

M. Tech.
Semester – I

CURRICULUM AND SYLLABUS
2026 REGULATION



A CMI INSTITUTION

CHRIST COLLEGE OF ENGINEERING
(AUTONOMOUS)

Irinjalakuda, Thrissur 680125



A CMI INSTITUTION

CHRIST COLLEGE OF ENGINEERING (AUTONOMOUS)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

2026 REGULATION (SEMESTER- I, II, III and IV)

Approved by BoS meeting held on: 19/6/2026

Approved by Academic Council meeting held on: 23/6/2026

BoS Chairperson

Director of Academics

Principal

Name: Dr Sreetha ES

Name: Dr. Manoj George

Name: Dr. Solomon PA

CHAIRPERSON
BOARD OF STUDIES

Science & Engineering
(Autonomous)
Irinjalakuda, Kerala



(College seal)

M.Tech REGULATIONS 2026

**CHRIST COLLEGE OF
ENGINEERING
(Autonomous)**



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CHRIST COLLEGE OF ENGINEERING (AUTONOMOUS)
MASTER OF TECHNOLOGY (REGULAR) ACADEMIC
REGULATIONS, 2026

Preamble: In exercise of the powers conferred autonomous status by the provisions of UGC (Conferment of Autonomous Status upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023; Master of Technology (Regular) Academic Regulations, 2026.

1. *Short Title* - These Regulations may be called “The Christ College of Engineering Master of Technology (Regular) Academic Regulations, 2026”.
2. *Commencement*- These Regulations shall come into force from the academic year 2026-2027.
3. *Application*- These Regulations shall apply to students admitted from the academic year 2026-2027.
4. *Definitions*-

For the purposes of these Regulations: -

- ‘Act’ means APJ Abdul Kalam Technological University Act, 2015 (17 of 2015)
- ‘*Academic Calendar*’ means the schedule of commencement and culmination of classes and events for M. Tech programme started every academic year and declared by the College by order issued from time to time.
- ‘*Academic Council (AC)*’ means the Academic Council of the College constituted in accordance with the provisions of the UGC (Conferment of Autonomous Status upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023.
- ‘*Academic Year (AY)*’ means the academic year consisting of two consecutive (one odd + one even) semesters.
- ‘*AICTE*’ means the All India Council for Technical Education constituted under the All India Council for Technical Education Act, 1987.
- ‘*College*’ means Christ College of Engineering (CCE).
- ‘*Governing Body (GB)*’ means the Governing Body of the College constituted in accordance with the provisions of the UGC (Conferment of Autonomous Status upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023.

- '*Board of Studies (BoS)*' means the Board of Studies constituted by the College in accordance with the provisions of the UGC (Conferment of Autonomous Status upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023.
- '*CGPA*' means Cumulative Grade Point Average.
- '*CIE*' means Continuous Internal Evaluation which is assessed for every student for every course during the semester.
- '*Course*' means a theory / dissertation / mini project / practical subject that is normally studied included in the curriculum.
- '*Discipline*' means the branch of M. Tech Degree Programme or the broad branch of engineering. Example: Civil Engineering, Mechanical Engineering etc.
- '*ESE*' means the End Semester Examination which is conducted by the College at the End of the Semester for all the courses of that semester as per the curriculum.
- '*M.Tech Degree Programme*' means a programme leading to the award of a Master of Technology Degree by the Parent University (A P J Abdul Kalam Technological University, Thiruvananthapuram).
- '*Grade Card*' means the certificate issued to each candidate generally containing course type, course code, course title, grade, credit values and grade points along with SGPA of that semester/CGPA of the Programme.
- '*Private Candidate*' means a student who has not completed the M. Tech programme within the stipulated duration of the programme but permitted to appear in the End Semester Examination of the programme.
- '*Programme*' means the combination of courses and/or requirements to be completed that lead to a degree or certificate. Example, M.Tech in Information Security, M.Tech in Construction Management etc.
- '*SGPA*' means the Semester Grade Point Average
- '*Stream*' means two or more similar M.Tech Programmes.
- '*Supervisor*' means the person who supervises the work and mentors/advises the student in his Dissertation/Research Project work.
- '*Regulations*' means the College M.Tech Academic Regulations 2026.
- '*UGC*' means the University Grants Commission constituted under the University Grants Commission Act 1956.

- '*University*' means the APJ Abdul Kalam Technological University (APJAKTU) established by the Act.

Words and expressions used in these Regulations but not defined herein shall have their respective meanings assigned to them in the Regulations or Act or First Statutes of APJ Abdul Kalam Technological University.

1. PREAMBLE	
R1.1	These regulations are applicable to all M.Tech (Regular) Degree Programmes conducted in College affiliated to APJ Abdul Kalam Technological University from the Academic Year 2026-27 onwards.
R1.2	The provisions contained in these regulations shall govern the policies and procedures on the admission and registration of students, imparting instructions of course, conduct of the examination, evaluation, and certification of students' performance leading to the award of M.Tech Degree(s).
R1.3	These regulations for the M.Tech Degree Programmes, along with all the amendments thereto, shall be binding on all students undergoing the said M.Tech Degree Programme(s) conducted in College affiliated to APJ Abdul Kalam Technological University from the Academic Year 2026-27 onwards.
R1.4	These regulations, as amended from time to time, shall be binding on all parties concerned, including the Students, Faculty, and Staff of College
R1.5	In all matters related to the interpretation of the provisions in these Regulations, the decision of the GB and Academic Council of the College shall be the final

2. ELIGIBILITY OF ADMISSION	
R2.1	The candidate shall be an Indian National.
R2.2	The candidate should have a B.Tech. Degree in the appropriate branch of APJ Abdul Kalam Technological University or a bachelor's degree in Engineering from another University approved by AICTE/UGC, approved Deemed Universities in India and recognized as eligible for higher studies by APJAKTU.
R2.3	In the case of candidates who have an Undergraduate Degree in Engineering from foreign universities, an eligibility certificate from APJ Abdul Kalam Technological University is to be produced.
R2.4	The candidate should have a minimum CGPA of 6.0 in a 10 point scale in the Engineering Degree Examination. For SEBC (OBC) students, the minimum CGPA requirement is 5.5 in a 10 point scale. Wherever the credit system is/was followed, only CGPA will be considered for selection. If the candidate has obtained the bachelor's degree in Engineering from a

	University where credit system is/was not followed, he/she should have a minimum of 60% aggregate marks (For SEBC /OBC students, a minimum of 55% aggregate marks in the Engineering Degree examination is mandatory). For SC/ST candidates a pass in the Engineering Degree Programme is sufficient.
R2.5	In case the CGPA by any University is mentioned on a scale other than 10 point, then the corresponding CGPA will be proportionally scaled to 10 pointscale.
R2.6	Candidates, who have passed AMIE / AMIETE Examinations and satisfyingthe following conditions, are also eligible for admission. i) They must havevalid GATE score. ii) A minimum of 55% marks for section B in AMIE/AMIETE examination.
R2.7	Sponsored candidates from Industries, R&D organizations, National Laboratories well as Educational Institutions, with a bachelor's degree in Engineering, are eligible for admission to the M.Tech Programme.
R2.8	Candidate for sponsored quota must have a minimum experience of three years in the relevant field and must be sponsored by University or Industry/Teaching/Research Organizations of Centre/State Government/Private or by Private Engineering Colleges approved by AICTE. A special fee will be levied on the sponsored candidates. Such candidates may opt for admission into a programme recommended by the sponsoring institute/organization.
R2.9	Admission shall normally be restricted to those with valid GATE score.However, this stipulation is relaxed in the case of sponsored candidates. Incase seats remain vacant due to lack of candidates with valid GATE score,candidates without valid GATE score shall be considered. Admission to suchseats will be made on the basis of their CGPA/% marks scored in theirEngineering Degree.
R2.10	The reservation policy of the Government of Kerala shall be followed in admission to the M.Tech programme.
R2.11	Notwithstanding all that is stated above; the admission policy may be modified from time to time by the college, particularly to confirm to the directions from the Government of Kerala/Government of India/AICTE as the case may be.
R2.12	The maximum number of seats under various categories (regular, sponsored, SC/ST) shall be as per the intake as

	approved by AICTE, State Government, and APJ Abdul Kalam Technological University
R2.13	If at any time after admission a candidate is found not to have fulfilled any of the requirements stipulated by the University or statutory bodies concerned, the Principal may revoke the admission of the candidate and report the matter to the GB for ratification.

3. STRUCTURE OF THE M.TECH PROGRAMME	
R3.1	All the M. Tech programmes will be structured on a credit-based system following the semester pattern having continuous evaluation.
R3.2	Every M.Tech Programme shall have a curriculum and syllabi approved by the Academic Council. Syllabus for any course can be modified/updated by the Academic Council upon the recommendations of the Board of Studies. All revisions shall be only based on the recommendations of the Board of Studies.
R3.3	Each semester shall have a minimum of 90 working days out of which 75 days shall be instructional days.
R3.4	Duration of the Programme: The minimum duration of M. Tech programme will normally be two years consisting of four semesters. The maximum duration which a student can take to complete a programme shall be as follows: Maximum duration = N+2 years, where N stands for the minimum duration (In Years) prescribed for completion of the programme. Under exceptional circumstance, a further extension of one more year may be granted subject to approval of the College for the requisition made by the student. The request made by the student for duration extension shall be recommended by the Principal with valid justification. During the extended period (beyond maximum duration) the student shall be considered as a private candidate and not eligible for first class.
R3.5	The academic work in each semester shall consist of course work, mini project, lab and/or dissertation work as specified for each programme. The curriculum is so drawn up that the minimum number of credits for successful completion of the M.

	Tech programme of any specialisation is 68. Each programme will consist of: • Core courses (Discipline core courses and Programme core courses) • Elective courses (Programme electives and Interdisciplinary electives) • Audit course • Research Methodology & IPR • Mini project • Laboratory work • Dissertation/Research work
R3.6	Every Course comprises of specific Lecture-Tutorial-Practical (L-T-P) schedule. The course credits are fixed based on the following norms: (i) Lectures/Tutorials: 1 hour per week is assigned one credit (ii) Practical/Project: 2 hours per week is assigned one credit (iii) Dissertation/Research Project: 1.5 hours per week is assigned one credit. The distribution of credits for the course work is given in Table 1.

Table 1 Distribution of credits among Semesters

Semester	Coursework content	Totalcredits allotted	Credits allotted semester-wise
I	Core courses:3nos	3x3=9	18
	Programme electives:2nos	2x3=6	
	Laboratory:1no	1x1=1	
	Research Methodology & IPR:1 no	1x2=2	
II	Core courses:2nos	2x3=6	18
	Industry/Interdisciplinary Elective 1 no	1x3=3	
	Programme electives:2nos	2x3=6	
	Laboratory:1no	1x1=1	

	Miniproject:1no	1x2=2	
III	MOOC:1no	1x2=2	16
	Internship:1no	1x3=3	
	Audit course:1no	No credit	
	Phase1: Dissertation/Research Project:1no	1x11=11	
IV	Phase2: Dissertation/Research Project:1no	1x16=16	16
Total credits in all four semesters			68

R3.7	The nomenclature and its abbreviation given below shall be used for the degree programmes under the Institution. Master of Technology shall be abbreviated as M.Tech. Examples: - PG engineering degree academic programme in <i>Structural Engineering and Construction Management</i> shall be mentioned as <i>Master of Technology (M.Tech.) in Structural Engineering And Construction Management (Discipline: Civil Engineering)</i>. - PG engineering degree academic programme in <i>Computer Science And Engineering</i> shall be mentioned as <i>Master of Technology (M.Tech.) in Computer Science and Engineering (Discipline: Computer Science and Engineering)</i>.
R3.8	The medium of instruction followed shall be English.

4. LEAVE RULES FOR M.TECH STUDENTS	
R4.1	M. Tech students are eligible for leave of 30 days in a year (15 days per semester). The intervening holidays will be treated as part of leave with provision of suffixing and prefixing holidays. In no way the leave rules would relax the attendance requirements for the students mentioned in R 6.7.
R4.2	M. Tech students would apply to the HoD concerned for leave stating the specific reasons.
R4.3	M. Tech students shall be eligible to leave station for visiting other places preferably after completion of their course work or during vacations when there is no teaching work scheduled based on the recommendation by the supervisor(s) and approval by the HoD. The permission will be granted for library consultation, meeting experts, presentation of research papers/participation in the conferences/short term courses/symposiums etc., getting samples tested from other laboratories, using the lab facilities elsewhere, interaction with

	the External supervisor, and any other similar purpose. For these purposes, he/she shall be permitted for 30 days per year. The leave as mentioned at Clause 4.1 shall be in addition to this.
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5. COURSE REGISTRATION AND ENROLMENT	
R5.1	It is mandatory for students to register for the courses they intend to attend in a semester. For the first semester, every student has to enrol and register for the courses he/she intends to undergo on a specified date notified by the College. Similarly, the students need to register for second, third, and fourth semesters.
R5.2	The dates for registration and enrolment will be given in the academic calendar.
R5.3	A student will become eligible for enrolment only if he/she has registered for all the courses listed in the curriculum of the previous semester. In addition, the student must clear all dues to the Institute up to the end of the previous semester, and also he/she not have any pending disciplinary proceedings. Besides a student should have fulfilled the credit requirement as given in Table 2 for registering to higher semesters

Table 2. Minimum Cumulative Credit Requirements for Registering to Higher Semesters

Semester	Allotted credits	Cumulative credits	Minimum credits required
1	18	18	Not Applicable
2	18	36	Not Insisted
3	16	52	12 credits from S1
4	16	68	Not Insisted

R5.4	The maximum number of credits a student can register (course registration) in a semester is limited to 6 credits in excess of the total credits allotted in the curriculum for that semester.
R5.5	In extraordinary circumstances like medical grounds, a student may be permitted to withdraw from a semester completely. Normally, a student will be permitted to withdraw

	from the programme for a maximum continuous period of two semesters only.
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6. ASSESSMENT PROCEDURE	
R6.1	For all the lecture based courses in first, second and third semester is evaluated by through continuous internal evaluation and end semester examinations. All the Lab courses, Mini project and Dissertation/Research Project Phase I will be evaluated through continuous internal evaluation. Dissertation/ Research Project Phase II and Internship will be evaluated through continuous internal evaluation and end semester examinations. For comprehensive details, refer to Table 3 : Weightage of the CIE and ESE for various categories of the course
R6.2	The maximum marks allotted for all lecture based courses for continuous internal evaluation is fixed as 40 and for the end semester examination as 60, unless otherwise specified in the curriculum. The assessment marks for all courses are listed in the curriculum.
R6.3	Students registered for a course have to attend the course regularly, meet the attendance requirements and undergo the entire evaluation procedure for the completion of the course. Credits for the courses are deemed to be earned only on getting a P grade (Pass) in the composite evaluation.
R6.4	Continuous Internal Evaluation (CIE): The marks awarded for the continuous internal evaluation shall be on the basis of the day-to-day work, micro project, course based project/task, seminar, data collection/interpretation, preparation of review articles, quizzes, periodic tests, etc. The faculty member (s) concerned shall carry out the continuous assessment for the course allotted to him/her. The CIE marks for individual courses shall be computed by giving weightage to the parameters as specified in the syllabus
R6.5	The CIE marks obtained by the student for all courses in a semester are to be published in the department notice board as stipulated in the academic calendar. Anomalies if any shall be rectified by the Institution. A copy of the CIE marks uploaded to College Portal shall be kept in the department for scrutiny and reference.
R6.6	The end semester examinations shall be held twice in a year: April/May session (for even semesters) and November/December session (for odd semesters). A supplementary examination will be conducted within 1 month after the publication of the result.

