MAR ATHANASIUS COLLEGE OF ENGINEERING
(Government Aided &Autonomous)

Kothamangalam 686 666

Affiliated to APJ Abdul Kalam Technological University

Thiruvananthapuram

Master of Technology (M. Tech.)

Curriculum and Syllabus – 2026

Computer Science and Engineering

Department of Computer Science and Engineering

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Master of Technology (M. Tech.) Curriculum - 2026

COLLEGE VISION AND MISSION

VISION

Excellence in education through resource integration.

MISSION

The institution is committed to transform itself into a centre of excellence in Technical Education upholding the motto "Knowledge is Power."
This is to be achieved by imparting quality education to mould technically competent professionals with moral integrity, ethical values and social commitment, and by promoting innovative activities in the thrust areas emerging from time to time.

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS)
M.TECH CURRICULUM 2026
(Branch and Specialization)

PROGRAM OUTCOMES – PO

Outcomes are the attributes that are to be demonstrated by a graduate after completing the programme

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development of the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects. Also to develop cognitive skills for project management and finance which focus on Industry and Entrepreneurship.

The departments conducting the M.Tech programme shall define their own PSOs, if required, and evaluation shall also be done for the same.

SEMESTER I

Slot	Course Code	Courses	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
A	M26CS1D101	Computational Intelligence	60	40	3-0-3-6	6	5
B	M26CS1D102	Advanced Machine Learning	60	40	3-0-3-6	6	5
C	M26CS1T103	Advanced Data Structures And Algorithms	60	40	4-0-0-5	4	4
D	M26CS1E104x	Programme Elective 1	60	40	4-0-0-5	4	4
J	M26GE1R105	Research Methodology & IPR	60	40	2-0-0-4	2	2
Total			300	200		22	20

Teaching Assistance: 8 hours/week

Self-study- 26 Hrs

SEMESTER II

Slot	Course Code	Courses	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
A	M26CS1D201	Advanced Database Management Systems	60	40	3-0-3-6	6	5
B	M26CS1D202	Deep Learning And Transformer Architectures	60	40	3-0-3-6	6	5
C	M26CS1E203x	Programme Elective 2	60	40	4-0-0-5	4	4
E	M26CS1S204	Industry Integrated Course	60	40	4-0-0-5	4	4
G	M26CS1P205	Mini project	100		0-0-4-6	4	2
TOTAL			340	160		24	20

Teaching Assistance: 8 hours/week

Self-study- 28 Hrs

SEMESTER III

Slot	Course Code	Courses	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
A	M26CS1M301	*MOOC	To be completed successfully		--	--	2
K	M26CS1I302	Internship	50	50	--	--	10
P	M26CS1P303	Dissertation Phase 1	100	--	0-0-12-18	12	8
TOTAL			150	50		12	20

Teaching Assistance:8 hours/week

*MOOC Course of minimum 8 weeks duration to be successfully completed before the end of fourth semester (starting from semester 1).

Internship - mandatory internship of minimum 16 weeks duration.

Dissertation Phase 1 may be undertaken either in the college or in the industry. Dissertation Phase 1 can be linked with internship. Students are expected to have the following skills: Technical Skills, Research Skills, Communication Skills, Critical Thinking Skills, and Problem Solving Skills.

SEMESTER IV

Slot	Course Code	Courses	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
P	M26CS1P401	Dissertation Phase II	100	100	0-0-24-26	24	20
TOTAL			100	100		24	20
Total credits in all four semesters							**80**

COURSE NUMBERING SCHEME

The course number consists of digits/alphabets. The pattern to be followed is

For General Courses - MYYBBXCSNN
For Elective Courses - MYYBBXCSNNA

- M: MASTERS
- YY: Last two digits of year of regulation
- BB: DEPARTMENT

Sl.No	Department	Course Prefix
01	Civil Engg	CE
02	Computer Science	CS
03	Electrical & Electronics	EE
04	Electronics & Communication	EC
05	Mechanical Engg	ME
06	Any	GE
07	External (Industry/NPTEL etc)	EX

- X : Specialization number
- C : Course Type

  T- Core Course

  E- Elective Course

  R- Research Methodology & IPR

  D- Lab integrated Course

  S- Industry Integrated Course

  I- Internship

  M- MOOC

  P- Project/Dissertation

- S : Semester of Study

  1. Semester 1
  2. Semester 2

3. Semester 3
4. Semester 4

- NN: Course sequence number
- A : Elective sequence number - A/B/C/D/E

It is illustrated below: Examples:

M26CE1T103 is a core course of first specialization offered by the Civil Department in semester 1

M26CE1D201 is a lab integrated core course of first specialization offered by the Civil Department in semester 2

M26GE1R106 is Research Methodology & IPR offered in semester 1offered by all Departments

M26EC1E104A is the first subject of Elective 1 of first specialization offered by the EC Department in semester 1.

EVALUATION PATTERN

(i) LAB INTEGRATED COURSES

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations).

Continuous Internal Evaluation (CIE) : 60 marks

Theory Evaluation : 30 marks

Self-study (Course based task/Seminar/ Quiz/ Micro project) :10 marks

Test paper 1 :10 marks

Test paper 2 :10 marks

Lab Evaluation : 30 marks

Lab work : 10 marks

Final evaluation Test : 20 marks

(Note: 50% of Module 1, 2 and 3 may be considered for each test)

End Semester Examination (ESE) : 40marks

The end semester examination should be conducted by the college. The time duration will be 2 Hrs and will contain 6 questions from first three modules, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

(ii) ELECTIVE COURSES/CORE COURSE

Evaluation shall only be based on application, analysis or design based questions(for both internal and end semester examinations).

Continuous Internal Evaluation : 60 marks

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/Data collection and interpretation/Case study : 20 marks

Test paper 1 (Module 1 and Module 2) : 15 marks

Test paper 2 (Module 3 and Module 4) : 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination (ESE) : 40marks

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

(iii) RESEARCH METHODOLOGY & IPR

Continuous Internal Evaluation: 60 marks

Self-study (Preparing a review article based on peer reviewed original publications in the relevant discipline (minimum 10 publications shall be referred)) : 10 marks

Course based task/Seminar/Quiz : 20 marks

Test paper 1 (Module 1 and Module 2) : 15 marks

Test paper 2 (Module 3 and Module 4) : 15 marks

End Semester Examination : 40 marks

The end semester examination should be conducted by the college. The time duration will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question carries 10 marks.

(iv) INTERNSHIP

Internships are educational and career development opportunities, providing practical experience in a field or discipline. They are structured, short-term, supervised placements often focused around particular tasks or projects with defined time scales. An internship may be compensated or non-compensated by the

organization providing the internship. The internship has to be meaningful and mutually beneficial to the intern and the organization. It is important that the objectives and the activities of the internship program are clearly defined and understood. The internship offers the students an opportunity to gain hands-on industrial or organizational exposure; to integrate the knowledge and skills acquired through the coursework; interact with professionals and other interns; and to improve their presentation, writing, and communication skills. Internship often acts as a gateway for final placement for many students.

A student shall opt for carrying out the Internship at an Industry/Research Organization or at another institute of higher learning and repute (Academia). The organization for Internship shall be selected/decided by the students on their own with prior approval from the faculty advisor/respective PG Programme Coordinator/Guide/Supervisor. Every student shall be assigned an internship Supervisor/Guide at the beginning of the Internship. The training shall be related to their specialization after the second semester for a minimum duration of sixteen weeks. On completion of the course, the student is expected to be able to develop skills in facing and solving the problems experiencing in the related field.

Objectives

- Exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn understand and sharpen the real time technical / managerial skills required at the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Create conducive conditions with quest for knowledge and its applicability on the job.
- Understand the social, environmental, economic and administrative considerations that influence the working environment.
- Expose students to the engineer's responsibilities and ethics.

Benefits of Internship Benefits to Students

- An opportunity to get hired by the Industry/ organization.
- Practical experience in an organizational setting & Industry environment.
- Excellent opportunity to see how the theoretical aspects learned in classes are integrated into the practical world. On-floor experience provides much more professional experience which is often worth more than classroom teaching.
- Helps them decide if the industry and the profession is the best career option to pursue.
- Opportunity to learn new skills and supplement knowledge.
- Opportunity to practice communication and teamwork skills.
- Opportunity to learn strategies like time management, multi-tasking etc in an industrial setup.
- Makes a valuable addition to their resume.
- Enhances their candidacy for higher education/placement.

- Creating network and social circle and developing relationships with industrypeople.
- Provides opportunity to evaluate the organization before committing to a fulltime position.

Benefits to the Institute

- Build industry academia relations.
- Makes the placement process easier.
- Improve institutional credibility & branding.
- Helps in retention of the students.
- Curriculum revision can be made based on feedback from Industry/students.
- Improvement in teaching learning process.

Benefits to the Industry

- Availability of ready to contribute candidates for employment.
- Year round source of highly motivated pre-professionals.
- Students bring new perspectives to problem solving.
- Visibility of the organization is increased on campus.
- Quality candidate's availability for temporary or seasonal positions andprojects.
- Freedom for industrial staff to pursue more creative projects.
- Availability of flexible, cost-effective workforce not requiring a long-termemployer commitment.
- Proven, cost-effective way to recruit and evaluate potential employees.
- Enhancement of employer's image in the community by contributing to theeducational enterprise.

Types of Internships

- Industry Internship with/without Stipend
- Govt / PSU Internship (BARC/Railway/ISRO etc)
- Internship with prominent education/research Institutes
- Internship with Incubation centres /Start-ups

Guidelines

- All the students need to go for internship for minimum duration of 16 weeks.
- Students can take mini projects, assignments, case studies by discussing it with concerned authority from industry and can work on it during internship.
- All students should compulsorily follow the rules and regulations as laid by industry.
- Every student should take prior permissions from concerned industrialauthority if they want to use any drawings, photographs or any otherdocument from industry.

- Student should follow all ethical practices and SOP of industry.
- Students have to take necessary health and safety precautions as laid bythe industry.
- Student should contact his /her Guide/Supervisor from college on weeklybasis to communicate the progress.
- Each student has to maintain a diary/log book
- After completion of internship, students are required to submit
    - Report of work done
    - Internship certificate copy
    - Feedback from employer / internship mentor
    - Stipend proof (in case of paid internship).

Total Marks 100: The marks awarded for the Internship will be on the basis of (i)Evaluation done by the Industry (ii) Internal evaluation & Student's diary (iii) Internship Report and (iv) Comprehensive Viva Voce.

Continuous Internal Evaluation: 50 marks

Internal evaluation & Student's diary- 25 Marks

Evaluation done by the Industry - 25 Marks

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit. Student's diary will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary
- Adequacy & quality of information recorded
- Drawings, design, sketches and data recorded
- Thought process and recording techniques used
- Organization of the information.

The format of student's diary

Name of the Organization/Section:

Name and Address of the Section Head:

Name and Address of the Supervisor:

Name and address of the student:

Internship Duration: From ..... To .....

Brief description about the nature of internship:

Day	Brief write up about the Activities carried out: Such as design, sketches, result observed, issues identified, data recorded, etc.
1	
2	
3	

Signature of Industry Supervisor *Signature of Section Head/HR Manager* *Office Seal*

Attendance Sheet

Name of the Organization/Section:

Name and Address of the Section Head:

Name and Address of the Supervisor:

Name and address of the student:

Month & Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	...
Month & Year																					
Month & Year																					

Internship Duration: From ..... To .....

Signature of Industry Supervisor *Signature of Section Head/HR Manager* *Office Seal*

Note:

- Student's Diary shall be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
- Attendance Sheet should remain affixed in daily training diary. Do not remove or tear it off.
- Student shall sign in the attendance column. Do not mark 'P'.
- Holidays should be marked in red ink in the attendance column. Absent should be marked as 'A' in red ink.

Evaluation done by the Industry (Marks 25)

Format for Supervisor Evaluation of Intern

Student Name :_____ Date:_____ Supervisor Name :_____

_____ Designation:_____ Company/Organization :_____

_____

Internship Address: _____ Dates of Internship: From_____ To _

_____

Please evaluate intern by indicating the frequency with which you observed the following parameters:

Parameters	**Marks** Rating (0-10 mark)
Behavior	
Performs in a dependable Manner	
Cooperates with coworkers and supervisor	
Shows interest in work	
Learns quickly	
Shows initiative	
Produces high quality work	
Accepts responsibility	
Accepts criticism	
Demonstrates organizational skills	

Uses technical knowledge and expertise	
Shows good judgment	
Demonstrates creativity/originality	
Analyzes problems effectively	
Is self-reliant	
Communicates well	
Writes effectively	
Has a professional attitude	
Is punctual	
Uses time effectively	

Evaluation marks: 20 Marks

Overall performance of student: 5 Marks

Intern (Tick one) : Needs improvement (0 - 1 mark) / Satisfactory (1-2 mark) /Good (2-3 mark) / Very Good (3-4 mark) / Excellent (4-5 mark)

Signature of Industry Supervisor *Signature of Section Head/HR Manager* *Office Seal*

End Semester Evaluation (External Evaluation): 50 Marks

Internship Report - 25 Marks

Viva Voce - 25 Marks

Internship Report: After completion of the internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period and should be submitted to the faculty Supervisor. The student may contact Industrial Supervisor/ Faculty Mentor for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor, Programme Coordinator and Faculty Mentor.

The Internship report (25 Marks) will be evaluated on the basis of following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.

- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taughtin the course

Viva Voce (25 Marks) will be done by a committee comprising Faculty Supervisor, PG Programme Coordinator and an external expert (from Industry or research/academic Institute). This committee will be evaluating the internship report also.

