEM – Introduction (Role of SIEM in SOC), SOC and Splunk (Splunk architecture & SOC, Splunk Rules, Splunk log management, Splunk correlation), SOC and Health Care - A Case study (SOC Considerations for a HealthCare situation), SOC and Application security (OWASP, Application security and SOC).

Textbooks / References:

1. Security Operations Center: Building, Operating, and Maintaining Your SOC, Book by Gary McIntyre, Joseph Muniz, and Nadhem AlFardan
2. Designing and Building Security Operations Center, 2015, Book by David Nathans
3. Security Operations Center - SIEM Use Cases and Cyber Threat Intelligence, 2018, Book by Arun E Thomas.
4. The Modern Security Operations Center, 2021, Book by Joseph Muniz
5. Principles for Cyber Security Operations, 2020, Book by Hinne Hettema.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA554	CLOUD AND INFRASTRUCTURE SECURITY	L-T-P-C: 3-0-0-3

Course Objectives

- Familiarization of popular cloud platforms, VM creation, Container management, and Kubernetes, Storage management, Database creation, Network management, Access control mechanism in a computing environment, Virtual private cloud, Design and deployment of secure microservice applications, load balancing, Identity management, Homomorphic encryption, VPC Networking, and security.

Course Outcomes

COs	Description
CO1	Understand the architecture and infrastructure of cloud computing along with hands-on experience in various cloud computing platforms.
CO2	Identify the known threats, risks, vulnerabilities, and privacy issues in the various layers of cloud computing.
CO3	Compare modern security concepts as they are applied to cloud computing.
CO4	Understand the concepts and various methods of secure data management in the cloud.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-
CO4	3	-	2	1	-	-	-	-

Syllabus

Unit I

Cloud computing essentials: - Characteristics, service models, deployment models, NIST reference architecture, virtualization, containers, Kubernetes, design of microservices, high availability, Load Balancing in the cloud, cloud storage, and databases, cloud networking and vpc, popular cloud platforms, open-source architectures.

Unit II

Threats classification and countermeasures: - Infrastructure and host threats, service provider threats, generic threats, threats assessment, CSA Top threats, Virtualization system vulnerabilities, Authentication and authorization techniques for cloud solutions, Protection of application infrastructure, Protecting Data in the Cloud:- Tokenization, Cryptographic key management for data protection, Encryption techniques and applications for cloud computing, homomorphic encryption, Intrusion Detection and Prevention for cloud workloads

Unit III

Security breaches management for cloud computing, Cloud-centric regulatory compliance issues, and mechanisms.

Textbooks / References:

1. John R. Vacca (Editor), “Cloud Computing Security - Foundations and Challenges” CRC Press, 2017
2. Ronald L. Krutz and Russell Dean Vines, “Cloud Security- A Comprehensive Guide to Secure Cloud Computing”, Wiley, 2010
3. Chris Dotson “Practical Cloud Security “, O'Reilly,2019
4. Tim Mather, S. Kumaraswamy, and S. Latif, “Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance”, O’Reilly Media, 2009.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA555 CYBERSECURITY GOVERNANCE, RISK AND COMPLIANCE L-T-P-C: 3-0-0-3

Course Objectives

- The students will learn the principles of cybersecurity governance, risk, and compliance. They will understand the tools methods, including vulnerability management, threat detection, metrics, and evaluations of organizations. Students will study the NIST framework and learn organizational roles within a company.

Course Outcomes

COs	Description
CO1	Understand the different methods to assess cybersecurity maturity.
CO2	Understand the vulnerability management techniques and threat management methodologies.
CO3	Understand the governance metrics (Application security, vulnerability, and network security).
CO4	Know the relation between security analytics and security governance.
CO5	Understand the NIST compliance for security mandate.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-
CO4	3	1	-	1	-	-	1	-
CO5	2	-	-	-	-	-	-	-

Syllabus

Unit I: Basics of Cyber security governance, Principles of cyber-security governance, Assessment of cyber security maturity, Theories of governance – introduction, Governance – definitions and typologies.

Unit II: Governance of security operations, Tools, methods, and processes, Vulnerability management, Threat management, Endpoint management, Intrusion detection and prevention (IDPS), Security incident management.

Unit III: Security metrics and governance, Measurement of governance: Metrics – concepts, Application security metrics, Network security metrics, Security incident metrics, Vulnerability metrics, Service level objectives/agreement (SLO / SLA), NIST metrics.

Unit IV: Security analytics and governance, Basics of security analytics, Threat intelligence and governance, Data-driven security governance, Impact of cognitive security on security governance.

Unit V: Compliance and governance, Industry-specific security compliance, Cyber security governance – Republic of India, NIST mandates for compliance, Security reporting basics, CISO – role and organization structure, HIPAA, COBITZ compliance.

Unit VI: Cyber Security Risk: Information security risk management framework and methodologies, Risk Management Process, Framework, and Life Cycle, Identifying and modeling information security risks, Qualitative and quantitative risk assessment methods, Articulating information security risks as business consequences

Textbooks / References:

1. Information Security Governance: A Practical Development and Implementation Approach, Wiley publications 2009.
2. Information Security Governance, S.H. Solms, Rossouw Solms, Springer Science & Business Media.
3. Internet governance in an age of cyber insecurity,2010, Council on Foreign Relations Press.
4. Cyber justice: human rights and good governance for the internet, 2017, Springer.
5. Cyber Risk Management: Prioritize Threats, Identify Vulnerabilities and Apply Controls 1st Edition, Kogan Publishers, 2019.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA556	CYBER SECURITY LAW	L-T-P-C: 3-0-0-3

Course Objectives

Students will learn the cybersecurity laws in India and abroad. A clear introduction to the laws behind data security, breaches, cybercriminal combat, and much more.

Course Outcomes

COs	Description
CO1	Understand the history of cybercrime and the laws created
CO2	Understand the different classes of cyber-crime.
CO3	Gain knowledge of the IT act.
CO4	Know the procedures and authorities in India and abroad.
CO5	Gain familiarity with all laws regarding privacy.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	1	-	-	-	-	-	2	-
CO2	1	-	-	-	-	-	2	-
CO3	1	-	-	-	-	-	2	-
CO4	1	-	-	-	-	-	2	-
CO5	1	-	-	-	-	-	2	-

Syllabus

Unit I

Jurisprudence of cyber law, Information Technology Act, 2008, Cybercrimes, history and evolution of cybercrime, unauthorized access crimes, BEC, ATM frauds, online banking frauds, SIM swap frauds, email frauds, lottery frauds, Web defacement, Web Jacking, crimes relating to digital signature

Unit II

Penalties under the IT Act, Relevant Offences under the IT Act

Exemption of liability of intermediaries, Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Rules, 2021, due diligence, Procedures & Authorities

Unit III

Authorities and their duties; The National Cyber Coordination Centre (NCCC), Cyber and Information Security (C&IS) Division, National Critical Information Infrastructure Protection Centre (NCIIPC), National Technical Research Organization (NTRO)

Law of Privacy.

GDPR and the EU.

Textbooks / References:

1. Satish Chandra, “Cyberlaw in India”.
2. Nilakshi Jain, Ramesh Menon “Cybersecurity and Cyber laws” Wiley media.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA557 **L-T-P-C:3-0-0-3**

MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE IN CYBERSECURITY

Course Objectives

The students will be exposed to the fundamentals of machine learning: classification, regression, supervised and unsupervised learning. They will learn which algorithms to use in which context, including model validation and evaluation. They will be exposed to a thorough survey of the fundamental security applications that machine learning provides the current security limitations of machine learning as well.

Course Outcomes

COs	**Description**
CO1	Understand relevance of machine learning and AI in cyber security
CO2	Gain proficiency in scikit-learn, using supervised and unsupervised learning.
CO3	Learn the fundamentals of regression and classification.
CO4	Make use of classification and anomaly detection systems in security – fraud and spam detection.
CO5	Learn to threat model for machine learning, understanding adversarial attacks.

CO-PO Mapping

PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO								
CO1	2	3	2					
CO2	1	3	1					
CO3	3	1						
CO4	2	3	3	1				
CO5	2	2	3					

Syllabus

Unit I: Python, Jupyter Notebooks, Pandas, Numpy, Matplotlib, Seaborn

Unit II: Scikit-Learn, Supervised learning: Linear regression, Decision Trees, Support Vector Machines, K-nearest neighbors, random forests, AdaBoost, gradient boosting, multi-layer perceptrons, logistic regression.
Unsupervised learning: k-means clustering, DBSCAN, GMM, PCA, T-SNE.
Bias-variance tradeoff. Learning and validation curves. Cross-validation, shuffle split, k-fold, time-series split. Random seeds. Baseline and benchmarking models. Gradient descent, regularization, feature scaling, one-hot encoding, label encoding. Train-test-split.
Metrics: accuracy, f1-score, precision, recall, confusion matrices. Gini impurity, information gain ratio, feature ranking with multivariate and univariate methods. Hyper-parameter tuning with grid search and random search. Natural language processing, ngrams, bag of words, vectorizers. Data wrangling with feature preprocessing and EDA.

Unit III: Artificial Intelligence (AI), Deep Learning (DL), and Machine learning (ML) in security. Understand the role AI plays in making decisions in large-scale settings. Algorithm bias and fraud.
Machine learning for security - anomaly detection, fraud detection, malware detection, spam detection, phishing detection, IDS, and NIDS.
Security of machine learning: adversarial attacks on machine learning. Data poisoning, model stealing, evasion attacks at inference time. Adversarial hardening.

Textbooks / References:

1. Tom M Mitchell, Machine Learning, McGraw Hill, 1997
2. Jake Vanderplas, Python Data Science Handbook, O’Reilly Media, 2016
3. Clarence Chio, David Freeman, Machine Learning and Security, O’Reilly Media, 2018

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA558	MOBILE SECURITY AND DEFENCE	L-T-P-C: 3-0-0-3

Course Objectives

- The students will learn the fundamental of mobile security and defense. Focus on android platform using android framework and APIs. Students will learn the structure of android applications, the exploits involved and common hardening techniques. Students will learn to perform static and dynamic analysis to identify malicious apps.

Course Outcomes

COs	Description
CO1	Understand internals of Android Operating System, security model of Android and iOS.
CO2	Understand how to make use of relevant tools to inspect and understand the working of Android and iOS application.
CO3	Learn how to identify vulnerable codebase and insecure configuration of application components.
CO4	Learn how to reverse engineer and perform advanced static and dynamic analysis.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	-	-	-	-	-
CO2	2	-	-	3	-	-	-	-
CO3	2	1	-	2	-	-	-	-
CO4	3	1	-	2	-	-	-	-

Syllabus

Unit I: History of Smartphones, Smartphone Applications and Development Ecosystem, Android Architecture, Syscalls, IPC mechanism in Android, Android Framework and APIs - APK, App Signing, Java/Dalvik Byte code, Android Run-Time, Reflection, Dynamic Code Loading, Serialization,

Unit II: Android Apps Overview - Java, Kotlin, Flutter and Android Studio, Activities and Intents - Life cycle, State and Architecture (Eg: MVVM), Broadcast Receiver, Content Provider, Services, Room Database and Shared Preference, Android emulator, AVD, ADB, SSL Pinning,

Unit III: Static Analysis - Assets and resources, Android Manifest, Native Code, Reverse engineering – apktool, jadx, Android App Bundles (AAB), Android System Security – Google Services, Android OS and Kernel, Device hardware, Android Malware – Stalkerware, Spyware, Adware. Vulnerabilities and Attack surfaces, Dynamic Analysis – Frida, Proxying Android traffic, Intercepting traffic using burp.

Textbooks / References:

1. Joshua J. Drake, Pau Oliva Fora, Zach Lanier, Collin Mulliner, Stephen A. Ridley, Georg Wicherski - “Android™ Hacker’s Handbook” 2014
2. Keith Makan - “Android Security Cookbook”, ISBN - 978-1782167167, December 2013
3. Dominic Chell, Tyrone Erasmus, Shaun Colley, Ollie Whitehouse - “The Mobile Application Hacker's Handbook”, ISBN: 978-1-118-95850-6, February 2015
4. Nikolay Elenkov - “Android Security Internals: An In-Depth Guide to Android's Security Architecture”, ISBN - 978-1593275815, 2014
5. Jonathan Levin, “Android Internals - A Confectioner's Cookbook - Power User's View - 1st edition”, ISBN - 978-0991055524, January 2015
6. Mobile Systems and Smartphone Security course (MOBISEC), Fall 2020 at EUROCOM

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA559	CYBER FORENSICS	L-T-P-C: 3-0-0-3

Course Description

After completion of the course the students will be able to learn investigation tools and techniques, analysis of data to identify evidence, Technical Aspects & Legal Aspects related to cybercrime.

Course Objectives

- Students will learn an introduction to cyber forensics with investigation tools. They will be able to perform evidence collection, preservation, and data recovery. All platforms: Windows, Linux, iOS, Android will be covered.

Course Outcomes

COs	Description
CO1	Understand digital evidence collection and preservation techniques.
CO2	Familiarize with hardware forensics including disk, SSD, memory, and mobile device analysis.
CO3	Explore host/OS forensics for MS Windows, Linux, Android, iOS, and related file system forensics.
CO4	Understand forensic analysis of databases, emails, browsers, the dark web, and anti-forensic techniques
CO5	Explore network, wireless, cloud, and IoT forensics.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	-	-	-	-	-
CO2	3	1	-	1	-	-	-	-
CO3	3	1	-	1	-	-	-	-
CO4	3	1	-	1	-	-	-	-
CO5	3	1	-	1	-	-	-	-

Syllabus

Unit I: Introduction to Cyber Forensic Investigation, Investigation Tools, Digital Evidence Collection, Evidence Preservation

Unit II: Data Recovery, Encryption and Decryption methods, Search and Seizure of Computers and devices, Recovering deleted evidence, Password Cracking, Security Standards, Cyber Laws and Legal Frameworks, Cyber laws in India, Case studies and tools.
Hardware/SSD/Device Forensics

Unit III: File System Forensics, OS Forensics (Windows, Linux, Android and iOS), Memory Forensics, Web/Browser Forensics, Dark Web/Tor Forensics, E-Mail Forensics,

Unit IV: Mobile/Wireless Forensics, Network and Communication Forensics, Anti-forensics, Steganography, and Image File Forensics, IOT Forensics, Cloud Forensics, Overwriting/Forging/Wiping/Destruction, Obfuscation, Online Anonymity and Rootkits.
Assessing Threat Levels, Operating System Attacks, Malware Analysis, Financial Frauds, Espionage and Investigations, Investigating copiers, IVR, Video surveillance, RFID and Sim cards.

Textbooks / References:

1. File System Forensic Analysis by Brain Carrier ISBN: 978-0-32-126817-2
2. Incident Response and Computer Forensics, Third Edition by Jason T Luttgens, Mathew Pepe ISBN: 978-0-07-179869-3
3. Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software by Michael Sikorski, Andrew Honig ISBN: 978-1-59327-290-6
4. Android Forensics: Investigation, Analysis and Mobile Security for Google Android by Andrew Hoog, ISBN: 978-1-59749-651-3
5. iPhone and iOS Forensics: Investigation, Analysis and Mobile Security for Apple iPhone, iPad, and iOS Devices by Andrew Hoog, Katie Strzempka ISBN: 978-1-59749-659-9.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

IoT & EMBEDDED SYSTEMS STREAM

26CSA571	EMBEDDED OPERATING SYSTEMS	L-T-P-C: 3-0-0-3

Course Description

This course provides a comprehensive understanding of operating systems used in embedded systems. It focuses on real-time and embedded operating system concepts, kernel architecture, task scheduling, inter-process communication, memory management, and device drivers. The course equips students with the knowledge required to design, analyze, and evaluate embedded and real-time operating systems for resource-constrained and time-critical applications.

Course Objectives

- To introduce the fundamentals of embedded and real-time operating systems
- To understand kernel architecture, task scheduling, and synchronization mechanisms
- To study memory management, device drivers, and file systems in embedded OS
- To analyze performance issues and design considerations in embedded operating systems

Course Outcomes

COs	Description
CO1	Explain the concepts, architecture, and design principles of embedded operating systems
CO2	Analyze task scheduling, synchronization, and inter-process communication mechanisms
CO3	Design memory management, file systems, and device drivers for embedded systems
CO4	Evaluate embedded OS performance and apply OS concepts to real-time applications

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	–	–	1	–	–	–
CO2	3	3	2	–	2	–	–	–
CO3	2	3	3	–	3	–	–	1
CO4	2	2	2	–	2	1	1	1
CO5	3	2	–	–	1	–	–	–

Syllabus

Unit I: Introduction to Embedded and Real-Time Operating Systems

Overview of embedded systems, characteristics of embedded OS, general-purpose OS vs embedded OS, real-time systems and classification (hard, firm, soft), RTOS architecture, kernel services, design constraints in embedded operating systems.

Unit II: Task Management and Scheduling

Tasks, threads, and processes, task states and life cycle, preemptive and non-preemptive scheduling, scheduling algorithms (Rate Monotonic Scheduling, Earliest Deadline First), context switching, task synchronization, mutexes, semaphores, priority inversion and inheritance.

Unit III: Inter-Process Communication and Memory Management

Inter-process communication mechanisms (message queues, mailboxes, pipes, signals), event handling, shared memory, dynamic and static memory allocation, memory protection, segmentation and paging in embedded systems, stack and heap management.

Unit IV: Embedded File Systems, Device Drivers, and Performance Analysis

Embedded file systems, flash file systems, device drivers and interrupt handling, timers and clocks, power management, performance metrics, timing analysis, debugging and testing of embedded OS, challenges and future trends in embedded operating systems.

Text Books

1. David E. Simon, *An Embedded Software Primer*, Addison-Wesley, 2000.
2. Qing Li, Caroline Yao, *Real-Time Concepts for Embedded Systems*, CMP Books, 2003.