R6.7	The eligibility criteria for registering to the end semester examination are attendance in the course and no pending disciplinary action. The minimum attendance for appearing for the end semester examination for any course is 75%. Students who get scholarships from the Central or State Governments or any other agencies are expected to have 100 % attendance. However, under unavoidable circumstances students are permitted to take leave as per clause number 4. Leave of absence for all these activities is limited to 25 % of the academic contact hours for the course. Students who do not meet these eligibility criteria are ineligible (identified by FE grade) to appear for the ESE. Menstrual Leave Attendance Relaxation: A 2% relaxation in attendance shall be granted to eligible students as menstrual leave. PWD Attendance Relaxation: A 5% relaxation in attendance shall be granted to students with disabilities (PWD).
R6.8	On medical ground the Principal can relax the minimum attendance requirement to 65%, to register for the end semester examination. This is permitted for one or more courses registered in the semester. The Principal shall keep all records which led to the decision on attendance, for verification by the Academic Auditor. However this concession is applicable to any one semester during the entire programme.
R6.9	The Principal of the Institution is authorized to grant attendance relaxation (duty leave) to the students for organizing extra/co-curricular activities, up to a maximum of 5%. Students should produce required documents countersigned by the University Sports Coordinator/ the Director of Physical Education in the case of sports activities or the Faculty Advisor in the case of other extra/co-curricular activities, as the case may be, within ten days of the event, for awarding the relaxation. The documents thus produced shall be forwarded to the Principal with due recommendation of the Head of the Department. Under any circumstances, the principal shall not consider the documents, if the overall attendance of the candidate is less than 65%. Late applications received shall not be considered.
R6.10	The students with courses having FE grade shall register for the courses again during the succeeding semesters in which the courses are offered. However, for the third semester students having FE grades can register for the courses in the next immediate chance, if offered by College.
R6.11	Students, who have completed a course but could not write the end semester examination, shall be awarded 'AB' Grade, provided they meet other eligibility criteria (R 6.7). They shall

	register (exam registration) and appear for the end semester examination at the next available opportunity and earn credits without having to register (course registration) for the course again.
R6.12	A student should obtain a minimum of 45% marks in the end semester examination and a minimum of 50 % of the total mark (CIE marks + ESE marks) (See Table 3) to be eligible for grading a course as Pass. The students who have not scored minimum of 45% marks in the end semester examination and minimum of 50 % of the total mark (CIE marks + ESE marks) will be considered to have failed in the course and an F grade will be awarded.

Table 3: Weightage of the CIE and ESE for various categories of the course

Sl. No	Category	CIE Weightage	ESE Weightage	PassMinimum
1	DisciplineCore Courses	40%	60%	45% for ESE and 50%for (CIE and ESE) put together
2	Programme Core Courses	40%	60%	45% for ESE and 50%for (CIE and ESE) put together
3	Programme Elective Courses	40%	60%	45% for ESE and 50%for (CIE and ESE) put together
4	Lab Courses/Mini-project	100%	---	50% for CIE
5	MOOC	----	----	As stipulated by the agency conducting MOOC
6	Audit Course	40%	60%	45% for ESE and 50%for (CIE and ESE) put together
7	Internship	50%	50%	45% for ESE and 50%for(CIE' and ESE)put together
8	Dissertation/ Research Project Phase 1	100%	---	50% for CIE

9	Dissertation/ Research Project Phase 2	50%	50%	45% for ESE and 50% for (CIE and ESE) put together
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Regulation	Details
R6.13	For the courses with no end semester examination, Letter grade 'F' will be awarded if CIE mark is below 50%.
R6.14	Candidates who received F grade in a course shall have to appear the end semester examination at the next available opportunity and earn the credits. Grades awarded in the supplementary examination will be considered as the grades in these courses.
R6.15	A student shall be eligible for the award of M. Tech Degree of the University on satisfying the following requirements: • Fulfilled all the curriculum requirements within the maximum duration permitted for the programme • No pending disciplinary action.
R6.16	Grading is based on the % marks obtained by the student for a course. Semester grade card shall contain the grade for each registered course, Semester Grade Point Average (SGPA) for the semester as well as Cumulative Grade Point Average (CGPA) up to that semester.

Grades and Grade Points are assigned as follows:

Grades	Grade Point	% of Total Marks obtained in the course
S	10	90% and above
A+	9	85% and above but less than 90%
A	8.5	80% and above but less than 85%
B+	8	75% and above but less than 80%
B	7.5	70% and above but less than 75%
C+	7	65% and above but less than 70%
C	6.5	60% and above but less than 65%
D	6	55% and above but less than 60%
P(Pass)	5.5	50% and above but less than 55%
F(Fail)	0	Below 50% (CIE + ESE) or Below 45% for ESE
FE	0	Failed due to lack of eligibility criteria
AB	0	Could not appear for the end semester Examination but fulfils the eligibility criteria.

Calculation of SGPA/CGPA

Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) are calculated as follows:

$SGPA = \Sigma(C_i \times GP_i) / \Sigma C_i$, where 'C_i' is the credit assigned for a course i and 'GP_i' is the grade point for that course. Summation is done for all courses registered by the student in the semester. The failed and incomplete courses shall also be considered in the calculation.

$CGPA = \Sigma(C_i \times GP_i) / \Sigma C_i$, where 'C_i' is the credit assigned for a course i and 'GP_i' is the grade point for that course. Summation is done for all courses specified in the curriculum up to that semester for which the 'CGPA' is needed. Here the failed courses shall also be accounted. CGPA for the M. Tech programme is arrived at by considering all course credits that are needed for the degree and their respective grade points.

Note: Students whoever successfully completed MOOC Course, GP_i will be taken as 10 for both SGPA and CGPA calculation.

R6.17	Classification of M.Tech Degree First Class with Distinction: CGPA 8.0 and above First Class: CGPA 6 and above
R6.18	Grade cards shall be made available in the student login for the registered courses, in every semester. On earning the required credits for the degree, the University will issue the Degree Certificate and Consolidated Grade Card.
R6.19	Valuation: Answer papers of theory examinations, for which end semester examinations are conducted by the College, shall be valued by two examiners. If the difference between the marks awarded by the two Examiners is not more than 15 per cent of the maximum marks for ESE for the course, the marks awarded to the candidate shall be the average of two evaluations. If the difference in marks obtained in two valuations exceeds 15% of the maximum marks for the course, the answer script will be evaluated by a third examiner. The average of the closest two marks shall be considered as the marks secured by the candidate. However, if one of the three

	marks falls exactly midway between the other two, then the highest two marks shall be taken for averaging.
R6.20	Review: Option for revaluation is not available to the M.Tech programme. However, answer scripts of the courses for which examinations have been conducted by the College can be reviewed as per request by the student. Outcome of the review shall be for improvement of marks and improvement of grade. In this case, the marks obtained in the 1 st valuation, 2 nd valuation and review shall be considered. The average of the two closest marks of the above three shall be considered as the marks obtained after review. In case of a tie of the closest marks, the average of all three above i.e. 1 st valuation, 2 nd valuation and review shall be considered as the marks obtained after review. Detailed procedure is given in the examination manual.
R6.21	Malpractices in Examinations: Any act of violation of the directions of the College, indiscipline, misbehaviour, unfair practice in examinations from the part of students and malpractices in examinations observed or reported by faculty member, invigilator, any official appointed by the College shall be dealt with promptly as per the prescribed norms in the examination manual. Note: Notwithstanding the above regulations related to examinations, assessments and malpractices, the details provided in the Examination Manual shall be taken as reference and final.

7. ACADEMIC MONITORING AND STUDENT SUPPORT	
R7.1	The implementation and monitoring of academic activities relating to the PG programme will be entrusted with the College Level Academic Committee (CLAC) for the institution and with the Department Level Academic Committee (DLAC) for each department. CLAC comprises the following members: • Principal – Chairman • PG Dean – Secretary • Heads of Departments/PG Coordinators of the Department having M.Tech Programme – Members • Director Academics – Member • Director Research – Member Functions of CLAC: CLAC shall conduct at least two meetings in each semester. The minutes of the meeting along with the action taken report shall be maintained with the counter sign of the Principal in the PG Dean's Office. All these documents

	will be verified by the external auditor during academic auditing. Agenda of the meeting shall include: • Review of the progress of course coverage against the academic calendar and the course plan and suggestions for improvement • Academic standard and excellence of various programmes • Performance appraisal of Faculty handling the course as reported by DLAC • Matters related to the postgraduate programme of various departments • Any responsibility or function assigned by the college. DLAC comprises the following members: • Head of the Department – Chairman • PG Coordinator of the Department – Secretary • Programme Coordinators of all M.Tech Programmes in the Department – Members • Department Coordinator for UG – Member • Two Faculty Members handling PG Classes – Members Functions of DLAC: DLAC shall conduct at least three meetings in each semester. Minutes of the meeting along with the action taken report (with the counter sign of the HoD) shall be maintained by the PG coordinator. The relevant points of the meeting shall be communicated to the Principal/PG Dean for reporting in the CLAC. All these documents will be verified by the external auditor during academic auditing. The following points shall be discussed: • Academic standard and excellence of the courses offered by the department. • To verify whether the course progress is in alignment with Academic calendar. • To oversee the continuous internal evaluation of the students in a class, for each course. • Performance appraisal of Faculty handling the courses • Any matter related to the M.Tech programme of the department. • Any appropriate responsibility or function assigned by the Principal.
R7.2	PG Coordinator: Each Department will have a Professor as the PG Coordinator. Responsibilities of the P.G. Coordinator are • To supervise and coordinate the activities of the PG courses. • To guide and advise the students in all academic matters. • To keep a record of the academic activities of students registered for all M.Tech programmes in that department.

	• To maintain the attendance of the students on a daily basis (FN & AN).
R7.3	Programme Coordinators: In the departments where more than one M.Tech programme is offered, one senior faculty assigned by HoD will act as the programme coordinator for coordinating the academic activities in the department for that PG programme. Programme coordinator will be having the role of Faculty Adviser (FA) of that programme. If the department has only one M.Tech programme, PG coordinator may serve as the programme coordinator. Responsibilities of the coordinators are • To supervise and coordinate the activities of the particular programme. • To guide and advise the students in all academic matters. • To keep a record of the academic and non-academic activities of students registered for the particular M.Tech programme. • Regular communication with the parents of students in respect of progress in academic and other general matters. • Keep custody of the minutes and action taken reports of the meetings conducted with the students.
R7.4	The internal marks and attendance shall be uploaded in the College portal by the respective faculty members after displaying the same in the department notice board as stipulated in the academic calendar. If any anomalies are raised by the students, it shall be rectified by the Institution. A copy of the CIE marks uploaded to the College shall be kept in the department for scrutiny and reference.

8. BREAK OF STUDY	
R8.1	Students are permitted to avail break of study for a maximum duration of two semesters. Availing break of study could extend the duration of the programme up to eight semesters, the maximum permitted duration by the regulation. The student can avail the break of study only with the prior approval of the College. The Principal, along with his/her recommendations, shall upload the request of the student with all relevant documents to the Principal for the approval. Students shall have to re-join at the commencement of the incomplete semester where he/she had started availing the break of study. Students are permitted to avail break of study:

	• In case of accident or serious illness needing prolonged hospitalization and rest. • In case of any personal reasons that need a break in study. • For taking up an employment.
R8.2	For break of study due to illness, student shall submit all necessary medical reports together with the recommendation of the doctor treating him giving definite reasons for break of study and its duration. Before joining back, the student should submit the fitness certificate from the doctor who treated him.
R8.3	Students who require a break in study due to personal reasons shall get the approval from the Principal on the genuineness of the need for it by providing authentic evidences for the same.
R8.4	Students who require break of study for 'taking up a job' shall produce the offer letter obtained from the employer concerned. The PG Dean shall verify the authenticity of the offer and submit his recommendation to the principal in advance for approval.

9. ACADEMIC AUDITING	
R9.1	There shall be academic auditing in college at stipulated intervals. The internal academic auditing shall be conducted by Internal Quality Assurance Cell (IQAC) functioning within the college and the external audit committee. The IQAC in college shall oversee and monitor all the academic activities including all internal evaluations and examinations. This cell shall prepare academic audit statements in formats prescribed by the College for each semester at regular intervals. These reports shall be presented to the external audit committee, who shall use it as reference for independent auditing. The external auditors shall submit the final audit report to the College in the prescribed format. Academic auditing shall cover the activities mentioned in the audit manual and in the regulations. Important aspects to be covered are the following: Course delivery, adherence to the academic calendar regarding meetings of various committees and series tests, syllabus coverage, quality of question papers used for internal

	examinations, internal evaluation, maintenance of laboratory experimental set ups and equipment, mini projects, seminar and project evaluation, innovative teaching methods, and conduct of practical classes and their evaluation. • Facility for Co-curricular and Extra-curricular activities available for the students. • Academic functioning of the college encompassing students, faculty and college administration covering punctuality, attendance, discipline, academic environment, learning ecosystem, academic accountability, academic achievements and benchmarking.
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10. MIGRATION FROM OTHER UNIVERSITIES	
R10.1	The autonomous college shall permit migration from other universities in accordance with the directives from the APJ Abdul Kalam Technological University

11. GRACE MARKS FOR SPORTS/ARTS COMPETITIONS	
R11.1	Only bonafide, regular students are eligible for the award of Grace Marks.
R11.2	The grace marks will be awarded to the students for representing the University in official level competitions/championships/tournaments when called upon to do so. The student shall get official prior permission from the College for representing the University.
R11.3	The maximum grace marks that can be awarded to a candidate in a particular semester for all events participated during that semester shall be 5% of the aggregate maximum of the End Semester Examination marks of all theory courses for which the College conducts End Semester Examinations.
R II.4	The maximum grace marks that can be awarded to a student for a theory course in a particular semester for all events participated during that semester shall not exceed 10% of the maximum aggregate marks of the End Semester Examination of that course
R11.5	The Grace Marks shall not be awarded for Programme Electives/ Research Methodology & IPR/ Laboratory Courses/ Industry Elective/ Interdisciplinary Elective / Mini project / Audit Course/ Dissertation/ Research Project etc even though she/he fails for the same.

R11.6	Eligible Grace Marks shall be distributed equally on all theory papers/courses of end semester examination of the semester concerned. However, redistribution of Grace Marks shall be allowed only in the case of those courses of an examination for which the candidate has passed. Redistribution is possible from passed courses to failed courses only. Redistribution of Grace Marks is not permissible from failed courses to other courses for a pass.
R11.7	The Grace Marks shall be awarded for all theory papers/courses in a semester for which end semester examinations are conducted by the College.
R11.8	Redistribution shall be done only for enabling a candidate to obtain the minimum marks required for a pass.
R11.9	Grace Marks shall not be redistributed from one semester to another semester.
R11.10	If the candidate does not secure the minimum marks required for a pass even after effecting redistribution, eligible moderation fixed by the respective pass board if any, shall be awarded to that candidate in addition to the Grace Marks for a pass.
R11.11	Eligible Grace Marks shall be awarded for the regular examination of the performing semester only. Grace Marks shall not be awarded for supplementary examinations.
R11.12	The performing semester shall generally be considered as per institutional calendar for the purpose of awarding grace marks
R11.13	The request for Grace Marks shall be submitted to the Controller of Examinations through the principal along with all relevant documents, within the time limit prescribed by the College. The request for Grace Marks received after the time limit shall not be entertained on any account.
R11.14	Only a single highest achievement during the period of a semester shall be considered for awarding the grace marks.
R11.15	Notwithstanding the above in R11, the guidelines given in the Examination manual and orders issued by the College from time-to-time will be followed. The R11.1 to R11.14 shall be taken as general information.

12. GRACE MARKS TO DIFFERENTLY ABLED CANDIDATES

R12.1	A person with disability (PWD) is a student of the College suffering from not less than 40% of any disability, as certified by the District Medical Board. To be eligible for the Grace marks, certificate of
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	disability specifying the percentage of disability shall be produced before the Principal at the time of admission.
R12.2	The Grace marks that can be awarded for PWD shall be 25% of the marks, scored by the candidate in each course, at the time of finalization of the results.
R12.3	Transfer of marks from one paper to another shall not be permitted. Fractions of marks if any, while computing the Grace marks, shall be rounded off to the next higher integer.
R12.4	PWD who are eligible for Grace marks shall be awarded Grace marks, for regular and supplementary chances until they pass the whole examination.
R12.5	Grace marks shall be awarded only for the marks of the End Semester examinations conducted by the College.
R12.6	The request for Grace marks shall be submitted to the Controller of Examinations, through the Principal, along with all relevant documents, within the time limit prescribed by the College. The request for Grace marks received after the time limit shall not be entertained on any account.

M.Tech. Computer Science and Engineering

The logo of Christ College of Engineering (Autonomous) is a circular emblem. It features a central gear with a yellow and orange sun-like center. The text "CHRIST COLLEGE OF ENGINEERING" is written around the top half of the gear, and "AUTONOMOUS" is written at the bottom. The entire emblem is enclosed in a blue hexagonal border.