(v) INDUSTRY INTEGRATED COURSE

Engineering students frequently aspire to work in areas and domains that are keytopics in the industry. There are concerns by recruiters that skill sets of engineering students did not match with the Industry requirements, especially in the field of latest topics. In response to their desires, the College has incorporated Industry integrated course in the curriculum.

The evaluation pattern for Industry based electives is as follows:

Continuous Internal Evaluation: 60 marks

Self-study (*Seminar)	:	10 marks
Course based task/Seminar/Data collection and interpretation/Case study	:	20marks
Test paper 1 (Module 1 and Module 2)	:	15 marks
Test paper 2 (Module 3 and Module 4)	:	15 marks

End Semester Examination: 40 marks

The examination will be conducted by the College with the question paper provided by the Industry. The examination will be for 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks. The valuation of the answer scripts shall be done by the expert in the Industry handling the course.

(vi) MOOC COURSES

The MOOC course shall be considered only if it is conducted by the agencies namely AICTE/NPTEL/SWAYAM or NITTTR. The MOOC course should have a minimum duration of 8 weeks and the content of the syllabus shall be enough for at least 40 hours of teaching. The course should have a proctored/offline end semester examination. The students can do the MOOC according to their convenience, but shall complete it before the end of fourth semester. The list of MOOC courses will be provided by the concerned BoS if at least 70% of the course content match with the area/stream of study. The course shall not be considered if its content has more than 50% of overlap with a core/elective course in the concerned discipline or with an open elective.

MOOC Course to be successfully completed before the end of fourth semester (starting from semester 1). A credit of 2 will be awarded to all students whoever successfully completes the MOOC course as per the evaluation pattern of the respective agency conducting the MOOC.

(vii) MINIPROJECT

Total marks: 100

Mini project can help to strengthen the understanding of student's fundamentals through application of theoretical concepts and to boost their skills and widen the horizon of their thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem- solving skills. The introduction of mini projects ensures preparedness of students to undertake dissertation. Students should identify a topic of interest in consultation with PG Programme Coordinator. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Interim evaluation: 60 (30 marks for each review), final evaluation by a Committee (will be evaluating the level of completion and demonstration of functionality/specifications, clarity of presentation, oral examination, work knowledge and involvement): 25, Report (the committee will be evaluating for the technical content, adequacy of references, templates followed and permitted plagiarism level is not more than 25%): 10, Supervisor/Guide: 5

(viii) DISSERTATION

Dissertation: All Students should carry out the dissertation in the college or can work either in any CSIR/Industrial R&D organization/any other reputed Institute which have facilities for dissertation work in the area proposed.

Dissertation outside the Institute: For doing dissertation outside the Institution, the following conditions are to be met:

- They have completed successfully the course work prescribed in the approved curriculum up to the second semester.
- The student has to get prior approval from the DLAC and CLAC.
- Facilities required for doing the dissertation shall be available in the Organization/Industry (A certificate stating the facilities available in the proposed organization and the time period for which the facilities shall be made available to the student, issued by a competent authority from the Organization/Industry shall be submitted by the student along with the application).
- They should have an external as well as an internal supervisor. The internal supervisor should belong to the parent institution and the external supervisor should be Scientists or Engineers from

the Institution/Industry/ R&D organization with which the student is associated for doing the dissertation work. The external supervisor shall be with a minimum post graduate degree in the related area.

- The student has to furnish his /her monthly progress as well as attendance report signed by the external guide and submit the same to the concerned Internal guide.
- The external guide is to be preferably present during all the stages of evaluation of the dissertation.

Note1- Students availing this facility should continue as regular students of the College itself.

Internship leading to Dissertation: The M. Tech students who after completion of 16 weeks internship at some reputed organization are allowed to continue their work as dissertation for the third and fourth semester after getting approval from the DLAC. Such students shall make a brief presentation regarding the work they propose to carry out before the DLAC for a detailed scrutiny and to resolve its suitability for accepting it as an M.Tech dissertation. These students will be continuing as regular students of the Institute in third semester for carrying out all academic requirements as per the curriculum/regulation. However, they will be permitted to complete their dissertation in the Industry/Organization (where they have successfully completed their internship) during fourth semester.

Dissertation as part of Employment: Students may be permitted to discontinue the programme and take up a job provided they have completed all the courses till second semester (FE status students are not permitted) prescribed in the approved curriculum. The dissertation work can be done during a later period either in the organization where they work if it has R & D facility, or in the Institute. Such students should submit application with details (copy of employment offer, plan of completion of their project etc.) to the Dean (PG) through HoD. When the students are planning to do the dissertation work in the organization with R & D facility where they are employed, they shall submit a separate application having following details:

- Name of R&D Organization/Industry
- Name and designation of an external supervisor from the proposed Organization/Industry (Scientists or Engineers with a minimum post graduate degree in the related area) and his/her profile with consent
- Name and designation of a faculty member of the Institute as internal supervisor with his/her consent
- Letter from the competent authority from the Organization/Industry granting permission to do the dissertation
- Details of the proposed work
- Work plan of completion of project

DLAC will scrutinize the proposal and forward to the Dean (PG) through HoD for approval.

When students are doing dissertation work along with the job in the organization (with R & D facility) where they are employed, the dissertation work shall be completed in four semesters normally (two

semesters of dissertation work along with the job may be considered as equivalent to one semester of dissertation work at the Institute). Extensions may be granted based on requests from the student and recommendation of the supervisors such that he/she will complete the M. Tech programme within four years from the date of admission as per the regulation. Method of evaluation and grading of the dissertation will be the same as in the case of regular students. MOOC can be completed as per the norms mentioned earlier.

Extended Submission for PG Thesis/Project: Extended submission may be permitted for students who have registered for the dissertation / thesis but require additional time for completion. The extended submission period shall be limited to a maximum of three months from the scheduled date of normal submission. Evaluation of theses submitted during the extended period shall be treated as part of the regular examination, and not as a supplementary examination. Extended submission shall be permitted only on the recommendation of the Project Supervisor. If the attendance requirements are not met, an 'FE' grade shall be awarded.

Mark Distribution:

Phase 1: Total marks: 100, only CIE
Phase 2: Total marks: 200, CIE = 100 and ESE = 100 marks

- If the student publishes the dissertation work in a recognized national/international conference or an indexed journal, 10 marks should be awarded.
- Final Evaluation (ESE) should be done by a three-member committee comprising of the Department Project coordinator, Guide and an External expert. The external expert shall be an academician or from industry
- If the quantum of work done by the candidate is found to be unsatisfactory, the evaluation committee may extend the duration of the project up to maximum of three months, giving reasons for this in writing to the student. Normally further extension will not be granted and there shall be no provision to register again for the project. A separate evaluation may be conducted for such candidates

(ix) TEACHING ASSISTANCESHIP (TA)

All M.Tech students irrespective of their category of admission, shall undertake TA duties for a minimum duration as per the curriculum. Being a TA, the student will get an excellent opportunity to improve their expertise in the technical content of the course, enhance communication skills, obtain a hands-on experience in handling the experiments in the laboratory and improve peer interactions.

The possible TA responsibilities include the following: facilitate a discussion section or tutorial for a theory/ course, facilitate to assist the students for a laboratory course, serve as a mentor for students, and act as the course web-master. TAs may be required to attend the instructor's lecture regularly. A TA shall not be employed as a substitute instructor, where the effect is to relieve the instructor of his or her teaching responsibilities.

For the tutorial session:

(i) Meet the teacher and understand your responsibilities well in advance, attend the lectures of the course for which you are a tutor, work out the solutions for all the tutorial problems yourself, approach

the teacher if you find any discrepancy or if you need help in solving the tutorial problems, use reference text books, beinnovative and express everything in English only.

(ii) Try to lead the students to the correct solutions by providing appropriate hints rather than solving the entire problem yourself, encourage questions from the students, lead the group to a discussion based on their questions, plan to ask them some questions be friendly and open with the students, simultaneously being firm with them.

(iii) Keep track of the progress of each student in your group, give a periodic feedback to the student about his/her progress, issue warnings if the student is consistently under-performing, report to the faculty if you find that a particular student is consistently underperforming, pay special attention to slow-learners and be open to the feedback and comments from the students and faculty.

(iv) After the tutorial session you may be required to grade the tutorials/assignments/tests. Make sure that you work out the solutions to the questions yourself, and compare it with the answer key, think and work out possible alternate solutions to the same question, understand the marking scheme from the teacher. Consult the teacher and make sure that you are not partial to some student/students while grading. Follow basic ethics.

Handling a laboratory Session:

(i) Meet the faculty – in- charge a few days in advance of the actual lab class and get the details of the experiment, get clarifications from him/her regarding all aspects of the experiment and the expectations, prepare by reading about the theoretical background of the experiment, know the physical concepts involved in the experiment, go to the laboratory and check out the condition of the equipment/instrumentation, perform the laboratory experiment at least once one or two days before the actual laboratory class, familiarize with safety/ security aspects of the experiment / equipment/laboratory, prepare an instruction sheet for the experiment in consultation with the faculty, and keep sufficient copies ready for distribution to students for their reference.

(ii) Verify condition of the equipment/set up about 30 minutes before the students arrive in the class and be ready with the hand outs, make brief introductory remarks about the experiment, its importance, its relevance to the theory they have studied in the class, ask the students suitable questions to know there level of preparation for the experiment, discuss how to interpret results, ask them comment on the results.

(iii) Correct/evaluate/grade the submitted reports after receiving suitable instructions from the faculty in charge, continue to interact with students if they have any clarifications regarding any aspect of the laboratory session, including of course grading, Carefully observe instrument and human safety in laboratoryclass, Preparing simple questions for short oral quizzing during explanation of experiments enables active participation of students, facilitate attention, provides feedback and formative evaluation.

POINTS TO REMEMBER

1. Arrange an awareness programme to all M.Tech students on day 1 regarding the curriculum and the regulation.
2. The departments should prepare the list of MOOC courses suitable to their programmes and encourage the students to complete at the earliest.

3. Make a tie up with industries by the middle of semester for Industry Integrated Course. While choosing the course, it should be ensured that the programme is relevant and updated in that discipline. The Industry expert handling the course shall be a postgraduate degree holder. The evaluation procedure shall also be clearly explained to them.
4. Each department offering M.Tech programme should be careful in selecting the mini project in semester 2.
5. The departments should invite the Industries/research organizations during first semester and inform them about the mandatory 16 weeks internship that the students should undergo after their second semester. The possibility of doing their dissertation at the Industry shall also be explored. They shouldalso be made aware about the evaluation procedure of the Internships. Theymay also be informed that it is possible to continue internship provided if it leads to their dissertation. Proposals may be collected from them for allottingto students according to their fields of interest.
6. Make sure that all internal evaluations and the end semester examinations to be conducted by the college are carried out as per the evaluation procedure listed in the curriculum. Any dilution from the prescribed procedure shall be viewed seriously.
7. Teaching assistance shall be assigned to all students as per the curriculum. However, a TA shall not be employed as a substitute instructor, where the effect is to relieve the instructor of his or her teaching responsibilities.
8. The possible TA responsibilities include the following: facilitate a discussionsection or tutorial for a theory/ course, facilitate to assist the students for a laboratory course, serve as a mentor for students, and act as the course web-master.

MAR ATHANASIUS COLLEGE OF ENGINEERING

Government Aided, Autonomous Institution
Kothamangalam, Kerala, India

M.Tech
Computer Science and Engineering

SEMESTER 1

SYLLABUS

SEMESTER 1

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A	M26CS1D101	COMPUTATIONAL INTELLIGENCE	3-0-3-6	6	5
B	M26CS1D102	ADVANCED MACHINE LEARNING	3-0-3-6	6	5
C	M26CS1T103	ADVANCED DATA STRUCTURES AND ALGORITHMS	4-0-0-5	4	4
D	M26CS1E104x	PROGRAMME ELECTIVE I	4-0-0-5	4	4
J	M26GE1R105	RESEARCH METHODOLOGY & IPR	2-0-0-4	2	2
TOTAL				**22**	**20**

PROGRAMME ELECTIVE I

COURSE NO.	**COURSES**
M26CS1E104A	ADVANCED COMPUTER NETWORKS
M26CS1E104B	CRYPTOGRAPHY & QUANTUM COMPUTING
M26CS1E104C	COMPUTATIONAL BIOLOGY
M26CS1E104D	GPU ARCHITECTURES
M26CS1E104E	DRONE TECHNOLOGY

Teaching Assistance : 8 Hours
Self-study: 26 Hours

M26CS1D101	Computational Intelligence	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	0	3	6	5	2026

Preamble

This course introduces students to computational intelligence techniques, including fuzzy logic, neural networks, and evolutionary algorithms. It focuses on applying these methods to practical engineering problems, optimization, and system modeling, while incorporating sustainability and SDG-aligned considerations.