Reference Books

1. Raj Kamal, Embedded Systems: Architecture, Programming and Design, McGraw-Hill.
2. Jean J. Labrosse, MicroC/OS-II: The Real-Time Kernel, CMP Books.
3. Abraham Silberschatz et al., Operating System Concepts, Wiley.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA572	CLOUD IOT PLATFORMS	L-T-P-C: 3-0-0-3

Course Description

This course introduces cloud-based platforms that support Internet of Things (IoT) applications. It focuses on integrating IoT devices with cloud infrastructure for data ingestion, storage, processing, analytics, and visualization. Students gain hands-on understanding of major cloud IoT platforms, device management, scalability, security, and deployment of end-to-end IoT solutions using cloud services.

Course Objectives

- To understand the role of cloud computing in IoT ecosystems
- To study architectures and services of cloud-based IoT platforms
- To learn device connectivity, data management, and messaging services
- To explore analytics, visualization, and deployment of scalable IoT applications
- analysis, semantic analysis, intermediate code generation, code optimization, and code generation.

Course Outcomes

COs	Description
CO1	Explain cloud computing concepts and their integration with IoT systems
CO2	Analyze architectures and services of popular cloud IoT platforms
CO3	Design cloud-based solutions for device management and data processing
CO4	Deploy and evaluate scalable, secure IoT applications on cloud platforms

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	–	–	2	–	–	–
CO2	3	3	2	–	3	–	–	–
CO3	2	3	3	–	3	–	–	1
CO4	2	2	2	–	3	1	1	1
CO5	3	2	–	–	2	–	–	–

Syllabus

Unit I: Cloud Computing and IoT Integration

Overview of cloud computing, service models (IaaS, PaaS, SaaS), deployment models (public, private, hybrid), role of cloud in IoT, IoT-cloud reference architecture, edge computing vs cloud computing, benefits and challenges of cloud-based IoT.

Unit II: Cloud IoT Platform Architecture

IoT platform components, device gateways, device provisioning and registration, communication protocols (MQTT, HTTP, CoAP), message brokers, data ingestion pipelines, scalability and fault tolerance.

Unit III: Device Management, Data Storage, and Security

Device monitoring and firmware updates, digital twins, identity and access management, authentication and authorization, data storage models (time-series databases, NoSQL), cloud storage services, data security and privacy in IoT cloud platforms.

Unit IV: Analytics, Visualization, and Deployment

Stream and batch data processing, real-time analytics, rule engines, dashboards and visualization tools, integration with AI/ML services, deployment of end-to-end IoT applications, case studies using platforms such as AWS IoT, Microsoft Azure IoT Hub, and Google Cloud IoT.

Text Books

1. Rajkumar Buyya, James Broberg, Andrzej Goscinski, *Cloud Computing: Principles and Paradigms*, Wiley.
2. Arshdeep Bahga, Vijay Madisetti, *Internet of Things: A Hands-On Approach*, Universities Press.

Reference Books

1. Perry Lea, Internet of Things for Architects, Packt Publishing.
2. Honbo Zhou, The Internet of Things in the Cloud, CRC Press.
3. Kai Hwang et al., Distributed and Cloud Computing, Morgan Kaufmann.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA573	EMBEDDED LINUX PORTING WITH YOCTO	L-T-P-C: 2-0-2-3

Course Description

This course provides an in-depth understanding of Embedded Linux system development and porting using the Yocto Project. It focuses on building, configuring, and customizing embedded Linux distributions for specific hardware platforms. Students will learn the structure and workflow of Yocto, including layers, recipes, and build processes, along with bootloaders, kernel concepts, and customization techniques. The course also introduces lightweight communication protocols such as MQTT and CoAP, which are widely used in embedded and IoT systems. By the end of the course, students will be equipped to design, customize, and deploy Embedded Linux solutions for real-world applications.

Course Objective(s)

- Introduce Embedded Linux development using the Yocto Project.
- Enable customization and deployment of Linux systems for embedded hardware.
- Familiarize students with kernel, bootloader, and IoT communication protocols.

Course Outcomes

COs	Description
CO1	Explore and understand the Yocto Project framework for embedded Linux development
CO2	Describe the key concepts and roles of bootloaders and the Linux kernel
CO3	Familiarize with Yocto layers, recipes, and metadata organization
CO4	Explain and perform kernel and bootloader customization for target hardware
CO5	Explore and apply lightweight communication protocols such as MQTT and CoAP

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	–	2	–	2	–
CO2	3	2	2	–	2	–	1	–
CO3	2	2	2	–	2	–	2	–
CO4	3	3	3	2	3	–	2	1
CO5	2	2	2	2	3	–	2	1

Syllabus

Unit I: **Topic: Introduction to the Yocto**

Overview of Yocto - Components and Architecture - Advantages - Use cases of Yocto - Configuration Files in Yocto - Understanding and configuring local .conf, machine .conf, and distro .conf files – Customizing settings and environments – Managing different configuration options.

Unit II: Topic: Bootloaders and Kernel

Introduction to bootloaders – Primary Boot Loader-main boot Loader (U-Boot / Bare box) –Building Kernel - configuring the Linux kernel –Introduction to Root File System (RFS) - creation and integration of RFS – Flashing Images and Cross-Compiling - Flashing bootloaders, kernel, and RFS using TFTP - Cross-compiling C applications – Troubleshooting and Debugging

Unit III: Topic: Recipes and Layers in Yocto

Understanding Yocto recipes and layers – layers workflow for custom recipes - Defining tasks – writing new Recipes - Adding Patches - Creating applications (e.g., hello.bb) - Modify existing recipes to customize packages – Using bbappend files.

Unit IV: Topic: Kernel and Bootloader Customization

Linux kernel configuration – kernel patches - Configuration fragments - Kernel versions - Adding Bootloaders - Machine Configuration – Integration of bootloader and machine configuration - Applying patches and setting defconfig for bootloaders - Managing Linux kernel configuration options.

Unit V: Topic: MQTT and CoAP

Building and integrating MQTT - CoAP packages- Examples - Integration of external libraries into the Yocto build - Modifying Rootfs Image Recipe – Interacting Root file system (rootfs) - Selecting different types of root file system images - Creating custom rootfs images - Machine Configuration –Add new machine –Custom rootfs image

Tutorial Components:

Level 1: Basics

1. Define a simple recipe for a "hello world" application. Understand the concept of Yocto layers and their workflow. Use .bbappend files to modify existing recipes.
2. Create a simple Yocto project with a basic configuration. Explore and modify local, machine,and distro configuration files.
3. Build and flash U-Boot as the bootloader. Configure the Linux kernel and create a basic Root File System (RFS).

Level 2: Intermediate
4. Customize the Linux kernel configuration for a specific target. Apply patches and explore kernel version management.
5. Integrate bootloader and machine configuration into the Yocto project.
6. Cross-compile a C application and flash it onto the target. Troubleshoot and debug issues encountered during the cross-compilation process.
7. Modify an existing recipe to customize package features. Add patches to recipes and observe their effects. Understand the tasks involved in creating a new Yocto recipe.

Level 3: Advanced
8. Experiment with different types of root file system images.
9. Create a customized RFS image for a specific application. Interact with and explore the modified root file system.
10. Implement kernel patches to enhance or modify kernel functionality.
11. Integrate external libraries into the Yocto build system.

Level 4: Complex
12. Build and integrate MQTT and CoAP packages into the Yocto project. Develop examples showcasing the functionality of MQTT and CoAP.
13. Explore advanced U-Boot configurations. Integrate additional features into the bootloader.
14. Create a complex custom recipe for a specialized application. Modify multiple existing recipes to achieve a specific system configuration.

Text Books (Sample Format)

- "Embedded Linux Systems with the Yocto Project" by Rudolf J. Streif

Reference Book

- Embedded Linux Development using Yocto Projects, 2nd Edition" by Otavio Salvador and Daiane Angolini, Packet Publishing, 2018.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA574 IOT DATA ANALYTICS L-T-P-C: 2-0-2-3

Course Description

This course focuses on analytics techniques for data generated by Internet of Things (IoT) systems. It covers data acquisition, preprocessing, storage, and analysis of large-scale, real-time IoT data streams. Students will learn statistical, machine learning, and visualization methods to extract actionable insights from sensor and device data, enabling intelligent decision-making in IoT applications such as smart cities, healthcare, industrial automation, and environmental monitoring.

Course Objective(s)

- To understand the characteristics and challenges of IoT data
- To learn data preprocessing and management techniques for sensor data
- To apply statistical and machine learning methods to IoT datasets
- To develop skills in real-time analytics and visualization for IoT applications

Course Outcomes

COs	Description
CO1	Explain the nature, sources, and challenges of IoT data
CO2	Apply data preprocessing and exploratory analysis techniques to IoT datasets
CO3	Implement analytical and machine learning models for IoT data analysis
CO4	Design and evaluate real-time analytics and visualization solutions for IoT applications

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	–	–	2	–	–	–
CO2	2	3	2	–	3	–	–	–
CO3	2	3	3	–	3	1	–	–
CO4	2	2	2	–	3	1	1	1

Syllabus

Unit I: Introduction to IoT Data and Analytics

Characteristics of IoT data, data generation models, structured and unstructured sensor data, data streams vs batch data, challenges in IoT data analytics, overview of analytics pipeline for IoT systems.

Unit II: Data Acquisition, Storage, and Preprocessing

Data collection from sensors and devices, data ingestion techniques, missing data handling, noise removal and filtering, normalization and aggregation, feature extraction from sensor data, time-series data representation.

Unit III: Analytical and Machine Learning Techniques for IoT

Descriptive and inferential statistics for IoT data, correlation and trend analysis, classification and regression models, clustering techniques, anomaly and outlier detection, predictive analytics for IoT applications.

Unit IV: Real-Time Analytics and Visualization

Stream processing frameworks, real-time analytics concepts, rule-based analytics, dashboards and visualization tools, alerting mechanisms, case studies in smart cities, healthcare IoT, and industrial IoT analytics.

Text Books

1. Bahga, A., Madisetti, V., *Internet of Things: A Hands-On Approach*, Universities Press.
2. Han, J., Kamber, M., Pei, J., *Data Mining: Concepts and Techniques*, Morgan Kaufmann.

Reference Books

1. Zikopoulos, P., Eaton, C., Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data, McGraw-Hill.
2. Bifet, A., et al., Machine Learning for Data Streams, MIT Press.
3. Perry Lea, Internet of Things for Architects, Packt Publishing.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA575	EMBEDDED C PROGRAMMING II	L-T-P-C: 2-0-2-3

Course Description

This course provides an in-depth continuation of Embedded C Programming with a strong focus on system-level programming concepts required for embedded systems development. It covers advanced C language constructs, memory handling using pointers, modular programming, library creation, and low-level communication interfaces. The course equips students with practical skills for developing efficient, reliable, and portable embedded applications using C, emphasizing real-time constraints, hardware interaction, and communication modules commonly used in embedded platforms.

Course Objective(s)

- To strengthen understanding of advanced C programming concepts used in embedded systems
- To develop skills in modular programming, memory management, and pointer manipulation
- To understand compilation models, static and dynamic libraries, and multi-file projects
- To introduce low-level communication interfaces using C
- To enable students to write efficient and portable embedded C programs

Course Outcomes

COs	Description
CO1	Apply advanced C programming constructs for embedded system development
CO2	Implement modular and memory-efficient programs using pointers, arrays, and structures
CO3	Develop reusable code using libraries and multi-file compilation techniques
CO4	Design and implement basic communication modules using C

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	2	–	2	–	1	–
CO2	3	3	2	–	2	–	1	–
CO3	2	2	3	–	3	–	1	–
CO4	2	3	3	–	3	–	1	–

Syllabus

Unit I: Introduction

History of C, C standardization, introduction to VIM editor, basic structure of a C program, input/output functions (printf, scanf), escape sequences, comments, data types and variables, address variables, type qualifiers (const, volatile), C preprocessor directives.

Unit II: Operators, Conditional and Iterative Statements

Classification of operators (unary, binary, ternary), arithmetic, relational, logical, bitwise, assignment, and miscellaneous operators (sizeof, &, *, ?:), decision-making statements (if, if–else, nested if, switch), looping constructs (while, do–while, for), control statements (goto, break, continue, return).

Unit III: Functions, Storage Classes and Arrays

Library and user-defined functions, function declaration and definition, function calling mechanisms, call by value and call by address, local and global variables, storage classes, command-line arguments, arrays (1D and 2D), array initialization, array size and length, introduction to Makefile.

Unit IV: Pointers, Strings, Structures and Unions

Pointer declaration and initialization, pointer types, NULL and void pointers, pointer arithmetic, arrays and pointers, dynamic memory allocation, strings and string operations, structures, bit fields, unions.

Unit V: Library Implementation and Communication Modules

Multiple file compilation, static and dynamic libraries, library creation and usage, introduction to communication interfaces, UART interface programming, terminal programming using C.

Text Books

- Michael J. Pont, *Embedded C*, Addison-Wesley, Pearson Education, 2002.

Reference Books

1. Paul Deitel and Harvey Deitel, *C How to Program*, 8th Edition, Pearson Education, 2016.
2. Noel Kalicharan, *Learn to Program with C*, Apress Inc., 2015.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

REGULAR STREAM

26CSA560	COMPILER DESIGN	L-T-P-C: 3-0-0-3

Course Description

A compiler is system software that is required to convert computer programmes into a format that can be executed on the intended machine. Creating a compiler necessitates knowledge of several areas of computer science, including logic, formalism, mathematics, data structures, algorithms, and programming. This course is intended to serve as an introduction to the various stages involved in the design of standard compilers, beginning with the front-end stages of compilation and progressing to the back end and some recent advancements in the field.

Course Objectives

- The goal of this course is to educate students on the phases of a compiler and the techniques for designing a compiler. This course introduces students to the fundamental concepts of compilation phases such as lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization, and code generation.

Course Outcomes

After completing this course, students will be able to:

COs	Description
CO1	Describe stages of compilation, and lexical Analysis
CO2	Compare different types of parsers (Bottom-up and Top-down) and construct a parser for a given grammar.
CO3	Analyze syntax directed translation and representations of intermediate code
CO4	Describe type checking and run time environment
CO5	Illustrate code optimization and code generation techniques in the compilation.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	2	-	-	-	-	-	2
CO2	2	2	-	-	-	-	-	2
CO3	3	3	2	-	-	-	-	2
CO4	3	3	2	-	-	-	-	2
CO5	3	3	-	-	-	-	-	2

Syllabus

Unit I

Introduction To Compilers: Definition of compiler, interpreter and its differences, the phases of a compiler, role of lexical analyzer, regular expressions, finite automata, from regular expressions to finite automata, pass and phases of translation, bootstrapping, LEX-lexical analyzer generator.

Unit II

Parsing: Parsing, the role of the parser, context free grammar, derivations, parse trees, ambiguity, elimination of left recursion, left factoring, eliminating ambiguity from dangling-else grammar, classes of ptop-downtop down parsing - backtracking, recursive descent parsing, predictive parsers, LL (1) grammars.

Bottom-Up Parsing: Definition of bottom-up parsing, handles, handle pruning, stack implementation of shift-reduce parsing, conflicts during shift-reduce parsing, LR grammars, LR parsers-simple LR, canonical LR(CLR) and Look Ahead LR (LALR) parsers, error recovery in parsing, parsing ambiguous grammars, YACC-automatic parser generator.

Unit III

Syntax Directed Translation: Syntax directed definition, construction of syntax trees, S-attributed and L-attributed definitions, translation schemes.

Intermediate Code Generation: intermediate forms of source programs– abstract syntax tree, polish notation and three address code, types of three address statements and their implementation syntax-directed translation into three-address code, translation of simple statements, Boolean expressions and flow-of-control statements.

Unit IV

Type Checking: Definition of type checking, type expressions, type systems, static and dynamic checking of types, specification of a simple type of checker, equivalence of type expressions, type conversions, overloading of functions and operators.

Run Time Environments: Source language issues, Storage organization, storage-allocation strategies, access to non-local names, parameter passing, symbol tables and language facilities for dynamic storage allocation.

Unit V

Code Optimization: Organization of code optimizer, basic blocks and flow graphs, optimization of basic blocks, the principal sources of optimization, the directed acyclic graph (DAG) representation of basic block, and global data flow analysis.

Code Generation: Machine dependent code generation, object code forms, the target machine, a simple code generator, register allocation and assignment, peephole optimization.

Textbooks / References:

1. Keith Cooper and Linda Torczon, “Engineering a Compiler”, Second Edition, Morgan Kauffmann, 2011.
2. Alfred V.Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, “Compilers: Principles, Techniques and Tools”, Prentice Hall, Second Edition, 2006.
3. Andrew W. Appel and Jens Palsberg, “Modern Compiler Implementation in Java”, Cambridge University Press, Second Edition, 2002.
4. Tremblay and Sorenson, The Theory and Practice of Compiler Writing, Tata McGraw Hill & Company.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA561 ADVANCED OPERATING SYSTEMS L-T-P-C: 3-0-0-3

Course Description

This is a graduate level course which provides a platform for students to dig deeper into modern operating system technology, implementation techniques and research issues. The course enables the students to specialize in Operating Systems by exposing the recent developments and research in the area. This course covers a broad range of topics which includes Unix architecture, design of modern operating systems, resource sharing and scheduling, software and hardware interaction, memory management, distributed and real time system behaviors etc.

Course Objectives

- Provide insights on the design principles of modern operating systems
- Understanding low level OS code and its interaction with hardware
- To gain knowledge on Distributed Operating System concepts
- To gain insights on the distributed resource management
- Create interest in students to explore more on the research aspects in the area

Course Outcomes

After completing this course, students will be able to:

COs	Description
CO1	Describe the architecture and process management system calls
CO2	Discuss memory management and I/O management services of OS
CO3	Illustrate the file and process subsystem of Linux Operating System
CO4	Apply the concepts of file management to implement different file access methods and directory structures in an operating system.
CO5	Interpret the challenges involved in designing distributed and real-time operating systems, emphasizing their practical applications and limitations.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	1	-	-	-	-	-	-
CO2	2	2		1	-	-	-	-
CO3	2	1		-	-	-	-	2
CO4	2	1	1	1	-	-	-	-
CO5	2	2		-	-	-	-	

Prerequisites

- Computer Architecture
- C Programming
- Data Structures

Syllabus

Unit I: Computer hardware review – Instruction execution cycle, Interrupts; Operating system concepts: Process abstraction, System calls for process management, Process execution mechanisms, Scheduling policies, Inter-process communication, Classic synchronization problems and their solutions, Deadlocks.