SEMESTER I

FIRST SEMESTER: COMPUTER SCIENCE AND ENGINEERING

Sl. No:	Slot	Course Code	Course Type	Course Category	Course Title (Course Name)	Credit Structure				SS	Total Marks		Credits	Hrs./Week
						L	T	P	R		CAE	ESE		
THEORY														
1	A	R26CST101	BS	PC	Foundations of Computer	3	0	0	0	4.5	40	60	3	3
2	B	R26CST102	PC	PC	Advanced Machine Learning	3	1	0	0	5	40	60	3	4
3	C	R26CST103	PC	PC	Advanced Database Management	3	1	0	0	5	40	60	3	4
4	D	R26CST1X4	PE	PE1	Program Elective I	3	0	0	0	4.5	40	60	3	3
5	E	R26CST1X5	PE	PE2	Program Elective II	3	0	0	0	4.5	40	60	3	3
	F	G26RMT106	GC	GC	Research Methodology & IPR	2	0	0	0	3	40	60	2	2
PRACTICALS														
7	G	R26SCP107	PC	L	Computing Lab 1	0	0	3	0	1	50	50	1	3
Total										27.5			18	22

Sl. No:	Slot	Course Code	Course Type	Course Category	Course Title (Course Name)	Credit Structure				SS	Total Marks		Credits	Hrs./Week
						L	T	P	R		CAE	ESE		
PROGRAM ELECTIVE-I (SEMESTER I)														
1	D	R26CST114	PE	PE1	Object Oriented Software Engineering	3	0	0	0	4.5	40	60	3	3
2	D	R26CST124	PE	PE1	Advanced Data Mining	3	0	0	0	4.5	40	60	3	3
3	D	R26CST134	PE	PE1	Cloud Computing	3	0	0	0	4.5	40	60	3	3
4	D	R26CST144	PE	PE1	Web Services	3	0	0	0	4.5	40	60	3	3
5	D	R26CST154	PE	PE1	Computational Intelligence	3	0	0	0	4.5	40	60	3	3
6	D	R26CST164	PE	PE1	Automated Verification	3	0	0	0	4.5	40	60	3	3
PROGRAM ELECTIVE-II (SEMESTER I)														
1	E	R26CST115	PE	PE2	Advanced Computer Networks	3	0	0	0	4.5	40	60	3	3
2	E	R26CST125	PE	PE2	Pattern Recognition	3	0	0	0	4.5	40	60	3	3
3	E	R26CST135	PE	PE2	Advanced Computer Architecture	3	0	0	0	4.5	40	60	3	3
4	E	R26CST145	PE	PE2	Natural Language Processing & Text Mining	3	0	0	0	4.5	40	60	3	3
5	E	R26CST155	PE	PE2	Advanced Compiler Design	3	0	0	0	4.5	40	60	3	3
6	E	R26CST165	PE	PE2	Bioinformatics	3	0	0	0	4.5	40	60	3	3

SEMESTER 1
R26CST101- FOUNDATIONS OF COMPUTER SCIENCE

COURSE CODE	R26CST101	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Problem)

Course Objectives:

1. To expose the students to proof techniques and counting principles for developing mathematical reasoning in problem solving
2. To equip the students with the ability to apply recurrence relations, generating functions, and probability theory in computational contexts.
3. To equip the students with knowledge of algebraic structures and classical probability problems for applications in computer science

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

Course Outcomes		Bloom's Knowledge Level (KL)
CO 1	Apply Direct proof technique, Indirect proof technique and Mathematical Induction to prove various theorems and results	K3
CO 2	Solve counting problems using Pigeon hole principle, Principle of Inclusion exclusion, Permutations, Combinations, Cantor's Diagonalization argument and Derangements	K3
CO 3	Solve Recurrence relations and counting problems using Generating Functions	K3
CO 4	Solve problems on probability using the fundamentals of Probability, Bayes theorem, and Probability Distributions	K3
CO5	Solve problems using concepts in algebraic structures such as Groups, Cosets and Lagrange's Theorem.	K3
CO6	Design solutions for various computational problems using the mathematical concepts of computer science and prove the correctness of the solution developed.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	3	2			2
CO 2	2	1	3	2	3		2
CO 3	2	1	3	2	3		2
CO 4	2	1	3	2	3		2
CO 5	2	1	3	2	3		
CO6	3	2	3	3	3	2	2

(1- Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	
Create	

Mark Distribution**Continuous Assessment and Evaluation (CAE):** 40 Marks**End Semester Exam (ESE):** 60 Marks**Total Marks:** 100 Marks**ESE Duration:** 2 Hrs 30 Mins

CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Theorem Proving Techniques Theorem proving techniques: Direct Proof, Indirect proof - Proof by Contrapositive, Proof by contradiction and Proof by exhausting cases, Principle of mathematical induction, Complete induction and Well-ordering principle. The Pigeonhole principle	7
2	Fundamentals of Counting The Basics of counting, Addition and multiplication principles, Permutations and Combinations. Countable and uncountable sets, Principle of inclusion and exclusion – applications, derangements	8
3	Generating Functions Recurrence Relations, Modelling problems with recurrence relations. Generating functions, solving counting problems using Generating functions, solving recurrence relations using Generating functions.	8

4	Probability Theory Probability theory – Properties of Probability, Conditional Probability, Independent Events, Bayes Theorem, Mathematical Expectation and Variance of Random variables. Discrete Distributions and its mean and variance- Binomial Distribution, Bernoulli Distribution, Geometric Distribution, Poisson Distribution. Continuous Distributions and its mean and variance-Uniform and Exponential Distributions, Normal Distribution.	10
5	Classic Problems in Probability and Algebraic Structures Classic Problems in Probability- Birthday Paradox, The Hat Problem, Coupon Collector Problem. Groups and subgroups, generators for a group, Homomorphism theorems, cosets and normal subgroups, Lagrange's theorem.	9

COURSE PLAN

No	Topic	No. of Lectures
1	Theorem Proving Techniques (7)	
1.1	Theorem proving techniques: Direct Proof, Indirect proof - Proof by Contrapositive, Proof by contradiction and Proof by exhausting cases,	4
1.2	Principle of mathematical induction, Complete induction and Well-ordering principle.	2
1.3	The Pigeonhole principle	1
2	Fundamentals of Counting (8)	
2.1	The Basics of counting, Addition and multiplication principles	2
2.2	Permutations and Combinations.	2
2.3	Countable and uncountable sets	2

2.4	Principle of inclusion and exclusion – applications, derangements	2
3	Generating Functions (8)	
3.1	Recurrence Relations	2
3.2	Modelling problems with recurrence relations	2
3.3	Generating functions, solving counting problems using Generating functions,	2
3.4	solving recurrence relations using Generating functions.	2
4	Probability Theory(10)	
4.1	Probability theory – Properties of Probability, Conditional Probability, Independent Events,	2
4.2	Bayes Theorem, Mathematical Expectation and Variance of Random variables.	2
4.3	Discrete Distributions and its mean and variance- Binomial Distribution, Bernoulli Distribution,	2
4.4	Continuous Distributions and its mean and variance-Uniform and Exponential Distributions, Normal Distribution.	2
4.5	Geometric Distribution, Poisson Distribution	2
5	Classic Problems in Probability and Algebraic Structures(9)	
5.1	Classic Problems in Probability- Birthday Paradox	2
5.2	The Hat Problem, Coupon Collector Problem.	2
5.3	Groups and subgroups	1
5.4	generators for a group, Homomorphism theorems,	2
5.5	cosets and normal subgroups, Lagrange's theorem.	2
	Total	42

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher & Edition
1	Discrete Mathematics and its Applications	Kenneth H. Rosen	McGraw Hill
2	Discrete Mathematical Structures with Application to Computer Science	J. P. Tremblay, R. Manohar	Tata McGrawHill, 2000
3	Introduction to Probability Models	Sheldon M. Ross	
4	A First Course in Probability	Sheldon M. Ross	
5	An introduction to probability theory and its applications	William Feller	Wiley,1957
6	Randomized Algorithms	Rajeev Motwani and Prabhakar Raghavan	Cambridge University Press 1995

SEMESTER 1
R26CST102- ADVANCED MACHINE LEARNING

COURSE CODE	R26CST102	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:1:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. To understand the fundamental concepts and paradigms of Machine Learning.
2. To apply machine learning algorithms for regression, classification, clustering, neural networks, and SVM.
3. To explore advanced techniques such as regularization, ensemble learning, boosting, kernel methods, and graphical models.
4. To evaluate machine learning models using appropriate performance metrics, validation techniques, and model selection methods.

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Analyse the Machine Learning concepts, classifications of Machine Learning algorithms and basic parameter estimation methods	K4
CO 2	Illustrate the concepts of regression and classification techniques	K2
CO 3	Describe unsupervised learning concepts and dimensionality reduction techniques.	K2
CO 4	Explain Support Vector Machine concepts and graphical models.	K2
CO 5	Choose suitable model parameters for different machine learning techniques and to evaluate a model performance.	K5
CO6	Design, implement and analyse machine learning solution for a real world problem	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	3	2	3	2	
CO 2	2	1	3	2	3	2	
CO 3	2	1	3	2	3	2	
CO 4	2	1	3	2	3	2	
CO 5	3	2	3	3	3	2	1
CO 6	3	2	3	3	3	2	2

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Parameter Estimation and Regression: Overview of machine learning: supervised, semi-supervised, unsupervised learning, reinforcement learning. Basics of parameter estimation: Maximum Likelihood Estimation (MLE), Maximum a Posteriori Estimation (MAP). Gradient Descent Algorithm, Batch Gradient Descent, Stochastic Gradient Descent. Regression algorithms: least squares linear regression, normal equations and closed form solution, Polynomial regression	9
2	Regularization techniques and Classification algorithms: Overfitting, Regularization techniques - LASSO and RIDGE. Classification algorithms: linear and non-linear algorithms, Perceptron's, Logistic regression, Naive Bayes, Decision trees. Neural networks: Concept of Artificial neuron, Feed-Forward Neural Network, Back propagation algorithm.	9
3	Unsupervised learning: Unsupervised learning: clustering, k-means, Hierarchical clustering, Principal component analysis, Density-based spatial clustering of applications with noise (DBSCAN). Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model.	8
4	Support Vector Machine and Graphical Models: Support vector machines and kernels: Max margin classification, Nonlinear SVM and the kernel trick, nonlinear decision boundaries, Kernel functions. Basics of graphical models - Bayesian networks, Hidden Markov model - Inference and estimation.	7
5	Evaluation Metrics and Sampling Methods: Classification Performance Evaluation Metrics: Accuracy, Precision, Precision, Recall, Specificity, False Positive Rate (FPR), F1 Score, Receiver Operator Characteristic (ROC) Curve, AUC. Regression Performance Evaluation Metrics: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination. Clustering Performance Evaluation Metrics: Purity, Jaccard index,	9

	Normalized Mutual Information, Clustering Accuracy, Silhouette Coefficient, Dunn's Index. Boosting: AdaBoost, gradient boosting machines. Resampling methods: cross-validation, bootstrap. Ensemble methods: bagging, boosting, random forests Practical aspects in machine learning: data pre-processing, overfitting, accuracy estimation, parameter and model selection Bias-Variance trade-off	
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COURSE PLAN

No	Topic	No. of Lectures
Parameter Estimation and Regression (9)		
1.1	Overview of machine learning: supervised, semi-supervised, unsupervised learning, reinforcement learning.	2
1.2	Basics of parameter estimation: Maximum Likelihood Estimation (MLE), Maximum a Posteriori Estimation (MAP).	2
1.3	Gradient Descent Algorithm, Batch Gradient Descent, Stochastic Gradient Descent	3
1.4	Regression algorithms: least squares linear regression, normal equations and closed form solution, Polynomial regression	2
Regularization techniques and Classification algorithms (9)		
2.1	Overfitting, Regularization techniques - LASSO and RIDGE.	3
2.2	Classification algorithms: linear and non-linear algorithms, Perceptron's, Logistic regression, Naive Bayes, Decision trees.	3
2.3	Neural networks: Concept of Artificial neuron, Feed-Forward Neural Network, Back propagation algorithm.	3
Unsupervised learning (8)		
3.1	Unsupervised learning: clustering, k-means, Hierarchical clustering,	3
3.2	Principal component analysis, Density-based spatial clustering of applications with noise (DBSCAN).	2
3.3	Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model.	3
Support Vector Machine and Graphical Models (7)		
4.1	Support vector machines and kernels: Max margin classification,	2
4.2	Nonlinear SVM and the kernel trick, nonlinear decision boundaries, Kernel functions.	3
4.3	Basics of graphical models - Bayesian networks, Hidden Markov model - Inference and estimation.	2
Evaluation Metrics and Sampling Methods (9)		

5.1	Classification Performance Evaluation Metrics: Accuracy, Precision, Precision, Recall, Specificity, False Positive Rate (FPR), F1 Score, Receiver Operator Characteristic (ROC) Curve, AUC.	2
5.2	Regression Performance Evaluation Metrics: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination.	2
5.3	Clustering Performance Evaluation Metrics: Purity, Jaccard index, Normalized Mutual Information, Clustering Accuracy, Silhouette Coefficient, Dunn's Index. Boosting: AdaBoost, gradient boosting machines.	2
5.4	Resampling methods: cross-validation, bootstrap.	1
5.5	Ensemble methods: bagging, boosting, random forests Practical aspects in machine learning: data pre-processing, overfitting, accuracy estimation, parameter and model selection Bias-Variance trade-off	2
Total		42

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University
2	Machine Learning: A Probabilistic Perspective	Kevin P. Murphy	MIT Press 2012
3	The Elements Of Statistical Learning	Trevor Hastie, Robert Tibshirani, Jerome Friedman	Second edition Springer 2007
4	Introduction to Machine Learning	Ethem Alpaydin	2nd edition, MIT Press 2010
5	Machine Learning	Tom Mitchell	McGraw-Hill, 1997

R26CST103- ADVANCED DATABASE MANAGEMENT

COURSE CODE	R26CST103	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:1:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. To understand advanced query processing, indexing, hashing, query optimization, and database security techniques.
2. To develop knowledge of database security threats, access control, and preventive measures such as protection against SQL injection.
3. To gain conceptual and practical knowledge of modern database architectures, concurrency control, commit protocols, and distributed query processing.
4. To explore advanced data models and specialized indexing techniques, including XML, object-relational systems, Bloom filters, bitmap, spatial, and hash-based indexing.

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Identify various measures of query processing and optimization.	K1
CO 2	Analyze and implement security mechanisms to secure a database system.	K4
CO 3	Apply knowledge and awareness of the different database architectures in different scenarios	K3
CO 4	Analyze implementation aspects of distributed system on database architecture	K4
CO 5	make use of semi structured data, XML and XML queries for data management	K3
CO6	Design, Develop and Implement innovative ideas on advanced database concepts and techniques	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1	1	3	2	3	1	
CO 2	2	2	3	3	3	2	
CO 3	2	1	3	3	3	2	

CO 4	2	1	3	3	3	2	
CO 5	2	1	3	3	3	2	
CO6	3	2	3	2	3	3	2

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Review of indexing and Hashing - Overview- Measures of query cost- Algorithms for Selection and Join with cost analysis-Evaluation of expressions- Optimization of RA expressions.	9
2	Threats to databases, control measures, database security and DBA, Discretionary access control, Mandatory access control (role-based only), SQL injection.	9
3	Centralized and Client-Server Architectures – Centralized server systems - Server System Architectures - Parallel Systems- - Parallel storage - Data partitioning, replication and indexing in Parallel Databases- Parallel query processing	8
4	Distributed System architecture- Distributed storage - Distributed file systems – Distributed RDB design-Transparency– Distributed Transactions - Commit Protocols – Concurrency Control - Distributed Query Processing Advanced Indexing Techniques: Bloom filter - Bitmap indices - Indexing spatial data - Hash indices.	7
5	Semi-structured Data and XML Databases: XML Data Model – XSD – XPath and XQuery – Example Queries. Native XML databases, Object Relational Systems	9

COURSE PLAN

No	Topic	No. of Lectures
Review of indexing and Hashing (9)		
1.1	Overview- Measures of query cost- Algorithms for Selection and Join with cost analysis	3
1.2	-Evaluation of expressions.	3
1.3	- Optimization of RA expressions	3
Threats to databases (9)		
2.1	Threats to databases, control measures,	3

2.2	database security and DBA, Discretionary access control,	3
2.3	Mandatory access control (role-based only), SQL injection.	3
Centralized and Client-Server Architectures (8)		
3.1	Centralized server systems , Server System Architectures	3
3.2	Parallel Systems, Parallel storage	2
3.3	Data partitioning, replication and indexing in Parallel Databases- Parallel query processing	3
Distributed System architecture (7)		
4.1	Distributed System architecture- Distributed storage, Distributed file systems	2
4.2	Distributed RDB design, Transparency, Distributed Transactions	1
4.3	Commit Protocols, Concurrency Control	2
4.4	Distributed Query Processing Advanced Indexing Techniques: Bloom filter, Bitmap indices, Indexing spatial data, Hash indices.	2
Evaluation Metrics and Sampling Methods (9)		
5.1	Semi-structured Data and XML Databases: XML Data Model – XSD	3
5.2	XPath and XQuery	3
5.3	Example Queries. Native XML databases, Object Relational Systems	3
Total		42