Prerequisites

Nil

Course Outcomes

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

CO 1	Apply fuzzy logic principles to model uncertain systems by designing membership functions, fuzzy rule-based systems, and fuzzy controllers for real-world applications.**(Cognitive Level: Apply)**
CO 2	Design and implement evolutionary algorithms such as Genetic Algorithms, Evolution Strategies, and Differential Evolution to solve optimization problems using appropriate encoding, fitness evaluation, and genetic operators. **(Cognitive Level: Apply / Analysis)**
CO 3	Evaluate and develop optimization solutions using multi-objective optimization techniques and swarm intelligence methods like PSO and ACO, with analysis of Pareto optimality and system performance. **(Cognitive Level: Apply)**
CO 4	Implement, analyze, and evaluate computational intelligence techniques including fuzzy systems, evolutionary algorithms, and multi-objective optimization using MATLAB/Python tools to solve real-world problems and assess system performance. **(Cognitive Level: Apply)**

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand			
Apply	70	70	70
Analyse	30	30	30
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Theory Evaluation	:	30 marks
Self-study (Course based task/Seminar/ Quiz/ Micro project)	:	10 marks
Test paper 1	:	10 marks
Test paper 2	:	10 marks
Lab Evaluation	:	30 marks
Lab work	:	10 marks
Final evaluation Test	:	20 marks

(Note: 50% of Module 1, 2 and 3 may be considered for each test)

End Semester Examination Pattern

The end semester examination should be conducted by the college. The time duration will be 2 Hrs and will contain 6 questions from first three modules, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions

SYLLABUS

MODULE 1 (11 hours)

Foundations of Computational Intelligence & Fuzzy Logic:

Introduction to Computational Intelligence Paradigms- Fuzzy Logic, Evolutionary Computing, Swarm Intelligence,Applications and challenges. Fundamentals of Fuzzy Logic- Fuzzy sets and membership functions, Features of membership functions.
Operations and Representation- Operations on fuzzy sets, Linguistic variables and hedges, Fuzzy relations and compositional rule of inference. Fuzzy Rule-Based Systems- Fuzzy If–Then rules, rule aggregation, Fuzzification and defuzzification. Fuzzy Systems and Applications- Fuzzy modelling: structure and parameter identification, Fuzzy control systems and controller design.

MODULE 2 (8 hours)

Evolutionary Computing:

Fundamentals of Evolutionary Computing- Chromosome representation, encoding schemes,

population, Fitness functions and scaling. Genetic Operators- Selection, crossover, mutation. Evolutionary Algorithms- Genetic Algorithms, Genetic Programming, Evolution Strategies, Differential Evolution.

MODULE 3 (11 hours)

Advanced Optimization:

Multi-objective optimization problems: principles of multi-objective optimization, dominance, and Pareto optimality. Biological self-organization and swarm intelligent systems: background and fundamentals. Ant Colony Optimization (ACO): biological inspiration, development of ant colony systems, working mechanism, pheromone updating, and types of ant systems; ACO algorithms for the Traveling Salesman Problem (TSP). Particle Swarm Optimization (PSO). Grey Wolf Optimization (GWO).

MODULE 4 (30 hours)

List of Experiments / Exercises

1. Introduction to MATLAB/Python tools for CI
2. Implement basic fuzzy set operations (union, intersection, complement), design and visualize different membership functions (Triangular, Trapezoidal, Gaussian, Bell-shaped, Sigmoidal), and analyze their key features such as support, core, and crossover points.
3. Design a fuzzy rule-based system for a real-world problem (e.g., temperature control or traffic signal control).
4. Implement a complete fuzzy inference system (Mamdani and Sugeno) and compare their outputs for the same input.
5. Design a fuzzy controller (e.g., speed/temperature control) and evaluate system performance.
6. Solve an optimization problem (e.g., TSP or path planning) using a Genetic Algorithm.
7. Implement Differential Evolution (DE) and compare its performance with GA.
8. Perform multi-objective optimization using a suitable evolutionary algorithm and visualize the Pareto front.
9. Simulate a real-world optimization problem (e.g., resource allocation or scheduling) using evolutionary techniques and evaluate convergence.
10. Solve a path optimization problem using Ant Colony Optimization (ACO) and visualize the optimal path.

11. Implement Artificial Bee Colony (ABC) algorithm for solving a numerical optimization problem and analyze convergence behavior.
12. Apply Grey Wolf Optimizer (GWO) for solving a benchmark optimization problem and evaluate its performance.
13. Compare the performance of swarm intelligence algorithms (ACO/ABC/GWO) with evolutionary algorithms (GA/DE) for a given optimization problem.

Text Books

1. Dilip K. Pratihar, *Soft Computing and AI: Fundamentals and Applications*, Narosa Publishing House, 2025.
2. Andries P. Engelbrecht, *Computational Intelligence: An Introduction*, 2007.
3. S.N. Sivanandam and S.N. Deepa, *Principles of Soft Computing*, 2nd Edition, John Wiley & Sons, 2011.
4. Kalyanmoy Deb, *Multi-objective Optimization using Evolutionary Algorithms*, 1st Edition, John Wiley & Sons, 2009.

Reference Books

1. Timothy J. Ross, *Fuzzy Logic with Engineering Applications*, John Wiley & Sons, 2016.
2. T.S. Rajasekaran and G.A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic & Genetic Algorithms: Synthesis and Applications*, Prentice-Hall India.
3. Simon Haykin, *Neural Networks: A Comprehensive Foundation*, 2nd Edition, Pearson Education.
4. H.J. Zimmermann, *Fuzzy Set Theory and Its Applications*, Allied Publishers Ltd.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	60 Hours

Module 1: Foundations of Computational Intelligence & Fuzzy Logic (11 hours)		
1.1	Introduction to Computational Intelligence Paradigms	1
1.2	Fuzzy Logic, Evolutionary Computing, Swarm Intelligence	1
1.3	Applications and challenges of Computational Intelligence	1
1.4	Fundamentals of fuzzy sets and membership functions	1
1.5	Types of membership functions and their features	1
1.6	Operations on fuzzy sets	1
1.7	Linguistic variables, hedges, and fuzzy relations	1
1.8	Compositional rule of inference	1
1.9	Fuzzy If–Then rules and rule aggregation	1
1.10	Fuzzification and defuzzification methods	1
1.11	Fuzzy modelling and fuzzy control systems	1
Module 2: Evolutionary Computing (8 hours)		
2.1	Fundamentals of Evolutionary Computing	1
2.2	Chromosome representation and encoding schemes	1
2.3	Population initialization and fitness functions	1
2.4	Selection methods	1
2.5	Crossover operators	1
2.6	Mutation operators	1
2.7	Genetic Algorithms and Genetic Programming	1
2.8	Evolution Strategies and Differential Evolution	1
Module 3: Advanced Optimization (11 hours)		
3.1	Multi-objective optimization: concepts and principles	1
3.2	Dominance and Pareto optimality	1
3.3	Biological self-organization and swarm intelligence	1
3.4	Ant Colony Optimization: biological inspiration	1
3.5	Development and working of Ant Colony Systems	1
3.6	Pheromone updating and types of ant systems	1
3.7	ACO algorithms for Traveling Salesman Problem (TSP)	1
3.8	Particle Swarm Optimization: concepts and working	1
3.9	PSO algorithm and applications	1

3.10	Grey Wolf Optimization: principles and hierarchy	1
3.11	GWO algorithm and applications	1
Module 4: Laboratory / Experiments (30 hours)		
4.1	Introduction to MATLAB/Python tools for Computational Intelligence	2
4.2	Implement fuzzy set operations and membership functions	3
4.3	Design a fuzzy rule-based system	2
4.4	Implement Mamdani and Sugeno fuzzy inference systems	3
4.5	Design and evaluate a fuzzy controller	2
4.6	Solve optimization problems using Genetic Algorithm	3
4.7	Implement Differential Evolution and compare with GA	2
4.8	Multi-objective optimization and Pareto front visualization	3
4.9	Real-world optimization using evolutionary techniques	2
4.10	Path optimization using Ant Colony Optimization	2
4.11	Artificial Bee Colony algorithm implementation	2
4.12	Grey Wolf Optimizer implementation	2
4.13	Performance comparison of optimization algorithms	2

MODEL QUESTION PAPER

QP CODE: **Pages: 1**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

First SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1D101

Course Name: Computational Intelligence

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Define Computational Intelligence. Explain different paradigms such as Fuzzy Logic, Evolutionary Computing and Swarm Intelligence. (5)
   (b) Explain applications and challenges of Computational Intelligence with suitable examples. (5)
2. (a) Explain fuzzy sets and membership functions. Illustrate with suitable examples. (5)
   (b) Describe different types of membership functions (Triangular, Trapezoidal, Gaussian) with diagrams. (5)
3. (a) Explain operations on fuzzy sets (union, intersection, complement) with examples. (5)
   (b) Discuss linguistic variables and hedges. Explain their role in fuzzy systems. (5)
4. (a) Explain fuzzy relations and compositional rule of inference. (5)
   (b) Describe fuzzification and defuzzification methods with examples. (5)
5. (a) Explain Genetic Algorithms with flowchart and working principle. (5)
   (b) Describe selection, crossover and mutation operators in evolutionary algorithms. (5)
6. (a) Explain Differential Evolution and compare it with Genetic Algorithm. (5)
   (b) Discuss multi-objective optimization, dominance and Pareto optimality with examples. (5)

M26CS1D102	ADVANCED MACHINE LEARNING	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	0	3	6	5	2026

Preamble

This course develops advanced analytical and computational skills for designing robust machine learning solutions to complex engineering problems. It covers statistical learning theory, advanced optimization methods, kernel-based learning, ensemble techniques, probabilistic graphical models, and sequential decision-making frameworks. After completing the course, students will be able to design efficient learning frameworks, implement advanced algorithms, evaluate model performance, and apply machine learning techniques to real-world applications.

Prerequisites

Fundamentals of Machine Learning, Probability and Statistics, Linear Algebra, and proficiency in programming using Python or similar scientific computing environments.

Course Outcomes

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

CO 1	Apply principles of statistical learning theory and advanced optimization techniques to formulate and solve machine learning model training problems. (Cognitive Knowledge Level: Apply)
CO 2	Analyze and implement kernel-based learning algorithms, support vector machines, and ensemble methods for building accurate predictive models. (Cognitive Knowledge Level: Analyze)
CO 3	Apply probabilistic graphical models and sequential probabilistic frameworks to model uncertainty and perform structured inference in complex systems. (Cognitive Knowledge Level: Apply)
CO 4	Analyze sequential decision-making problems and implement Markov Decision Process–based solutions using dynamic programming and reinforcement learning techniques. (Cognitive Knowledge Level: Analyze)

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	-	-	-
Understand	20	20	20
Apply	60	60	60
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Theory Evaluation	:	30 marks
Self-study (Course based task/Seminar/ Quiz/ Micro project)	:	10 marks
Test paper 1	:	10 marks
Test paper 2	:	10 marks
Lab Evaluation	:	30 marks
Lab work	:	10 marks
Final evaluation Test	:	20 marks

(Note: 50% of Module 1, 2 and 3 may be considered for each test)

End Semester Examination Pattern

The end semester examination should be conducted by the college. The time duration will be 2 Hrs and will contain 6 questions from first three modules, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions

SYLLABUS

MODULE 1 (10 hours)

Statistical Learning Theory and Advanced Optimization

Foundations of statistical learning: risk minimization framework, empirical risk minimization, bias–variance decomposition. Advanced parameter estimation: regularized Maximum Likelihood and Bayesian estimation. Advanced optimization techniques: stochastic gradient descent, momentum methods.

MODULE 2 (10 hours)

Advanced Kernel Methods and Ensemble Learning

Kernel methods: kernel trick, similarity measures, kernel ridge regression. Support Vector Machines: Support Vector Regression, one-class SVM for novelty detection. Ensemble learning methods: bagging, random forests, boosting frameworks, gradient boosting machines, XGBoost.

MODULE 3 (10 hours)

Probabilistic Graphical Models and Sequential Learning

Probabilistic graphical models: Bayesian Networks, conditional independence, exact inference methods. Sequential probabilistic models: Markov chains, Hidden Markov Models. Sequential decision processes: Bellman equations, value iteration, Q-learning.

MODULE 4 (30 hours)

List of Experiments

1. Implement Stochastic Gradient Descent with Momentum for parameter estimation and compare convergence behavior.
2. Implement Regularized Maximum Likelihood Estimation for a probabilistic model and analyze the effect of regularization.
3. Implement Kernel Ridge Regression and compare performance with Linear Ridge Regression.
4. Implement Support Vector Regression using different kernel functions and analyze parameter sensitivity.
5. Implement One-Class SVM for novelty detection in a real-world dataset.
6. Implement Random Forest and Gradient Boosting models and compare performance using cross-validation.
7. Implement XGBoost for classification and study feature importance measures.
8. Construct a Bayesian Network for a given dataset and perform probabilistic inference.
9. Implement Hidden Markov Model for sequence modeling and perform decoding using the Viterbi algorithm.
10. Implement a reinforcement learning agent using Q-learning to solve a sequential decision-making problem.