Unit II: Memory Management: physical memory organization, Address space abstraction, Address binding, Memory allocation strategies, fragmentation, swapping, Paging, Segmentation, Virtual memory, demand paging and its implementation, Page replacement algorithms,

Unit III: Unix Internals: Architecture of Unix OS- Kernel Data structures, File subsystem and process subsystem – Process states and transitions – sleep and wakeup – buffer cache. File system – Internal representation of files – system calls for the file system.

Unit IV: File Management File concept, Access methods, Access Matrix, Implementation of Access Matrix, Access Control. File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management.

Unit V: Distributed Operating Systems – Architecture of Distributed systems, Communication mechanisms, Real Time Operating Systems: Introduction to Real Time Operating Systems, Concepts of scheduling, Real Time Memory Management.

Textbooks / References:

1. Silberschatz, Galvin, Gagne, Operating System Concepts, Tenth Edition, John Wiley & Sons, Inc.
2. Distributed Operating Systems Concepts and Design – Pradeep K Sinha - Prentice-Hall India.
3. The Design of the Unix Operating System - Maurice J Bach – Prentice-Hall India.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA562	SOFTWARE TESTING	L-T-P-C: 3-0-0-3

Course Description
Software testing courses equip and help students to understand the various theoretical aspects of the program ranging from manual testing to test automation. Also, the students can understand the skills that are relevant to the industry by getting experience in the latest and advanced technology.

Course Objectives

- To study the underlying concepts in software testing and to examine the various software testing issues and find their solutions. Students are also exposed to advanced software testing topics, such as object-oriented software testing activities, methods and tools.

Course Outcomes

COs	Description
CO1	Identify the different software testing techniques, processes and errors handled in software projects.
CO2	Classify black box and white box testing techniques for functional and structural testing and test case designing.
CO3	Describe the different testing activities and levels of testing which aim to uncover the defects in all the project's stages.
CO4	Discuss the non-functional testing and debugging methods.
CO5	Recognize the various issues for object-oriented testing and tools for testing.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	1	-	-	-	1	-
CO2	3	2	2	-	-	-	-	1
CO3	2	2	2	-	-	-	1	-
CO4	2	2	-	-	-	-	1	-
CO5	2	2	2	-	-	-	-	-

Syllabus
Unit I: Introduction: Introduction to software testing and analysis - Purpose of Software testing – Some Dichotomies – a model for testing - Error, Fault, Failure, Incident, Test Cases, Testing Process, Limitations of Testing - No absolute proof of correctness.
Software testing Fundamentals - Specification-based testing techniques, code-based testing techniques, Model-based testing.

Unit II: Blackbox box testing- Functional Testing: Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique.
Whitebox testing- Structural Testing: Path testing, DD-Paths, Cyclomatic Complexity, Graph Metrics, Data Flow Testing, Mutation testing, Static Analysis, Dynamic Analysis. Reducing the number of test cases: Prioritization guidelines, Priority category, Scheme, Risk Analysis, Regression Testing, Slice-based testing

Unit III: Testing Activities - Unit Testing, Levels of Testing, Integration Testing, System Testing, Debugging, Domain Testing, Regression Testing, Acceptance testing,
Unit IV: Object Oriented Testing: Issues in Object Oriented Testing, Class Testing, GUI Testing, Object Oriented Integration and System Testing, Methods of test data generation and validation.

Unit V: Program slicing and its application, Reliability analysis, Formal methods; verification methods; oracles. Testing Tools: Static Testing Tools, Dynamic Testing Tools, and Characteristics of Modern Tools

Textbooks / References:

1. William Perry, “Effective Methods for Software Testing”, John Wiley & Sons, New York, 2007.
2. Cem Kanerner, Jack Falk, Nguyen Quoc, “Testing Computer Software”, Second Edition, Van Nostrand Reinhold, New York, 2000.
3. Boris Beizer, “Software Testing Techniques”, Second Volume, Second Edition, Van Nostrand Reinhold, New York, 1990.

4. Louise Tamers, “Software Testing”, Pearson Education Asia, 2002
5. "Software Testing: A Craftsman's Approach, Second Edition," by Paul C Jorgensen, CRC Press, June 26, 2002. (required)
6. "The Art of Software Testing," 2nd ed., Glenford J. Myers, John Wiley & Sons, Inc., Hoboken, New Jersey, 2004. (optional)
7. "Lessons Learned in Software Testing: a Context-Driven Approach," Cem Kaner, James Bach, and Bret Pettichord, John Wiley & Sons, Inc., New York, 2002. (optional).

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA563	THEORY OF COMPUTATION	L-T-P-C: 3-0-0-3

Course Description

Formal languages and automata theory deals with the concepts of automata, formal languages, grammar, computability and decidability. The reasons to study. Automata Theory possesses a high degree of permanence and stability, in contrast with the ever-changing paradigms of the technology, development, and management of computer systems.

Course Objectives

- This course gives an overview of the theoretical foundations of computer science from the perspective of formal languages. Formal Languages and Automata Theory provide a simple, elegant view of the complex machine we call a computer. Further, parts of the Automata theory have a direct bearing on circuit design, compiler design, and search algorithms.

Course Outcomes

COs	Description
CO1	Explain kinds of finite automata and their capabilities.
CO2	Design Finite Automata for different Regular Expressions and Languages.
CO3	Construct context-free grammar for various languages.
CO4	Solve various problems by applying normal form techniques, push down automata and Turing Machines.
CO5	Explain Recursively enumerable languages

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	2	-	-	-	-	-	2
CO2	2	2	-	-	-	-	-	2
CO3	3	2	-	-	1	-	-	2
CO4	3	2	-	-	-	-	-	2
CO5	3	2						2

Syllabus

Unit I: Finite Automata (FA): Introduction, Deterministic Finite Automata (DFA) -Formal definition, simpler notations (state transition diagram, transition table), the language of a DFA. Nondeterministic Finite Automata (NFA)- Definition of the FA, language of an NFA, Equivalence of Deterministic and Nondeterministic Finite Automata, Applications of Finite Automata, Finite Automata with Epsilon Transitions, Eliminating Epsilon transitions, Minimization of Deterministic Finite Automata, Finite automata with output (Moore and Mealy machine Interconversion.

Unit II: Regular Expressions (RE): Introduction, Identities of Regular Expressions, Finite Automata and Regular Expressions- Converting from DFA's to Regular Expressions, Converting Regular Expressions to Automata, applications of Regular Expressions. REGULAR GRAMMARS: Definition, regular grammar and FA, FA for regular grammar, Regular grammar for FA. Proving languages to be non-regular -Pumping lemma, applications, Closure properties of regular languages.

Unit III: Context Free Grammar (CFG): Derivation Trees, Sentential Forms, Rightmost and Leftmost derivations of Strings. Ambiguity in CFGs, Minimization of CCFGs CNF, GNF, Pumping Lemma for CFLs Enumeration of Properties of CFL

Unit IV: Pushdown Automata: Definition, Model, Acceptance of CFL, Acceptance by Final State and Acceptance by Empty stack and its Equivalence, Equivalence of CFG and PDA. TURING MACHINES (TM): Formal definition and behavior, Languages of a TM, TM as accepters, and TM as a computer of integer functions, Types of TMs.

Unit V: Recursive And Recursively Enumerable Languages (REL): Properties of recursive and recursively enumerable languages, Universal Turing machine, The Halting problem, Undecidable problems about TMs. Context-sensitive language and linear bounded automata (LBA), Chomsky hierarchy, Decidability, Post's correspondence problem (PCP), undecidability of PCP.

Textbooks / References:

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman (2007), Introduction to Automata Theory Languages and Computation, 3rdedition, Pearson Education, India.
2. Martin, John C., Introduction to Languages and the Theory of Computation, 3rd ed., Tata McGraw Hill Education Private Limited.
3. H.R.Lewis and C.H.Papadimitriou, ―Elements of the theory of Computation‖, Second Edition, PHI, 2003.
4. Micheal Sipser, ―Introduction of the Theory and Computation‖, Thomson Brokecole, 1997.
5. Peter Linz, "An Introduction to Formal Languages and Automata", Third Edition, 2002.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA564 ENTERPRISE RESOURCE PLANNING MANAGEMENT L-T-P-C: 3-0-0-3

Course Description

This course deals with ERP to improve the productivity of your organization's processes and product life cycle management in a company. Adopt the necessary skills to select and implement the most suitable ERP system for your business.

Course Objectives

- To facilitate the flow of information between all business functions inside the organization's boundaries and manage connections to outside stakeholders.

Course Outcomes

Cos	**Description**
CO1	Demonstrate significance and principles of BE.
CO2	Use Business modelling concepts for ERP and its implementation.
CO3	Describe the concept of ERP and the competitive strategy and different ERP domains.
CO4	Examine market dynamics and competitive strategy of ERP using case studies.
CO5	Interpret ERP and client-server architecture, open-source ERP and commercial ERP.

CO-PO Mapping

PO/PSO **CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	2	2	-	-	-	-		-
CO2	2	2	-	-	-	-		-
CO3	2	2	-	-	-	-		-
CO4	2	3	-	-	-	-		-
CO5	2	2	3	-	-	-		-

Syllabus

Unit I: Introduction to ERP
Accommodating Variety – Integrated Management Information – Seamless Integration – Supply Chain Management – Resource Management – Integrated Data Model – Scope – Technology – Benefits of ERP.
Business Engineering and ERP
What is BE? – Significance and Principles of BE – BPR, ERP and IT – BE with IT – ERP and Management Concerns.

Unit II: Business Modelling for ERP
Building the Business Model.
ERP Implementation
Role of Consultants, Vendors and Users – Customization – Precautions – ERP: Post-implementation Options – ERP Implementation Methodology – Guidelines for ERP Implementation.

Unit III: ERP and the Competitive Advantage
ERP and the Competitive Strategy
The ERP Domain
MFG/PRO, IFS/Avalon - Industrial and Financial systems – Baan IV – SAP – SAP R/3 Applications – Example of an Indian ERP Package – The Arrival of ERP III.

Unit IV: Marketing of ERP
Market Dynamics and Competitive Strategy.
Sample Case Studies.

Unit V: Client Server and ERP Architecture
Introduction to Client Server – Advantages and Disadvantages – N tier Architecture – ERP Architecture.
http://ebuild.imtindia.com/erp_software_architecture.html
Open Technology
Background of Open Technology – Introduction – Proprietary v/s Open source – Need for Open-Source Solutions – Open-Source ERP.
http://elearning.nic.in/mdp/2-open-technology/opentechnology-mdp.pdf
Commercial ERP

Commercial ERP – Open-Source ERP v/s Commercial ERP.
http://www.erpwire.com/erp-articles/commercial-and-open-source-erp.htm.

Textbooks / References:

1. Enterprise Resource Planning – Concepts and Practice", Vinod Kumar Garg, N.K. Venkitakrishnan, Second Edition, Eastern Economy Edition, Prentice-Hall of India Pvt., Ltd., 2008.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA565 AUTOMATION AND ROBOTICS L-T-P-C: 3-0-0-3

Course Description

This course provides the detailed idea about the fields of robotics and its control mechanisms.

Course Objectives

- The main objective is to provide information on various parts of robots and ideas on robotics.
- It also focuses on various kinematics and inverse kinematics of robots, trajectory
- planning of robots and to study the control of robots for some specific applications.

Course Outcomes

COs	Description
CO1	Describe the fields of robotics and explain the major components
CO2	Explain about various robot processes and functions
CO3	Discuss the various Programmable Logic Control and Experiment with various control mechanisms of robotics.
CO4	Explain the kinematics of robots and trajectory,
CO5	Implement different applications of robotics

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	-	3
CO2	2	1	-	-	-	-	-	1
CO3	3	-	2	-	1		3	
CO4	-	1	-	-	-	-	2	1
CO5	2		-	-	1	1	-	-

Syllabus

Unit I: Introduction - Definition and Origin of Robotics, Types of Robotics, Major Components, Historical development of Robot, Robotic System and Robot anatomy, Degrees of freedom, Coordinate System and its type Asimov's laws of robotics, Dynamic stabilization of robots.

Unit II: Power Sources and Sensors - Hydraulic, pneumatic and electric drives, determination of HP of motor and gearing ratio, variable speed arrangements, path determination, micro machines in robotics, machine vision, ranging, laser, acoustic, magnetic, fibre optic and tactile sensors.

Unit III: Manipulators, Actuators, and Grippers - Manipulators, Classification, Construction of manipulators, manipulator dynamics and force control, electronic and pneumatic manipulator control, End effectors, Loads and Forces, Grippers, design considerations, Robot motion Control, Position Sensing.

Unit IV: Kinematics and Path Planning - Solution of Inverse Kinematics Problem, Multiple Solution Jacobian Work Envelop, Hill Climbing Techniques, Robot Programming Languages. Process Control and Types, On-Off Control Systems, Proportional Control Systems, Proportional Plus Integral (PI) Control Systems, Three Mode Control (PID) Control Systems, Process Control Tuning.

Case Studies:

Multiple robots, Machine Interface, Robots in Manufacturing and not-Manufacturing Application, Robot Cell Design, Selection of a Robot.

Laboratory Works:

The laboratory work should be focused on the implementation of sensors, design of control systems. It should also deal with developing programs related to Robot design and control using python.

Textbooks / References:

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw Hill.
2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers.

3. Jain K.C. and Aggarwal B.E., Robotics – Principles and Practice, Khanna Publishers
4. Schuler, C.A. and McNamee, W.L. Modern Industrial Electronics, Macmillan/McGraw-Hill
5. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering – An Integrated Approach, Prentice Hall of India.
6. Deb.S.R., Robotics Technology and Flexible Automation, John Wiley, USA 1992.
7. Asfahl C.R., Robots and Manufacturing Automation, John Wiley, USA 1992
8. Mc Kerrow P.J. Introduction to Robotics, Addison Wesley, USA, 1991.
9. Issac Asimov I. Robot, Ballantine Books, New York, 1986.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA566	SOFTWARE DEFINED NETWORKS	L-T-P-C: 3-0-0-3

Course Objectives

- This course aims to develop knowledge in networking fundamentals, gain a conceptual understanding of Software Defined Networks (SDN) and study industrial deployment use-cases of SDN.

Course Outcomes

Cos	Description
CO1	Differentiate between traditional networks and software defined networks and learn the fundamentals of software defined networks.
CO2	Describe characteristics of SDN
CO3	Explain Open SDN Implementations
CO4	Use SDN in data centers
CO5	Apply SDN concepts to solve real time world problems.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	-	-	-	-	-
CO2	3	1	1	-	-	-	-	1
CO3	3	2	-	-	-	-	-	2
CO4	3	2	2	-	-	-	-	2
CO5	3	2	2	-	-	-	-	2

Syllabus

Unit I: Basic Packet Switching Terminology, Historical Background, The Modern Data Center, Traditional Switch Architecture, Autonomous and Dynamic Forwarding Tables, Open Source and Technological Shifts. Why SDN? Genesis of SDN.

Unit II: Working of SDN- Fundamental Characteristics of SDN, SDN Operation, SDN Devices, SDN Controller, SDN Applications, Alternate SDN Methods. Introduction to OpenFlow Specification, Improving OpenFlow Interoperability, OpenFlow Limitations, Optical Transport Protocol Extensions.

Unit III: Introduction to Open SDN and its limitations, SDN via APIs, SDN via Hypervisor Based Overlays, SDN via Opening up the Device, Introduction of SDN Controllers and its general concepts, Layer 3 Centric, Plexxi, Cisco OnePK. Introduction of Network Programmability, Management Interface, Application-Network Divide, Modern Programmatic Interfaces, I2RS, Modern Orchestration

Unit IV: SDN in the Data Center- Introduction of Data Center and its demands, Tunneling Technologies for the Data Center, Path Technologies in the Data Center, Ethernet Fabrics in the Data Center, SDN Use Cases in the Data Center, Comparison of Open SDN, Overlays and APIs, Real-World Data Center Implementations.

Unit V: Introduction SDN application and its usages, SDN in the Data Center - SDN in Other Environments - SDN Applications - SDN Use Cases – The Open Network Operating System.

Textbooks / References:

1. Paul Goransson and Chuck Black, Software Defined Networks: A Comprehensive Approach, Second Edition, Morgan Kaufmann, 2014.
2. SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies, By Thomas Nadeau, Ken Gray, Publisher: O'Reilly Media.
3. Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud 1st Edition, Kindle Edition, by William Stallings.
4. SDN and NFV Simplified: A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization 1st Edition, Kindle Edition, by Jim Doherty.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA567	ROBOTIC OPERATING SYSTEM	L-T-P-C: 3-0-0-3

Course Description

This course introduces the Robot Operating System (ROS) including many of the available tools that are commonly used in robotics. With the help of different examples, the course should provide a good starting point for students to work with robots. They learn how to create software including simulation, to interface sensors and actuators, and to integrate control algorithms.

Course Objectives

- Introduce the basics of Robot Operating Systems and its architecture.
- Provide knowledge on the hardware interfacing aspects.
- Analyze the working of ROS in real world complex applications.

Course Outcomes

Cos	Description
CO1	Explain the Role of ROS in real time scenario and its significance.
CO2	Apply the Linux commands in ROS used in robotics.
CO3	Discuss the concepts behind navigation through file system.
CO4	Analyze and debug the node created using hardware for application.
CO5	Analyze the issues in hardware interfacing and implement the working of specific application hardware using Hardware with ROS.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	1	1	-	1	-	-	-
CO2	-	3	2	2	-	-	-	-
CO3	1	2	1	-	-	-	-	-
CO4	1	-	1	1	-	-	-	-
CO5	1	-	-	1	1	-	-	-

Pre-requisites: Introduction to Linux and terminal commands and Basics of Python programming.