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Fundamentals of Database Systems	R. Elmasri, S.B. Navathe	Pearson Education/ Addison Wesley, 2016
2	Database Systems, A Practical Approach to Design, Implementation and Management	Thomas Cannolly and Carolyn Begg	3/e, Pearson Education, 2010
3	Database System Concepts	Henry F Korth, Abraham	7/e, Tata McGraw Hill, 2019

		Silberschatz, S. Sudharshan	
4	A Semantic Web Primer	Joe Fawcett, Danny Ayers, Liam R. E. Quin	John Wiley & Sons, 2012 Grigoris Antoniou. Frank van Harmelen





SEMESTER I

PROGRAM ELECTIVE I

R26CST114 - OBJECT ORIENTED SOFTWARE ENGINEERING

COURSE CODE	R26CST114	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. Students will understand the principles of object-oriented software engineering and various software lifecycle models.
2. The course will enable learners to analyze, design, develop, and deploy software using appropriate tools and techniques.
3. Students will gain the skills to perform software testing, maintenance, and configuration management efficiently

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Make use of project organization and management concepts and analyse the various tasks carried out	K4
CO 2	Identify and select suitable process model for a given problem	K4
CO 3	Analyse the requirements of a given software project and produce requirement specification	K4
CO 4	Examine the various designing principles and patterns of a software product.	K4
CO 5	Build the mapping of product design to code, its testing and maintenance	K6
CO6	Design, analyse object models and dynamic models for a given problem statement	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	2	3	2	3	2	
CO 2	2	1	3	3	3	3	2
CO 3	3	3	3	3	3	2	2

CO 4	2	2	3	3	3	2	2
CO 5	3	2	3	3	3	3	2
CO6	3	2	3	3	3	3	2

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Classical Paradigm: System Design Concepts – Project Organization Concepts: Project Organizations, Roles, Tasks and Work Products, Schedule – Project Communication concepts: Planned Communication, Unplanned Communication, Communication Mechanism – Project Management Concepts: Tasks and Activities, Work Products, Work Packages and Roles, Work Breakdown Structure	10
2	Process Models: Life cycle models: Sequential Activity Centered Models, Iterative Activity Centered models, Entity Centered models – Unified Process – Iterative and Incremental – Workflow – Agile Processes	8
3	Analysis: Requirements Elicitation Concepts – An Overview of Unified Modeling Language – Analysis Concepts: Analysis Object Model and Analysis Dynamic Models – Non-functional requirements – Analysis Patterns – Executable specification	7
4	Design: System Design, Architecture – Design Principles - Design Patterns – Dynamic Object Modeling Static Object Modeling – Model based approach vs Document based approach – Interface Specification – Object Constraint Language	8
5	Implementation & Testing: Mapping Design (Models) to Code – Testing - Usability – Deployment – Configuration Management – Maintenance	4

COURSE PLAN

No	Topic	No. of Lectures
Classical Paradigm (10)		
1.1	System Design Concepts , Project Communication concepts	2

1.2	Project Organization Concepts: Project Organizations , Roles , Tasks and Work Products ,Schedule	2
1.3	Planned Communication, Unplanned Communication ,Communication Mechanism	3
1.4	Project Management Concepts : Tasks and Activities ,Work Products , Work Packages and Roles , Work Breakdown Structure	3
Process Models (8)		
2.1	Life cycle models: Sequential Activity Centered Models, –	2
2.2	Iterative Activity Centered models, Entity Centered models	2
2.3	Unified Process – Iterative and Incremental – Workflow –	3
2.4	Agile Processes	1
Analysis (7)		
3.1	Requirements Elicitation Concepts	1
3.2	An Overview of Unified Modeling Language	2
3.3	Analysis Concepts: Analysis Object Model and Analysis Dynamic Models	2
3.4	Non-functional requirements, Analysis Patterns, Executable specification	2
Design (8)		
4.1	System Design, Architecture	2
4.2	Design Principles, Design Patterns	2
4.3	Dynamic Object Modeling Static Object Modeling	2
4.4	Model based approach vs Document based approach, Interface Specification, Object Constraint Language	2
Implementation & Testing (4)		
5.1	Mapping Design (Models) to Code	1
5.2	Testing - Usability, Deployment	2
5.3	Configuration Management, Maintenance	1
Total		37

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Object-Oriented Software Engineering	Bernd Bruegge, Alan H Dutoit	2nd edition, Pearson Education, 2004.
2	Applying UML and Patterns	Craig Larman	3rd edition, Pearson Education, 2005
3	Software Engineering	Stephen Schach	7th ed, McGraw-Hill, 2007
4	The Unified Software Development Process	Ivar Jacobson, Grady Booch, James Rumbaugh	Pearson Education, 1999.
5	Agile Software Development	Alistair Cockburn	2nd ed, Pearson Education



R26CST124 - ADVANCED DATA MINING

COURSE CODE	R26CST124	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. Understand key concepts and techniques in data mining and knowledge discovery.
2. Apply data preprocessing, warehousing, and mining methods to real-world datasets.
3. Analyze, evaluate, and interpret mining results with focus on accuracy and impact

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Summarise basic concepts of Data mining and Illustrate feature vector representation for a given data collection	K2
CO 2	Design Data Warehouse for problems in various domains.	K6
CO 3	Implement Association Rules for analysing Transactional databases	K3
CO 4	Implement major Classification and Clustering Algorithms to a given problem.	K3
CO 5	To develop Data Mining system and analyze the performance	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1	1	3	2	3	2	
CO 2	3	2	3	3	3	3	2
CO 3	2	1	3	2	3	2	1
CO 4	3	2	3	3	3	3	2
CO 5	3	2	3	3	3	3	2

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Data Mining and Knowledge Discovery: Desirable Properties of Discovered Knowledge – Knowledge representation, Data Mining Functionalities, Motivation and Importance of Data Mining, Classification of Data Mining Systems, Integration of a Data Mining System with a Database or Data Warehouse System, Classification, Clustering, Regression, Data Pre-processing: Data Cleaning, Data Integration and Transformation, normalization, standardization, Data Reduction, Feature vector representation. importance of feature engineering in machine learning; forward selection and backward selection for feature selection; curse of dimensionality; data imputation techniques; No Free Lunch theorem in the context of machine learning, Data Discretization and Concept Hierarchy Generation	9
2	Data Warehouse and OLAP Technology for Data Mining: Data warehouses and its Characteristics - Data warehouse Architecture and its Components, Data Warehouse Design Process, Data Warehouse and DBMS, Data marts, Metadata, Data Cube and OLAP, Extraction - Transformation – Loading - Schemas for Multidimensional Database: Stars, Snowflakes and Fact constellations, OLAP Cube - OLAP Operations - OLAP Server Architecture - Data Warehouse Implementation - From Data Warehousing to Data Mining, Trends in data warehousing	9
3	Association Pattern Mining: Mining Frequent Patterns, Associations and Correlations –Mining Methods – Mining Various Kinds of Association Rules – Correlation Analysis – Constraint Based Association Mining, Single Dimensional Boolean Association Rules From Transaction Databases, Multilevel Association Rules from transaction databases – Multi dimension Association Rules from Relational Database and Data Warehouses, Frequent Item Set Generation, Apriori Algorithm, Improved Apriori Algorithm for Association Rules Mining, Methods to improve Apriori, FP Growth Algorithm - Generating association rules from frequent itemset, Compact Representation of Frequent Item set - Maximal Frequent Item Set - Closed Frequent Item Sets. Pattern Evaluation Methods- Relationship Between FP-Growth and Enumeration-Tree Methods From Association Analysis to Correlation Analysis, Lift	8
4	Classification and Prediction: Classification Techniques, Decision Tree - Decision tree Construction, Measures for Selecting the Best Split - Algorithm for Decision tree	7

	Induction - CART, Bayesian Belief Networks, Instance-Based Learning, K-Nearest neighbor classification, Accuracy and Error measures, Multiclass Classification, Semi-Supervised Classification, Multi class Learning, Rare class learning, Active Learning, Transfer Learning, Fuzzy Set Approaches for Classification, Rough Set Approaches, Techniques to improve classification accuracy-Ensemble methods, Bias-Variance Trade-off, Improving classification accuracy of class imbalanced data	
5	Cluster Analysis: Desired features of cluster Analysis, Types of data in cluster analysis, Categorization of Major Clustering Methods, Density-Based Methods, Clustering High Dimensional Data, Constraint Based Cluster Analysis, GA based clustering, Dealing with Large Databases, Probabilistic Model Based Clustering, Clustering with Constraints, Semi supervised clustering, Cluster Ensembles, Quality and validity of cluster analysis methods, Outlier Analysis-Statistical Approaches, Proximity Based Approaches Advanced Mining: Multimedia Data Mining - Text Mining, Graph Mining and Social Network Analytics - Geospatial Data Mining, Temporal Mining, Data Mining Applications - Social Impacts of Data Mining.	8

COURSE PLAN

No	Topic	No. of Lectures
Data Mining and Knowledge Discovery(9)		
1.1	Desirable Properties of Discovered Knowledge – Knowledge representation, Data Mining Functionalities,	1
1.2	Motivation and Importance of Data Mining, Classification of Data Mining Systems,	1
1.3	Integration of a Data Mining System with a Database or Data Warehouse System,	9
1.4	Classification, Clustering, Regression, Data Pre-processing: Data Cleaning,	1
1.5	Data Integration and Transformation, normalization, standardization,	1
1.6	Data Reduction, Feature vector representation. importance of feature engineering in machine learning	1

1.7	forward selection and backward selection for feature selection, curse of dimensionality,	1
1.8	data imputation techniques, No Free Lunch theorem in the context of machine learning,	1
1.9	Data Discretization and Concept Hierarchy Generation	1
Data Warehouse and OLAP Technology for Data Mining (9)		
2.1	Data warehouses and its Characteristics	1
2.2	Data warehouse Architecture and its Components,	1
2.3	Data Warehouse Design Process, Data Warehouse and DBMS,	1
2.4	Data marts, Metadata, Data Cube and OLAP,	1
2.5	Extraction - Transformation – Loading -	1
2.6	Schemas for Multidimensional Database: Stars, Snowflakes and Fact constellations,	2
2.7	OLAP Cube - OLAP Operations - OLAP Server Architecture - Data Warehouse Implementation - From Data Warehousing to Data Mining, Trends in data warehousing	2
Association Pattern Mining(8)		
3.1	Mining Frequent Patterns, Associations and Correlations	1
3.2	Mining Methods – Mining Various Kinds of Association Rules –	1
3.3	Correlation Analysis – Constraint Based Association Mining, Single Dimensional Boolean Association Rules From Transaction Databases,	1
3.4	Multilevel Association Rules from transaction databases – Multi dimension Association Rules from Relational Database and Data Warehouses,	1
3.5	Frequent Item Set Generation, Apriori Algorithm, Improved Apriori Algorithm for Association Rules Mining, Methods to improve Apriori, FP Growth Algorithm -	1
3.6	Generating association rules from frequent itemset, Compact Representation of Frequent Item set -	1
3.7	Maximal Frequent Item Set - Closed Frequent Item Sets.	1

3.8	Pattern Evaluation Methods- Relationship Between FP-Growth and Enumeration-Tree Methods From Association Analysis to Correlation Analysis, Lift	1
Classification and Prediction (7)		
4.1	Classification Techniques, Decision Tree - Decision tree Construction, Measures for Selecting the Best Split - Algorithm for Decision tree Induction - CART, Bayesian Belief Networks, Instance-Based Learning	2
4.2	, K-Nearest neighbor classification, Accuracy and Error measures, Multiclass Classification	1
4.3	Semi-Supervised Classification, Multi class Learning, Rare class learning, Active Learning, Transfer Learning, Fuzzy Set Approaches for Classification, Rough Set Approaches	2
4.4	Techniques to improve classification accuracy-Ensemble methods, Bias-Variance Trade-off, Improving classification accuracy of class imbalanced data	2
Cluster Analysis (8)		
5.1	Desired features of cluster Analysis, Types of data in cluster analysis, Categorization of Major Clustering Methods	2
5.2	Density-Based Methods, Clustering High Dimensional Data, Constraint Based Cluster Analysis, GA based clustering, Dealing with Large Databases	2
5.3	Probabilistic Model Based Clustering, Clustering with Constraints, Semi supervised clustering, Cluster Ensembles, Quality and validity of cluster analysis methods, Outlier Analysis-Statistical Approaches, Proximity Based Approaches	2
5.4	Advanced Mining: Multimedia Data Mining - Text Mining, Graph Mining and Social Network Analytics - Geospatial Data Mining, Temporal Mining, Data Mining Applications - Social Impacts of Data Mining	2
Total		41

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Machine Learning: A Probabilistic Perspective (MLAPP)	Kevin Murphy	MIT Press, 2012
2	Pattern Recognition and Machine Learning (PRML)	Christopher Bishop	Springer, 2007.
3	Data Mining: Concepts and Techniques	Jiawei Han, Micheline Kamber, Jian Pei	Morgan Kaufmann, 2nd Ed., 2005

4	Data Mining: Introductory and Advanced Topics	Margaret H. Dunham	Prentice Hall, 1st Ed., 2002.
5	Pattern Classification	David G. Stork, Peter E. Hart, and Richard O. Duda	Wiley-Blackwell, 2000



R26CST134 - CLOUD COMPUTING

COURSE CODE	R26CST134	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. Students will understand the core concepts of virtualization and its application in cloud computing, including server, network, and storage virtualization.
2. The course will equip students with the practical skills to deploy and manage both virtualization solutions and private cloud environments.
3. Students will be able to identify and address security challenges inherent in grid and cloud computing to ensure the protection of private cloud infrastructure

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Employ the concepts of storage virtualization, network virtualization and its management	K3
CO 2	Apply the concept of virtualization in the cloud computing.	K3
CO 3	Apply domain knowledge in architecture, infrastructure and delivery models of cloud computing in designing and developing cloud applications.	K6
CO 4	Develop services using Cloud computing.	K6
CO 5	Analyse and choose security models appropriate to the cloud environment	K5
CO6	Design, develop and implement cloud based applications	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	3	2	3	2	1
CO 2	2	1	3	2	3	2	1
CO 3	3	2	3	3	3	3	2
CO 4	3	2	3	3	3	3	2
CO 5	3	2	3	3	3	3	2

CO6	3	2	3	3	3	3	3
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(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Virtualization - Basics of Virtual Machines, Process & System VMs, Emulation, Interpretation, Binary Translation, Taxonomy of Virtual Machines, Virtualization Management, Hardware Maximization, Architectures, Storage Virtualization, Network Virtualization	8
2	Virtualization Infrastructure - Comprehensive Analysis, Resource Pool, Testing Environment, Server Virtualization, Virtual Workloads, Provision of VMs, Desktop & Application Virtualization, CPU/Memory/I/O Virtualization, Virtual Clusters, Resource Management, Data Centre Automation	8
3	Cloud Platform Architecture - Cloud computing basics, History, Advantages & Disadvantages, Deployment Models (Public/Private/Hybrid), Everything as a Service (IaaS/PaaS/SaaS), Generic Cloud Architecture, Virtualization Support, Disaster Recovery, Public Cloud Platforms (GAE, AWS), Inter-cloud Resource Management	9
4	Programming Mode - Hadoop Framework, MapReduce, Input Splitting, Functions, Configuring & Running Jobs, Developing MapReduce Apps, Hadoop File System, Cluster Setup, Cloud Software Environments (Eucalyptus, Open Nebula, OpenStack, Nimbus)	8
5	Cloud Security -Infrastructure Security, Network/Host/Application Security, Data Security, Provider Data Security, Identity & Access Management Architecture, IAM Practices, SaaS/PaaS/IaaS Availability, Privacy Issues, Cloud Security & Trust Management	7

COURSE PLAN

No	Topic	No. of Lectures
Virtualization (8)		
1.1	Basics of Virtual Machines, Process & System VMs	2

1.2	Emulation, Interpretation, Binary Translation, Taxonomy of Virtual Machines	3
1.3	Virtualization Management, Hardware Maximization, Architectures, Storage Virtualization, Network Virtualization	3
Virtualization Infrastructure (8)		
2.1	Comprehensive Analysis, Resource Pool, Testing Environment,	3
2.2	Server Virtualization, Virtual Workloads, Provision of VMs, Desktop & Application Virtualization	3
2.3	CPU/Memory/I/O Virtualization, Virtual Clusters, Resource Management, Data Centre Automation	3
Cloud Platform Architecture (9)		
3.1	Cloud computing basics, History, Advantages & Disadvantages,	2
3.2	Deployment Models (Public/Private/Hybrid), Everything as a Service (IaaS/PaaS/SaaS),	2
3.3	Generic Cloud Architecture, Virtualization Support, Disaster Recovery,	2
3.4	Public Cloud Platforms (GAE, AWS), Inter-cloud Resource Management	2
Programming Mode (8)		
4.1	Hadoop Framework, MapReduce, Input Splitting, Functions	2
4.2	Configuring & Running Jobs, Developing MapReduce Apps, Hadoop File System	2
4.3	Cluster Setup, Cloud Software Environments (Eucalyptus, Open Nebula, OpenStack, Nimbus)	2
Cloud Security (7)		
5.1	Cloud Security -Infrastructure Security, Network/Host/Application Security	2
5.2	Data Security, Provider Data Security, Identity & Access Management Architecture	3
5.3	IAM Practices, SaaS/PaaS/IaaS Availability, Privacy Issues, Cloud Security & Trust Management	2
Total		40

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Cloud and Virtual Data Storage Networking	Greg Schulz	Auerbach Publications
2	Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online	Michael Miller	Que Publishing, August 2008
3	Enterprise Cloud Computing: Technology, Architecture, Applications	GauthamShroff	Cambridge press, 2010
4	Information Storage and Management	Wiley	EMC 2 edition
5	Distributed and Cloud Computing – From Parallel Processing to the Internet of Things	Kai Hwang , Geoffrey C Fox, Jack J Dongarra	Morgan Kaufmann Publishers – 2012

R26CST144 - WEB SERVICES

COURSE CODE	R26CST144	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. To understand the details of web services technologies: SOAP, WSDL, UDDI.
2. To learn how to implement and deploy web services clients and servers.
3. explore interoperability between different frameworks.
4. To learn basic concepts of SOAP.