Text Books

1. Carl E. Rasmussen & Christopher K. I. Williams — Gaussian Processes for Machine Learning, The MIT Press
2. Kevin P. Murphy — Probabilistic Machine Learning: Advanced Topics, The MIT Press
3. Richard S. Sutton & Andrew G. Barto — Reinforcement Learning: An Introduction, MIT Press

4. Moritz Hardt & Benjamin Recht — Patterns, Predictions, and Actions: A Story About Machine Learning, arXiv
5. Avrim Blum, John Hopcroft & Ravindran Kannan — Foundations of Data Science, Cambridge University Press
6. Christopher M. Bishop — Pattern Recognition and Machine Learning, Springer

Reference Books

1. Daphne Koller & Nir Friedman — Probabilistic Graphical Models: Principles and Techniques, MIT Press
2. Trevor Hastie, Robert Tibshirani & Jerome Friedman — The Elements of Statistical Learning, Springer
3. Yoshua Bengio, Ian J. Goodfellow & Aaron Courville — Deep Learning, MIT Press
4. Allen B. Downey — Think Bayes: Bayesian Statistics in Python, O'Reilly/Green Tea Press
5. Allen B. Downey — Think Stats: Exploratory Data Analysis in Python, O'Reilly/Green Tea Press
6. Tor Lattimore & Csaba Szepesvári — Bandit Algorithms for Website Optimization, Cambridge University Press

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	60 Hours
Module 1: Statistical Learning Theory and Advanced Optimization (10 hours)		
1.1	Foundations of statistical learning: Risk minimization framework	2
1.2	Empirical risk minimization	1
1.3	Bias–variance decomposition	1
1.4	Advanced parameter estimation: Regularized Maximum Likelihood	2
1.4	Bayesian estimation	1

1.4	Advanced optimization techniques: Stochastic gradient descent	2
1.5	Momentum methods	1
Module 2: Advanced Kernel Methods and Ensemble Learning (10 hours)		
2.1	Kernel trick and Similarity measures	1
2.2	Kernel Ridge Regression	1
2.3	Support Vector Machines: Support Vector Regression	2
2.4	One-class SVM for novelty detection	1
2.5	Ensemble learning: bagging, random forests and	2
2.6	Boosting frameworks	1
2.7	Gradient boosting machines, XGBoost	2
Module 3: Probabilistic Graphical Models and Sequential Learning (10 hours)		
3.1	Bayesian Networks	2
3.2	Conditional independence	1
3.3	Exact inference methods in graphical models	1
3.4	Markov chains	1
3.5	Hidden Markov Models	2
3.6	Bellman equations	1
3.7	Value iteration and Q-learning	2
Module 4: Advanced Machine Learning Laboratory (30 hours)		
4.1	Implement Stochastic Gradient Descent with Momentum for parameter estimation and compare convergence behavior	3
4.2	Implement Regularized Maximum Likelihood Estimation for a probabilistic model and analyze the effect of regularization	3
4.3	Implement Kernel Ridge Regression and compare performance with Linear Ridge Regression	3
4.4	Implement Support Vector Regression using different kernel functions and analyze parameter sensitivity	3
4.5	Implement One-Class SVM for novelty detection in a real-world dataset	3
4.6	Implement Random Forest and Gradient Boosting models and compare performance using cross-validation	3

4.7	Implement XGBoost for classification and study feature importance measures	3
4.8	Construct a Bayesian Network for a given dataset and perform probabilistic inference	3
4.9	Implement Hidden Markov Model for sequence modeling and perform decoding using the Viterbi algorithm	3
4.10	Implement a reinforcement learning agent using Q-learning to solve a sequential decision-making problem	3

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1D102

Course Name: ADVANCED MACHINE LEARNING

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Explain the bias–variance decomposition and its role in model generalization. (5)

   (b) For a model with training error 0.02 and validation error 0.15, analyse the bias–variance characteristics and suggest suitable regularization strategies within the risk minimization framework. (5)

2. (a) Apply stochastic gradient descent with momentum to minimize a given loss function and analyse its convergence behaviour for large-scale learning. (5)

   (b) Consider the loss function $L(w) = w^2+4w+4$. Starting from $w_0 = 2$, perform two iterations of stochastic gradient descent with learning rate $\eta = 0.1$ and momentum coefficient 0.9. (5)

3. (a) Explain the kernel trick and the role of similarity measures in kernel-based learning. (5)

   (b) A nonlinear regression dataset is given. Design a Support Vector Regression model using an appropriate kernel and justify the kernel choice based on data characteristics. (5)

4. (a) Compare bagging, random forests, and boosting frameworks in ensemble learning with suitable examples. (5)

   (b) A classification dataset is provided with high variance. Design a Random Forest model and justify parameter choices. Compare expected performance with Gradient Boosting and XGBoost. (5)

5. (a) Using probability rules, show how conditional independence simplifies joint probability computation in Bayesian Networks. (5)

   (b) A Bayesian Network has three variables $A \rightarrow B \rightarrow C$. Given probabilities $P(A)$, $P(B|A)$, and $P(C|B)$, derive the joint probability $P(A, B, C)$ and compute posterior probability $P(A|C)$. (5)

6. (a) Explain Markov chains and Hidden Markov Models with suitable examples. (5)

   (b) For a Markov Decision Process with reward $R(s, a)$ and discount factor $\gamma = 0.9$, formulate the Bellman optimality equation. Illustrate how Q-learning updates action values for a grid-world navigation task. (5)

M26CS1T103	ADVANCED DATA STRUCTURES AND ALGORITHMS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

The course introduces advanced data structures and algorithms in different domains. The goal of this course is to provide a solid background in the design and analysis of the major classes of algorithms. The course helps the learners to develop their own versions for a given computational task and to compare and contrast their performance.

Prerequisites

Data Structures and Algorithms

Course Outcomes

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

CO 1	Analyze the relevance and applications of amortized analysis in optimizing algorithm performance and illustrate efficient string matching techniques (Cognitive Level: Apply)
CO 2	Illustrate advanced data structures like Binomial heap, Fibonacci heap, Disjoint set (Cognitive Level: Apply)
CO 3	Illustrate network flow algorithms and applications. (Cognitive Level: Apply)
CO 4	Analyze computational geometry using convex hull techniques and understand NP-Complete problems through reducibility, including vertex-cover, traveling salesman, set-covering, and subset-sum problems. (Cognitive Level: Analyze)

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	-	-	-
Understand	20	20	20
Apply	60	60	60
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/
Data collection and interpretation/
Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

SYLLABUS

MODULE 1 (11 hours)

Asymptotic Analysis and String Matching Algorithms:

Overview of asymptotic notations and complexity analysis, Amortized analysis – aggregate analysis, accounting method, potential method. String matching – introduction, Rabin-Karp algorithm, Knuth-Morris-Pratt algorithm, Boyer Moore Algorithms.

MODULE 2 (9 hours)

Advanced Heap Structures and Disjoint Set Data Structures:

Overview of binary heap operations, Binomial tree and heap, Binomial heap operations, Fibonacci heap structure, Fibonacci heap operations, Disjoint set – overview, linked list representation, disjoint set forests.

MODULE 3 (10 hours)

Network Flow:

Network flow properties, examples, residual network, augmenting path, cut of network,maxflow-mincut theorem, Ford-Fulkerson algorithm, Edmonds-Karp algorithm, Layered Network, MPM algorithm, Maximum Bipartite matching, Application of Network Flow.

MODULE 4 (10 hours)

Computational Geometry and NP-Complete Problems:

Computational Geometry - convex hull - NP Hard and NP Complete problems,Art Gallery Problem, Vertex-cover problem, Traveling-salesman problem, Set-covering problem, Subset-sum problem.

Text Books

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, "Introduction to Algorithms", MIT Press, 3rd edition, 2009.
2. H. S. Wilf, "Algorithms and Complexity", Prentice Hall.

Reference Books

1. Gilles Brassard and Paul Bratley, "Fundamentals of algorithms", Prentice-hall of India Private Limited, 2001.
2. Rajeev Motwani, Prabhakar Raghavan, "Randomized Algorithms", Cambridge University Press, 2000.
3. Dexter C. Kozen, "The Design and Analysis of Algorithms", Springer.
4. Jon Kleinberg and Eva Tardos, "Algorithm Design", Pearson Education, 2006.
5. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Second Edition, Universities Press, Reprint 2017.
6. Subrahmanian, "Principles of Multimedia Database systems", First Edition, Elsevier, 2008

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	40 Hours
Module 1: Asymptotic Analysis and String Matching Algorithms: (11 hours)		
1.1	Overview of asymptotic notations and complexity analysis	1
1.2	Overview of asymptotic notations and complexity analysis	1
1.3	Amortized analysis – aggregate analysis	1
1.4	Accounting method	1
1.5	Potential method	1
1.6	String matching – introduction	1
1.7	Rabin-Karp algorithm	1
1.8	Knuth-Morris-Pratt algorithm	1
1.9	Knuth-Morris-Pratt algorithm	1
1.10	Boyer Moore algorithms.	1
1.11	Boyer Moore algorithms.	1
Module 2: Advanced Heap Structures and Disjoint Set Data Structures: (9 hours)		
2.1	Overview of binary heap operations	1

2.2	Binomial tree and heap	1
2.3	Binomial heap operations	1
2.4	Binomial heap operations	1
2.5	Fibonacci heap structure	1
2.6	Fibonacci heap operations	1
2.7	Fibonacci heap operations	1
2.8	Disjoint set – overview, linked list representation	1
2.9	Disjoint set forests	1
Module 3:Network Flow: (10 hours)		
3.1	Network flow properties and example	1
3.2	Residual network, augmenting path, cut of network	1
3.3	Maxflow-mincut theorem	1
3.4	Ford-Fulkerson algorithm	1
3.5	Edmonds-Karp algorithm	1
3.6	Edmonds-Karp algorithm	1
3.7	Layered Network	1
3.8	MPM Algorithm	1
3.9	Maximum bipartite matching	1
3.10	Applications of network flow	1
Module 4: Computational Geometry and NP-Complete Problems: (10 hours)		
4.1	Computational Geometry - convex hull	1
4.2	NP Hard and NP Complete problems	1
4.3	Art Gallery Problem	1
4.4	Vertex-cover problem	1
4.5	Traveling-salesman problem	1
4.6	Traveling-salesman problem	1
4.7	Set-covering problem	1
4.8	Set-covering problem	1
4.9	Subset-sum problem	1
4.10	Subset-sum problem	1

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1T103

Course Name:ADVANCED DATA STRUCTURES AND ALGORITHMS

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Describe the potential method of amortized analysis. Compare it with the accounting method using a suitable example. (6)
   (b) What is the prefix function in the Knuth-Morris-Pratt algorithm? Explain briefly. (4)
2. (a) Explain the structure and properties of Fibonacci heap. (6)
   (b) What is the advantage of Fibonacci heap over binomial heap (4)
3. (a) Explain the structure of a Fibonacci heap. Apply the extract minimum operation on the Fibonacci heap shown in the figure and show the result. (6)
   (b) Differentiate between min heap and max heap. (4)
4. (a) Maximum matching in a bipartite graph G corresponds to a maximum flow in its corresponding flow network G'. Comment on this statement. Explain how the maximum f low problem can be used to solve the maximum bipartite matching problem (4)
   (b) Describe the Ford-Fulkerson algorithm and apply it to the following network. Also, obtain the minimum cut across the network. (6)
5. (a) A city wants to install cameras at road intersections such that every road is monitored. Explain how this situation can be modeled and solved using graph theory concepts. (6)
   (b) Explain the approximation algorithm for the traveling salesperson problem. (4)
6. (a) Describe Knuth-Morris-Pratt algorithm and illustrate using given text T = AABAACAADAABAABA and pattern P = AABA (5)
   (b) Compare any two string matching algorithms briefly. (5)

M26CS1E104A	ADVANCED COMPUTER NETWORKS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

This course provides an in-depth understanding of advanced networking concepts, including modern architectures, protocols, security mechanisms and emerging technologies. It enables students to design, analyze, and optimize complex network systems for high performance and reliability. The course also equips learners with the skills required for research and innovation in next-generation networking domains.

Prerequisites

Basic understanding of computer networking concepts including OSI and TCP/IP models, familiarity with data communication principles and knowledge of fundamental programming concepts.

Course Outcomes

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

CO 1	Explain advanced network architectures and protocols, and analyze the role of SDN and NFV in modern networking environments (Cognitive Knowledge Level: Understand)
CO 2	Apply advanced routing and traffic engineering techniques to network scenarios, and analyze their impact on performance and QoS (Cognitive Knowledge Level: Apply)
CO 3	Evaluate network security threats and mechanisms, and analyze the effectiveness of security protocols in protecting communication systems(Cognitive Knowledge Level: Evaluate)
CO 4	Examine emerging networking technologies and analyze their challenges and potential applications in next-generation networks(Cognitive Knowledge Level: Evaluate)

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	-	-	-
Understand	20	20	20
Apply	60	60	60
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/
Data collection and interpretation/
Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

SYLLABUS

MODULE 1 (10 hours)

Advanced Network Architecture and Protocols :

Review of OSI and TCP/IP models and their limitations, evolution of modern network architectures, high-speed network requirements, data center networks and their design, Fat-tree and Clos topologies, Software Defined Networking (SDN) concepts, SDN architecture and components, OpenFlow protocol and its operation, Network Function Virtualization (NFV), advanced transport protocols including QUIC and SCTP

MODULE 2 (10 hours)

Routing, Switching and Traffic Engineering:

Advanced routing concepts, link-state routing and OSPF, path-vector routing and BGP, inter-domain and policy-based routing, Multi-Protocol Label Switching (MPLS), traffic engineering techniques, Quality of Service using IntServ model, Quality of Service using DiffServ model, load balancing techniques, routing in data center and cloud environments.

MODULE 3 (10 hours)

Network Security and Privacy:

Network security fundamentals, cryptographic techniques in networking (symmetric and asymmetric cryptography, authentication and key management), IPsec protocol, SSL/TLS protocols, distributed denial-of-service attacks and spoofing, man-in-the-middle attacks, intrusion detection systems, intrusion prevention systems, firewalls and next-generation firewalls, privacy and anonymity in communication networks.

MODULE 4 (10 hours)

Emerging Trends in Networking:

Internet of Things (IoT) architecture and networking, IoT protocols and challenges, 5G network architecture and key features, emerging trends beyond 5G (6G), edge and fog computing, cloud networking and virtualization, applications of AI and ML in networking, future Internet architectures Content- Centric Networking (CCN) and Delay-Tolerant Networking (DTN).