Syllabus

Unit I: Introduction –The ROS Equation - History - distributions -difference from other meta-operating systems– services - ROS framework – operating system – releases. ROS Best Practices: ROS Local Setup guidelines, Using open-source packages with ROS, ROS Unit tests and ROS Bags.

Unit II: UNIX commands - file system – redirection of input and output - File system security - Changing access rights – process commands – compiling, building and running commands – handling variables.

Unit III: File system - packages – stacks – messages – services – catkin workspace – working with catkin workspace – working with ROS navigation and listing commands.

Unit IV: Navigation through file system -Understanding of Nodes – topics – services – messages – bags – master – parameter server. Introduction to the ROS Navigation Stack, Navigation stack-creating transforms.

Unit V: Debugging of Nodes – topics – services – messages – bags – master – parameter – visualization using Gazebo – Rviz – URDF modeling – Xacro – launch files. Hardware Interface: Sensor Interfacing – Sensor Drivers for ROS – Actuator Interfacing – Motor Drivers for ROS. Case Studies: Using ROS In Real World Applications.

Textbooks / References:

1. Lentin Joseph, “Robot Operating Systems (ROS) for Absolute Beginners, Apress, 2018
2. Aaron Martinez, Enrique Fernández, “Learning ROS for Robotics Programming”, Packt Publishing Ltd, 2013.
3. Reference Books: 1. Jason M O'Kane, “A Gentle Introduction to ROS”, CreateSpace, 2013.
4. AnisKoubaa, “Robot Operating System (ROS) – The Complete Reference (Vol.3), Springer, 2018.
5. Kumar Bipin, “Robot Operating System Cookbook”, Packt Publishing, 2018.
6. Wyatt Newman, “A Systematic Approach to learning Robot Programming with ROS”, CRC Press, 2017.
7. Patrick Gabriel, “ROS by Example: A do it yourself guide to Robot Operating System”, Lulu, 2012.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA568	SOFTWARE QUALITY ASSURANCE	L-T-P-C: 3-0-0-3

Course Description

This course helps and throws an insight into students by making then understand that all software engineering processes, methods, activities, and work items are monitored and comply with the defined standards. The course also incorporates all software development processes starting from defining requirements to coding until release. Its prime goal is to make students aware of different quality standards and its management methods.

Course Objectives

- To convey quality management processes, various activities of quality assurance, quality planning and quality control. Students understand the importance of standards in the quality management process and their impact on the final product.

Course Outcomes

Cos	Description
CO1	Recognize the quality challenges, factors and activities in the project life cycle.
CO2	Describe the idea on the testing strategies and building a testing process.
CO3	Identify the software quality in management and business context. Also, regarding Process and Product Quality.
CO4	Explain the ISO origins, different audit methods and quality assessment procedures.
CO5	Execute a clear-cut idea on CMM and Process improvement models, Configuration Management and processes along with experience gaining through various case studies.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	1	1	-	-	-	1	2
CO2	3	2	2	-	-	-	-	-
CO3	2	2	2	-	-	-	1	-
CO4	2	2	2	-	-	-	-	2
CO5	2	2	-	-	1	-	1	-

Syllabus

Unit I: Introduction: The Software Quality Challenge - Software Quality Factors-The Components of Software Quality System-Integrating Quality Activities in the Project Life Cycle.

Unit II: Software Testing: Strategies and Implementation-Building the Software Testing Process-Software Quality- Five Views of Software Quality, McCall's Quality Factors and Criteria, Quality Factors Quality Criteria, Relationship between

Unit III: Quality Factors and Criteria- Management Components: Metrics and Costs-Software Quality in the Business Context- Product Quality and Process Quality -

Unit IV: ISO 9001: The Origins of ISO 9001- need for ISO 9001-Assessment and Audit Preparation-The Assessment Process.

Unit V: Software CMM and other Process Improvement Models-Software Configuration Management-Introduction to Six Sigma - Case Studies: Indian Software Industry in Perspective.

Textbooks / References:

1. Daniel Galin, "Software Quality Assurance: From theory to Implementation", Pearson Education, 2008
2. Nina Godbole, "Software Quality Assurance, Principles and Practice", NarosaPublications, 2011.
3. William Perry, "Effective Methods of Software Testing", Third Edition, Wiley, 2006.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA569	WEB SERVICES	L-T-P-C: 3-0-0-3

Course Description

This course deals with how students will be able to define a web service, deploy a web service within WSDL, understand the SOAP protocol, read and understand SOAP messages passed between server and client. It will also explain how to register and discover the service.

Course Objectives

- To Understand Web Services and implementation model for SOA.
- To Understand the SOA, its Principles and Benefits.
- To Understand XML concepts and paradigms needed for testing Web Services.

Course Outcomes

Cos	Description
CO1	Describe architecture of web services
CO2	Illustrate web service architecture and characteristics.
CO3	Use SOAP for inter application communication.
CO4	Implement framework using WSDL
CO5	Describe Registering and Discovering Services

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	-	1	-	-	-
CO2	3	-	-	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-
CO4	-	3	1	-	2	-	-	-
CO5	1	-	2	-	1	-	-	-

Prerequisites

- Programming languages

Syllabus

Unit I

Evolution and Emergence of Web Services – Evolution of distributed computing. Core distributed computing technologies – client/server, CORBA, JAVA RMI, Microsoft DCOM, Challenges in Distributed Computing, Introduction to Web Services – The definition of web services, basic operational model of web services, tools and technologies enabling web services, benefits and challenges of using web services.

Unit II

Web Service Architecture – Web services Architecture and its characteristics, core building blocks of web services, standards and technologies available for implementing web services, web services communication, basic steps of implementing web services. Brief Overview of XML – XML Document structure, XML namespaces, Defining structure in XML documents, Reuse of XML schemes, Document navigation and transformation.

Unit III

SOAP: Simple Object Access Protocol, Inter-application communication and wire protocols, SOAP as a messaging protocol, Structure of a SOAP message, SOAP envelope, Encoding, Service Oriented Architectures, SOA revisited, Service roles in a SOA, Reliable messaging, Message Exchange Patterns, Message Exchange Formats.

Unit IV

Describing Web Services – WSDL introduction, nonfunctional service description, WSDL1.1 Vs WSDL 2.0, WSDL document, WSDL elements, WSDL binding, WSDL tools, WSDL port type, limitations of WSDL.

Unit V

Registering and Discovering Services: The role of service registries, Service discovery, Universal Description, Discovery, and Integration, UDDI Architecture, UDDI Data Model, Interfaces, UDDI Implementation.

Textbooks / References:

1. Web Services & SOA Principles and Technology, Second Edition, Michael P. Papazoglou.
2. Developing Java Web Services, R. Nagappan, R. Skoczylas, R.P. Sriganesh, Wiley India
3. Thomas Erl, "Service Oriented Architecture", Concepts, Technology and Design", Prentice Hall of India, 2005.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA570	SOFTWARE PROJECT MANAGEMENT	L-T-P-C: 3-0-0-3

Course Description

This course provides a comprehensive understanding of software project management principles, processes, and practices. It introduces the concepts of software projects, their importance, and their relationship with programs and portfolios. The course covers project management process groups and knowledge areas as defined by PMBOK, along with common problems encountered in software projects. Students will learn project evaluation techniques, project integration, scheduling, resource, communication, and risk management. Practical exposure using software project management tools and case studies enables students to apply theoretical concepts to real-world software projects.

Course Objectives

- To understand the fundamentals and significance of software project management
- To familiarize students with PMBOK process groups and knowledge areas
- To analyze cost–benefit and feasibility of software projects
- To apply scheduling, resource, communication, and risk management techniques
- To develop skills in planning, monitoring, controlling, and closing software projects
- To use project management tools for practical project execution and analysis

Course Outcomes (COs)

COs	Description
CO1	Explain the concepts, importance, and challenges of software project management
CO2	Apply project management processes and knowledge areas to software projects
CO3	Evaluate software projects using cost–benefit and feasibility techniques
CO4	Develop project charters, project management plans, and schedules
CO5	Manage project resources, communication, and risks effectively
CO5	Use project management tools to plan, monitor, and control software projects

CO–PO Mapping (8 Program Outcomes)

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	-	-	1	-	-	3
CO2	3	2	2	-	-	-	-	-
CO3	-	2	2	2	2	-	-	-
CO4	3	2	1	1	2	-	-	-
CO5	2	2	2	2	1	-	-	-

Syallbus

Unit I: Introduction to Software Project Management

Definition and overview of software projects,Importance of software project management, Relationship between project, program, and portfolio, Key components of a software project, Project management process, process groups, and knowledge areas, Problems with software projects (Bob Hughes).

Unit II: Project Evaluation and Integration Management

Evaluation of individual projects, Cost–benefit evaluation techniques (Bob Hughes), Project charter and project management plan, Organizational process assets, Project integration management overview

Unit III: Project Integration Management Processes

Develop project charter, develop project management plan, Direct and manage project work, Monitor and control project work, Integrated change control, Project closure

Unit IV: Project Schedule, Resource, and Communication Management

Schedule management,Plan schedule management: Define and sequence activities,Estimate activity durations, develop schedule, Resource management: Plan and estimate resources, Acquire resources, Develop and manage teams, Control resources, Project communication management overview

Unit V: Project Risk Management

Plan risk management, Identify risks,Qualitative risk analysis, Risk response planning, Monitor and control risks

Text Books / References

1. PMBOK® Guide, Sixth Edition, Part 1
2. Mike Cotterell & Bob Hughes, *Software Project Management*, Fifth Edition, Tata McGraw-Hill, 2010
3. Software project management tools for case studies (e.g., ProjectLibre)

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

ELECTIVES – 4 Credits

AI & DS STREAM

26CSA631 DATA MODELLING AND VISUALIZATION L-T-P-C: 3-0-2-4

Course Description

Data Modeling and Visualization is delivered to explore the domain of data analysis using the methods of data visualization and data modelling countering the challenges and risks associated with data analytics. The learners of this course are engaged with extensive learning methods and evaluation techniques to gain theoretical and practical knowledge of the concepts

Course Objectives

- To understand The Data Modeling and Visualization is built for the learners of this program to gain fundamental to the advanced level understanding of the concepts of data analysis aided by the strategies of data visualization and data modelling.
- The students are familiarized with the tools of R programming for data analysis and acquire competence in problem-solving and decision-making
- To learn and implement various data modelling algorithms

Course Outcomes

COs	Description
CO1	Understand data and its processing using python.
CO2	Apply and visualize data modelling using R.
CO3	Apply data visualization using Tableau.
CO4	Understand and visualize data modelling using different types of data sources using various techniques.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	1	-	2	1	2
CO2	3	2	3	1	1	2	1	2
CO3	3	2	3	2	1	2	1	2
CO4	3	2	3	-	2	2	1	2

Syllabus

Unit I: Data-Analytic Thinking: Knowing your data, Data pre-processing, Storytelling with data. Data Visualization using Python: Introduction to Python programming, Visualization using python, Transformation using python, exploratory data analysis.

Unit II: Data Visualization using R: Introduction to R programming, Visualization using R, Transformation using R, exploratory data analysis. Data Modeling: Linear regression, Logistic regression, K-nearest neighbors, K-means clustering, Performance measure, Implementation of some modelling algorithms using python.

Unit III: Data Visualization using Tableau: Introduction to Tableau, data import and management, data type and operations, Different types of data visualizations, dashboards, storytelling, Understanding of the concepts of dynamic/interactive data visualization and report generation.

Unit IV: Data Modeling from Different Data Sources for Visualization: Understanding structured, unstructured and semi-structured data sources, Data modelling and creating visualization charts/dashboards from structured data like databases (SQL and NoSQL), Data modelling and creating visualization charts/dashboards from semi-structured data like CSV files, XML, JSON and others, Data modelling and creating visualization charts/dashboards from live streaming data.

Textbooks / References:

1. Data Analysis and Visualization Using Python: Analyze Data To Create Visualizations For Bi Systems by Embarak, Apress.
2. Jiawei Han, Micheline Kamber and Jian Pei, “Data mining concepts and Techniques”, Third Edition, Elsevier Publisher, 2006.
3. K.P.Soman, Shyam Diwakar and V.Ajay, “Insight into data mining Theory and Practice”, Prentice Hall of India, 2006.

4. Data Science with R: A Step-by-Step Guide with Visual Illustrations & Examples, Andrew Oleksy.
5. Practical Data Science with R, Nina Zumel and John Mount, Dreamtech/Manning, 2014
6. R Programming for Data Science, Roger D. Peng, Lean Publishing, 2015.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA632	EXPLORATORY DATA ANALYSIS	L-T-P-C: 3-0-2-4

Course Description

This course covers the essential exploratory techniques for summarizing data. These techniques are typically applied before formal modelling commences and can help inform the development of more complex statistical models. Exploratory techniques are also important for sharpening potential hypotheses about the world that can be addressed by the data.

Course Objectives

- To understand the problems of working with real-time data sets
- To learn how to work with python programming tools and algorithms.
- To explore how to use data visualization.

Course Outcomes

COs	Description
CO1	Use python/R libraries for exploratory computing and explore data wrangling technique
CO2	Examine Cumulative Distribution functions and Probability Density functions
CO3	Conceive and apply the knowledge on data aggregation and group operations
CO4	Explore and solve problems on various supervised and unsupervised learning algorithms

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	2	1	1	2	-	2
CO2	2	3	3	3	1	1	-	1
CO3	3	3	3	3	1	2	-	1
CO4	4	4	3	3	-	1	-	1

Syllabus

Unit I: Introduction to exploratory data analysis and what it is used for – Introduction to machine learning – about the dataset, data Preprocessing techniques, Data wrangling: Join, combine and reshape, numerical summarization, visualization – statistical learning and model selection, Prediction accuracy, cross-validation.

Unit II: Cumulative Distribution functions: Percentiles, CDF's, Percentile based statistics, Modeling Distributions: Exponential Distributions, Normal distributions, Normal probability plot, long normal distributions, Descriptive statistics– location, spread, Probability Density functions: PDFs, Kernel density estimation, Distribution framework, Skewness, Relationship between variables: Correlation, covariance, Pearson's correlation, Non-linear relationship, Estimation: Sampling distribution, sampling Bias, Exponential distributions, Hypothesis testing, Regression.

Unit III: Data aggregation and group operations – group by Mechanics, Data aggregation, group-wise operations and transformations, Pivot tables and cross-validation. Time series: Date Ranges, frequencies and shifting, Time zone handling, Period arithmetic, Resampling and frequency conversion and moving window function.

Unit IV: Supervised Learning algorithms – Classification, Forecasting, prediction and regression, Linear Models, SVM, K-nn, Decision tree classifier, Artificial neural networks, Ensemble methods, Deep neural networks. Unsupervised learning algorithms: K-means, association rule mining, reinforcement learning, Instance-based learning.

Textbooks / References:

1. Practical machine learning for data analysis using python, Abdul Hamid Subasi, Elsevier Publication
2. Think Stats exploratory data analysis, Allen B. Downey, 2nd edition
3. Python for data analysis, Oreily, Wes McKinney.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA633 DATA MINING AND APPLICATIONS L-T-P-C: 3-0-2-4

Course Description

This is an introductory course on data mining. This course introduces the basic concepts, algorithms, principles, implementation techniques and applications of data mining.

Course Objectives

- To understand concepts of pattern discovery
- To familiarize yourself with data preprocessing and mining algorithms
- To understand prediction algorithms and cluster analysis

Course Outcomes

Cos	Description
CO1	Study important Knowledge discovery concepts, methods, and applications, in particular, the basic concepts of data preprocessing to prepare the data for mining.
CO2	Identify efficient pattern mining association methods and rules, such as Apriori, and FP-growth.
CO3	Learn pattern-based classifications and prediction, including all classifiers.
CO4	Understand classifier Evaluation methods
CO5	Study basic concepts, methods, and applications of cluster analysis

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	1	1	1	2	-	1	1	2
CO2	3	3	3	2	-	1	2	2
CO3	3	3	3	2	1	1	1	2
CO4	3	3	3	2	1	1	1	2
CO5	3	3	3	2	1	1	1	2

Syllabus

Unit I: Introduction: Evolution and Importance of Data Mining-Types of Data and Patterns Mined-Technologies-Applications-Major Issues in Data Mining. Knowing about Data-Data Preprocessing: attribute type, Basic statistical descriptions of data, measuring data similarity and dissimilarity, Cleaning– Integration–Reduction–PCA, Data Transformation and Discretization.

Unit II: Mining Frequent Patterns: Basic Concept – Frequent Item Set Mining Methods – Mining Association Rules – Association to Correlation Analysis.

Unit III: Classification and Prediction: Issues - Decision Tree Induction - Bayesian Classification – Rule-Based Classification – k-Nearest-Neighbor Classification - Linear SVM - Regression – Linear, Logistic - Accuracy and Error measures –Introduction to Ensemble methods.

Unit IV: Classifier Evaluation methods

Unit V: Clustering: Overview of Clustering – Types of Data in Cluster Analysis – Major Clustering Methods-Partitioning Methods- k-Means, k-Medoids. Hierarchical Methods-Agglomerative and Divisive hierarchical clustering-single linkage, complete linkage, average linkage. Density-Based Methods-DBSCAN, Graph-based clustering (CHAMELEON), Grid-based Clustering: CLIQUE, probabilistic Model-Based Clustering-EM algorithm. Datamining trends and research frontiers- Mining complex Data types- Mining other kinds of data-data mining applications.
Lab: Implementation of Data mining algorithms using Latest Open-Source Data mining Tools. TensorFlow, python, R

Textbooks / References:

1. Jiawei Han, Micheline Kamber and Jian Pei, “Data mining concepts and Techniques”, Third Edition, Elsevier Publisher, 2006.
2. K.P.Soman, Shyam Diwakar and V.Ajay, “Insight into data mining Theory and Practice”, Prentice Hall of India, 2006.
3. Yanchang Zhao, “R and Data Mining”, Elsevier, 2013 4. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and TensorFlow, O'Reilly Media, 2017 5. Itay Lieder, Yehezkel Resheff, Tom Hope, Learning TensorFlow, O'Reilly Media, 2017.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA634	MACHINE LEARNING	L-T-P-C: 3-0-2-4

Course Description

This course will enable students to understand the basic concepts of machine learning. It will help students to apply different machine learning models to real-world problems.