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Illustrate the need of web services in developing applications	K2
CO 2	Make use of Server-side and Client-side RESTful web services	K3
CO 3	Analyze how web services can be published in standalone web servers	K4
CO 4	Employ techniques on creating dynamic web pages	K3
CO 5	Utilize emerging technologies in web services	K3
CO6	Design, Develop, Implement and Present innovative ideas on modern web services concepts and techniques	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1	2	3	2	2	2	1
CO 2	2	2	3	3	3	2	2
CO 3	2	2	3	3	3	2	2
CO 4	2	2	3	3	3	2	2
CO 5	2	2	3	3	3	3	2
CO6	3	3	3	3	3	3	3

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Web Services: Web Services Standards Organizations, Service oriented architecture, Advantages of web services over distributed object architecture, SOAP-based web services, RESTful web services. Review of HTTP requests and responses- HTTP as an API, A RESTful example, Use of Servlets for RESTful Web Services	8
2	RESTful services: A RESTful service as an HttpServlet, Implementation details. A RESTful Web Service as a JAX-RS Resource- JAX-RS Web Service Using Jersey, Publishing JAX-RS Resources with a Java Application, Publishing JAX-RS Resources with Tomcat, JAX-RS Generation of XML and JSON Responses, Porting the Predictions Web Service to JAX-RS. A RESTful Web Service as Restlet Resources. GraphQL- Introduction to GraphQL, GraphQL Architecture, Basic Queries	8
3	RESTful Web Services and Client-Side Integration : A Perl Client Against a Java RESTful Web Service. RESTful Clients and WADL Documents- The JAX-RS Client API, JSON for JavaScript Clients- JSONP and Web Services.	8
4	SOAP-Based Web Services and Service Description: Introduction and Evolution of SOAP, Architecture of a typical SOAP-based service, Publishing a SOAP-Based Service with a Standalone Web Server. RandService- JavaClient Against the RandService, C# Client Against the RandService, A Perl Client Against the RandService. WSDL – WSDL document structure	8
5	Modern Web Development with React, Node.js and Angular: Introduction to React and Node-Basic Concepts and Applications, Rendering Elements and Components, Comparison and Purpose of Node.js and React.js, Angular JS Basics-Modules, Creating Components, Directives, Filters, Angular Forms-Services, Single page application and Multipage application, Use case of a real-time single page chat application.	8

COURSE PLAN

No	Topic	No. of Lectures
Web Services (8)		
1.1	Web Services Standards Organizations, Service oriented architecture, Advantages of web services over distributed object architecture,	2
1.2	SOAP-based web services, RESTful web services.	2
1.3	Review of HTTP requests and responses- HTTP as an API,	2
1.4	A RESTful example, Use of Servlets for RESTful Web Services	2
RESTful services(8)		
2.1	A RESTful service as an HttpServlet, Implementation details.	2
2.2	A RESTful Web Service as a JAX-RS Resource- JAX-RS Web Service Using Jersey, Publishing JAX-RS Resources with a Java Application,	2
2.3	Publishing JAX-RS Resources with Tomcat, JAX-RS Generation of XML and JSON Responses, Porting the Predictions Web Service to JAX-RS.	2
2.4	A RESTful Web Service as Restlet Resources.GraphQL-Introduction to GraphQL, GraphQL Architecture, Basic Queries	2
RESTful Web Services and Client-Side Integration (8)		
3.1	A Perl Client Against a Java RESTful Web Service.	3
3.2	RESTful Clients and WADL Documents	2
3.3	The JAX-RS Client API, JSON for JavaScript Clients- JSONP and Web Services	3
SOAP-Based Web Services and Service Description (8)		
4.1	Introduction and Evolution of SOAP, Architecture of a typical SOAP-based service,	2
4.2	Publishing a SOAP-Based Service with a Standalone Web Server.	2
4.3	RandService- JavaClient Against the RandService, C# Client Against the RandService,	2
4.4	A Perl Client Against the RandService. WSDL – WSDL document structure	2
Modern Web Development with React, Node.js and Angular (8)		
5.1	Introduction to React and Node-Basic Concepts and Applications	2

5.2	Rendering Elements and Components, Comparison and Purpose of Node.js and React.js, Angular JS Basics-Modules,	2
5.3	Creating Components, Directives, Filters, Angular Forms-Services,	2
5.4	Single page application and Multipage application, Use case of a real-time single page chat application	2
Total		40

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Java Web Services: Up and Running	Martin Kalin	Second Edition, O'Reilly, 2013.
2	The Road to Learn React	Robin Wieruch	https://www.roadtoreact.com , 2022 Edition.
3	Beginning Angular JS	Andrew Grantt	Apress, 2014.
4	ReactJS by Example - Building Modern Web Applications with React	Vipul A M and Prathamesh Sonpatki	PACKT Publishing, 2016.
5	Learning GraphQL	Alex Banks, Eve Porcello	O'Reilly Media, 2018.

R26CST154 - COMPUTATIONAL INTELLIGENCE

COURSE CODE	R26CST154	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. Students will understand the core concepts and principles of computational intelligence.
2. The course will enable learners to apply fuzzy logic, genetic algorithms, and swarm optimization to solve complex problems.
3. Students will be able to design and implement effective computational intelligence solutions for real-world applications

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Apply fuzzy logic to handle uncertainty and solve engineering problems	K3
CO 2	Apply Fuzzy Logic Inference methods in building intelligent machines.	K3
CO 3	Design genetic algorithms for optimized solutions in engineering problems	K6
CO 4	Analyze the problem scenarios and apply Ant colony system to solve real optimization problems.	K4
CO 5	Apply PSO algorithm to solve real world problems.	K3
CO6	Design, develop and implement solutions based on computational intelligence concepts and techniques.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	3	3	3	2	1
CO 2	2	1	3	3	3	2	2
CO 3	2	2	3	3	3	3	2
CO 4	2	2	3	3	3	3	2
CO 5	3	2	3	3	3	3	2
CO6	3	3	3	3	3	3	3

(1-Weak, 2-Medium,3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Fundamentals of Fuzzy Sets and Fuzzy Relations: Crisp sets vs fuzzy sets- Operations and properties of Fuzzy sets. Membership functions - Linguistic variables. Operations on fuzzy sets- Fuzzy laws- Operations on fuzzy relations, Fuzzy composition- Max- min, Max – product. Alpha-cut representation.	9
2	Fuzzy Reasoning and Inference Systems : Fuzzy Reasoning – GMP and GMT. Fuzzy Inference System: Defuzzification methods - Fuzzy Controllers - Mamdani FIS, Larsen Model	7
3	Genetic Algorithms and Multi-Objective Optimization: Introduction to Genetic Algorithms – Theoretical foundation - GA encoding, decoding - GA operations – Elitism – GA parameters – Convergence. Multi-objective Genetic Algorithm – Pareto Ranking.	7
4	Swarm Intelligence and Ant Colony Optimization: Swarm intelligent systems - Background Ant colony systems – Biological systems- Development of the ant colony system- - Working - Pheromone updating- Types of ant systems- ACO algorithms for TSP	8
5	Particle Swarm Optimization and Convergence Techniques: Basic Model - Global Best PSO- Local Best PSO-Comparison of ‘gbest’ to ‘lbest’- PSO Algorithm Parameters- Problem Formulation of PSO algorithm- Working. Rate of convergence improvements -Velocity clamping- Inertia weight- Constriction Coefficient- Boundary Conditions- Guaranteed Convergence PSO- Initialization, Stopping Criteria, Iteration Terms and Function Evaluation.	9

COURSE PLAN

No	Topic	No. of Lectures
Fundamentals of Fuzzy Sets and Fuzzy Relations (9)		
1.1	Crisp sets vs fuzzy sets- Operations and properties of Fuzzy sets.	3
1.2	Membership functions - Linguistic variables. Operations on fuzzy sets- Fuzzy laws- Operations on fuzzy relations,	3
1.3	Fuzzy composition-Max-min, Max-product. Alpha-cut representation.	3
Fuzzy Reasoning and Inference Systems (7)		
2.1	Fuzzy Reasoning – GMP and GMT.	3
2.2	Fuzzy Inference System: Defuzzification methods - Fuzzy Controllers - Mamdani FIS	3
2.3	Larsen Model	1
Genetic Algorithms and Multi-Objective Optimization (7)		
3.1	Introduction to Genetic Algorithms – Theoretical foundation	2
3.2	GA encoding, decoding - GA operations – Elitism – GA parameters – Convergence..	3
3.3	Multi-objective Genetic Algorithm – Pareto Ranking	2
Swarm Intelligence and Ant Colony Optimization (8)		
4.1	Swarm intelligent systems - Background Ant colony systems –	3
4.2	Biological systems- Development of the ant colony system- - Working - Pheromone updating-	2
4.3	Types of ant systems- ACO algorithms for TSP	3
Particle Swarm Optimization and Convergence Techniques (9)		
5.1	Basic Model - Global Best PSO- Local Best PSO-Comparison of ‘gbest’ to ‘lbest’- PSO Algorithm Parameters	2
5.2	Problem Formulation of PSO algorithm-Working.	2
5.3	Rate of convergence improvements -Velocity clamping- Inertia weight- Constriction Coefficient-Boundary Conditions-	2
5.4	Guaranteed Convergence PSO-Initialization, Stopping Criteria, Iteration Terms and Function Evaluation.	3
Total		40

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Introduction to Soft Computing Neuro- Fuzzy Genetic Algorithms	Samir Roy, Udit Chakraborty	Pearson, 2013
2	Artificial Intelligence and Intelligent systems	N.P. Padhy	Oxford Press New Delhi, 2005.
3	Nature-Inspired Optimization Algorithms	Xin-She Yang School of Science and Technology, Middlesex University London,	Elsevier, First edition, 2014
4	Mathematical Modelling and Applications of Particle Swarm Optimization,	Satyobroto Talukder, Blekinge Institute of Technology	
5	An Introduction to Genetic Algorithm	Mitchell Melanie	Prentice Hall,1998
6	Computational Intelligence: An Introduction	Andries Engelbrecht	Wiley, 2007

R26CST164 - AUTOMATED VERIFICATION

COURSE CODE	R26CST164	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

- 1.To understand formal reasoning, propositional logic, normal forms, SAT solvers, and Boolean structures.
2. To analyze equality logic, uninterpreted functions, congruence closure, and reduction methods.
3. To apply linear arithmetic techniques such as Simplex, Fourier-Motzkin, and Omega Test for constraint solving.

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Use the model-theoretic and proof-theoretic approaches towards formal reasoning	K3
CO 2	Demonstrate how decision procedures can be developed for propositional logic using SAT solvers and Binary Decision Diagrams.	K2
CO 3	Develop methods to prove the validity and satisfiability of formulas using Equality Logic and Uninterpreted Functions.	K6
CO 4	Illustrate decision procedures using linear arithmetic	K2
CO 5	Design, develop and implement solutions based on the concepts of automated verification.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	3	2	3	2	
CO 2	2	2	3	2	3	2	1
CO 3	3	2	3	3	3	2	1
CO 4	2	1	3	2	3	2	
CO 5	3	3	3	3	3	3	2

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Introduction and Basic Concepts: Two approaches to Formal Reasoning, Basic Definitions, Normal forms and their properties, The theoretical point of view, Expressiveness vs. Decidability, Boolean structure in Decision Problems.	6
2	Decision Procedures for Propositional Logic: Propositional Logic, SAT Solvers, Binary Decision Diagrams	8
3	Equality Logic and Uninterpreted Functions: Introduction, Uninterpreted Functions, From Uninterpreted Functions to Equality Logic, Functional Consistency is not enough, Two examples of the use of Uninterpreted Functions.	7
4	Decision Procedures for Equality Logic and Uninterpreted Functions: Congruence Closure, Basic Concepts, Simplification of the formula, A Graph-Based Reduction to Propositional Logic, Equalities and Small Domain Instantiations, Ackermann's vs. Bryant's Reduction	8
5	Linear Arithmetic: Introduction, The Simplex Algorithm, The Branch and Bound Method, Fourier-Motzkin Variable Elimination, The Omega Test, Preprocessing, Difference Logic	11

COURSE PLAN

No	Topic	No. of Lectures
Introduction and Basic Concepts (6)		
1.1	Two approaches to Formal Reasoning, Basic Definitions,	2
1.2	Normal forms and their properties, The theoretical point of view,	2
1.3	Expressiveness vs. Decidability, Boolean structure in Decision Problems.	2
Decision Procedures for Propositional Logic:(8)		
2.1	Propositional Logic	3

2.2	SAT Solvers	3
2.3	Binary Decision Diagrams	2
Equality Logic and Uninterpreted Functions (7)		
3.1	Introduction, Uninterpreted Functions,.	3
3.2	From Uninterpreted Functions to Equality Logic,	2
3.3	Functional Consistency is not enough, Two examples of the use of Uninterpreted Functions	2
Decision Procedures for Equality Logic and Uninterpreted Functions (8)		
4.1	Congruence Closure, Basic Concepts,	2
4.2	Simplification of the formula, A Graph-Based Reduction to Propositional Logic	2
4.3	Equalities and Small Domain Instantiations	2
4.4	Ackermann's vs. Bryant's Reduction	2
Linear Arithmetic (11)		
5.1	Introduction, The Simplex Algorithm,	4
5.2	The Branch and Bound Method,	2
5.3	Fourier-Motzkin Variable Elimination,	2
5.4	The Omega Test, Preprocessing, Difference Logic	3
Total		42

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Decision Procedures – An Algorithmic Point of View	Daniel Kroening and Ofer Strichman	Springer, 2008.
2	Principles of Model Checking	Christel Baier and Joost-Pieter Katoen.	The MIT Press
3	Logic in Computer Science – Modelling and Reasoning about Systems	Michael Huth and Mark Ryan	Cambridge University Press



SEMESTER I

PROGRAM ELECTIVE II

**R26CST115 - ADVANCED COMPUTER
NETWORKS**

COURSE CODE	R26CST115	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. To understand advanced networking concepts, including congestion control, QoS, multimedia communication, and routing.
2. To analyze network protocols, traffic engineering, SDN, and NFV.
3. To understand modern network security challenges and protection techniques.
4. To design solutions for next-generation networks, including IoT, cloud, and data center networks.