Text Books

1. James F. Kurose and Keith W. Ross Computer Networking: A Top-Down Approach Publisher: Pearson Education Year: 2021 (8th Edition)
2. Machine Learning for Networking Author: Brunilde Sansò Publisher: Wiley Year: 2019

Reference Books

1. Software Defined Networking: A Comprehensive Approach Author: Paul Goransson, Chuck Black Publisher: Morgan Kaufmann Year: 2016
2. Cloud Computing: Concepts, Technology Architecture Author: Thomas Erl Publisher: Pearson Year: 2013
3. Internet of Things: A Hands-On Approach Author: Arshdeep Bahga, Vijay Madisetti Publisher: Universities Press Year: 2015
4. Larry L. Peterson and Bruce S. Davie Computer Networks: A Systems Approach Publisher: Morgan Kaufmann (Elsevier) Year: 2021 (6th Edition)
5. Data Communications and Networking Publisher: McGraw Hill Year: 2022 (6th Edition)
6. William Stallings Data and Computer Communications Publisher: Pearson Education Year: 2017 (10th Edition)
7. Andrew S. Tanenbaum, Nick Feamster David J. Wetherall Computer Networks Publisher: Pearson Education Year: 2022 (6th Edition)
8. Rajkumar Buyya and Satish Narayana Srirama (Eds.), Fog and Edge Computing: Principles and Paradigms, Wiley, 2019.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	40 Hours
Module 1: Advanced Network Architecture and Protocols (10 hours)		
1.1	Review of layered architecture: OSI and TCP/IP models	1
1.2	Evolution of modern network architectures	1
1.3	High-speed networks	1
1.4	Data Center Networks (DCN)	1
1.5	DCN architectures (Fat-tree, Clos)	1
1.6	Introduction to SDN	1
1.7	SDN architecture and components	1
1.8	OpenFlow protocol and its operation	1
1.9	Network Function Virtualization (NFV)	1
1.10	Advanced transport protocols (QUIC, SCTP)	1
Module 2: Routing, Switching and Traffic Engineering (10 hours)		
2.1	Advanced routing concepts	1
2.2	Link-state routing (OSPF)	1
2.3	Path-vector routing (BGP)	1
2.4	Multi protocol Label Switching	1
2.5	Traffic engineering concepts	1
2.6	QoS IntServ	1
2.7	QoS DiffServ	1
2.8	Load balancing techniques	1
2.9	Routing in data center and cloud environments	2
Module 3: Network Security and Privacy (10 hours)		
3.1	Network security fundamentals	1
3.2	Cryptographic techniques in networking (symmetric and asymmetric cryptography, authentication and key management)	1
3.3	IPsec protocol	1

3.4	SSL/TLS protocols	1
3.5	DDoS and spoofing attacks	1
3.6	MITM Attack	1
3.7	Intrusion Detection Systems	1
3.8	Intrusion Prevention Systems	1
3.9	Firewalls and next-generation firewalls	1
3.10	Privacy and anonymity in communication networks	1
Module 4: Emerging Trends in Networking (10 hours)		
4.1	IoT architecture and networking	1
4.2	IoT protocols and challenges	1
4.3	5G network architecture and key features	1
4.4	Emerging trends beyond 5G (6G)	1
4.5	Edge and Fog computing	1
4.6	Cloud networking and virtualization	1
4.7	Machine learning techniques for traffic analysis and anomaly detection in networks	2
4.8	Future Internet architectures: Content- Centric Networking (CCN)	1
4.9	Delay-Tolerant Networking (DTN).	1

MODEL QUESTION PAPER

QP CODE: **Pages: 1**

Reg.No.: .....

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MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1E104A

Course Name: ADVANCED COMPUTER NETWORKS

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Explain the limitations of traditional OSI and TCP/IP models in modern networking. (5)
   (b) Analyze the architecture and working of Software Defined Networking. (5)
2. (a) Explain the design and advantages of Fat-tree topology in data center networks. (5)
   (b) Analyze the role of Network Function Virtualization in modern networks. (5)
3. (a) Explain the working of OSPF and BGP routing protocols. (5)
   (b) Analyze the importance of MPLS in traffic engineering. (5)
4. (a) Explain IntServ and DiffServ models for Quality of Service. (5)
   (b) Analyze load balancing techniques in cloud and data center networks. (5)
5. (a) Explain the architecture and working of IPsec protocol. (5)
   (b) Analyze different types of network attacks such as DDoS and MITM. (5)
6. (a) Explain the architecture of 5G networks and its key features. (5)
   (b) Analyze the role of AI/ML in modern networking applications (5)

M26CS2E104B	CRYPTOGRAPHY AND QUANTUM COMPUTING	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

This course provides an advanced treatment of cryptographic theory and practice, focusing on mathematical foundations, provable security, modern symmetric and public-key cryptographic constructions, and emerging paradigms such as quantum computing. The course emphasizes rigorous analysis, protocol design, and evaluation of cryptographic systems under realistic threat models.

Prerequisites

Cryptography, Discrete Mathematics

Course Outcomes

CO 1	Apply number-theoretic foundations to analyse classical cryptosystems and evaluate information-theoretic security measures.
CO 2	Evaluate symmetric cryptographic constructions using provable security models and perform advanced cryptanalysis techniques.
CO 3	Analyse and design advanced public-key cryptographic schemes and secure protocols for real-world applications.
CO 4	Evaluate quantum algorithms and assess their impact on classical cryptographic systems.

Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	-
CO2	3	2	3	2	3	1
CO3	3	3	3	3	3	2
CO4	2	2	3	2	2	2

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	**Test 2 (%Marks)**	
Remember			
Understand			
Apply	70	70	70
Analyse	30	30	30
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/
Data collection and interpretation/
Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

SYLLABUS

MODULE 1 (8 hours)

Mathematical Foundations and Classical Cryptography:

Number theory foundations, Primality testing (Miller-Rabin), Computational complexity classes, Classical ciphers, Cryptanalysis techniques, Entropy, Perfect secrecy, One-time pad, Shannon theory.

MODULE 2 (11 hours)

Advanced Symmetric Cryptography and Provable Security:

Provable security models, Differential and linear cryptanalysis, Authenticated encryption, hash function analysis, Side-channel and fault attacks.

MODULE 3 (12 hours)

Advanced Public Key Cryptography and Protocols:

RSA attacks, Elliptic curve cryptography, Pairing-based cryptography, Digital signatures, Zero-knowledge proofs, MPC, TLS 1.3.

MODULE 4 (9 hours)

Quantum Computing:

Quantum states, gates, circuits, Deutsch-Jozsa, Grover, Shor algorithms, Quantum Key Distribution(QKD), Post-quantum cryptography, Case Study: IBM Quantum Experience using Qiskit

Text Books

1. Jonathan Katz and Yehuda Lindell, *Introduction to Modern Cryptography*, CRC Press, 3rd Edition, 2021.

2. Phillip Kaye, Raymond Laflamme and Michele Mosca, *An Introduction to Quantum Computing*, Oxford University Press, 2007.

Reference Books

1. William Stallings, *Cryptography and Network Security*, Pearson, 8th Edition, 2022.
2. Douglas R. Stinson and Maura Paterson, *Cryptography: Theory and Practice*, CRC Press, 4th Edition, 2018.
3. Michael A. Nielsen and Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press, 2010.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	Hours
	Total Hours	40
Module 1: Mathematical Foundations and Classical Cryptography (8 hrs)		
1.1	Number theory foundations, primality testing (Miller–Rabin), and computational complexity classes	2
1.2	Classical cryptographic techniques and ciphers	2
1.3	Cryptanalysis techniques for classical systems	2
1.4	Information-theoretic security: entropy, perfect secrecy, one-time pad, and Shannon theory	2
Module 2: Advanced Symmetric Cryptography and Provable Security (11 hrs)		
2.1	Provable security models and formal definitions	2
2.2	Differential cryptanalysis and attack strategies	3
2.3	Linear cryptanalysis techniques	2
2.4	Authenticated encryption and hash function analysis	2
2.5	Side-channel and fault attacks in cryptographic systems	2
Module 3: Advanced Public Key Cryptography and Protocols (12 hrs)		
3.1	RSA cryptosystem and common attacks	2
3.2	Elliptic Curve Cryptography (ECC)	3
3.3	Pairing-based cryptography	2
3.4	Digital signatures and Zero-Knowledge Proofs (ZKP)	3
3.5	Multi-Party Computation (MPC) and TLS 1.3 protocol	2
Module 4: Quantum Computing and Cryptography (9 hrs)		

4.1	Quantum computing fundamentals: states, gates, and circuits	2
4.2	Quantum algorithms: Deutsch–Jozsa, Grover, and Shor algorithms	4
4.3	Quantum Key Distribution (QKD)	1
4.4	Post-quantum cryptography and case study using IBM Quantum Experience (Qiskit)	2

MODEL QUESTION PAPER

QP CODE: **Pages: 4**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS2E104B

Course Name: Cryptography and Quantum Computing

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Illustrate the Miller-Rabin primality test and analyse its probabilistic correctness. (5)
   (b) Examine the concept of perfect secrecy and justify how the one-time pad satisfies Shannon's definition. (5)
2. (a) Analyse the role of entropy in cryptographic security and relate it to information leakage. (5)
   (b) Compare classical cryptanalysis techniques used against substitution and transposition ciphers. (5)
3. (a) Examine differential cryptanalysis and illustrate how it can be applied to block ciphers. (5)
   (b) Interpret provable security models and evaluate their importance in modern symmetric cryptography. (5)
4. (a) Analyse authenticated encryption schemes and justify their necessity over traditional encryption. (5)
   (b) Evaluate side-channel attacks and discuss possible countermeasures. (5)
5. (a) Analyse common attacks on RSA and evaluate their implications on security. (5)
   (b) Illustrate the working principle of elliptic curve cryptography and compare it with RSA. (5)
6. (a) Explain the structure of quantum circuits and demonstrate the working of Grover's algorithm. (5)
   (b) Examine Quantum Key Distribution and discuss its significance in post-quantum cryptography. (5)

M26CS1E104C	COMPUTATIONAL BIOLOGY	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

It covers Bio-molecules- DNA, RNA, Protein and amino acids, RNA processing , Central Dogma Bioinformatics databases, Secondary nucleotide sequence databases. Nature and scope of Computational ,Basic algorithms in Computational Biology has covered in this course. computational biology helps to sequence the human genome, it also helps to create accurate models of the human brain, map the 3D structure of genomes, and model biological systems.

Prerequisites

Nil

Course Outcomes

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

CO 1	Identify Chromosome-Genome-Genes-Databases and RNA processing **(Cognitive Knowledge Level : Understand)**
CO 2	Summarize the Nature and scope of Computational ,Basic algorithms in Computational Biology, and sequence alignment . **(Cognitive Knowledge Level: Apply)**
CO 3	Illustrate Sequence Representation& Analysis.**(Cognitive Knowledge Level: Apply)**
CO 4	Interpret Sequence alignment: Pair-wise sequence alignment.**(Cognitive Knowledge Level: Apply)**

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	2	1	3	-	-	-
CO2	2	2	3	2	2	-
CO3	3	2	3	2	3	2
CO4	3	2	3	3	3	2

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	20	20	20
Apply	60	60	60
Analyse	20	20	20
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/
Data collection and interpretation/
Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

SYLLABUS

MODULE 1 (10 hours)

Chromosome-Genome-Genes-Databases: Bio-molecules- DNA, RNA, Protein and amino acids, Chargaff's Rules, Codon bias, GC content. Central Dogma: Replication, Transcription, Translation, Post transcriptional & post translational modifications, RNA processing, RNA splicing and RNA editing. Sense/coding and anti-sense/template strands, Genetic code, wobble hypothesis. Introduction to DNA and Protein sequencing, Human Genome Project.

MODULE 2 (10 hours)

Introduction to Computational Biology : Nature and scope of Computational Biology ,Basic algorithms in Computational Biology, Introduction to sequence alignment - Local and global, pair wise and multiple, BLAST. Basic file formats: FASTA, GenBank, EMBL, GCG, PIR, Phylip, Nexus file formats etc. Sequence Data Bases, detailed study of GenBank of NCBI- typical Gen Bank (DDBJ+EMBL) for DNA and RNA. , Bioinformatics databases, Type of databases, Nucleotide sequence databases, Primary nucleotide sequence databases,Secondary nucleotide sequence databases.

MODULE 3 (8 hours)

Sequence Representation & Analysis : Basic gene statistics–base counts, word, frequencies, , vector contamination analysis, experiments using Perl scripts, gene finding, splice site recognition, transcription factor binding site identification, SNPs, microsatellite, minisatellite, sequence profiles, sequence logos, sequence chromatograms.

MODULE 4 (12 hours)

Sequence alignment: Pair-wise sequence alignment, Need of Scoring schemes- Penalizing gaps – Linear and Affine gap penalty; Effect of scoring schemes, Scoring matrices for amino acid sequence alignment, PAM Probability matrix- Log odds matrix, BLOSUM, Dot-plot visualization, Smith –Waterman algorithm for local alignment, Needleman-Wunsch algorithm, Statistics of Sequence alignment score: E- values, bit scores and sensitivity, specificity; BLAST and FASTA.
Multiple sequence alignment : Need for MSA, SP measure- n dimensional dynamic programming- Heuristics algorithm for multiple sequence alignment - Progressive alignment, Iterative alignment - Tools for local, global and MSA: Muscle, T-Coffee, and ClustalW. Transcriptomics: Concept of Transcriptome, transcriptome analysis and Gene Expression-An Overview-introduction to microarrays; Types of non-coding RNA's-lncRNAs, miRNAs, piRNAs, siRNAs ceRNAs .