Course Objectives

- To understand basic concepts of machine learning
- To familiarize the machine learning models like linear and logistic regression
- To understand different classifiers
- To understand different clustering algorithms

Course Outcomes

After completing this course, students will be able to:

Cos	Description
CO1	Understand the definition, tools and applications of machine learning
CO2	Implement prediction models using linear regression
CO3	Implement different classifiers and ensemblers
CO4	Understand the different evaluation and validation methods
CO5	Implement different clustering algorithms

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	2	1	1	-	2	-	2
CO2	3	3	2	1	1	2	-	2
CO3	3	3	2	1	1	2	1	2
CO4	3	3	3	1	1	2	2	2
CO5	3	3	2	1	1	2	2	2

Syllabus

Unit I

Introduction to ML; Problems, data and tools. Learning systems, goals, challenges and applications of machine learning systems. Aspects of developing system, training data, testing data, concept representation, classification errors, validation. Dimensionality Reduction, Data compression, PCA.

Unit II

Linear regression, SSE, gradient descent, bias and variance estimation, overfitting and underfitting, regularization, ridge and lasso regression.

Unit III

Logistic regression, hypothesis representation, decision boundary, cost function, multi-class classification. Nearest neighbour methods. Decision Tree learning, representing concepts as decision trees, picking the best splitting attribute: entropy and information gain. Probability and classification, Naïve Bayes classification, EM algorithm, kernels, Kernel regression, kernels, Support Vector Machine (SVM) and kernels, kernel optimization. Linear Discriminant Analysis algorithm, Ensemblers, Neural networks learning, model representation, perceptron, cost function, back propagation algorithm.

Unit IV

Model selection, Evaluation and Validation methods for classifiers

Unit V

Unsupervised learning, clustering, different clustering methodologies. Current problems on machine learning.

Textbooks / References:

1. Machine Learning, Tom Mitchell, McGraw Hill, 1997.

2. Duda, Richard, Peter Hart, and David Stork, “Pattern Classification” Second Edition, New York, NY: Wiley-Interscience, 2000.
3. Hastie, T., R. Tibshirani, and J. H. Friedman, “The Elements of Statistical Learning: Data Mining, Inference and Prediction”, New York, Springer, 2001
4. Christopher, M. Bishop. Pattern Recognition and Machine Learning, Springer-Verlag New York, 2016.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA636	BIG DATA ANALYTICS	L-T-P-C: 3-0-2-4

Course Description

The process of analysis of large volumes of diverse data sets, using advanced analytic techniques is referred to as Big Data Analytics. Big data analytics has found several applications in different industries. This course deals with how to use advanced analytic techniques to analyze large volume of diverse data sets. Along with introduction of the Big Data, students will learn about No-SQL, Hadoop, and MapReduce. Students will also be able to learn recent trends and tools of the Big Data such as HBase, Cassandra and Hive.

Course Objectives

- To provide an overview of an exciting growing field of big data analytics.
- To introduce the tools required to manage and analyze big data like Hadoop, NoSQL, and Map-Reduce.
- To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
- To enable students to have skills that will help them to solve complex real-world problems for decision support.

Course Outcomes

After completing this course, students will be able to:

COs	Description
CO1	Describe big data and use cases from selected business domains.
CO2	Explain NoSQL big data management.
CO3	Install, configure, and run Hadoop and HDFS.
CO4	Perform map-reduce analytics using Hadoop.
CO5	Use Hadoop related tools such as HBase, Cassandra, and Hive for big data Analytics, and understanding the recent trends in Big Data analytics.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	1	-	-	1	-	-	1
CO2	2	1	2	1	-	-	-	1
CO3	1	2	3	1	-	-	-	-
CO4	1	1	3	1	-	-	-	-
CO5	2	2	3	1	-	-	-	-

Syllabus

Unit I

Introduction to Big Data: What is big data, why big data, the convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open-source technologies, cloud and big data, mobile business intelligence, Crowd-sourcing analytics, inter and trans firewall analytics.

Unit II

No SQL: Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schema less databases, materialized views, distribution models, sharding, master-slave replication, peer-peer replication, sharding and replication, consistency, relaxing consistency, version stamps, map-reduce, partitioning and combining, composing map-reduce calculations.

Unit III

Hadoop: Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures.

Unit IV

MapReduce: MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats.

Unit V

Recent Trends in Big Data Analytics: HBase, data model and implementations, HBase clients, HBase examples, praxis. Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration, Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.

Textbooks / References:

1. Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning, Raj Kamal, Preeti Saxena, McGraw Hill, 2018.
2. Big Data, Big Analytics: Emerging Business intelligence and Analytic Trends for Today's Business, Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, John Wiley & Sons, 2013.
3. Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013
4. Hadoop: The Definitive Guide, Tom White, Third Edition, O'Reilly, 2012.
5. Hadoop Operations, Eric Sammer, O'Reilly, 2012.
6. Programming Hive, E. Capriolo, D. Wampler, and J. Rutherglen, O'Reilly, 2012.
7. HBase: The Definitive Guide, Lars George, O'Reilly, 2011.
8. Cassandra: The Definitive Guide, Eben Hewitt, O'Reilly, 2010.
9. Programming Pig, Alan Gates, O'Reilly, 2011.

E-Books:

1. http://index-of.co.uk/Big-Data-Technologies/Data%20Science%20and%20Big%20Data%20Analytics.pdf

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA637 NATURAL LANGUAGE PROCESSING L-T-P-C: 3-0-2-4

Course Description

This course is intended as a theoretical and methodological introduction to a the most widely used and effective current techniques, strategies and toolkits for natural language processing. The ability to harness, employ and analyze linguistic and textual data effectively is a highly desirable skill for academic work, in government, and throughout the private sectors.

Course Objectives

- Students will be able to comprehend the importance of using natural language processing when resolving issues in the real world.
- Enables students to apply and match the proper processing technique to a given situation.
- Students will be able to exhibit the necessary design abilities for large collection sets. Additionally, capable of understanding and presenting cutting-edge, sophisticated NLP research materials to an audience.

Course Outcomes

After completing this course, students will be able to:

COs	Description
CO1	Discern the concept of POS tagging and CFG for the English language.
CO2	Cognize the Vector Representation of words and skip-gram models
CO3	Explore semantic analysis algorithms and deep learning techniques, to apply them in various NLP applications.
CO4	Get acquainted with Mathematical and programming tools for implementing NLP applications.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	2	2	3	1	2	-	1
CO2	2	3	3	-	1	1	3	2
CO3	1	3	3	3	2	2	2	1
CO4	2	3	3	3	1	1	3	1

Syllabus

Unit I

Basics of Machine Learning, Python Programming language, Basics of Probability, Introduction - terminologies - empirical rules – Statistical Properties of words – Probability and NLP – Vector Space Models - Pre-processing-Tokenization, Parts-Of-Speech (POS) tagging, chunking, syntax parsing, Dependency parsing.

Unit II

Vector Representation of words – Contextual Understanding of text – Cooccurrence of matrix – N-grams – Dense Word Vector. Word2Vec – CBOW and Skip-gram Models – One-word learning architecture- Forward pass for Word2Vec – Reduction of complexity – subsampling and negative sampling. Continuous Skip-Gram Model, GloVe, BERT, XLNet.

Unit III

NLP Applications: Named Entity Recognition, Sentiment analysis, Text categorization using Machine learning algorithms, SVD and Latent semantic Indexing, Probabilistic Latent Semantic Indexing (pLSI) and Latent Dirichlet Allocation (LDA).

Deep Learning for NLP: Neural Networks Basics, Feedforward Neural Network, Recurrent Neural Networks, LSTM, An Introduction to Transformers and Sequence-to-Sequence Learning.

Unit IV

Historical Approaches to Machine Translation – Statistical Machine Translation – Translation Models – Healthcare Data analysis and Text visualization: Summarizing lengthy blocks of narrative text, such as a clinical note or academic journal article. Answering unique free-text queries that require the synthesis of multiple data sources. Introduce Mathematical and programming tools to visualize a large collection of text documents.

Textbooks / References:

1. C.D. Manning et al, "Foundations of Statistical Natural Language Processing," MIT Press. MIT Press, 1999. isbn: 9780262133609.
2. James Allen, "Natural Language Processing with Python", O'Reilly Media, July 2009.
3. NiladriSekhar Dash and S. Arulmozi, Features of a Corpus. Singapore: Springer Singapore,2018, pp. 17–34.

ISBN: 978-981-10-7458-5.

4. Ian Goodfellow, YoshuaBengio, and Aaron Courville, Deep Learning, http://www.deeplearningbook.org. MIT Press, 2016.
5. NitinIndurkhya and Fred J Damerau,” Handbook of natural language processing,” Chapman and Hall/CRC, 2010.
6. Daniel Jurafsky and James H. Martin” Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition,” 1st. Upper Saddle River, NJ, USA: Prentice Hall PTR, 2000. ISBN: 0130950696.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA630	NLP FOR ROBOTICS	L-T-P-C: 3-0-2-4

Course Objectives

- The course aims to introduce spoken language technology with an emphasis on dialog and conversational systems
- The course helps in establishing the understanding of Deep learning and other methods for automatic speech recognition, speech synthesis systems for robotics

Course Outcomes

After completing this course, students will be able to:

COs	Description
CO1	Demonstrate understanding of acoustic phonetics in the context of spoken language
CO2	Analyse different types of dialog systems and their applications
CO3	Apply AI techniques used in dialog systems
CO4	Implement automatic speech recognition, text-to-speech synthesis, and evaluation

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	2	1	2	-	-	-	2
CO2	2	2	1	2	-	-	-	2
CO3	2	2	1	2	-	-	-	2
CO4	2	2	1	2	-	-	-	2

Syllabus

Unit 1

Introduction and Acoustic Phonetics, Overview of dialog: Human conversation. Task-oriented dialog. Dialog systems, Machine Learning in Dialog- Recurrent NNs, Attention, Transformers

Unit 2

Automatic Speech Recognition, Foundation models for spoken language-Using the Speech Brain ASR toolkit, Advanced ASR

Unit 3

Text to Speech (TTS): Overview. Text normalization, Spectrogram prediction, Vocoding, TTS, Evaluation.

Unit 4

NLP Applications: Machine Translation, Question Answering, Information Retrieval, and RAG, Chatbots and Dialogue Systems

Textbooks / References:

1. Dan Jurafsky and James H. Martin. Speech and Language Processing, (3rd ed. draft), available at https://web.stanford.edu/~jurafsky/slp3/
2. Yoav Goldberg. A Primer on Neural Network Models for Natural Language Processing. Available at https://u.cs.biu.ac.il/~yogo/nnlp.pdf
3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville. Deep Learning. MIT Press. Available at https://www.deeplearningbook.org/

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA638 LARGE LANGUAGE MODELS L-T-P-C: 3-0-2-4

Course Description

Large language models (LLMs) represent an emerging form of artificial intelligence with the capability to transform our interactions with computers. LLMs are trained on massive datasets of text and code, and they can be used to perform a wide range of tasks, including generating text, translating languages, writing different kinds of creative content, and answering your questionsin an informative way.

This course provides an in-depth exploration of large language models, focusing on understanding their architecture, training and fine-tuning process, applications, and practical use cases. Students will gain hands-on experience with language model tools and libraries.

Course Outcomes

After completing this course, students will be able to:

COs	Description
CO1	Explore fundamental principles of Large Language Model (LLM) architectures
CO2	Evaluate strengths and weaknesses of various LLM architectures for critical/insightful analysis.
CO3	Apply and analyze techniques for training and fine-tuning LLMs for specific tasks
CO4	Apply LLM expertise to address real-world challenges effectively.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	3	2	3	0	0	2	2
CO2	3	3	2	3	0	2	2	2
CO3	3	3	2	3	1	2	2	2
CO4	3	3	2	3	1	2	2	2

Prerequisites:

- Basic knowledge of machine learning and natural language processing
- Familiarity with Python programming.

Syllabus

Unit 1

Computational linguistics: Overview of NLP, Introduction, syntax, semantics, morphology, Word representation: One-hot encoding, Bag-of-Words (BoW), Dictionary: TF-IDF,Embedding: Word2vec, Glove, Fasttext, Language Model: n-gram, Sequences and sequential data. Neural Networks and Deep Learning, Transformer Architecture- Pre-training and Fine-tuning

Unit 2

Introduction to Large Language Models – Decoder-only LLMs: A deep dive into GPT, Encoder Only LLMs-BERT, prompting – different prompting strategies– Instruction tuning – fine tuning – parameter efficient fine-tuning – quantized fine tuning. Small Language models. Training LLMs using reinforcement Learning.

Unit 3

Evaluating LLMs: Benchmarks, evaluation frameworks and popular leaderboards. Applications/Case study of Large Language Models - Text Generation, Translation, and Summarization -Question Answering, Sentiment Analysis, Chatbots, Application of LLMs in healthcare and Code generation, latest advancements in LLMs.

Text Books/References

1. *Hands-On Large Language Models by Jay Alammar, Maarten Grootendorst, December 2024 Publisher(s): O'Reilly Media.*
2. *'Deep Learning for Natural Language Processing: Develop Deep Learning Models for your Natural Language Problems (Ebook)', Jason Browlee, Machine Learning Mastery, 2017.*
3. *Getting Started with Google BERT: Build and train state-of-the-art natural language processing models using BERT by Sudharsan Ravichandiran, Packt Publishing Limited January 2021*

4. *Latest research papers on LLM*
5. *Comprehensive Overview of LLMs- A survey paper: https://arxiv.org/pdf/2307.06435*
6. *'Foundations of Statistical Natural Language Processing', Christopher Manning and Hinrich Schütze, MIT press, 1999*
7. *'Natural Language Processing with Python', Steven Bird, Ewan Klein and Edward Loper, O'Reilly Media, Inc.", 2009.*
8. *'Speech & language processing' , Daniel Jurafsky, James H Martin, preparation [cited 2020 June 1] Available from:* https://web. *stanford. edu/~ jurafsky/slp3 (2018).*

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA639	COMPUTER VISION	L-T-P-C: 3-0-2-4

Course Description

This course is a broad introduction to computer vision. This course includes topics like image types, their conversion, operation on images, image representation using feature extraction and video analysis.

Course Objectives

- To understand image types and conversion
- To understand different operations on images
- To understand image representation and video analysis

Course Outcomes:

After completing this course, students will be able to:

COs	Description
CO1	Understand the fundamentals of computer vision, their applications, image types and basic operations
CO2	Apply various image processing techniques to binary images and understand different color spaces
CO3	Understand image representation using different feature extraction algorithms
CO4	Understand the methods used for analysis of videos

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1	1	-	-	-	-	1
CO2	2	2	2	1	-	-	-	1
CO3	2	2	2	2	-	-	-	2
CO4	2	2	2	2	-	-	-	2

Syllabus

Unit I

Introduction to computer vision. Image processing v/s computer vision. Applications of computer vision. Types of images: binary, greyscale, color image. Image channels, splitting and merging channels, manipulating color pixels. Mathematical operations on images.

Unit II

Binary Image Processing: Thresholding, Erosion and Dilation, opening and closing. Connected component analysis, contour analysis. Color spaces: RGB, HSV, CMYK, Y'CbCr, Y'UV. Image filtering, smoothing and gradient

Unit III

Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Gabor filters, LBP, GLCM.

Unit IV

Video Analysis**:** Motion Estimation using Optical Flow, Video stabilization, object tracking, Kalman filter, MeanShift and CamShift**.** Background Subtraction and Modeling**.** Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Textbooks / References:

1. Computer Vision: Algorithms and Applications by Richard Szeliski
2. Computer Vision: A Modern Approach (Second Edition) by David Forsyth and Jean Ponce
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA640	GENERATIVE AI	L-T-P-C: 3-0-2-4

Course Description

This course focuses on the integration of Internet of Things (IoT) systems with cloud computing platforms to enable scalable data storage, processing, and intelligent services. It covers cloud architectures, IoT middleware, data ingestion pipelines, device management, security, and analytics services offered by major cloud providers. Students will gain the ability to design, deploy, and manage cloud-connected IoT applications for real-world domains such as smart cities, industrial automation, and healthcare.

Course Objectives

- To understand cloud computing concepts and architectures for IoT systems
- To study IoT–cloud integration models and middleware platforms
- To learn device connectivity, data ingestion, and cloud-based processing
- To design secure, scalable, and reliable cloud-enabled IoT applications

Course Outcomes (COs)

COs	Description
CO1	Explain cloud computing architectures and service models used in IoT systems
CO2	Implement IoT device connectivity and data ingestion using cloud platforms
CO3	Design cloud-based storage, processing, and analytics pipelines for IoT data
CO4	Apply security, monitoring, and device management mechanisms in cloud-integrated IoT solutions

CO–PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	–	–	2	–	–	–
CO2	2	3	2	–	3	1	–	–
CO3	2	3	3	–	3	1	–	–
CO4	2	2	2	–	3	1	1	1

Syllabus

Unit I: Cloud Computing Fundamentals for IoT

Cloud computing concepts, cloud service models (IaaS, PaaS, SaaS), deployment models (public, private, hybrid), cloud reference architectures for IoT, benefits and challenges of cloud–IoT integration.

Unit II: IoT–Cloud Integration Models and Middleware

IoT cloud architecture layers, IoT gateways and edge–cloud interaction, message brokers and middleware, REST APIs, MQTT and AMQP integration, data ingestion pipelines.

Unit III: Cloud Platforms and Services for IoT

Overview of cloud IoT platforms, device registration and provisioning, device shadow and digital twins, data storage services, serverless computing for IoT, cloud-based analytics and visualization.