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Examine the problem of scalability for routing and also identify the challenges in mobile and multicast routing	K4
CO 2	Choose the technique that provides the Quality-of-Service needs of a particular application.	K5
CO 3	Survey various wired and wireless networking technologies including wireless cellular technologies	K2
CO 4	Classify the multimedia applications in the Internet and compile the various protocols handling these applications.	K4
CO 5	Describe examples of current networking trends and identify the technological gaps.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	3	3	3	2	1
CO 2	2	2	3	3	3	2	2
CO 3	2	2	3	2	3	3	2
CO 4	2	2	3	2	3	2	2
CO 5	3	2	3	3	3	3	2

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A 5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	Part B 7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Advanced Internetworking and Routing: Advanced Internetworking The Global Internet, Routing Areas, Interdomain Routing -BGP, IP Version 6, Multicast, Multicast Addresses, Multicast Routing -DVMRP-PIM-MSDP, Routing to a mobile node, Mobile IP, TCP and Mobility, Mobile TCP	8
2	Quality of Service and Network Performance: Internetwork Quality of Service QoS Architectural Framework - Integrated Services Architecture – RSVP - Differentiated Services, Multiprotocol Label Switching-Destination-Based Forwarding - Explicit Routing Virtual Private Networks and Tunnels, Performance issues in networks, Delay Tolerant Networking	8
3	Networking Technologies : Wired: DSL, Cable Networks, SONET, ATM, VLAN, Wireless: Satellite Networks, WiMAX.Cellular Networks: Introduction-Wireless links and Network characteristics -CDMA, Cellular Internet access -An overview of cellular network architecture, 3G cellular data networks, 4G LTE Cellular networks - LTE Protocol Stacks -LTE Radio Access Network -Additional LTE functions, 5G Cellular networks, Managing mobility in cellular networks, Wireless and Mobility-Impact on higher level protocols, Personal Area Networks: Bluetooth, Zigbee.	9
4	Networking Applications: Multimedia in the Internet: Streaming stored audio/video, Streaming live audio/video, Real time interactive audio/video, Real time Interactive Protocols: RTP- RTCP-SIP-H.323, SCTP. Compression: Audio Compression, Image compression- JPEG, Video Compression- MPEG	7
5	Current Topics in Networking: Overlay Networks: Routing overlays -Resilient overlay networks, Peer-Peer Networks – Bit Torrent Distributed Hash Tables, Content Distribution networks, Software Defined Networks: Architecture – Control and Data Planes – Open Flow – SDN Controllers, Network Function Virtualization, Data Center Networking	8

COURSE PLAN

No	Topic	No. of Lectures
Advanced Internetworking and Routing (6)		
1.1	Advanced Internetworking The Global Internet, Routing Areas,	1
1.2	Interdomain Routing -BGP, IP Version 6, Multicast,	2
1.3	Multicast Addresses, Multicast Routing -DVMRP-PIM-MSDP,	1
1.4	Routing to a mobile node, Mobile IP, TCP and Mobility, Mobile TCP	2
Quality of Service and Network Performance (8)		
2.1	Internetwork Quality of Service QoS Architectural Framework -	2
2.2	Integrated Services Architecture – RSVP - Differentiated Services,	2
2.3	Multiprotocol Label Switching- Destination-Based Forwarding - Explicit Routing Virtual Private Networks and Tunnels,	2
2.4	Performance issues in networks, Delay Tolerant Networking	2
Networking Technologies (7)		
3.1	Wired: DSL, Cable Networks, SONET, ATM, VLAN, Wireless: Satellite Networks, WiMAX.Cellular	2
3.2	Networks: Introduction-Wireless links and Network characteristics - CDMA,	1
3.3	Cellular Internet access -An overview of cellular network architecture, 3G cellular data networks, 4G LTE Cellular networks - LTE Protocol Stacks -LTE Radio Access Network -Additional LTE functions,	2
3.4	5G Cellular networks, Managing mobility in cellular networks, Wireless and Mobility-Impact on higher level protocols	1
3.5	Personal Area Networks: Bluetooth, Zigbee.	1
Networking Applications (8)		
4.1	Multimedia in the Internet: Streaming stored audio/video, Streaming live audio/video,	2
4.2	Real time interactive audio/video, Real time Interactive Protocols: RTP- RTCP-SIP-H.323, SCTP.	3
4.3	Compression: Audio Compression, Image compression- JPEG, Video Compression- MPEG	3
Current Topics in Networking(11)		

5.1	Overlay Networks: Routing overlays	2
5.2	Resilient overlay networks, Peer-Peer Networks – Bit Torrent Distributed Hash Tables,	2
5.3	Content Distribution networks, Software Defined Networks: Architecture	2
5.4	Control and Data Planes – Open Flow – SDN Controllers,	2
5.5	Network Function Virtualization, Data Center Networking	3
Total		40

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Computer Networks - A Systems Approach	Larry Peterson and Bruce Davie	
2	Computer Networking A Top-Down Approach	James F. Kurose and Keith W. Ross	Pearson, 8th edition, 2022
3	Mobile Communications	Jochen Schiller	Addison-Wesley, 2nd edition, 2003
4	William Stallings	Data and Computer Communications	Pearson, 5th edition, 2017 5
5	Andrew Tanenbaum and David Wetherall,	Computer Networks	Pearson, 5th edition, 2010

R26CST125 - PATTERN RECOGNITION

COURSE CODE	R26CST125	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. To introduce fundamental concepts of statistical, syntactic, and structural approaches to pattern recognition.
2. To develop analytical skills for applying supervised and unsupervised learning algorithms to real-world recognition problems.
3. To familiarize learners with feature extraction, dimensionality reduction, and classification techniques used in machine learning.
4. To enable evaluation of recognition models in terms of accuracy, robustness, and computational efficiency.

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Apply probability and numerical methods in statistical pattern recognition.	K3
CO 2	Apply statistical methods in feature selection.	K3
CO 3	Apply linear algebra and statistical methods in parameter and non-parameter estimation.	K3
CO 4	Apply the technique of decision trees in pattern recognition.	K3
CO 5	Analyze the use of deep learning networks and artificial neural networks in pattern recognition.	K4
CO6	Design, Develop, Implement and Present innovative ideas in problem solving with various pattern recognition techniques.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	3	2	3	2	1
CO 2	2	1	3	2	3	2	1
CO 3	2	1	3	2	3	2	1
CO 4	2	2	3	3	3	2	2
CO 5	3	2	3	3	3	3	2
CO 6	3	3	3	3	3	3	3

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Introduction to Pattern Recognition: Introduction to Pattern Recognition No Basics of pattern recognition systems, various applications, Machine Perception, classification of pattern recognition systems. Design of Pattern recognition system, Pattern recognition Life Cycle. Statistical Pattern Recognition: Review of probability theory, Gaussian distribution. Normal density and discriminant functions.	6
2	Feature Selection: Feature selection – Outlier removal – Data normalization – Missing data, The Peaking phenomenon, Feature selection using statistical hypothesis testing- Hypothesis testing basics – Application of t-Test in feature selection. Class separability measures-Divergence-Chernoff bound and Bhattacharya distance-Scatter matrices, Feature subset selection –Scalar feature selection, Feature vector selection.	8
3	Clustering Algorithms: Unsupervised learning and clustering - Criterion functions for clustering. Cluster validation. Fuzzy clustering algorithms-Point representatives- quadratic surfaces and representatives – hyper plane representatives. Binary morphology clustering algorithms (BMCAs) – Discretization – Morphological operations - Determination of clusters in a discrete binary set- Assignment of feature vectors to clusters – The algorithmic scheme, Boundary detection algorithms.	7
4	Dimensionality reduction: Principal component analysis - its relationship to Eigen analysis. Fisher discriminant analysis - Generalised Eigen analysis. Eigen vectors/Singular vectors as dictionaries. Factor Analysis, Total variability space - a dictionary learning method.Non negative matrix factorisation - a dictionary learning method. Linear discriminant functions: Gradient descent procedures, Perceptron.	8
5	Artificial neural networks and Pattern Classification: Review of Artificial neural network concepts, convolutional neural networks, recurrent neural networks. Non-metric methods for pattern classification: non-numeric data or	11

	nominal data. Decision trees: Classification and Regression Trees (CART).	
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COURSE PLAN

No	Topic	No. of Lectures
Introduction to Pattern Recognition (7)		
1.1	Introduction to Pattern Recognition No Basics of pattern recognition systems, various applications,	2
1.2	Machine Perception, classification of pattern recognition systems. Design of Pattern recognition system,.	2
1.3	Pattern recognition Life Cycle. Statistical Pattern Recognition: Review of probability theory	2
1.4	Gaussian distribution. Normal density and discriminant functions	1
Feature Selection (10)		
2.1	Feature selection – Outlier removal – Data normalization – Missing data	2
2.2	The Peaking phenomenon, Feature selection using statistical hypothesis testing	2
2.3	Hypothesis testing basics – Application of t-Test in feature selection.	2
2.4	Class separability measures-Divergence-Chernoff bound and Bhattacharya distance-Scatter matrices,	2
2.5	Feature subset selection –Scalar feature selection, Feature vector selection.	2
Clustering Algorithms (9)		
3.1	Unsupervised learning and clustering - Criterion functions for clustering.	3
3.2	Cluster validation. Fuzzy clustering algorithms-Point representatives- quadratic surfaces and representatives – hyper plane representatives.	2
3.3	Binary morphology clustering algorithms (BMCAs) – Discretization, Morphological operations	2
3.4	Determination of clusters in a discrete binary set- Assignment of feature vectors to clusters – The algorithmic scheme, Boundary detection algorithms	2
Dimensionality reduction (8)		

4.1	Principal component analysis - its relationship to Eigen analysis.	1
4.2	Fisher discriminant analysis - Generalised Eigen analysis.	2
4.3	Eigen vectors/Singular vectors as dictionaries. Factor Analysis, Total variability space - a dictionary learning method.	2
4.4	Non negative matrix factorisation - a dictionary learning method..	2
4.5	Linear discriminant functions: Gradient descent procedures, Perceptron	1
Artificial neural networks and Pattern Classification (6)		
5.1	Review of Artificial neural network concepts,	1
5.2	convolutional neural networks, recurrent neural networks.	2
5.3	Non-metric methods for pattern classification: non-numeric data or nominal data.	2
5.4	Decision trees: Classification and Regression Trees (CART).	1
Total		40

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Pattern Recognition	S.Theodoridis and K.Koutroumbas	4th Ed., Academic Press,2009
2	C.M.Bishop	Pattern Recognition and Machine Learning	Springer, 2006
3	Pattern Classification	R.O.Duda, P.E.Hart and D.G.Stork	John Wiley, 2001
4	The Elements of Statistical Learning	Hastie, T., Tibshirani, R. and Friedman, J.	Springer. 2001.

R26CST135 ADVANCED COMPUTER ARCHITECTURE

COURSE CODE	R26CST135	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. To provide a solid foundation in advanced computer architecture by introducing principles of design, performance evaluation, and the hardware/software interface.
2. To develop analytical and problem-solving skills in memory hierarchy, pipelining, multiprocessor systems, and parallelism (thread-level and data-level).
3. To familiarize learners with emerging architectural trends such as SIMD, GPUs, and modern processor designs to enable innovation in hardware/software solutions.

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Identify and solve the advanced issues in design of computer processors, caches and memory.	K4
CO 2	Analyze the memory hierarchy design, performance improvement techniques and cache optimization techniques.	K4
CO 3	Analyze the working and features of branching and exception handling in pipeline architecture.	K4
CO 4	Analyze the operation of multiprocessors, thread-level parallelism, and the concepts of data-level parallelism including SIMD and GPU processors.	K4
CO 5	Design, Develop, Implement and Present innovative ideas on advanced computer architecture and techniques.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	1	3	3	3	2	1
CO 2	3	1	3	3	3	2	1
CO 3	2	1	3	2	3	3	1
CO 4	3	2	3	3	3	3	2
CO 5	3	3	3	3	3	3	3

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Design and Analysis: Principles of computer design, Fallacies and Pitfalls, Instruction Set Principles-Classifying instruction set architecture, Memory addressing, Type and size of operands, Operations in the instruction set, Instruction for control flow, Encoding an instruction set, Role of compiler.	8
2	Memory Hierarchy: Introduction, Cache performance, Basic cache optimizations, Virtual memory–Techniques for fast address translation, Protection via virtual memory, Fallacies and Pitfalls, Case study of Pentium/Linux memory system-Pentium address translation.	8
3	Pipelining: Introduction, Pipeline hazards, Static branch prediction and dynamic branch prediction, Implementation of MITS, Basic pipeline of MITS, Implementing the control in MITS pipeline, Dealing with branches in pipeline, Dealing with exceptions, Handling of multi-cycle operations, Maintaining precise exceptions, Case study of MITS R4000 pipeline.	8
4	Thread Level Parallelism: Introduction, Centralized Shared-Memory Architectures, Performance of Symmetric Shared Memory Multiprocessors, Distributed Shared-Memory and Directory-Based Coherence, Synchronization: The Basics, Models of Memory Consistency: An Introduction, Crosscutting Issues, Case study of Sun T1 Multiprocessor.	8
5	Data Level Parallelism: Vector architecture, SIMD instruction set, Extension for multimedia, Graphic Processing Units, Case study Nvidia GPU instruction set architecture, GPU memory structure, Innovations in GPU architecture, Comparisons between vector architecture and GPUs, Comparisons between multimedia SIMD computers and GPUs, Loop level parallelism, Finding dependencies, Eliminating dependencies.	8

COURSE PLAN

No	Topic	No. of Lectures
Design and Analysis (8)		
1.1	Principles of computer design, Fallacies and Pitfalls	2
1.2	Instruction Set Principles-Classifying instruction set architecture,	2
1.3	Memory addressing, Type and size of operands, Operations in the instruction set	2
1.4	Instruction for control flow, Encoding an instruction set, Role of compiler.	2
Memory Hierarchy(8)		
2.1	Introduction, Cache performance, Basic cache optimizations	2
2.2	Virtual memory–Techniques for fast address translation, Protection via virtual memory	2
2.3	Fallacies and Pitfalls	2
2.4	Case study of Pentium/Linux memory system-Pentium address translation.	2
Pipelining (8)		
3.1	Introduction, Pipeline hazards, Static branch prediction and dynamic branch prediction,	2
3.2	Implementation of MITS, Basic pipeline of MITS, Implementing the control in MITS pipeline,	2
3.3	Dealing with branches in pipeline, Dealing with exceptions, Handling of multi-cycle operations,	2
3.4	Maintaining precise exceptions, Case study of MITS R4000 pipeline.	2
Thread Level Parallelism (8)		
4.1	Introduction, Centralized Shared-Memory Architectures	2
4.2	Performance of Symmetric Shared Memory Multiprocessors	2
4.3	Distributed Shared-Memory and Directory-Based Coherence,	2
4.4	Synchronization: The Basics, Models of Memory Consistency: An Introduction, Crosscutting Issues, Case study of Sun T1 Multiprocessor.	2
Data Level Parallelism (8)		
5.1	Vector architecture, SIMD instruction set, Extension for multimedia, architecture, GPU memory structure, Innovations in GPU	2

5.2	Graphic Processing Units, Case study Envida GPU instruction set architecture, GPU memory structure, Innovations in GPU architecture,	2
5.3	Comparisons between vector architecture and GPUs, Comparisons between multimedia SIMD computers and GPUs,	2
5.4	Loop level parallelism, Finding dependencies, Eliminating dependencies.	2
Total		40

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Computer Architecture- A Quantitative Approach	Hennessy J.L and David A. Patterson	Morgan Kaufmann Publication, Fifth edition, 2002.
2	Computer Systems A programmer's perspective	Randal E Bryant and David O'Hallaron	Pearson Education, 2nd edition 2010.
3	Advanced Computer Architecture	Kaihwang and Naresh Jotwani,	2nd edition Tata Mcgraw-Hill, 2010.
4	Advanced Computer Architecture: A Design Space Approach	Sima D,Fountain T and Kacsuk P	Pearson Education, 1st edition 1997.

**R26CST145 NATURAL LANGUAGE PROCESSING &
TEXT MINING**

COURSE CODE	R26CST145	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. To provide an exposure to the concepts and techniques in Natural language processing and Text mining.
2. Fundamental concepts and practical applications of Natural Language Processing (NLP) are covered in this course.
3. To help the learners to analyze and interpret textual data.