Text Books

1. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor

Laboratory Press, New York. 2004

2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009

3. Introduction to Bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson

Reference Books

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount

2. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, and Graeme Mitchison

3. Computational Biology: An Introduction by R. D. M. Page and E. C. Holmes

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	40 Hours
1	**Module 1**	10 hours
1.1	Bio-molecules- DNA, RNA, Protein and amino acids	2
1.2	Chargaff's Rules, Codon bias, GC content	1
1.3	Central Dogma: Replication, Transcrip- tion, Translation R	1
1.4	Post transcriptional & post translational modifications	1
1.5	RNA processing, RNA splicing and RNA editing.	2
1.6	Sense/coding and anti-sense/template strands	1
1.7	Genetic code, wobble hypothesis	1
1.8	Introduction to DNA and Protein sequencing, Human Genome Project	1
2	**Module 2**	10 hours
2.1	Nature and scope of Computational Biology ,Basic algorithms in Computational Biology	1

2.2	Introduction to sequence alignment - Local and global, pair wise and multiple, BLAST	1
2.3	Basic file formats: FASTA, GenBank,	1
2.4	EMBL, GCG, PIR, Phylip, Nexus file formats etc.	2
2.5	Sequence Data Bases, detailed study of Gen- Bank of NCBI- typical Gen Bank (DDBJ+EMBL) for DNA and RNA.	2
2.6	bioinformatics databases, Type of databases, Nucleotide sequence databases	2
2.7	Primary nucleotide sequence databases,Secondary nucleotide sequence databases.	1
3	**Module 3**	8 hours
3.1	Basic gene statistics–base counts, word, fre- quencies	1
3.2	vector contamination analysis, experiments using Perl scripts	1
3.3	Gene finding, splice site recognition	2
3.4	Transcription factor binding site identification, SNPs	2
3.5	Microsatellite, min- isatellite	1
3.6	Sequence profiles, sequence logos, sequence chromatograms	1
Module 4: Proteomics (9 hours)		
4	**Module 4**	12 hours
4.1	Pair-wise sequence alignment, Need of Scoring schemes	1
4.2	Penalizing gaps – Linear and Affine gap penalty; Effect of scoring schemes	1
4.3	Scoring matrices for amino acid sequence alignment	1
4.4	PAM Probability matrix- Log odds matrix	1
4.5	BLOSUM; Dot-plot vi- sualization	1
4.6	Smith –Waterman algorithm for local alignment, Needleman-Wunsch algorithm,	1
4.7	Statistics of Sequence alignment score: E- values, bit scores and sensitivity, specificity BLAST and FASTA.	1
4.8	Need for MSA, SP measure- n dimensional dynamic programming	1
4.9	Heuristics algorithm for multiple sequence alignment - Progressive alignment,	1

4.10	Progressive alignment, Iterative alignmen, Tools for local, global and MSA, Muscle, T-Coffee, and ClustalW.	1
4.11	Transcriptomics: Concept of Transcriptome, transcriptome analysis and Gene Expression-	1
4.12	An Overview-introduction to microarrays, Types of non-coding RNA's- lncRNAs, miRNAs, piRNAs, siRNAs ceRNAs .	1

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1E104C

Course Name: COMPUTATIONAL BIOLOGY

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Outline the steps of the central dogma of molecular biology, including replication, transcription, and translation. How do these processes ensure the flow of genetic information from DNA to protein? (5 marks)

   (b) Explain the genetic code and its characteristics. How does the wobble hypothesis contribute to the redundancy of the genetic code? (5 marks)

2. (a) Describe the role of basic algorithms in computational biology. Provide an example of a commonly used algorithm and its application. (5 marks)

   (b) Provide a detailed overview of the GenBank sequence database. How does it relate to the DDBJ and EMBL databases, and what are the typical contents of a GenBank record? (5 marks)

3. (a) Explain the role of sequence chromatograms in DNA sequencing. What challenges are involved in interpreting chromatograms, and how are these addressed computationally? (5 marks)

   (b) Compare and contrast microsatellites and minisatellites in terms of structure, function, and their use in genetic studies. How are these elements detected and analyzed computationally? (5 marks)

5. (a) Discuss the computational methods used for splice site recognition. What are the key features of splice sites, and how do algorithms identify these regions? (5 marks)

   (b) How are single nucleotide polymorphisms (SNPs) detected and analyzed in genomic studies? Discuss the impact of SNPs on gene function and their relevance in personalized medicine. (5 marks)

6. (a) Explain the key differences between global and local pair-wise sequence alignment. In what scenarios would you use the Needleman-Wunsch algorithm versus the Smith-Waterman algorithm? (5 marks)

   (b) What are linear and affine gap penalties, and how do they affect the outcome of sequence alignment? Provide an example of when each type of penalty might be preferable. (5 marks)

M26CS1E104D	GPU ARCHITECTURES	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

This course provides a comprehensive introduction to graphics processing units (GPUs), covering their architecture, programming models, and role in parallel computing. It explores both theoretical foundations and practical applications, enabling learners to leverage GPU computing for high-performance tasks in areas like machine learning, scientific computing, and real-time graphics.

Prerequisites

Computer Architecture

Course Outcomes

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

CO 1	Understand the pipeline organization, memory hierarchy, SIMD/SIMT paradigms, and the evolution of GPU architectures and graphics pipelines.(Cognitive Knowledge Level: Understand)
CO 2	Apply the GPU execution model by interpreting kernels, threads, blocks, grids, memory access mechanisms, and architectural components such as GPCs, SMs, warps, and cache hierarchy. (Cognitive Knowledge Level: Apply)
CO 3	Apply the concepts of data parallelism, thread organization, memory management, synchronization, and execution models to implement parallel programs using CUDA and OpenCL. (Cognitive Knowledge Level: Apply)
CO 4	Analyze GPU-based application designs and case studies to identify performance optimization strategies and efficient parallel implementations.(Cognitive Knowledge Level: Analyze)

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	25	25	25
Apply	50	50	50
Analyse	25	25	25
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/
Data collection and interpretation/
Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

SYLLABUS

MODULE 1 (10 hours)

Graphics Processors:

Traditional Computer Architecture - Basic 5-stage pipeline, Caches & Registers, Parallel Programming – Types of Parallelism – SIMD and SIMT, Traditional Technologies (ASIC, ASIP, FPGA), Traditional GPUs – Early days of GPUs, Hogh Level View of a Graphics Pipeline, Vortex Processor, Polymorph Engine, Rasterization, Fragment Processor, Pixel Engine.

MODULE 2 (10 hours)

GPGPUs & Architecture Overview:

Kernels, Threads, Blocks, and Grids,Memory Access, Streams, Graphs, and Events – General Purpose Graphics Processors - Overview of the Architecture of a GPU, Structure of a GPC (Graphics Processing Cluster), Structure of an SM (Streaming Multiprocessor), Concept of a Warp, The GPU Pipeline, The Register File, L1 Caches.

MODULE 3 (10 hours)

GPU Programming:

Introduction to CUDA programming, Data parallelism, CUDA program structure, Device Memories and Data Transfer,Kernel Functions and Threading, CUDA Threads - CUDA Thread Organization, Synchronization and Transparent Scalability, Thread Assignment, Thread Scheduling and Latency Tolerance. Introduction to OpenCL – OpenCL Device Architectures – Basic OpenCL Examples, Understanding OpenCL's Concurrency and Execution Model, Dissecting a CPU/GPU OpenCL Implementation.

MODULE 4 (10 hours)

Applications of GPU Computing:

Application Design : Efficient Neural Network Training/Inferencing. CUDA Case Study: Advanced MRI Reconstruction, Molecular Visualization and Analysis. OpenCL Case studies: Convolution, Video Processing, Histogram and Mixed Particle Simulation.

Text Books

1. Sarangi, S. R. (2021). "Advanced Computer Organization and Architecture". McGraw Hill Education (India).
2. "Computer Architecture – A Quantitative Approach" - John L.Hennessy and David A. Patterson
3. "Programming Massively Parallel Processors" - David Kirk and Wen-mei Hwu
4. Heterogeneous Computing with OpenCL" – Benedict Gaster,Lee Howes, David R. Kaeli

Reference Books

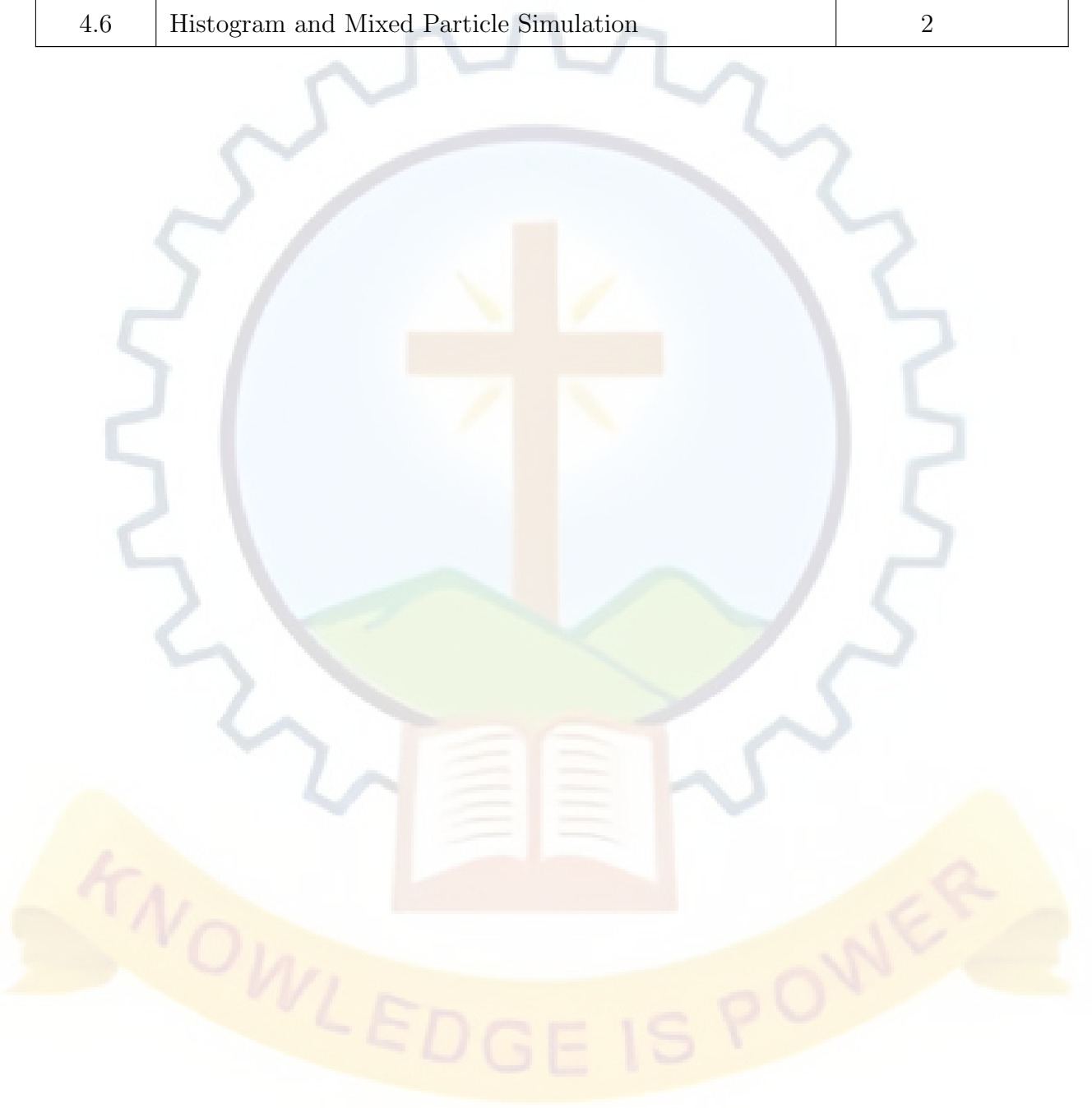
1. Jason Sanders, Edward Kandrot, "CUDA by Example: An Introduction to General-Purpose GPU Programming", Addison-Wesley Professional, 2010
2. Aaftab Munshi, Benedict Gaster, Timothy G. Mattson, James Fung and Dan Ginsburg, "OpenCL Programming Guide", Addison-Wesley Professional, 2011.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	40 Hours
Module 1: Graphics Processors (10 hours)		
1.1	Traditional Computer Architecture - Basic 5-stage pipeline, Caches & Registers	1
1.2	Parallel Programming – Types of Parallelism – SIMD and SIMT	2

1.3	Traditional Technologies (ASIC, ASIP, FPGA)	1
1.4	Traditional GPUs – Early days of GPUs	1
1.5	High Level View of a Graphics Pipeline, Vortex Processor	1
1.6	Polymorph Engine	1
1.7	Rasterization	1
1.8	Fragment Processor	1
1.9	Pixel Engine	1
Module 2: GPGPUs & Architecture Overview (10 hours)		
2.1	Kernels, Threads, Blocks, and Grids	2
2.2	Memory Access, Streams, Graphs, and Events	2
2.3	General Purpose Graphics Processors - Overview of the Architecture of a GPU	1
2.4	Structure of a GPC (Graphics Processing Cluster)	1
2.5	Structure of an SM (Streaming Multiprocessor)	1
2.6	Concept of a Warp	1
2.7	The GPU Pipeline	1
2.8	The Register File, L1 Caches	1
Module 3: GPU Programming (11 hours)		
3.1	Introduction to CUDA programming, Data parallelism	1
3.2	CUDA program structure	1
3.3	Device Memories and Data Transfer, Kernel Functions and Threading	2
3.4	CUDA Threads - CUDA Thread Organization, Synchronization and Transparent Scalability	2
3.5	Thread Assignment, Thread Scheduling and Latency Tolerance	1
3.6	Introduction to OpenCL – OpenCL Device Architectures	1
3.7	Basic OpenCL Examples, Understanding OpenCL's Concurrency and Execution Model	1
3.8	Dissecting a CPU/GPU OpenCL Implementation	1
Module 4: Applications of GPU Computing (10 hours)		
4.1	Application Design : Efficient Neural Network Training/Inferencing.	2