Unit IV: Security, Management, and Deployment

Authentication and authorization of IoT devices, key management and encryption, secure data transmission, monitoring and logging, scalability and fault tolerance, case studies of cloud-enabled IoT applications.

Text Books

1. Bahga, A., Madisetti, V., *Internet of Things: A Hands-On Approach*, Universities Press.
2. Erl, T., Puttini, R., Mahmood, Z., *Cloud Computing: Concepts, Technology & Architecture*, Pearson.

Reference Books

1. Buyya, R., Vecchiola, C., Selvi, S. T., *Mastering Cloud Computing*, McGraw-Hill.
2. Perry Lea, *Internet of Things for Architects*, Packt Publishing.
3. Minerva, R., Biru, A., Rotondi, D., *Towards a Definition of the Internet of Things (IoT)*, IEEE.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA641 ETHICAL HACKING AND INFORMATION SECURITY L-T-P-C: 3-1-0-4

Course Description

The course deals with learning the basic concepts of ethical hacking and information security. It will also offer knowledge on various practical skills on Ethical hacking Concepts.

Course Outcomes

COs	Description
CO1	Outline the basic concepts of networks and ethical hacking.
CO2	Examine various system hacking techniques.
CO3	Analyze the different concepts of cryptography for data security
CO4	Analyze various attacks against network and communication systems

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	-	3	2	2	-	-	1	-
CO2	-	2	2	2	-	-	1	-
CO3	-	3	3	2	2	-	1	-
CO4	-	2	3	2	2	-	1	-

Syllabus

UNIT I: Introduction to ethical hacking. Fundamentals of computer networking. Installation of attacker and victim system. Installation of attacker and victim system. Information gathering.

UNIT II: System Hacking: password cracking, privilege escalation, application execution. Malware and Virus. ARP spoofing and MAC attack

UNIT III: Introduction to cryptography, private-key encryption, public-key encryption. Cryptographic hash functions, digital signature and certificate, applications.
Steganography, biometric authentication, network-based attacks, DNS and Email security.
UNIT IV: Packet sniffing using wireshark, password attack using burp suite. Social engineering attacks and Denial of service attacks.
UNIT V: Different types of attacks using Metasploit framework: password cracking, privilege escalation, remote code execution, etc. Attack on web servers: password attack, SQL injection, cross site scripting.

Textbooks / References:

1. Data and Computer Communications -- W. Stallings.
2. Data Communication and Networking -- B. A. Forouzan
3. Michael T. Simpson, Kent Backman, James E. “Corley, Hands-On Ethical Hacking and Network Defense”, 2nd Edition, CENGAGE Learning, 2010.
4. Introduction to Computer Networks and Cybersecurity -- C-H. Wu and J. D. Irwin
5. Cryptography and Network Security: Principles and Practice -- W. Stallings

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA642	SYSTEM SECURITY	L-T-P-C: 3-0-2-4

Course Objectives

- Students will learn the fundamentals of securing a computer system. They will understand and implement defenses against all common system attacks.

Course Outcomes

After completing this course, students will be able to:

COs	Description
CO1	Describe security goals and principles which is used in designing a secure system.
CO2	Demonstrate the exploitation of Access control vulnerabilities and develop its mitigation.
CO3	Explain the basics of system organization, assembly language and Linux system calls.
CO4	Demonstrate buffer overflow attack, format string attack and return to libc attack with examples.
CO5	Understand the preventive mechanisms for different exploits.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-
CO3	3	-	-	1	-	-	-	-
CO4	3	1	-	-	-	-	-	-
CO5	3	1	1	1	-	-	-	-

Syllabus

Unit I: Security Goals, Secure Design Principles,

Unit II: Authentication, Linux Password scheme, Password Security, Authorization - Access control, MAC, DAC, ACL, Capabilities, Information flow control, Privilege Escalation Attacks, constraining and sandboxing users and applications.

Unit III: Assembly Primer, Shell coding, ELF File Format.

Unit IV: Memory Exploits – Buffer Overflow, off by one overflow, Format String Attacks, Integer Overflow, Return to Libc, Heap Overflow, Exploit prevention mechanisms: stack canaries,

Unit V: Data Execution Prevention, Address Space Layout Randomization, bypassing DEP & ASLR. Trusted Execution Environment - Case Study on IntelSGX. Fuzzing - Types of fuzzers, Bug detection, Case study - AFL fuzzer. Vulnerability and exploit analysis: spectre, meltdown, foreshadow, dirty COW.

Textbooks / References:

1. Neil Daswani, Christopher Kern, Anita Kesavan, “Foundations of Security, What Every Programmer Needs to Know”, Apress, 2007
2. Jon Ericson, “Hacking: The Art of Exploitation”, Second Edition, No Starch Press, 2008
3. Gary McGraw, John Viega, “Building Secure Software”, Addison-Wesley Professional, 2001.
4. Michael Sutton, Adam Greene, Pedram Amini, “Fuzzing Brute Force Vulnerability Discovery”.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA643 WEB APPLICATION SECURITY L-T-P-C: 3-0-2-4

Course Objectives

Students will learn an overview of web application architectures and the associated security vulnerabilities and defenses. By the end of the course, students will be confident to understand how to secure web applications.

Course Outcomes

Cos	Description
CO1	Understand the security requirements in web applications.
CO2	Understand the various attack against web applications
CO3	Implement secure coding practices.
CO4	Get trained in responsible vulnerability disclosure.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	-	-	-	-	-	-	-
CO2	3	1	-	2	-	-	-	-
CO3	3	-	2	1	-	-	-	-
CO4	1	-	-	1	-	-	-	-

Syllabus

Unit I: Introduction - Overview of web architecture, Protocols, Client-server architecture, P2P architecture, DNS, etc.
Understanding the browser: Same origin policy, Cookies, Cache, authentication.
Website development basics, understanding server-side languages like HTML, PHP and Database languages such as SQL.
Understanding the frontend, backend, database paradigm of web application development.

Unit II: Injection attacks: SQL injection, OS command injection.
File upload vulnerability: LFI, RFI, secure a file inclusion vulnerability.
Request forgery vulnerability: Server-side request forgery, Client-side request forgery.
Cross-site scripting attacks: Reflected XSS, Stored XSS, how to properly secure against XSS attacks.
DOS & DDOS attacks, Phishing attacks.
Automating vulnerabilities: SQL map, Burp Suite.

Unit III: OWASP Top 10: Broken Authentication, Sensitive Data Exposure, XML External Entities, Broken Access Control, Security Misconfiguration, Insecure Deserialization, Using Components with Known Vulnerabilities, Insufficient Logging & Monitoring.

Unit IV: Responsible vulnerability disclosure: CVE's, CVEmitre, Exploit-db, SearchSploit, bug bounty.
Secure coding practices: blacklisting, whitelisting, user input validation, automated testing, sanitizing HTML.

Textbooks / References:

1. Peter Yaworski, "Real-World Bug Hunting: A Field Guide to Web Hacking"
2. Michal Zalewski, "The Tangled Web: A Guide to Securing Modern Web Applications"
3. Dafydd Stuttard and Marcus Pinto, "The Web Application Hacker's Handbook" Second edition, 2011
4. OWASP, "Web Security Testing Guide", Fourth edition.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA645	ADVANCED NETWORK SECURITY	L-T-P-C: 3-0-2-4

Course Objectives

Students will gain a fundamental understanding of network security. They will protect networks, both physical and wireless. Common protocols and data management techniques. They will be comfortable with all the layers of a network, Wi-Fi, Bluetooth. The student will become comfortable with cryptography over networks, and IPv6 security, email security, and firewalls. Students will be familiar with IDS and IPS, common tools against network attacks.

Course Outcomes

COs	Description
CO1	Understand the basics of Computer Networking and Network Security.
CO2	Learn about how to maintain the Confidentiality, Integrity, and Availability of a Data over networks.
CO3	Understand various protocols for network security to protect against the threats in the networks.
CO4	Understand how to protect the data transferred over networks.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-
CO3	3	-	-	2	-	-	-	-
CO4	3	2	2	1	-	-	2	-

Syllabus

Unit I: Information Security Awareness: Bad Actors, Data Security Perspectives, Password Perspectives, Internet Threat Perspectives and Insider Threat Perspectives. Application Layer, Web and HTTP, Electronic mail protocols (SMTP, POP3, IMAP), DNS, Content Distribution Networks, Web Application Firewall

Transport Layer, Process to Process delivery, UDP, TCP, Flow Control and Error Control in TCP, Congestion Control in TCP, UDP Socket Programming, TCP Socket Programming, Practical.

Unit II: Evolution of Network Security, Secure Access Service Edge, Cloud Security, SD-WAN, Endpoint Security, Data Link Layer, Relationship with other layers, Error detection and correction Techniques, ARP and RARP, Link-layer protocols, Switched Local Area Networks, Practical

WIFI Technologies: Introduction 1 (Wi-Fi), NSE 2 Wi-Fi, Wi-Fi Security, Practical - Traffic analysis, Practical - Demonstration of WIFI Exploitation.

Unit III: Bluetooth and Zigbee, Bluetooth -Working, Zigbee – Working, Bluetooth and Zigbee security,

Symmetric Key Cryptography, Asymmetric Key Cryptography, Digital Signatures, Cryptographic, Hash Functions, Message Authentication Codes

IPv6 Security, Network Layer Security, Transport Layer Security

Email Security, Securing Email, Email Header Analysis, Secure Email Gateway

Firewalls, NSE 2 Firewall, Threat Intelligence Services

IDS and IPS, Types of IDS and IPS, IDS and IPS Designs

Unit IV: Network Risk and Vulnerability Management, Types of Vulnerability Assessment, Tools for Network Vulnerability Assessment, Network Attacks, Information Extraction using NMAP + Port scanning.

Access Attacks, DNS Poisoning + ARP Poisoning, Replay attack and privilege Escalation

Malware & DDoS Attacks, DOS & DDOS, MAC Spoofing + switch port stealing.

Textbooks / References:

1. J. F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach, Pearson Publication, 7th Edition, 2017.
2. L. Peterson and B. Davie, Computer Networks: A Systems Approach, 5th Edition, Elsevier Inc., 2011.
3. S.K.PARMAR, Cst, Computer, Internet, and Network Systems Security.
4. Scott Hogg and Eric Vyncke, IPv6 Security, Cisco, 2009.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA645 VAPT (VULNERABILITY AND PENETRATION TESTING) L-T-P-C: 3-0-2-4

Course Objectives

The student will be confident to perform vulnerability and penetration testing for any organization or product team, generate a report and communicate remediation steps.

Course Outcomes

After completing this course, students will be able to:

COs	Description
CO1	Gain the skills to analyze and identify weaknesses in network systems and web services.
CO2	Understand the importance of strong passwords and be able to ethically penetrate systems by leveraging weak password practices.
CO3	Use various tools to analyze network traffic and packets for security purpose
CO4	Perform different types of injection attacks, understanding their impact and potential for exploitation.
CO5	Develop the ability to document their penetration testing activities by creating comprehensive reports that detail vulnerabilities discovered and recommendations for remediation.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-
CO3	3	-	-	3	-	-	-	-
CO4	3	-	-	1	-	-	-	-
CO5	1	-	1	1	-	-	-	-

Syllabus

Unit I: Active information gathering, General vulnerability scanners, Port-based, Service-based, Banner grabbing, Web application scanners, General application flaw scanners, Directory listing/Brute forcing, Web server version/Vulnerability identification, Technology stacks and packages version detection, Network vulnerability scanners/Specific protocols, VPN, Manual direct connections.

Unit II: Passive information gathering, Metadata analysis, Traffic monitoring, ARP/MAC cache overflow, Etherleak, Misconfigured clusters or load balancers

Public Research: Vulnerability databases, Vendor advisories, Exploit databases and framework modules, Common/default passwords, Hardening guides/common misconfigurations, Private Research, Fuzzing. Wi-Fi password hacking, aircrack-ng,

Unit III: DNS Cache poisoning/Spoofing, Recon tools: NS enumeration tools, Nmap, Netcat, Tcpdump, Wireshark, Directory enumeration tools, Google hacking, Shodan.

Unit IV: SQL injection Case study: SQLi, File upload vulnerabilities, Case study: SSRF, Reverse shell, Password brute-forcing using shadow file, Hashcat, John the ripper, Hydra, Medusa, Ncrack, Cross site scripting, XSS, Client-side request forgery, IDOR, Metasploit.

Unit V: XML attacks, Case study: XXE, Vulnerability Exploitation and Generating PoC, Vulnerability assessment, Pen Test Report Generation.

Textbooks / References:

1. OWASP Web Security Testing Guide V4
2. Bugcrowd, “The Ultimate Guide to Penetration Testing”, 2020 edition
3. HackerOne, “Web hacking 101”

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA647	Secure DevOps	L-T-P-C: 3-0-2-4

Course Description

This course introduces the principles and practices of **Secure DevOps (DevSecOps)**, integrating security into every phase of the software development and deployment lifecycle. It focuses on automating security controls, identifying vulnerabilities early, and ensuring secure continuous integration and continuous delivery (CI/CD) pipelines. Students will learn modern DevOps tools, secure coding practices, infrastructure security, container and cloud security, and compliance automation to build resilient and secure software systems.

Course Objectives

- To introduce the concepts and evolution of DevOps and DevSecOps practices
- To integrate security principles into CI/CD pipelines and automation workflows
- To develop skills in secure coding, vulnerability assessment, and threat mitigation
- To understand container, cloud, and infrastructure security in DevOps environments
- To enable students to design, deploy, and monitor secure software delivery pipelines

Course Outcomes (COs)

COs	Description
CO1	Explain DevOps and DevSecOps principles, tools, and lifecycle models
CO2	Apply secure coding practices and vulnerability assessment techniques
CO3	Design secure CI/CD pipelines with automated security testing
CO4	Implement security controls for containers, cloud, and infrastructure
CO5	Analyze compliance, monitoring, and incident response in DevOps environments

CO–PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	–	–	–	–	–	1
CO2	3	3	2	–	–	–	–	1
CO3	2	3	3	2	–	–	–	1
CO4	2	3	2	3	–	–	–	1
CO5	2	3	2	2	–	–	–	2

Syllabus

Unit I – Introduction to DevOps and DevSecOps

DevOps concepts and culture, Agile vs DevOps, DevOps lifecycle, CI/CD fundamentals, Evolution from DevOps to DevSecOps, Shift-left security, Threat landscape in modern software delivery.

Unit II – Secure Coding and Application Security

Secure software development lifecycle (SSDLC), OWASP Top 10 vulnerabilities, secure coding standards, static application security testing (SAST), dynamic application security testing (DAST), software composition analysis (SCA).

Unit III – Secure CI/CD Pipelines

CI/CD tools overview (Git, Jenkins, GitHub Actions, GitLab CI), pipeline security risks, secrets management, integrating SAST/DAST into pipelines, automated vulnerability scanning, artifact integrity and signing.

Unit IV – Container, Cloud, and Infrastructure Security

Infrastructure as Code (IaC) security, container security (Docker), Kubernetes security fundamentals, cloud security basics, identity and access management (IAM), network security, zero-trust principles.

Unit V – Monitoring, Compliance, and Incident Response

Security monitoring and logging, DevSecOps metrics, compliance as code, policy enforcement, vulnerability management, incident response and forensics, case studies on secure DevOps adoption.

Textbooks

1. Laura Bell, Rich Smith, **“The Security of DevOps”**, O’Reilly Media, 2016
2. Julien Vehent, **“Securing DevOps”**, Manning Publications, 2018

Reference Books

1. Gene Kim et al., “The Phoenix Project”, IT Revolution Press, 2018

2. Nicole Forsgren et al., “Accelerate: The Science of Lean Software and DevOps”, IT Revolution Press, 2018
3. OWASP Foundation, OWASP DevSecOps Guidelines
4. NIST SP 800-series documents on DevOps and Cloud Security

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

IOT & EMBEDDED SYSTEMS STREAM

26CSA671 EMBEDDED APPLICATION DEVELOPMENT IN LINUX I L-T-P-C: 3-0-2-4

Course Objective(s)

1. Comprehensive understanding of network science, encompassing key concepts , and their applications to analyse real-world networks .
2. Introduce to the fundamental concepts of network communities, community structures, and various algorithms used for network navigation and community detection
3. Understanding of various models used in network science and models of network growth
4. Introduce to advanced topics in network analysis, search strategies, network navigation, and financial network analytics.

Course Outcomes

COs	Description
CO1	Understand fundamentals of graph theory and network mathematics as well as the statistical physics approach to large scale networks
CO2	Learn how to construct and analyze networks from real world data for network navigation and clustering tasks
CO3	Apply the fundamentals for generating random network models on a computer.
CO4	Demonstrate proficiency in conducting searches on networks, navigation techniques, economic and financial contexts.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	-	2	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	2
CO4	-	3	-	2	-	-	-	2

Syllabus

Unit 1: Overview of Network science, Review of topics in probability, linear algebra, Examples of real-world networks and their properties, Large scale dynamic networks, Challenges of graph theory, transitivity and clustering, centrality, spectral properties of adjacency matrix, maximum degree, degree distributions, degree correlations.

Unit 2: Basic concepts of network communities, community structures, network navigation, Modularity, Girvan-Newman Algorithm, Spectral Bisection Algorithm, Radicchi Edge Clustering Algorithm, Wu-Hubermann Algorithm, Random Walk based Algorithm

Unit 3: Generalized random graphs, Poisson random graphs, the configuration model, generating functions, power-law degree distribution, directed graph, bipartite graph, Models of Network Growth-Price model, Barabasi & Albert model, vertex copying models, Bipartite Network

Unit 4: Search on networks, exhaustive network search, guided network search, network navigation; network visualization and semantic zooming, Temporal network, Multilayer networks, Interdependent networks, Controllability of complex networks, Economic and financial network analytics.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA672 EMBEDDED APPLICATION DEVELOPMENT IN LINUX II L-T-P-C: 3-0-2-4

Course Description

This course builds on the fundamentals of Embedded Linux and focuses on advanced application development techniques for embedded systems. It covers process management, inter-process communication, multithreading, device interfacing, networking, real-time behavior, performance optimization, and system-level debugging in Linux-based embedded platforms. The course emphasizes hands-on embedded application design using Linux system calls, POSIX APIs, and real-world embedded scenarios relevant to IoT, industrial automation, and consumer electronics.