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Apply different approaches of syntax and semantics in NLP.	K3
CO 2	Employ approaches to generate dialogue and summarisation within NLP.	K3
CO 3	Apply different statistical approaches to machine translation.	K3
CO 4	Research, analyze and deploy appropriate machine learning techniques in NLP including hidden Markov models and unsupervised methods.	K4
CO 5	Use text mining concepts and methods to model real-world problems and develop technical solutions.	K6
CO6	Design, develop and implement NLP and text mining methods to solve real world problems.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	3	2	3	2	1
CO 2	2	2	3	3	3	2	2
CO 3	2	1	3	2	3	2	2
CO 4	3	2	3	3	3	3	2
CO 5	3	2	3	3	3	3	2
CO 6	3	3	3	3	3	3	4

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A 5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	Part B 7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Introduction: Natural Language Processing (NLP) - Syntax, semantics, pragmatics, and ambiguity in NLP, Regular Expressions, Text Normalisation, Edit Distance. N-gram Language Models-N-Grams, Evaluating Language Models, Generalisation and Zeros, Smoothing, Kneser-Ney Smoothing, The Web and Stupid Backoff, Perplexity's Relation to Entropy.	6
2	Neural Language Models, Vector Semantics and Embeddings: Neural Networks and Neural Language Models-Units, Feed-Forward Neural Networks, Training Neural Nets, Neural Language Models. Vector Semantics and Embeddings-Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in the vector, Applications of the tf-idf vector model, Word2vec, Visualizing Embeddings, Semantic properties of embeddings, Bias and Embeddings, Evaluating Vector Models.	8
3	Sentiment Classification and Part-of-Speech Tagging: Sentiment Classification –Sentiment classification. Machine Learning for Sentiment Classification - Training the Classifier (Naive Bayes, Logistic Regression, Support Vector Machine, Decision Tree, Random Forest), Optimising for Sentiment Analysis - Other text classification tasks – Evaluation of classification models: Precision, Recall, F-measure, Test sets and Cross-validation, Statistical Significance Testing. Part-of-Speech Tagging-English Word Classes, The Penn Treebank Part-of-Speech Tagset, Part-of-Speech Tagging, HMM Part-of-Speech Tagging, Maximum Entropy Markov Models, Bi-directionality, Part-of Speech Tagging for Morphological Rich Languages. Information Extraction-Named Entity Recognition, Relation Extraction, Extracting Times, Extracting Events and their Times, Template Filling.	10
4	Sequence Processing with Recurrent Networks: Sequence Processing with Recurrent Networks-Simple Recurrent Neural Networks, Applications of Recurrent Neural Networks, Deep Networks: Stacked and Bidirectional RNNs, Managing Context in RNNs: LSTMs and GRUs, Words, Subwords and Characters Neural Language Models and Generation Revisited, Encoder-Decoder Networks, Attention, Applications of Encoder-Decoder Networks. Case study: Machine translation, Question Answering	7

5	Text Mining: Document representation - representing unstructured text documents with appropriate format and structure, automated text mining algorithms. Text Mining: Text categorization, Text clustering, Topic modeling, Applications - classification, image annotation, collaborative filtering, and hierarchical topical structure modeling. Document summarization - Extraction- based summarization methods Sentiment analysis - concept, sentiment polarity prediction, review mining, aspect identification. Text visualization - introduction to mathematical and programming tools.	9
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COURSE PLAN

No	Topic	No. of Lectures
Introduction (6)		
1.1	Natural Language Processing (NLP) - Syntax, semantics, pragmatics, and ambiguity in NLP	1
1.2	Regular Expressions, Text Normalisation, Edit Distance.	1
1.3	N-gram Language Models-N-Grams, Evaluating Language Models, Generalisation and Zeros	2
1.4	Smoothing, Kneser-Ney Smoothing, The Web and Stupid Backoff, Perplexity's Relation to Entropy	2
Neural Language Models, Vector Semantics and Embeddings (8)		
2.1	Neural Networks and Neural Language Models-Units, Feed-Forward Neural Networks, Training Neural Nets, Neural Language Models.	2
2.2	Vector Semantics and Embeddings-Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity,	2
2.3	TF-IDF: Weighing terms in the vector, Applications of the tf-idf vector model, Word2vec,	2
2.4	Visualizing Embeddings, Semantic properties of embeddings, Bias and Embeddings, Evaluating Vector Models.	2
Sentiment Classification and Part-of-Speech Tagging (10)		
3.1	Sentiment Classification –Sentiment classification.	1
3.2	Machine Learning for Sentiment Classification - Training the Classifier (Naive Bayes, Logistic Regression, Support Vector Machine, Decision Tree, Random Forest),	2

3.3	Optimising for Sentiment Analysis - Other text classification tasks – Evaluation of classification models: Precision, Recall, F-measure, Test sets and Cross-validation, Statistical Significance Testing.	2
3.4	Part-of-Speech Tagging-English Word Classes, The Penn Treebank Part-of-Speech Tagset, Part-of-Speech Tagging,	1
3.5	HMM Part-of-Speech Tagging, Maximum Entropy Markov Models, Bi-directionality, Part-of Speech Tagging for Morphological Rich Languages.	2
3.6	Information Extraction-Named Entity Recognition, Relation Extraction, Extracting Times, Extracting Events and their Times, Template Filling.	2
Sequence Processing with Recurrent Networks (8)		
4.1	Sequence Processing with Recurrent Networks-Simple Recurrent Neural Networks, Applications of Recurrent Neural Networks	2
4.2	Deep Networks: Stacked and Bidirectional RNNs	2
4.3	Managing Context in RNNs: LSTMs and GRUs, Words, Subwords and Characters Neural Language Models and Generation Revisited,	2
4.4	Encoder-Decoder Networks, Attention, Applications of Encoder-Decoder Networks. Case study: Machine translation, Question Answering	2
Text Mining (9)		
5.1	Document representation - representing unstructured text documents with appropriate format and structure	2
5.2	automated text mining algorithms.	1
5.3	Text Mining: Text categorization, Text clustering, Topic modeling	1
5.4	Applications - classification, image annotation, collaborative filtering, and hierarchical topical structure modeling. Document summarization - Extraction- based summarization methods	2
5.5	Sentiment analysis - concept, sentiment polarity prediction, review mining, aspect identification. Text visualization - introduction to mathematical and programming tools.	3
Total		41

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Speech and Language Processing (2nd ed)	Daniel Jurafsky and James H. Martin.	Pearson International edition 2008
2	Foundations of Statistical Natural Language Processing	Manning C, Schuetze H	MIT Press, 1999
3	Natural Language Understanding	James Allen	2/E, Addison-Wesley, 1994
4	Mining Text Data	Charu C. Aggarwal and Cheng Xiang Zhai	Springer, 2012.
5	Text Mining Classification, Clustering, and Applications	Ashok N. Srivastava, Mehran Sahami	CRC Press



R26CST155 ADVANCED COMPILER DESIGN

COURSE CODE	R26CST155	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. To analyze the different phases of compiler /techniques for designing a compiler.
2. To introduce students to the advanced concepts of compilation phases such as lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization and code generation.
3. This course helps the learners to design and develop compilers for programming languages.

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Illustrate lexical rules and grammars for a representative programming language	K2
CO 2	Construct intermediate code representations and code optimization techniques.	K6
CO 3	Experiment with register allocation strategies and code scheduling	K3
CO 4	Inspect programming language design, target machine language design and runtime environment of compilers.	K4
CO 5	Assess recent trends in compiler design and build a compiler for a hypothetical language.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1	1	3	2	3	2	
CO 2	3	2	3	3	3	2	1
CO 3	2	1	3	3	3	2	1
CO 4	2	1	3	2	3	2	1
CO 5	3	3	3	3	3	3	2

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Overview of Compiler Design: Introduction - The phases of Compiler - Lexical Analysis - Role of Lexical Analyzer - Specification and Recognition of Tokens - Context Free Grammar – Symbol - Table Structure, Symbol Attributes and Symbol - Table Entries, Local Symbol - Table Management, Global Symbol - Table Structure, Storage Binding and Symbolic Registers, Approaches to Generating Loads and Stores. Intermediate representation – Issues – High level, medium level, low level intermediate languages –MIR, HIR, LIR – ICANfor Intermediate code.	8
2	Intermediate Representations: The value - number method for constructing DAGs - Addresses and instructions – Quadruples - Triples - Storage organization – Static versus dynamic storage allocation – stack allocation of space - Activation trees - Activation records - Garbage collection - Design goals for Garbage collectors - Reference counting garbage collectors - Introduction to trace - based collection - A basic mark - and-sweep collector. Translation of expressions Translation of expressions – Operations within expressions – Incremental translation – Addressing array elements – Translation of array references Control flow – Boolean expressions – Short - circuit code – flow – of - control statements – Control flow translation of Boolean expressions – Avoiding redundant Gotos – Boolean values and jumping code – Backpatching– One - passcode generation using back patching – Back patching for Boolean expressions –Flow- of-control statements – Break, continue and Goto statements Translation of switch statements – syntax directed translation of switch statements - intermediate code for procedures.	9
3	Code Optimization: Principal sources of optimization - causes of redundancy preserving transformations - Global common subexpressions - Copy Propagation - Dead code elimination – Code motion –Upward code motion – Downward code motion – Induction variables and reduction in strength -Introduction to data flow analysis - Loops in Flow graphs – Dominators - Introduction to global data flow analysis - Points and Paths – Reaching definitions - Live	8

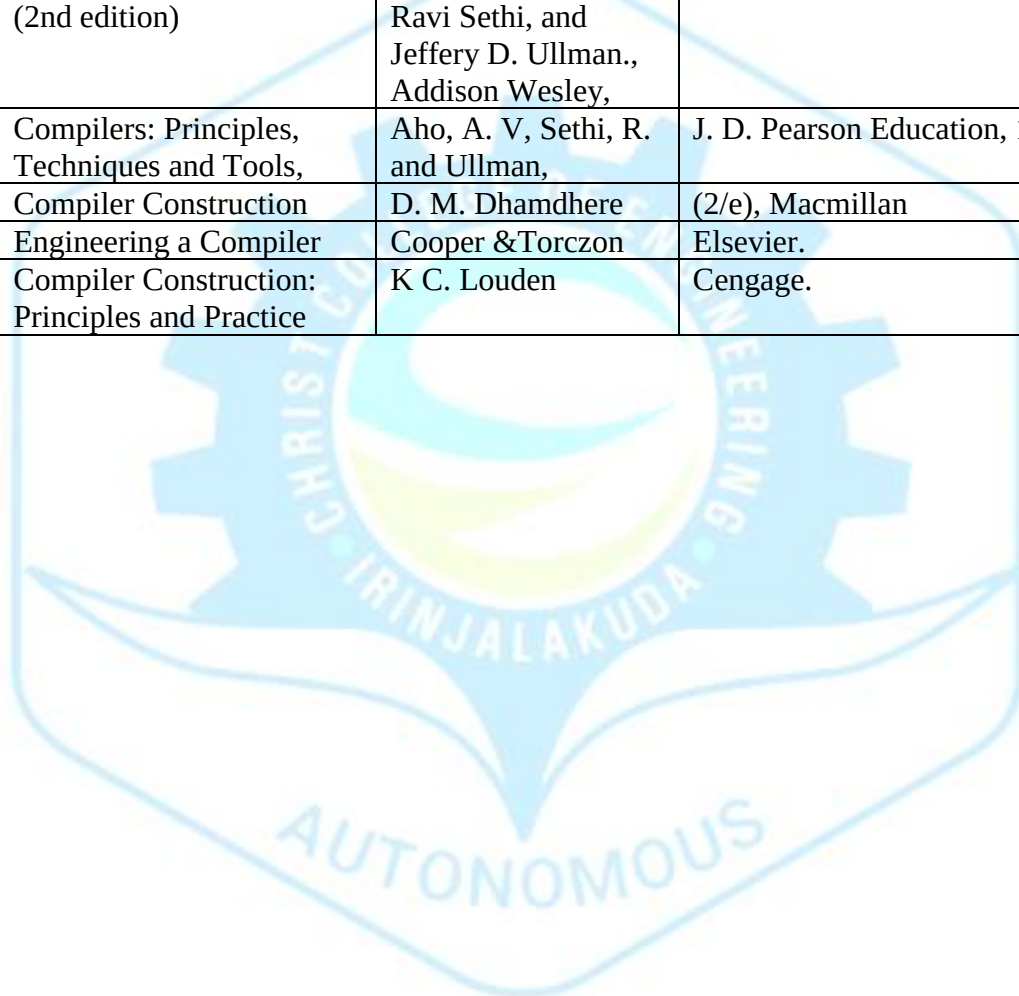
	variable analysis - Data flow analysis of structured programs.	
4	Register Allocation and Code Scheduling: Register allocation and assignment – graph coloring – control flow and low-level optimizations - Inter - procedural analysis and optimization – call graph — register allocation– global References: – Optimization for memory hierarchy. Code Scheduling – Instruction scheduling – speculative scheduling – Software pipelining – trace scheduling –percolation scheduling.	7
5	Parallelism and Case study: Instruction - level parallelism - Instruction pipelines and branch delays – pipelined execution –data dependence – dependencies among memory accesses. Case Studies – Sun Compilers for SPARC– IBMXL Compilers – Alpha compilers – PA – RISC assembly language – COOL– (Classroom Object oriented language) – Compiler testing tools – SPIM	8

COURSE PLAN

No	Topic	No. of Lectures
Overview of Compiler Design (8)		
1.1	Introduction - The phases of Compiler - Lexical Analysis.	1
1.2	Role of Lexical Analyzer -Specification and Recognition of Tokens	2
1.3	Context Free Grammar – Symbol - Table Structure, Symbol Attributes and Symbol - Table Entries, Local Symbol - Table Management, Global Symbol - Table Structure,	2
1.4	Storage Binding and Symbolic Registers, Approaches to Generating Loads and Stores.	1
1.5	Intermediate representation – Issues – High level, medium level, low level intermediate languages –MIR, HIR, LIR – ICANfor Intermediate code.	2
Intermediate Representations (9)		
2.1	The value - number method for constructing DAGs - Addresses and instructions – Quadruples - Triples	1
2.2	Storage organization – Static versus dynamic storage allocation – stack allocation of space -Activation trees - Activation records -	2

2.3	Garbage collection - Design goals for Garbage collectors - Reference counting garbage collectors - Introduction to trace - based collection - A basic mark - and-sweep collector.	1
2.4	Translation of expressions Translation of expressions – Operations within expressions – Incremental translation – Addressing array elements – Translation of array references Control flow –	1
2.5	Boolean expressions – Short - circuit code – flow – of - control statements – Control flow translation of Boolean expressions –	1
2.6	Avoiding redundant Gotos – Boolean values and jumping code – Backpatching– One - passcode generation using back patching – Back patching for Boolean expressions –	1
2.7	Flow- of-control statements – Break, continue and Goto statements Translation of switch statements – syntax directed translation of switch statements - intermediate code for procedures.	2
Code Optimization (8)		
3.1	Principal sources of optimization - causes of redundancy preserving transformations	2
3.2	Global common subexpressions - Copy Propagation - Dead code elimination – Code motion –Upward code motion – Downward code motion.	2
3.3	Induction variables and reduction in strength -Introduction to data flow analysis - Loops in Flow graphs – Dominators	2
3.4	Introduction to global data flow analysis - Points and Paths – Reaching definitions - Live variable analysis - Data flow analysis of structured programs	2
Register Allocation and Code Scheduling (7)		
4.1	Register allocation and assignment – graph coloring	2
4.2	control flow and low-level optimizations - Inter - procedural analysis and optimization – call graph — register allocation	2
4.3	global References: – Optimization for memory hierarchy.	1
4.4	Code Scheduling – Instruction scheduling – pecculative scheduling – Software pipelining – trace scheduling –percolation scheduling.	2
Parallelism and Case study (8)		
5.1	Instruction level parallelism - Instruction pipelines and branch delays	2
5.2	pipelined execution, data dependence , dependencies among memory accesses.	2
5.3	Case Studies-Sun Compilers for SPARC–IBMXL Compilers – Alpha compilers	2
5.4	PA, RISC assembly language – COOL– (Classroom Object oriented language) – Compiler testing tools – SPIM	2
Total		40

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Advanced Compiler Design and Implementation	Steven S Muchnik	Morgan Kaufmann publishers, Elsevier Science, India, Indian Reprint 2003.
2	Compilers: Principles, Techniques and Tools (2nd edition)	Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffery D. Ullman., Addison Wesley,	Boston, MA, 2006.
3	Compilers: Principles, Techniques and Tools,	Aho, A. V, Sethi, R. and Ullman,	J. D. Pearson Education, 1986.
4	Compiler Construction	D. M. Dhamdhare	(2/e), Macmillan
5	Engineering a Compiler	Cooper & Torczon	Elsevier.
6	Compiler Construction: Principles and Practice	K C. Louden	Cengage.