4.2	CUDA Case Studies: Advanced MRI Reconstruction	2
4.3	Molecular Visualization and Analysis	2
4.4	OpenCL Case studies: Convolution	1
4.5	Video Processing	1
4.6	Histogram and Mixed Particle Simulation	2



MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1E104D

Course Name: GPU Architectures

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Explain the stages of a traditional graphics pipeline. (5)
   (b) Describe the roles of rasterization, fragment processor, and pixel engine. (5)
2. (a) Compare ASIC, ASIP, and FPGA technologies in terms of flexibility and performance (5)
   (b) Differentiate between SIMD and SIMT execution models. (5)
3. (a) Demonstrate how streams and events can be used to overlap computation and data transfer. (5)
   (b) Apply this concept to improve the execution of a sample GPU application. (5)
4. (a) Illustrate synchronization mechanisms in CUDA using an example. (5)
   (b) Apply thread scheduling and latency hiding concepts to improve kernel performance. (5)
5. (a) Illustrate how threads are organized into warps and scheduled in an SM. (5)
   (b) Explain how the register file and L1 cache influence execution efficiency. (5)
6. (a) Analyze the CUDA-based MRI reconstruction workflow. (5)
   (b) Identify performance bottlenecks and propose improvements. (5)

M26CS1E104E	DRONE TECHNOLOGIES	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

This course introduces the fundamental concepts, design principles, and operational aspects of drone technologies, including aerodynamics, perception, and mission planning. It also provides practical exposure to drone configuration, testing, regulations, and the integration of AI and autonomous navigation in UAV systems.

Prerequisites

Nil

Course Outcomes

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

CO 1	Explain the fundamentals of drone systems, components, and flight dynamics.
CO 2	Analyze perception techniques including sensors, localization, and mapping in UAVs.
CO 3	Apply mission planning, path planning, control, and implementation strategies for autonomous and multi-UAV systems.
CO 4	Evaluate UAV regulations, safety aspects, and applications considering ethical and societal implications.

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand			
Apply	70	70	70
Analyse	30	30	30
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/
Data collection and interpretation/
Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

SYLLABUS

MODULE 1 (10 hours)

Introduction & Modelling:

Drone concept, history and classification of UAVs, aerodynamics and flight dynamics, drone design principles, calculations and assumptions, propulsion systems and energy sources, battery technologies, anti-vibration and noise reduction, multicopter flight control models, basics of control systems.

MODULE 2 (10 hours)

Perception and Autonomous Systems:

Introduction to autonomous navigation, UAV sensors, sensor perception and data acquisition, artificial intelligence and machine learning, computer vision basics, localization and mapping (SLAM), photogrammetry basics, 3D mapping and point clouds.

MODULE 3 (10 hours)

Mission Planning, Control and Implementation:

Obstacle detection and avoidance, mission planning, path planning techniques, autonomous navigation, wireless communication and telemetry, ground control systems, multi-UAV systems, real-time decision making, drone assembly and configuration, calibration of sensors and flight controllers, motor/propeller testing, flight testing and performance evaluation, ROS basics and UAV programming, data collection techniques.

MODULE 4 (10 hours)

Regulations, Safety & Applications:

Safety risks and mitigation, guidelines for safe flying, aviation regulations and standards, airspace and flight restrictions, drone licensing procedures, privacy and ethical issues, applications in medical, agriculture, construction, and surveillance, future trends in UAV systems.

Text Books

1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", John Wiley Sons, Inc., 2021.

2. Terry Kilby and Belinda Kilby, "Make: Getting Started with Drones "Maker Media, Inc, 2016.

Reference Books

1. Zavrsnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.
2. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001.
3. Reg Austin "Unmanned aircraft systems UAV design, development and deployment", Wiley, 2010.
4. John Baichtal, Building Your Own Drones: A Beginners' Guide, Que Publishing, 2016.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	Hours
	Total Hours	40
Module 1: Introduction & Modelling (10 hours)		
1.1	Drone concept, history, and classification of UAVs	1
1.2	Aerodynamics and flight dynamics	1
1.3	Drone design principles and assumptions	1
1.4	Propulsion systems and energy sources	1
1.5	Battery technologies for UAVs	1
1.6	Anti-vibration techniques and noise reduction	1
1.7	Multicopter flight control models	2
1.8	Basics of control systems in UAVs	2
Module 2: Perception and Autonomous Systems (10 hours)		
2.1	Introduction to autonomous navigation	1
2.2	UAV sensors and data acquisition	1
2.3	Sensor perception and integration	1
2.4	AI and Machine Learning basics for UAVs	1
2.5	Computer vision fundamentals	2
2.6	Localization and mapping (SLAM)	2
2.7	Photogrammetry basics	1
2.8	3D mapping and point cloud processing	1
Module 3: Mission Planning, Control and Implementation (10 hours)		

3.1	Obstacle detection and avoidance	1
3.2	Mission and path planning techniques	2
3.3	Autonomous navigation strategies	1
3.4	Wireless communication and telemetry	1
3.5	Ground control systems and multi-UAV coordination	1
3.6	Real-time decision making in UAVs	1
3.7	Drone assembly and configuration	1
3.8	Sensor calibration and flight controller tuning	1
3.9	Flight testing and performance evaluation	1
Module 4: Regulations, Safety & Applications (10 hours)		
4.1	Safety risks and mitigation techniques	1
4.2	Guidelines for safe drone operation	1
4.3	Aviation regulations and standards	2
4.4	Airspace classification and flight restrictions	1
4.5	Drone licensing procedures	1
4.6	Privacy and ethical issues	1
4.7	Applications in healthcare, agriculture, and construction	1
4.8	Surveillance and security applications	1
4.9	Future trends in UAV systems	1

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1E104E

Course Name: Drone Technologies

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) A drone is required to carry a payload of 2 kg for surveillance. Estimate the propulsion and battery requirements and justify your design assumptions. (5)

   (b) Analyze how propeller size and motor selection affect thrust and energy consumption in a multicopter. (5)

2. (a) A UAV is used for agricultural monitoring. Select suitable sensors and explain how the collected data is processed for decision-making. (5)

   (b) Explain how SLAM can be applied for autonomous navigation of a drone in an unknown environment. (5)

3. (a) Design a path planning strategy for a drone delivering packages in an urban environment with obstacles. (5)

   (b) Explain how real-time obstacle detection and avoidance is achieved using onboard sensors. (5)

4. (a) Explain the step-by-step procedure for assembling and calibrating a quadcopter for stable flight. (5)

   (b) A drone shows unstable flight during testing. Diagnose possible causes and suggest corrective measures. (5)

5. (a) A company plans to deploy drones for medical delivery. Identify the regulatory requirements and safety measures to be followed. (5)

   (b) Design a drone-based solution for precision agriculture and explain its advantages. (5)

6. (a) Explain the role of flight control systems in maintaining stability of a multicopter. (5)

   (b) Evaluate ethical and privacy concerns in drone surveillance applications and suggest mitigation strategies. (5)

M26CS1E104A	RESEARCH METHODOLOGY & IPR	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		2	0	0	4	2	2026

Preamble

Research methodology and intellectual property rights form an essential foundation for postgraduate students and research scholars engaged in advanced engineering studies. This course introduces the principles of scientific research, problem identification, experimental and analytical methods, and effective technical communication. It also emphasizes ethical research practices, scholarly publication processes, and the protection of intellectual property arising from research and innovation. The course aims to equip M Tech students and research scholars with the skills required to conduct systematic research, communicate findings effectively, and understand the legal and ethical frameworks governing intellectual property and technology development.

Prerequisites

Nil

Course Outcomes

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

CO 1	Explain the principles, processes, and characteristics of scientific research and apply creative and logical thinking approaches for identifying research directions. (Cognitive Knowledge Level: Understand)
CO 2	Apply literature survey techniques and analytical reasoning to identify research gaps and formulate well-defined research problems (Cognitive Knowledge Level: Apply)
CO 3	Analyze experimental data and develop appropriate experimental or modelling approaches for solving engineering research problems. s(Cognitive Knowledge Level: Analyze)
CO 4	Demonstrate effective technical communication while adhering to research ethics and intellectual property regulations.(Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	20	-	-
Understand	40	40	40
Apply	40	40	40
Analyse	-	20	20
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study(Preparing a review article based on peer reviewed original publications in the relevant discipline (minimum 10 publications shall be referred)) : 10 marks

Course based task/Seminar/Quiz : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

End Semester Examination Pattern

The end semester examination will be conducted by the college. The time duration will be 2 hours and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question carries 10 marks. .

SYLLABUS

MODULE 1 (6 hours)

Foundations of Research and Creative Thinking:

Meaning, objectives and significance of research, types of research including basic, applied and interdisciplinary research, characteristics of good research and stages in the research process, skills, habits and attitudes required for researchers, motivation for research with discussion of Richard Hamming's lecture "You and Your Research", thinking skills in research including levels and styles of thinking, common sense versus scientific thinking, logical reasoning and decomposition of complex problems, creativity in research, definitions and characteristics, intelligence versus creativity, creative thinking process and requirements for innovation.

MODULE 2 (5 hours)

Literature Survey and Research Problem Formulation:

Importance of literature survey in research, sources of scientific information including journals, conference papers, patents and technical reports, techniques for information search using digital databases, reading, documentation and referencing practices, integration of research literature and identification of research gaps, attributes and sources of research problems, problem formulation and research questions, multiple approaches to solving research problems, techniques for problem representation, graphical methods and reasoning, analytical and analogical reasoning, creative problem solving approaches including TRIZ.

MODULE 3 (8 hours)

Experimental Design, Modelling and Data Analysis:

Scientific method and hypothesis formulation, experimental variables including dependent and independent variables, control and reproducibility in experiments, precision, accuracy and measurement errors, random and systematic errors with detection and reduction, statistical treatment and interpretation of experimental data, principles of design of experiments and experimental documentation, modelling in engineering research including types and stages, curve fitting and approximations, mathematical representation and logical reasoning in models, continuum, meso and micro scale modelling approaches, introduction to numerical simulation methods with illustrative case studies.

MODULE 4 (6 hours)

Technical Communication, Research Ethics and Intellectual Property Rights:

Importance of effective communication in research, communication process and barriers, oral communication skills for seminars, conferences and project presentations, preparation and delivery of technical presentations, guidelines for effective presentation slides, principles of scientific writing, structure of technical papers, theses and reports, language, layout, typography, tables and figures, referencing and citation styles, tools for document preparation including LaTeX, scholarly publications including journals and conferences, journal selection and peer review process, research metrics, plagiarism, research integrity and ethical publication practices, introduction to Intellectual Property Rights, types of IPR including patents, copyrights, trademarks and industrial designs, patent concepts, objectives and patentability criteria, patent application procedures and documentation, technology transfer and IPR agreements.

Reference Books

1. Panneerselvam, R., *Research Methodology*, PHI Learning, New Delhi.
2. Kothari, C. R. and Garg, G., *Research Methodology: Methods and Techniques*, New Age International.
3. Phillips, E. M. and Pugh, D. S., *How to Get a PhD*, Viva Books.
4. Leedy, P. D. and Ormrod, J. E., *Practical Research: Planning and Design*, Pearson.
5. Day, R. A. and Gastel, B., *How to Write and Publish a Scientific Paper*, Cambridge University Press.
6. Thiel, D. V., *Research Methods for Engineers*, Cambridge University Press.
7. Bouchoux, D. E., *Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets.*
8. Resnik, D. B., *The Ethics of Science: An Introduction*, Routledge.
9. Medawar, P., *Advice to a Young Scientist.*
10. Wilson, E. O., *Letters to a Young Scientist.*
11. Hamming, R., *You and Your Research*, Bell Labs Lecture.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	25 Hours

Module 1: Introduction to Research (6 Hours)		
1.1	Meaning, objectives and significance of research – types of research: basic, applied and interdisciplinary	1
1.2	Characteristics of good research – stages in the research process	1
1.3	Skills, habits and attitudes required for researchers – motivation for research – discussion of Richard Hamming's lecture "You and Your Research"	1
1.4	Thinking skills in research – levels and styles of thinking – common sense versus scientific thinking	1
1.5	Logical reasoning and decomposition of complex problems	1
1.6	Creativity in research – intelligence versus creativity – creative thinking process and requirements for innovation	1
Module 2: Literature Survey and Problem Formulation (5 Hours)		
2.1	Importance of literature survey – sources of scientific information: journals, conference papers, patents and technical reports	1
2.2	Techniques for information search using digital databases	1
2.3	Reading, documentation and referencing practices	1
2.4	Integration of research literature and identification of research gaps	1
2.5	Research problem formulation – attributes and sources of research problems – research questions – introduction to problem representation and TRIZ	1
Module 3: Experimental Design and Modelling (8 Hours)		
3.1	Scientific method and hypothesis formulation	1
3.2	Experimental variables – dependent and independent variables – control and reproducibility	1
3.3	Precision, accuracy and measurement errors – random and systematic errors	1
3.4	Detection and reduction of experimental errors – statistical treatment and interpretation of data	1
3.5	Principles of design of experiments – experimental documentation	1
3.6	Modelling in engineering research – types and stages of modelling	1

3.7	Curve fitting, approximations and mathematical representation	1
3.8	Continuum, meso and micro scale modelling – introduction to numerical simulation methods	1
Module 4: Research Communication and Ethics (6 Hours)		
4.1	Importance of communication in research – communication process and barriers	1
4.2	Oral communication – technical presentation and slide design	1
4.3	Scientific writing – structure of papers, theses and reports – referencing styles	1
4.4	Scholarly publications – journal selection – peer review process – research metrics	1
4.5	Research ethics – plagiarism, integrity and ethical practices	1
4.6	Intellectual Property Rights – patents, criteria and procedures – technology transfer	1

MODEL QUESTION PAPER

QP CODE: **Pages: 4**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26GE1R105

Course Name: : RESEARCH METHODOLOGY & IPR

Max. Marks: 40 Duration: 2 hours

PART A

Answer any four questions. Each question carries 10 marks.