Course Objectives

- Develop advanced Linux-based embedded applications using system-level APIs
- Understand and apply process control, threading, and synchronization mechanisms
- Implement inter-process communication and networking in embedded systems
- Interface embedded applications with hardware devices and drivers
- Analyze performance, reliability, and real-time behavior in embedded Linux systems

Course Outcomes (COs)

COs	Description
CO1	Explain advanced Linux system programming concepts for embedded applications
CO2	Develop multithreaded and multiprocess embedded applications
CO3	Implement IPC and networking mechanisms in Linux-based embedded systems
CO4	Interface embedded applications with devices and system resources
CO5	Analyze performance, real-time constraints, and reliability of embedded Linux applications

CO–PO Mapping

CO \ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	3	2	1	–	2	–	1	–
CO2	2	3	3	–	2	–	1	–
CO3	2	3	3	2	3	–	1	–
CO4	2	2	3	3	3	–	1	–
CO5	1	2	2	3	2	2	2	1

Syllabus

Unit I – Advanced Linux Process and Memory Management

Linux process lifecycle, process creation and termination. System calls: fork(), exec(), wait(). Process scheduling concepts in embedded Linux. Virtual memory management, memory mapping, shared memory concepts. Signals and signal handling. Resource management and process priorities.

Unit II – Multithreading and Synchronization

POSIX threads (pthreads): thread creation, termination, and attributes. Thread synchronization mechanisms: mutexes, semaphores, condition variables. Thread safety and re-entrant code. Deadlocks and starvation. Multithreaded design patterns for embedded applications.

Unit III – Inter-Process Communication and Networking

IPC mechanisms: pipes, FIFOs, message queues, shared memory, sockets. POSIX and System V IPC. Embedded Linux networking fundamentals. TCP/IP socket programming for embedded devices. Client–server models. Network-based embedded applications.

Unit IV – Device Interaction, Debugging, and Optimization

User-space device interaction using /dev, ioctl(), and sysfs. Interaction with character devices. Timers and time management. Debugging tools: gdb, strace, ltrace. Performance profiling and optimization. Real-time considerations in embedded Linux applications. Case studies from IoT and industrial embedded systems.

Textbooks

1. Christopher Hallinan, Embedded Linux Primer, 2nd Edition, Prentice Hall
2. Robert Love, Linux System Programming, O’Reilly Media
3. Karim Yaghmour et al., Building Embedded Linux Systems, O’Reilly Media

Reference Books

1. Michael Kerrisk, The Linux Programming Interface, No Starch Press
2. Frank Vasquez & Chris Simmonds, Linux Kernel Programming, Packt
3. Linux Foundation Documentation and Embedded Linux Wiki

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

24CSA673	AI-IoT Application	L-T-P-C: 3-0-2-4

Course Description

This course provides a comprehensive understanding of modern IoT platforms with a strong focus on **ThingsBoard and edge computing using the Fledge framework**. Students learn how to design, deploy, and manage scalable IoT solutions by integrating edge devices, cloud platforms, and AI/ML models. The course emphasizes real-time data acquisition, visualization, rule-based automation, and intelligent analytics for industrial and smart application domains. Through hands-on tutorials and an end-to-end project, learners gain practical exposure to deploying production-ready IoT systems with edge intelligence and cloud-based dashboards.

Course Objective(s)

- To introduce students to open-source IoT platforms and their role in scalable IoT deployments
- To enable integration of edge devices with cloud IoT platforms using standard communication protocols
- To develop skills in designing interactive dashboards, alarms, and rule-based automation for IoT systems
- To impart knowledge on integrating AI/ML models into IoT workflows for intelligent decision-making

To provide hands-on experience in deploying end-to-end IoT solutions using edge, cloud, and analytics

Course Outcomes

COs	Description
CO1	Understand the architecture and development workflow of IoT dashboards using ThingsBoard.
CO2	Interface edge devices with the cloud using MQTT and REST APIs via the Fledge framework.
CO3	Integrate sensor data streams into ThingsBoard dashboards with rule chains and widget customization.
CO4	Apply AI/ML models (classification, regression) on real-time sensor data for analytics and prediction.
CO5	Design and deploy a complete AI-enabled IoT dashboard using Fledge and ThingsBoard with data visualization and alerts.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	–	–	1	–	–	–
CO2	2	3	2	–	2	–	–	–
CO3	2	3	3	1	2	–	–	–
CO4	2	3	2	2	3	–	–	–
CO5	3	3	3	2	3	1	–	–

Syllabus

Unit I Topic : Introduction to IoT Platforms and ThingsBoard

- Overview of Open-Source IoT Platforms
- ThingsBoard Architecture and Deployment (Community & PE)
- Device connectivity via MQTT, HTTP, CoAP
- Telemetry data upload and visualization using widgets

Unit II Topic : Edge Device Integration using Fledge Framework

- Fledge architecture and south/north plugin concept
- MQTT protocol communication with ThingsBoard
- Sensor data acquisition using Python plugins
- Data filtering, buffering, and transmission strategies

Unit III Topic : Advanced ThingsBoard Features

- Dashboard design principles and widget customization
- Alarm and notification setup using Rule Engine
- Dynamic device provisioning and asset mapping
- Customer and tenant configurations for industrial IoT

.

Unit IV Topic : AI/ML Model Integration

- Basics of ML pipelines for IoT: data preprocessing, feature engineering
- Training and deployment of ML models for anomaly detection, prediction
- Integration of scikit-learn/TensorFlow models into IoT workflows
- Running inference on edge or cloud and visualizing outcomes on dashboard

Unit V Topic : End-to-End Project Deployment

- Use case planning: Smart Industry, Smart Agriculture, or Smart Energy
- Implementation using Fledge (Edge) + ThingsBoard (Cloud)
- Incorporating ML model output into dashboard visual layers
- Final demo: dashboard + edge integration + real-time inference

Tutorial Components:

- Connecting sensors to edge nodes (RB-A5D2x)
- Creating custom widgets in ThingsBoard using JSON and JS
- Training ML models using sample datasets (e.g., temperature prediction)
- Simulating edge analytics and publishing predictions to ThingsBoard
- Integrating alarm conditions and email/SMS notifications

Text Books (Sample Format)

- *Machine Learning with Python* – A. Géron
- *Hands-On Internet of Things with MQTT and ThingsBoard* – Packt Publishing

Reference Book

- *Edge AI Applications* – NXP and ARM Industry White Papers

Reference Web Links:

- *ThingsBoard Documentation*, https://thingsboard.io/docs
- *Fledge Framework Docs*, **https://fledge-iot.readthedocs.io/**

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA675	CLOUD INTEGRATION FOR IOT	L-T-P-C: 3-0-2-4

Course Description

This course focuses on the integration of Internet of Things (IoT) systems with cloud computing platforms to enable scalable data storage, processing, and intelligent services. It covers cloud architectures, IoT middleware, data ingestion pipelines, device management, security, and analytics services offered by major cloud providers. Students will gain the ability to design, deploy, and manage cloud-connected IoT applications for real-world domains such as smart cities, industrial automation, and healthcare.

Course Objective(s)

- To understand cloud computing concepts and architectures for IoT systems
- To study IoT–cloud integration models and middleware platforms
- To learn device connectivity, data ingestion, and cloud-based processing
- To design secure, scalable, and reliable cloud-enabled IoT applications

Course Outcomes

COs	Description
CO1	Explain cloud computing architectures and service models used in IoT systems
CO2	Implement IoT device connectivity and data ingestion using cloud platforms
CO3	Design cloud-based storage, processing, and analytics pipelines for IoT data
CO4	Apply security, monitoring, and device management mechanisms in cloud-integrated IoT solutions

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	–	–	2	–	–	–
CO2	2	3	2	–	3	1	–	–
CO3	2	3	3	–	3	1	–	–
CO4	2	2	2	–	3	1	1	1

Syllabus

Unit I: Cloud Computing Fundamentals for IoT

Cloud computing concepts, cloud service models (IaaS, PaaS, SaaS), deployment models (public, private, hybrid), cloud reference architectures for IoT, benefits and challenges of cloud–IoT integration.

Unit II: IoT–Cloud Integration Models and Middleware

IoT cloud architecture layers, IoT gateways and edge–cloud interaction, message brokers and middleware, REST APIs, MQTT and AMQP integration, data ingestion pipelines.

Unit III: Cloud Platforms and Services for IoT

Overview of cloud IoT platforms, device registration and provisioning, device shadow and digital twins, data storage services, serverless computing for IoT, cloud-based analytics and visualization.

Unit IV: Security, Management, and Deployment

Authentication and authorization of IoT devices, key management and encryption, secure data transmission, monitoring and logging, scalability and fault tolerance, case studies of cloud-enabled IoT applications.

Text Books

1. Bahga, A., Madisetti, V., *Internet of Things: A Hands-On Approach*, Universities Press.
2. Erl, T., Puttini, R., Mahmood, Z., *Cloud Computing: Concepts, Technology & Architecture*, Pearson.

Reference Books

1. Buyya, R., Vecchiola, C., Selvi, S. T., *Mastering Cloud Computing*, McGraw-Hill.
2. Perry Lea, *Internet of Things for Architects*, Packt Publishing.
3. Minerva, R., Biru, A., Rotondi, D., *Towards a Definition of the Internet of Things (IoT)*, IEEE.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

REGULAR STREAM

26CSA651 COMPLEX NETWORK ANALYSIS L-T-P-C: 3-0-2-4

Course Description

Network science is an evolving field which focuses on the study of patterns of connection in a wide range of physical and social phenomena. The exponential increase in data sets derived from social, economic, and biological networks, along with modern computational power, has increased its relevance. The goal of this course is to provide a mathematical foundation for understanding and analyzing the structure of complex networks. The subject material is interdisciplinary, with topics of graph theory, probability theory, statistical physics, and computer science.

Course Objectives

- To understand and explain the workings of systems built upon complex networks
- To impart fundamental and advanced concepts in the areas of complex networks and network science that focus on study of the models and behavior of networked systems.

Course Outcomes

COs	Description
CO1	Describe the fundamental concepts of graph theory and network mathematics along with properties.
CO2	Use various measures and metrics for analyzing networks.
CO3	Implement the concept of large-scale networks, communities and community detection algorithms in various applications.
CO4	Differentiate random graphs and models of network growth.
CO5	Explore and describe the processes taking place in Networks.

CO-PO Mapping

PO/ PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	-	-	-	-	1
CO2	3	2	2	-	-	-	-	1
CO3	3	2	2	1	1	-	-	1
CO4	2	2	1	-	-	-	-	1
CO5	2	2	2	-	-	-	-	1

Prerequisites

- Proficiency in programming languages
- Basic knowledge in graph theory

Syllabus

Unit I: Graphs and Networks- Review of basic graph theory, Examples of real-world networks, networks and their representation, the adjacency matrix, weighted networks, directed networks, hypergraphs, bipartite networks, trees, planar networks, degree, paths, components, independent paths, connectivity and cut sets, the graph Laplacian, random walks, Properties of Networks.

Unit II: Measures and Metrics: Degree centrality, eigenvector centrality, Katz centrality, page rank, hubs and authorities, closeness centrality, betweenness centrality, groups of vertices, transitivity, reciprocity, signed edges and structural balance, similarity, homophily and assortative mixing.

Unit III: The large-scale structure of Networks, Basic concepts of network communities, community structures, network navigation, Modularity, Girvan-Newman Algorithm, Spectral Bisection Algorithm, Radicchi Edge Clustering Algorithm, Wu-Hubermann Algorithm, Random Walk based Algorithm.

Unit IV: Generalized random graphs, Poisson random graphs- the configuration model, generating functions, power-law degree distribution, Models of Network Growth-Price model, Barabasi & Albert model, other growth models, vertex copying models, Bipartite Network.

Unit V: Processes on Networks: Percolation theory and network resilience, Epidemiological processes, Cascades and information spread, Cohesiveness, Cliques, Clans, Clubs, Plex, Equivalence of ties, Ego-centric networks, Cascade formation and information diffusion in social media. Search on networks, exhaustive network search, guided network search, network navigation; network visualization and semantic zooming, Temporal network, Multilayer networks, Interdependent networks, Controllability of complex networks, Economic and financial network analytics.

The lab experiments/ case studies shall be implemented using any suitable tool such as Python/ R/ MATLAB.

Textbooks / References:

1. M.E.J. Newman, “Networks: An Introduction”, Oxford University Press, 2010
2. The structure and function of complex networks. https://epubs.siam.org/doi/10.1137/S003614450342480
3. Statistical mechanics of complex networks, Rev. Mod. Phys., 74(1), 2002.
4. Complex Graphs and Networks, by F. Chung and L. Lu
5. Dougles West, “Introduction to Graph Theory”, Second Edition, PHI Learning Private Limited, 2011.
6. Guido Caldarelli, “Scale-Free Networks”, Oxford University Press, 2007.
7. Alain Barrat, Marc Barthelemy and Alessandro Vespignani, “Dynamical processes on Complex networks”, Cambridge University Press, 2008.
8. Reuven Cohen and Shlomo Havlin, “Complex Networks: Structure, Robustness and Function”, Cambridge University Press, 2010.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA655	DevOps	L-T-P-C: 3-0-2-4

Course Description

This course deals with as a professional, you will be able to transform areas of code automation, configuration management, version controlling and monitoring of different applications. On successful completion of the course, a candidate is entitled to earn a certificate of achievement, which is proof of the merit of the candidate.

Course Objectives

- Understand the concepts of DevOps and the issues it resolves.
- Implement Automated Installations.
- Learn to Develop automation using Maven.
- Understand Continuous Delivery & Continuous Deployment

Course Outcomes

COs	Description
CO1	Describe traditional software development vs DevOps.
CO2	Recognize deployment and flow management in DevOps
CO3	Illustrate the Measurement, collaboration and visualizing using DevOps.
CO4	Demonstrate the Common DevOps Roles.
CO5	Define common DevOps practices and techniques

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	-	-	-	-	-	-
CO2	1	-	3	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-
CO4	-	2	-	-	2	-	-	-
CO5	1	-	3	-	1	-	-	-

Syllabus

Unit I: Introducing DevOps, Emergence of DevOps, History of DevOps, Transformation with DevOps and Agile, Business Case for DevOps, Benefits of DevOps, Agile Practices, Focus on Products and Service, Autonomy of Teams, Introducing CALMS, Culture, Team Behaviors, Team Agility, Cross-functional Delivery Teams, Job Satisfaction, Servant Leadership.

Unit II: Automation, Continuous Integration, Environment Management, Release Management , Test Automation, Deployment, Data and Data Management. . Lean, Flow Optimization, Work In Progress (WIP) , Constraint Management, Reducing Waste, Customer Focus.

Unit III: Measurement, Aligning Goals, Delivery Metrics, Operational Metrics, Metric Analysis, Lead and Cycle Time, Sharing, Collaboration, Feedback Loops, Visualizing, Business and IT Work Alignment, Education and Learning.

Unit IV: Common DevOps Roles, DevOps Evangelist, Automation Architect, Cloud Infrastructure Engineer, Software Developer, Software Test, Security Engineer, Database Administrator, Product Owner.

Unit V: Common DevOps Practices and Techniques, Continuous Integration, Testing and Deployment Infrastructure as Code, Test-Driven Deployment, Integrated Toolchains, Distributed Version Control, Production Monitoring, Public, Private and Hybrid Cloud Technologies
Relevant Methods and Approaches for DevOps Teams, DevOps Topologies and Target Operating Models, Scrum Development Delivery, Kanban Workflow, Transformational Leadership, Full-Stack Engineering, Collective Ownership, Continuous Experimentation.

Textbooks / References:

1. The DevOps Handbook - Book by Gene Kim, Jez Humble, Patrick Debois, and Willis.
2. What is DevOps? - by Mike Loukides.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA656	DIGITAL IMAGE PROCESSING	L-T-P-C: 3-0-2-4

Course Description

Image processing deals with methods to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. This course provides basic knowledge about digital images, Imaging geometry, Image transforms, Image enhancement and filtering, Image restoration, Image segmentation, and morphological operations which are useful in any computer vision applications. Image Compression – need for image compression, Huffman, run-length encoding, shift codes, Vector quantization, Transform coding, JPEG standard, MPEG.

Course Objectives

- To introduce students to the basics of digital image processing applicable to binary, gray scale and colour images.
- To familiarize students to various algorithms in spatial and frequency domain relevant to image enhancement and restoration.
- To provide an opportunity to learn image compression and segmentation and its applications.

Course Outcomes

COs	Description
CO1	Describe the fundamental concepts of digital image processing and perform basic operations on pixels.
CO2	Implement image transformation and image enhancement techniques in spatial and frequency domain to devise algorithms or mathematical models for real time image enhancement problems.
CO3	Implement various techniques used for image restoration.
CO4	Use morphological processing on images for simple image processing applications.
CO5	Implement segmentation and compression algorithms on Images and analyze their performance.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	-	-	-	-	-	-
CO2	3	2	2	1	-	-	-	-
CO3	2	2	2	1	-	-	-	-
CO4	2	2	1	1	1	-	-	-
CO5	2	2	2	1	1	-	-	-

Syllabus

Unit I: Digital Image Fundamentals: Elements of Visual Perception- Simple Image Formation Model -Image Sensing and Acquisition-Image Sampling and Quantization – Basic Relationships between Pixels - Image interpolation.

Unit II: Intensity Transformations and Filtering: Basic Intensity transformation Functions – Histogram Processing – Fundamentals of Spatial Filtering –Smoothing and Sharpening Spatial Filters. Filtering in Frequency Domain: 2D Discrete Fourier Transforms - Basics of filtering - Image Smoothing and Image Sharpening Using Frequency Domain Filters - Selective Filtering.