R26CST165 BIOINFORMATICS

COURSE CODE	R26CST165	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. To understand biomolecules, molecular biology, DNA, RNA, proteins, and genome organization.
2. To familiarize students with biological databases and effective retrieval of biological information.
3. To understand sequence alignment, BLAST, FASTA, phylogenetic analysis, and tree construction.
4. To introduce protein structure prediction, homology modeling, and AI/ML applications in bioinformatics.

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Make use of fundamental concepts of molecular biology to provide computational solutions	K3
CO 2	Utilize bioinformatics tools and databases for retrieving, analysing and understanding biological data	K3
CO 3	Analyze multiple sequences and find conserved regions.	K4
CO 4	Find the relationships between species by constructing phylogenetic tree.	K6
CO 5	Predict unknown protein structures and apply concepts of Machine learning and their applications in Bioinformatics.	K5
CO6	Design, Develop, Implement and Present innovative ideas on Bioinformatics techniques.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	3	2	3	2	1
CO 2	3	2	3	3	3	3	2
CO 3	3	2	3	3	3	3	1
CO 4	3	2	3	3	3	3	2
CO 5	3	2	3	3	3	3	2
CO6	3	3	3	3	3	3	3

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Micro project/ Course based project	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			5 questions with 1 question from each module (5 Marks each) Students shall answer all questions.	7 Questions with 1 question from each module and additional 2 questions from any module. Students shall answer any 5 questions out of 7
20	10	10	5×5=25	5×7=35
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Molecular Biology: Biomolecules-DNA, RNA and proteins-Components and structure. Genome organization. Letter codes for amino acids. Central dogma of molecular Biology. Genetic code. Interatomic forces in proteins, different levels of protein structure, protein domains, motifs.	8
2	Bioinformatics: Definition and brief history. Bioinformatics vs Computational Biology. Scope and research areas of Bioinformatics. Data archives: Biological Databases-classification and importance; Nucleic acid databases: GenBank, DDBJ, EMB. Protein Sequence Databases: SwissProt, PIR. Derived databases: InterPro, Prosite, Pfam. Structure Databases: RCSB PDB, CATH, SCOP. Bibliographic Databases: PubMed, MEDLINE. Specialized databases. Gateways to archives: Entrez, SRS, ExPASy.	8
3	Sequence Alignment: Concept of sequence alignment, Gaps in alignment, Scoring matrices: PAM and BLOSUM, Alignment of pairs of sequences: Dot Plot, Dynamic Programming, Alignment algorithms: The Needleman and Wunsch algorithm, Smith-Waterman algorithm. Search for homologous sequences using BLAST and FASTA programs. Statistical significance of database searches. Multiple sequence Alignment: Concept and Algorithms in MSA. Tools: Clustal, Mega.	8
4	Molecular Phylogenetics: Concept and its relation to Multiple Sequence Alignment. Representation of phylogeny. Concept of Outgroup. Gene and Species phylogeny. Phylogenetic tree construction methods: Distance based and Character based. Phylogenetic software's: PHYLIP, MrBayes.	8
5	Protein Structure Prediction and Advanced Bioinformatics: Protein Stability and folding, Ramachandran plot, Homology modelling, Energy minimization, CASP; Protein structure prediction software's: ESyPred3D, Rosetta; PSI-BLAST; Introduction to machine learning techniques: Hidden Markov models, Genetic algorithms and artificial neural networks. Applications of machine learning techniques in multiple sequence alignment, structure prediction and phylogenetic analysis	8

COURSE PLAN

No	Topic	No. of Lectures
Molecular Biology (8)		
1.1	Biomolecules-DNA, RNA and proteins-Components and structure.	2
1.2	Genome organization. Letter codes for amino acids. Central dogma of molecular Biology.	3
1.3	Genetic code. Interatomic forces in proteins, different levels of protein structure, protein domains, motifs.	3
Bioinformatics (8)		
2.1	Definition and brief history.	1
2.2	Bioinformatics vs Computational Biology. Scope and research areas of Bioinformatics. Data archives: Biological Databases-classification and importance;	1
2.3	Nucleic acid databases: GenBank, DDBJ, EMB. Protein Sequence Databases: SwissProt, PIR.	2
2.4	Derived databases: InterPro, Prosite, Pfam. Structure Databases: RCSB PDB, CATH, SCOP.	2
2.5	Bibliographic Databases: PubMed, MEDLINE. Specialized databases. Gateways to archives: Entrez, SRS, ExPASy	2
Sequence Alignment (8)		
3.1	Concept of sequence alignment, Gaps in alignment,	1
3.2	Scoring matrices: PAM and BLOSUM, Alignment of pairs of sequences: Dot Plot, Dynamic Programming,	1
3.3	Alignment algorithms: The Needleman and Wunsch algorithm, Smith-Waterman algorithm.	2
3.4	Search for homologous sequences using BLAST and FASTA programs. Statistical significance of database searches.	2
3.5	Multiple sequence Alignment: Concept and Algorithms in MSA. Tools: Clustal, Mega.	2
Molecular Phylogenetics (8)		
4.1	Concept and its relation to Multiple Sequence Alignment.	2
4.2	Representation of phylogeny. Concept of Outgroup. Gene and Species phylogeny.	3

4.3	Phylogenetic tree construction methods: Distance based and Character based. Phylogenetic software's: PHYLIP, MrBayes.	3
Protein Structure Prediction and Advanced Bioinformatics (8)		
5.1	Protein Stability and folding, Ramachandran plot, Homology modelling, Energy minimization	2
5.2	, CASP; Protein structure prediction software's: ESyPred3D, Rosetta; PSI-BLAST	2
5.3	Introduction to machine learning techniques: Hidden Markov models, Genetic algorithms and artificial neural networks.	2
5.4	Applications of machine learning techniques in multiple sequence alignment, structure prediction and phylogenetic analysis	2
Total		40

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	Essential Bioinformatics	Jin Xiong	Cambridge University Press 2006
2	Genomes 3	Brown T. A	BIOS Scientific Publishers Limited, 2007.
3	Biochemistry	Jeremy M. Berg, John L. Tymoczko, Lubert Stryer	5th Edition, W. H. Freeman, 2002
4	Introduction to Bioinformatics	Arthur Lesk,	5th Edition, Oxford University Press, 2019.
5	Fundamental concepts of Bioinformatics	Dan E. Krane	3rd Edition, Pearson Education India, 2002.
6	Bioinformatics Sequence and Genome Analysis	David W. Mount	2nd Edition, Cold Spring Press, 2004.

G26RMT16 RESEARCH METHODOLOGY AND IPR

COURSE CODE	G26RMT106	CAE Marks	40
Teaching Hours/ Week (L:T:P:R)	2:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. To develop research aptitude by fostering creativity, problem identification through literature survey, and adoption of suitable methodologies for solving engineering problems.
2. To enhance professional skills by delivering effective technical presentations, preparing quality technical reports, and disseminating research outcomes through publications or patents.

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

Course Outcomes		Bloom's Knowledge Level(KL)
CO 1	Apply creative thinking and research aptitude in the selection of research topics.	K3
CO 2	Analyze scholarly literature to define and refine research problems.	K4
CO 3	Apply suitable research methodologies for problem-solving and investigation.	K3
CO 4	Communicate research findings effectively through technical reports and presentations.	K3
CO 5	Evaluate and disseminate research outcomes through publications and intellectual property protection.	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	2	2	2	3	2
CO 2	3	2	3	2	2	3	1
CO 3	3	2	3	3	3	3	2
CO 4	2	3	2	2	2	3	1
CO 5	3	3	3	2	2	3	2

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	15
Apply	25
Analyse	20
Evaluate	-

Mark distribution

Continuous Assessment and Evaluation (CAE):			40 Marks	
End Semester Exam (ESE)			60 Marks	
Total Marks:			100 Marks	
ESE Duration			2 Hrs 30 Mins	
CAE			ESE	
Review article based on peer reviewed original publications	Course based task/ Seminar/ Quiz	Continuous Evaluation Test 1 (CET 1)	Part A	Part B
			6 questions with 1 question each from module 1 to 4 and 2 questions from module 5 (5 Marks each) Students shall answer all questions.	1 question based on a research article from the respective discipline and carries 30 marks.
20	10	10	6×5=30	1×30=30
Total	40		60	

SYLLABUS

MODULE	DESCRIPTION	CONTACT HOURS
1	Introduction: Meaning and significance of research, Skills, habits and attitudes for research, Types of research, Characteristics of good research, Research process Motivation for research: Motivational talks on research: "You and Your Research"- Richard Hamming. Thinking skills: Levels and styles of thinking, common sense and scientific thinking, examples, logical thinking, division into sub-problems, verbalization and awareness of scale. Creativity: Some definitions, illustrations from day to day life, intelligence versus creativity, creative process, requirements for creativity	6
2	Literature survey and Problem definition: Information gathering – reading, searching and documentation, types of literature. Integration of research literature and identification of research gaps. Attributes and sources of research problems, problem formulation, Research question, multiple approaches to a problem. Problem solving strategies – reformulation or rephrasing, techniques of representation, Importance of graphical representation, examples. Analytical and analogical reasoning, examples, Creative problem solving using Triz, Prescriptions for developing creativity and problem solving.	6
3	Experimental and modelling skills: Scientific method, role of hypothesis in experiment, units and dimensions, dependent and independent variables, control in experiment, precision and accuracy, need for precision, definition, detection, estimation and reduction of random errors, statistical treatment of data, definition, detection and elimination of systematic errors, Design of experiments, experimental logic, documentation. Types of models, stages in modelling, curve fitting, the role of approximations, problem representation, logical reasoning, mathematical skills. Continuum/meso/micro scale approaches for numerical simulation, Two case studies illustrating experimental and modelling skills.	5
4	Effective communication - oral and written: Examples illustrating the importance of effective communication, stages and dimensions of a communication process. Oral	5

	communication – verbal and non-verbal, casual, formal and informal communication, interactive communication, listening, form, content and delivery, various contexts for speaking- conference, seminar etc. Guidelines for preparation of good presentation slides. Written communication – Rules of scientific writing, form, content and language, layout, typography and illustrations, nomenclature, reference and citation styles, contexts for writing – paper, thesis, reports etc. Tools for document preparation-LaTeX. Common errors in typing and documentation	
5	Publication and Patents: Relative importance of various forms of publication, Choice of journal and reviewing process, Stages in the realization of a paper. Research metrics- Journal level, Article level and Author level, Plagiarism and research ethics. Introduction to IPR, Concepts of IPR, Types of IPR. Common rules of IPR practices, Types and Features of IPR Agreement, Trademark. Patents- Concept, Objectives and benefits, features, Patent process – steps and procedures	6

COURSE PLAN

No	Topic	No. of Lectures
Introduction (6)		
1.1	Meaning and significance of research, Skills, habits and attitudes for research, Types of research	1
1.2	Creativity: Some definitions, illustrations from day to day life, intelligence versus creativity, creative process, requirements for creativity	1
1.3	Characteristics of good research, Research process	1
1.4	Thinking skills: Levels and styles of thinking, common sense and scientific thinking, examples, logical thinking, division into sub-problems, verbalization and awareness of scale.	2
1.5	Motivation for research: Motivational talks on research: "You and Your Research"- Richard Hamming	1

Literature survey and Problem definition (6)		
2.1	Information gathering – reading, searching and documentation, types of literature.	1
2.2	Integration of research literature and identification of research gaps	1
2.3	Attributes and sources of research problems, problem formulation, Research question, multiple approaches to a problem	1
2.4	Problem solving strategies – reformulation or rephrasing, techniques of representation, Importance of graphical representation, examples.	1
2.5	Analytical and analogical reasoning, examples, Creative problem solving using Triz, Prescriptions for developing creativity and problem solving.	1
Experimental and modelling skills (5)		
3.1	Scientific method, role of hypothesis in experiment, units and dimensions, dependent and independent variables, control in experiment	1
3.2	precision and accuracy, need for precision, definition, detection, estimation and reduction of random errors, statistical treatment of data, definition, detection and elimination of systematic errors	1
3.3	Design of experiments, experimental logic, documentation	1
3.4	Types of models, stages in modelling, curve fitting, the role of approximations, problem representation, logical reasoning, mathematical skills.	1
3.5	Continuum/meso/micro scale approaches for numerical simulation, Two case studies illustrating experimental and modelling skills.	1
Effective communication - oral and written (5)		
4.1	Examples illustrating the importance of effective communication, stages and dimensions of a communication process	1
4.2	Oral communication –verbal and non-verbal, casual, formal and informal communication, interactive communication, listening, form, content and delivery, various contexts for speaking- conference, seminar etc	1
4.3	Guidelines for preparation of good presentation slides	1
4.4	Written communication – Rules of scientific writing, form, content and language, layout, typography and illustrations, nomenclature, reference and citation styles, contexts for writing – paper, thesis, reports etc. Tools for document preparation-LaTeX.	1
4.5	Common errors in typing and documentation	1
Publication and Patents (6)		

5.1	Relative importance of various forms of publication, Choice of journal and reviewing process, Stages in the realization of a paper.	1
5.2	Research metrics-Journal level, Article level and Author level, Plagiarism and research ethics	1
5.3	Introduction to IPR, Concepts of IPR, Types of IPR	1
5.4	Common rules of IPR practices, Types and Features of IPR Agreement, Trademark	1
5.5	Patents- Concept, Objectives and benefits, features, Patent process – steps and procedures	1
Total		28

Reference Books			
Sl. No.	Title of the Book	Name of Authors	Publisher
1	<i>How to Get a PhD: A Handbook for PhD Students and Their Supervisors</i>	E. M. Phillips & D. S. Pugh	Viva Books Pvt. Ltd.
2	<i>Practical Physics</i>	G. L. Squires	Cambridge University Press
3	<i>Handbook of Science Communication</i>	Antony Wilson, Jane Gregory, Steve Miller & Shirley Earl	Overseas Press India Pvt. Ltd., New Delhi, 1st Edition, 2005
4	<i>Research Methodology</i>	C. R. Kothari	New Age International, 2004
5	<i>Research Methodology</i>	Panneerselvam	Prentice Hall of India, New Delhi, 2012
6	<i>Practical Research: Planning and Design</i>	P. D. Leedy	McMillan Publishing Co.

R26CSP107 COMPUTING LAB 1

COURSE CODE	R26CSP107	CAE Marks	50
Teaching Hours/ Week (L:T:P:R)	2:0:0:0	ESE Marks	50
Credits	3	Exam Hours	2 Hrs. and 30 Mins
Prerequisites (If Any)	None	Course Type	Program Core (Theory)

Course Objectives:

1. To develop research aptitude by fostering creativity, problem identification through literature survey, and adoption of suitable methodologies for solving engineering problems.
2. To enhance professional skills by delivering effective technical presentations, preparing quality technical reports, and disseminating research outcomes through publications or patents.

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

	Course Outcomes	Bloom's Knowledge Level (KL)
CO 1	Apply modern machine learning notions in predictive data analysis	K3
CO 2	Analyze the range of machine learning algorithms along with their strengths and weaknesses	K4
CO 3	Design and develop appropriate machine learning models to solve real world problems.	K6
CO 4	Build predictive models from data and analyze their performance	K6

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	3	2	3	2	1
CO 2	3	2	3	3	3	3	1
CO 3	3	2	3	3	3	3	2
CO 4	3	2	3	3	3	3	2

Mark Distribution

Continuous Assessment and Evaluation (CAE):					50 Marks		
End Semester Exam (ESE)					50 Marks		
Total Marks:					100 Marks		
ESE Duration					2 Hrs 30 Mins		
CAE		ESE					
Preparation/ Pre-lab work, Viva and timely lab reports for each experiment	Internal Examination	Procedure/ preparatory work/ design or algorithm	Conduct of experiment/ execution/ troubleshooting/ programming	Result with valid inference	Viva Voce	Record	
30	20	10	15	10	10	5	
Total	50		50				

Final assessment in End Semester Examination shall be done by two examiners; one examiner will be a senior faculty from the same department.

Sl. No.	Experiment / Study
1	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample
2	Write a program to implement the naïve bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.

3	Assuming a set of documents that need to be classified, use the naïve bayesian Classifier model to perform this task. Calculate the accuracy, precision, and recall for your data set.
4	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Python ML library classes/API.
5	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Python ML library classes/API in the program
6	Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem
7	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select the appropriate data set for your experiment and draw graphs.
8	Write a program to implement 5-fold cross validation on a given dataset. Compare the accuracy, precision, recall, and F-score for your data set for different folds.
9	Implement SVM/Softmax classifier for CIFAR-10 dataset: (i) using KNN, (ii) using 3 layer neural network.
10	Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets
11	Image Captioning with Vanilla RNNs
12	Image Captioning with LSTMs
13	Familiarisation of cloud based computing like Google colab