Unit III: Image Restoration: Noise Models – Restoration using Spatial Filters – Periodic Noise Reduction by Frequency Domain Filters.

Unit IV: Morphological Image Processing: Erosion – Dilation – Opening – Closing – Hit-or-Miss Transform - Extraction of Connected Components.

Unit V: Image Segmentation: Fundamentals – Point, Line and Edge Detection – Thresholding-Region Based Segmentation – Region Growing – Region Splitting and Merging. Introduction to Color image processing. Image Compression – need for image compression, Huffman, Run-length encoding, shift codes, Vector quantization, Transform coding, JPEG standard, MPEG.

The lab experiments/ Case studies shall be done using MATLAB/ Python.

Textbooks / References:

1. Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 4th Edition, Pearson, 2018.
2. A K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.
3. Al Bovik, The Essential Guide to Image Processing, Academic Press, 2009.
4. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis, and Machine Vision, Thomson

Learning, 2008.

5. S Jayaraman, S Esakkirajan and T Veerakumar, Digital Image Processing, McGraw Hill Education, 2009.
6. Arthur R. Weeks, Jr., “Fundamentals of Electronic Image Processing”, First Edition, PHI,1996.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA657 ADVANCED COMPUTER NETWORKS L-T-P-C: 3-0-2-4

Course Description

The field of computer networking is rapidly changing. It is critical to consider not only what computer networks are today, but also why and how they are designed in the manner that they are. The goal of this course is to provide a solid conceptual foundation for computer networks and the principles that govern their design. The course covers the various protocols and the working of the Internet and its design which help students to contribute to research work.

Course Objectives

- The primary course objective is to provide the foundation of basics in computer networks in the digital era.
- Enable the student to understand the fundamental networking principles, standards, protocols and technologies.
- The course also provides insights into networking concepts in each layer of the protocol model.
- The course will enrich the students with hands-on experience in configuring networking devices using Packet Tracer and analyzing the protocols using Wireshark.

Course Outcomes

COs	Description
CO1	Discuss concepts of the core network and layered approach.
CO2	Describe routed network and design Network Models using Simulation tools.
CO3	Describe application protocols and its analysis using simulation tools
CO4	Describe IP Addressing and subnetting.
CO5	Demonstrate a real time network and study and network troubleshooting commands

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	1	1	-	-	-	-	-
CO2	2	2		3	-	-	1	-
CO3	1	1		2	-	-		-
CO4	2	2		2	-	-	-	1
CO5	3	2		3	-	-	1	

Syllabus

Unit I: Protocol layers -The Network Edge- The Network Core– Delay– Loss and Throughput in Packet Switched Networks
Unit II: IPV4, IPV6, Routing algorithm – Interior and Exterior routing. ICMP, Classless and Subnet Address Extensions (CIDR), Internet Multicasting. NAT Routing protocol design and architectures for RIP, OSPF, BGP, RIP.
Unit III: Application layer protocols – HTTP- DNS – PPP file sharing Introduction to Transport Layer Services - Connectionless Transport- UDP - Principles of Reliable Data Transfer- Connection Oriented Transport- TCP Traffic Control: Packet Scheduling, TCP Congestion Control, - Leaky Bucket, Token Bucket-Internet protocol
Unit IV: Internet Layer-Class full Addressing – Classless addressing – Private Addresses – Subnets – Subnet masks –ARP – ICMP-Routing & Forwarding
Unit V: Global Internet– RIP – OSPF – BGP – Broadcast & Multicast routing.
ifconfig, nw.js - netcat - netstat - DNS - dhcp and monitoring tool Wireshark Network simulator.

Textbooks / References:

1. James F. Kurose and Keith W. Ross, “Computer Networking: A Top-Down Approach”, 6th Edition, Addison Wesley, 2008.
2. Larry Peterson and Bruce Davie, “Computer Networks: A Systems Approach”, Fourth Edition, Morgan Kaufmann, 2007.
3. Richard Stevens, Bill Fenner and Andrew M. Rudoff, “UNIX Network Programming”, Volume 1: “The Sockets Networking API”, Third Edition, Addison Wesley, 2004.
4. Andrew S.Tanenbaum, “Computer Networks”, Fifth Edition, Prentice Hall of India, 2011.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA658	ADVANCED WEB TECHNOLOGIES AND MEAN STACK	L-T-P-C: 3-0-2-4

Course Description

This course deals with as a professional, you will be able to transform areas of code automation, configuration management, version controlling and monitoring of different applications. On successful completion of the course, a candidate is entitled to earn a certificate of achievement, which is proof of the merit of the candidate.

Course Objectives

- This course helps the students to proficient in Javascript and use HTML, CSS and Javascript to handle front-end operations and back-end server scripting. MEAN is a full-stack development toolkit used to develop a fast and robust web application.

Course Outcomes

COs	Description
CO1	Describe latest web application development trends in the IT industry
CO2	Get equipped with principles, knowledge, and skills for the design and construction of web-enabled internet applications
CO3	Design, Implement and deploy an in-house project using MongoDB, Express.js, Angular, and Node.js
CO4	Recognize and explore the REST architecture
CO5	Demonstrate the use of MongoDB and CRUD operations

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	3	-	-	-	-	2
CO2	2	3	3	-	-	-	-	2
CO3	2	3	3	-	-	-	-	2
CO4	2	3	3	-	-	-	-	2
CO5	2	3	3	-	-	-	-	2

Prerequisites

- Basic Web design concept
- Programming knowledge HTML, XML, CSS, Javascript
- Concept of database

Syllabus

Unit I: Basics of HTML, CSS, and JavaScript HTML, CSS, Bootstrap, JavaScript basics – Variables, functions, and scopes, Logic flow and loops, Events, and Document object model, Handling JSON data, Understanding JSON callbacks.

Unit II: Building Single Page Applications with Angular Single Page Application – Introduction, Two-way data binding (Dependency Injection), MVC in Angular, Controllers, getting user input, Loops, Client-side routing – Accessing URL data, Various ways to provide data in Angular – Services and Factories, Working with filters, Directives and Cookies.

Unit III: Introduction to Node JS Installation, Callbacks, installing dependencies with npm, Concurrency and event loop fundamentals, Node JS callbacks, Building HTTP server, Importing and exporting modules,

Unit IV: Building REST services using Node JS REST services, Installing Express JS, Express Node project structure, Building REST services with Express framework, Routes, filters, template engines - Jade, ejs.

Unit V: MongoDB Basics and Communication with Node JS Installation, CRUD operations, Sorting, Projection, Aggregation framework, MongoDB indexes, connecting to MongoDB with Node JS, Introduction to Mongoose, connecting to MongoDB using mongoose, Defining mongoose schemas, CRUD operations using mongoose.

Textbooks / References:

1. Simon Holmes, "Getting MEAN with Mongo, Express, Angular, and Node, Second Edition, Manning Publications; 1 edition (31 October 2015)
2. Jeff Dickey, "Write Modern Web Apps with Mean Stack, Peachpit press, 2015
3. Angular: From Theory to Practice by Asim Hussain, CodeCraft 1st edition
4. Beginning Angular with Typescript, Greg Lim
5. Mithun Satheesh, "Web development with MongoDB and Node JS", Packt Publishing Limited; 2nd Revised edition (30 October 2015).

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA659 MOBILE APPLICATION DEVELOPMENT L-T-P-C: 3-0-2-4

Course Description

Due to the growing popularity of technology and the digitization of everything, the Mobile App Development course is gaining popularity. It assists aspirants in learning how to develop smartphones and other mobile devices. The course teaches students how to create applications.

Course Objective

This Course provides a comprehensive overview of how to integrate mobile technology. Students learn how to create applications for mobile devices such as smartphones and tablets. They are introduced to current mobile operating systems and mobile application development environments. They will be able to create mobile applications with more than one user interface and more than one system component.

Course Outcomes

COs	Description
CO1	Describe characteristics of mobile communication and different application development environments
CO2	Demonstrate Android application development environment.
CO3	Implement user interfaces for interacting with apps and triggering actions for App development.
CO4	Implement mobile apps to solve real world problems using maps and google APIs
CO5	Demonstrate performance of android applications and role of permissions and security

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	2	3		-		-	-	2
CO2	2	3		1	-	-	-	2
CO3	2	3		2	1	-	-	
CO4	2	3		2		-	-	
CO5	2	3		-		-	-	

Syllabus

Unit I: Introduction-Mobile vs. Desktop devices -App Store, Google Play, Windows Store –Development Environments-Phone GAP- Native vs. web applications – Mobile Connectivity Evolution. Characteristics and advantages of mobile communication, types of mobile applications – development approaches, overview of mobile strategy and designing mobile solutions.

Unit II: Introduction to the Android Platform (Android Studio), Android Platform and Development Environment, Application Fundamentals, The Activity Class. Get started, Build your first app, Install Tools, Create HelloWorld App, Activities, Testing, debugging and using support Libraries.

Unit III: User Interaction Application Development, Testing UI, Background Tasks, Triggering, scheduling and optimizing tasks.

Unit IV: Data Storage and accessing the mobile data with different databases, Preferences and Settings, storing data using SQLite, sharing data with content providers, loading data using Loaders. Google APIs for Android - Maps, Cloud Messaging, Authentication, Storage, Hosting and Google Play services.

Unit V: Different level of security in mobile application, Solution of attacks, malware, permission, Firebase and Recent Trends.

Textbooks / References:

1. Google Developer Training, "Android Developer Fundamentals Course – Concept Reference”, Google Developer Training Team, 2017.
2. Brian Fling, ”Mobile Design and Development” O'Reilly Media,2009.
3. Maximiliano Firtman “Programming the Mobile Web”, O'Reilly Media, 2010.
4. Erik Hellman, “Android Programming – Pushing the Limits”, 1st Edition, Wiley India Pvt Ltd, 2014.
5. Valentino Lee, Heather Schneider, and Robbie Schell, “Mobile Applications: Architecture, Design and Development”, Prentice Hall , 2004.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	20
Continuous Assessment	50
End Semester Exam	30
Total Marks	100

26CSA660	MULTIVARIATE STATISTICS	L-T-P-C: 3-1-0-4

Course Description

The course will provide basic understanding of the multivariate statistics used in many areas. The course introduces some very powerful statistics behind solving real world problems from data reduction to forecasting.

Course Objectives

- To understand the concept of multivariate distributions
- To understand the computations of multivariate calculus.
- To explore the use of multivariate calculus in real life.

Course Outcomes

COs	**Description**
CO1	Describe basics of probability, random variables and distribution functions.
CO2	Discuss standard distributions and their properties.
CO3	Describe basics of multivariate distributions.
CO4	Explain PCA and its application on clustering.
CO5	Describe simple linear regression and its estimation.

CO-PO Mapping

PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO								
CO1	1	1	-	1	-	-	-	-
CO2	2	2	2	-	-	-	-	-
CO3	2	3	3	-	-	-	-	-
CO4	2	3	3	-	-	-	-	-
CO5	2	3	3	-	-	-	-	-

Syllabus

Unit I: Review of probability concepts-Conditional probability –Bayes Theorem, Introduction to Random variables: Discrete and Continuous random variables and its distribution –mathematical expectations.

Unit II: Some standard distributions –Binomial, Multinomial, Poisson, Uniform, exponential, Weibull, Gamma, Beta, Normal, Mean, variance, properties and application of these distributions.

Unit III: Introduction to multivariate random variables and distribution functions, variance-covariance matrix, correlation matrix, Bivariate normal distribution, Multivariate normal density.

Unit IV: Principal component Analysis, Dimensionality Reduction, Cluster Analysis: Hierarchical clustering and divisive clustering methods.

Unit V: Simple linear regression, properties, least squares estimation of parameters, Hypothesis test in simple linear regression.

Textbooks / References:

1. S.C Gupta and V.K Kapoor Fundamentals of Mathematical Statistics
2. Anderson T.W (1983): An introduction to multivariate statistical analysis, #rd Ed, Wiley
3. Ronald E.Walpole, Raymond H Myers, Sheron L Myers and Kreying Ye. Probability and Statistics for Engineers and Scientists, Eighth Edition, Pearson Education Asia 2007
4. Douglas C. Montgomery and Elizabeth A Peck and G Geoffrey Vining. "Introduction to linear regression Analysis", Third Edition, John Wiley and Sons, I

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA661 GRAPH THEORY AND COMBINATORICS L-T-P-C: 3-1-0-4

Course Description

This course demonstrates the knowledge of fundamental concepts in graph theory. Students will be able to use graphs to solve real life problems. This helps students to develop efficient algorithms for graph related problems in different domains of engineering and science.

Course Objectives

- To understand and apply the fundamental concepts in graph theory.
- To learn computational algorithms.
- To develop fundamental knowledge of combinatorics and complexity.

Course Outcomes

Cos	Description
CO1	Describe basic concepts of graphs.
CO2	Discuss the concepts of Trees and algorithms on trees.
CO3	Describe concepts of planar graphs and vertex colorings.
CO4	Implement concepts of principle of inclusion and exclusions.
CO5	Solve concepts of Polya's Enumeration Formula for enumeration problems.

CO-PO Mapping

PO/PSO **CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	3	2		-	-	-	-	-
CO2	2	1	2	2	-	-	-	1
CO3	2	3	-	-	-	-	-	2
CO4	2	3	-	-	-	-	-	1
CO5	2	3	-	-	-	1	-	2

Prerequisites

- Discrete Mathematics
- Linear Algebra
- Mathematical proof technique (induction, proof by contradiction)

Syllabus

Unit I: Graphs and Sub graphs, isomorphism, matrices associated with graphs, degrees, walks, paths, connected graphs, Euler graph, Hamilton graphs, shortest path algorithm. Text Book-1.

Unit II: Trees: Trees, cut-edges and cut-vertices, spanning trees, Cayley's formula, minimum spanning trees, DFS, BFS algorithms. Connectivity: Graph connectivity, k-connected graphs and blocks. Text Book-1

Unit III: Colorings: Vertex colorings, greedy algorithm and its consequences. Edge-colorings, Vizing theorem on edge-colorings. Planar graphs: Euler formula. Text Book-1

Unit IV: Some Essential Problems, Binomial Coefficients, Multinomial Coefficients, Pigeonhole Principle, Principle of Inclusion and Exclusion.

Generating Functions, Double Decks, Counting with Repetition, Fibonacci Numbers, Recurrence Relations. Textbook-2

Unit V: Polya's Theory of Counting, Permutation Groups, Burnside's Lemm, Cycle Index. Polya's Enumeration Formula, deBruijn's generalization. Textbook-2

Textbooks / References:

1. J. A. Bondy and U. S. R. Murty, Graph Theory and Applications, Springer, 2008.
2. Richard A. Brualdi, Introductory Combinatorics, Pearson, 2012
3. D. B. West, Introduction to Graph Theory, P.H.I. 2010.
4. J. H. van Lint and R. M. Wilson, A Course in Combinatorics, Cambridge University Press, 2001.
5. Bollobás, B. Modern Graph Theory (Graduate Texts in Mathematics). New York, NY: Springer-Verlag, 1998.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100

26CSA662	OPERATIONS RESEARCH AND OPTIMIZATION	L-T-P-C: 3-1-0-4

Course Description

The course is intended to impart knowledge in concepts and tools of Operations Research, to understand mathematical models used in Operations Research and to apply these techniques constructively to make effective business decisions.

Course Objectives

This course aims to introduce students to use quantitative methods and techniques for effective decisions–making; model formulation and applications that are used in solving business decision problems.

Course Outcomes

Cos	Description
CO1	Describe concepts of linear programming, duality and methods for solving a linear programming problem.
CO2	Explain mathematical formulation of transportation and assignment problems and solution methods.
CO3	Solve simple games using various techniques.
CO4	Solve nonlinear unconstrained optimization problems.
CO5	Describe problem of sequencing and integer programming problems.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO								
CO1	3	1	1	-	-	2	-	-
CO2	3	2	1	-	-	2	-	-
CO3	3	2	1	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-
CO5	3	1	-	-	-	3	-	-

Syllabus

Unit I: Linear Programming: Introduction - Mathematical Formulations - Solutions – Graphical Method - Simplex Method - Artificial Variables- Big M - Two Phase Methods - Variants in Simplex Method - Duality Theory and Problems. (T-1).

Unit II: Transportation and its Variants: Definition - Transportation Algorithms and Solutions -Assignment Model - Hungarian Method, Simulation -Types of Simulations - Monte Carlo Simulation(T-1).

Unit III: Game Theory: Competitive Games - Rectangular Game - Saddle point - Minmax (Maxmin)Method of Optimal Strategies - Value of the Game. Solution of Games with Saddle Points -Dominance Principle. Rectangular Games without Saddle Point – Mixed Strategy for 2 X 2Games. (T-1).

Unit IV: Single Variable Non-Linear Unconstrained Optimization: One dimensional Optimization methods, Uni-modal function, Region elimination methods - interval halving, Fibonacci search, Golden section search, point estimation method - successive quadratic search, Gradient based. Methods-Newton’s method, secant method(T-2).

Unit V: Problem of sequencing, n jobs through two machines – two jobs through m machines - n jobs through m machines. (T-1). Integer Programming Algorithms: Branch and Bound Algorithms and Cutting Plane Algorithm. (T-3).

Textbooks / References:

1. Kantiswarup, P. K. Gupta and Manmohan, “Operations Research”, Seventh Edition, Sultan Chand, 1991.
2. S.S. Rao, “Optimization Theory and Applications”, Second Edition, New Age International (P) Limited Publishers, 1995.
3. Hamdy A. Taha (1987): Operations Research– An Introduction, 4/e, Prentice Hall of India, Private Ltd, New Delhi.
4. Kapoor V.K. (2008): Operations Research, 8/e, Sultan Chand & Sons.
5. Kalyanmoy Deb, “Optimization for Engineering Design Algorithms and Examples”, Prentice Hall of India, New Delhi, 2004.

Evaluation Pattern

Assessment	Weightage (%)
Midterm	25
Continuous Assessment	25
End Semester Exam	50
Total Marks	100