1. (a) Explain the stages in the research process and the characteristics of good research. (5)

   (b) Discuss the role of creative and logical thinking in research with suitable examples from engineering research. (5)

2. (a) Describe the methods used for conducting an effective literature survey and the different sources of research information. (5)

   (b) A researcher intends to study energy efficiency improvement in electric vehicles. Explain how the researcher can identify research gaps and formulate a research problem based on literature survey. (5)

3. (a) Explain the scientific method and hypothesis formulation in experimental research. (5)

   (b) An experiment measures the temperature of a furnace multiple times giving the following readings (°C): 650, 652, 648, 651, 649. Calculate the mean temperature and comment on the precision of the measurements. (5)

4. (a) Explain the concept and stages of modelling in engineering research. (6)

(b) Discuss the importance of approximations and curve fitting in engineering models with examples. (4)

5. (a) Explain the structure of a scientific research paper and the important rules of scientific writing. (5)

   (b) Discuss the principles for preparing effective technical presentation slides for conferences or seminars. (5)

6. (a) Explain the peer review process and discuss the criteria used for selecting a suitable journal for publication. (5)

   (b) Explain the concept of patents, the criteria for patentability, and the steps involved in the patent filing process. (5)

MAR ATHANASIUS COLLEGE OF ENGINEERING

Government Aided, Autonomous Institution
Kothamangalam, Kerala, India

M.Tech
Computer Science and Engineering

SEMESTER 2

SYLLABUS

SEMESTER 2

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A	M26CS1D201	ADVANCED DATABASE MANAGEMENT SYSTEMS	3-0-3-6	6	5
B	M26CS1D202	DEEP LEARNING AND TRANSFORMER ARCHITECTURES	3-0-3-6	6	5
C	M26CS1E203X	PROGRAMME ELECTIVE II	4-0-0-5	4	4
E	M26CS1S204	INDUSTRY INTEGRATED COURSE	4-0-0-5	4	4
G	M26CS1P205	MINI PROJECT	0-0-4-6	4	2
TOTAL				24	20

PROGRAMME ELECTIVE II

COURSE NO.	**COURSES**
M26CS1E203A	ADVANCED OPERATING SYSTEMS
M26CS1E203B	REINFORCEMENT LEARNING FOR AUTONOMOUS AGENTS
M26CS1E203C	ALGORITHM FOR COMPUTATIONAL BIOLOGY
M26CS1E203D	HUMAN COMPUTER INTERACTION
M26CS1E203E	WIRELESS SENSOR NETWORKS

Teaching Assistance : 8 Hours
Self Study : 28 Hours

M26CS1D201	ADVANCED DATABASE MANAGEMENT SYSTEMS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	0	3	6	5	2026

Preamble

This course introduces modern database systems with a focus on NoSQL, big data, and distributed computing concepts.It covers data modeling across different NoSQL paradigms and key aspects like consistency, transactions, and scalability.It also emphasizes practical implementation using modern database technologies and big data tools

Prerequisites

Basic knowledge of database management systems, programming, and SQL.

Course Outcomes

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

CO 1	Explain NoSQL, big data fundamentals and distributed system concepts.
CO 2	Design data models for different NoSQL paradigms.
CO 3	Analyze consistency, transactions and scalability mechanisms
CO 4	Implement applications using NoSQL databases and big data tools

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	25	25	25
Apply	50	50	50
Analyse	25	25	25
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Theory Evaluation : 30 marks

Self-study (Course based task/Seminar/ Quiz/ Micro project) : 10 marks

Test paper 1 : 10 marks

Test paper 2 : 10 marks

Lab Evaluation : 30 marks

Lab work : 10 marks

Final evaluation Test : 20 marks

(Note: 50% of Module 1, 2 and 3 may be considered for each test)

End Semester Examination Pattern

The end semester examination should be conducted by the college. The time duration will be 2 Hrs and will contain 6 questions from first three modules, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions

SYLLABUS

MODULE 1 (10 hours)

NoSQL, Big Data and Data Modeling :

Evolution of modern databases, big data characteristics (3Vs), types of NoSQL databases (key-value, document, column, graph), CAP theorem, BASE properties, consistency models (strong and eventual consistency), distributed systems basics, consistent hashing and vector clocks (conceptual overview), data modeling in NoSQL systems (denormalization, query-driven design), comparison of RDBMS, NoSQL and big data systems.

MODULE 2 (10 hours)

Document Databases and Data Processing

Document databases (MongoDB), JSON and BSON data model, CRUD operations, indexing and query optimization, aggregation framework, replication and sharding, transactions in MongoDB (overview).
Big data processing concepts, HDFS architecture (conceptual), MapReduce model, Apache Spark basics, batch and stream processing, data lakes and data warehouses, data pipelines (ETL and ELT).

MODULE 3 (10 hours)

Big Data Analytics Tools & NoSQL Databases:

Databases (Cassandra), architecture, consistency levels (tunable consistency), data modeling, CQL, SSTables and MemTables (overview).
Graph databases (Neo4j), graph data model, data modeling, Cypher queries.
System level concepts, storage models (B-Tree vs LSM tree conceptual comparison), replication strategies (leader-based, leaderless), trade-offs between consistency, availability and latency.

MODULE 4 (30 hours)

Laboratory Experiments (with I/O)

List of experiments

1. Model an application in both relational and MongoDB databases and compare schema design and query complexity; Focus – normalization vs denormalization, schema design trade-offs
2. Implement and compare indexing strategies in SQL and MongoDB and analyze impact on query performance; Focus – indexing and read/write trade-offs
3. Store and query semi-structured JSON data in relational and document databases; Focus – schema flexibility and query handling
4. Configure a MongoDB replica set and analyze system behavior under node failure and read/write operations; Focus – CAP theorem and fault tolerance
5. Demonstrate eventual consistency by performing writes and immediate reads in a replicated setup; Focus – consistency models
6. Implement sharding (or simulated partitioning) and analyze data distribution and query performance; Focus – horizontal scaling
7. Model and query a graph dataset using a graph database and compare with relational queries; Focus – graph traversal vs joins
8. Configure a pseudo-distributed HDFS system and analyze block storage, replication, and data locality; Focus – HDFS architecture
9. Execute and analyze a MapReduce job and study map, shuffle, and reduce phases including handling of data skew; Focus – distributed batch processing
10. Execute equivalent data processing tasks using Apache Spark and analyze performance and execution model; Focus – in-memory processing and DAG
11. Perform data processing using RDDs and DataFrames and analyze differences in abstraction and efficiency; Focus – Spark data models
12. Simulate batch and stream processing workflows and implement window-based operations on streaming data; Focus – batch vs stream processing
13. Design and implement ETL and ELT pipelines using structured storage and data lake approaches; Focus – data pipelines, schema-on-write vs schema-on-read
14. Implement and analyze LSM-tree based storage (MemTable, SSTable, compaction) and compare with B-tree indexing; Focus – storage internals and performance trade-offs
15. Develop a micro project to design and implement a real-world application using appropriate database selection, data modeling, and query processing with NoSQL and/or big data tools.

Text Books

1. Martin Kleppmann, "Designing Data-Intensive Applications", O'Reilly Media, 2017.
2. Pramod Sadalage and Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley, 2012.

Reference Books

1. Om White, "Hadoop: The Definitive Guide", O'Reilly Media, 2015.
2. Alex Petrov, "Database Internals: A Deep Dive into How Distributed Data Systems Work", O'Reilly Media, 2019.
3. Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packt Publishing, 2013.
4. Guy Harrison, "Next Generation Databases: NoSQL, NewSQL, and Big Data", Apress, 2016.
5. Pramod J. Sadalage and Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley, 2012.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	Hours
	Total Hours	60
Module 1: NoSQL, Big Data and Data Modeling (10 hours)		
1.1	Evolution of modern databases and Big Data characteristics (3Vs)	1
1.2	Types of NoSQL databases: key-value, document, column, graph	2
1.3	CAP theorem and BASE properties	1
1.4	Consistency models: strong and eventual consistency	1
1.5	Distributed systems basics	1
1.6	Consistent hashing and vector clocks (conceptual)	1
1.7	Data modeling in NoSQL: denormalization and query-driven design	2
1.8	Comparison of RDBMS, NoSQL, and Big Data systems	1
Module 2: Document Databases and Data Processing (10 hours)		

2.1	Document databases (MongoDB), JSON and BSON models	1
2.2	CRUD operations and indexing techniques	2
2.3	Query optimization and aggregation framework	1
2.4	Replication and sharding concepts	2
2.5	Transactions in MongoDB (overview)	1
2.6	HDFS architecture (conceptual)	1
2.7	MapReduce model and batch processing	1
2.8	Apache Spark basics and stream processing	1
Module 3: Big Data Analytics Tools & NoSQL Databases (10 hours)		
3.1	Column databases (Cassandra) and architecture	1
3.2	Consistency levels and data modeling in Cassandra	2
3.3	CQL, SSTables, and MemTables (overview)	1
3.4	Graph databases (Neo4j) and graph data model	1
3.5	Data modeling and Cypher queries	1
3.6	Storage models: B-Tree vs LSM Tree	1
3.7	Replication strategies: leader-based and leaderless	1
3.8	Trade-offs: consistency, availability, latency	2
Module 4: LAB EXPERIMENTS (30 hours)		
4.1	Model an application in both relational and MongoDB databases and compare schema design and query complexity; Focus – normalization vs denormalization, schema design trade-offs	1
4.2	Implement and compare indexing strategies in SQL and MongoDB and analyze impact on query performance; Focus – indexing and read/write trade-offs	2
4.3	Store and query semi-structured JSON data in relational and document databases; Focus – schema flexibility and query handling	2
4.4	Configure a MongoDB replica set and analyze system behavior under node failure and read/write operations; Focus – CAP theorem and fault tolerance	2
4.5	Demonstrate eventual consistency by performing writes and immediate reads in a replicated setup; Focus – consistency models	2

4.6	Implement sharding (or simulated partitioning) and analyze data distribution and query performance; Focus – horizontal scaling	2
4.7	Model and query a graph dataset using a graph database and compare with relational queries; Focus – graph traversal vs joins	2
4.8	Configure a pseudo-distributed HDFS system and analyze block storage, replication, and data locality; Focus – HDFS architecture	2
4.9	Execute and analyze a MapReduce job and study map, shuffle, and reduce phases including handling of data skew; Focus – distributed batch processing	2
4.10	Execute equivalent data processing tasks using Apache Spark and analyze performance and execution model; Focus – in-memory processing and DAG	2
4.11	Perform data processing using RDDs and DataFrames and analyze differences in abstraction and efficiency; Focus – Spark data models	2
4.12	Simulate batch and stream processing workflows and implement window-based operations on streaming data; Focus – batch vs stream processing	2
4.13	Design and implement ETL and ELT pipelines using structured storage and data lake approaches; Focus – data pipelines, schema-on-write vs schema-on-read	2
4.14	Implement and analyze LSM-tree based storage (MemTable, SSTable, compaction) and compare with B-tree indexing; Focus – storage internals and performance trade-offs.	2
4.15	Develop a micro project to design and implement a real-world application using appropriate database selection, data modeling, and query processing with NoSQL and/or big data tools.	3

MODEL QUESTION PAPER

QP CODE: **Pages: 1**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1D201

Max. Marks: 40 Duration: 2 hours

PART A

Answer any four questions. Each question carries 10 marks.

1. (a) Explain the characteristics of big data (3Vs) and discuss the evolution of modern databases.. (5)

   (b) Compare RDBMS and NoSQL databases with suitable examples.. (5)

2. (a) Describe the CAP theorem and BASE properties in NoSQL systems. (5)

   (b) Explain different consistency models with examples. (5)

3. (a) Explain MongoDB data model (JSON/BSON) and CRUD operations. (5)

   (b) Discuss indexing and query optimization techniques in MongoDB. (5)

4. (a) Describe the architecture of HDFS and its components. (5)

   (b) AExplain the MapReduce model with an example. (5)

5. (a) Explain Cassandra architecture and data modeling approach. (5)

   (b) Discuss consistency levels in Cassandra with suitable examples. (5)

6. (a) Describe graph databases and explain data modeling in Neo4j. (5)

   (b) Explain Cypher queries with examples for graph traversal. (5)

M26CS1D202	DEEP LEARNING AND TRANSFORMER ARCHITECTURE	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	0	3	6	5	2026

Preamble

This course offers a comprehensive introduction to deep learning, covering fundamental concepts, advanced architectures, and modern techniques such as CNNs, RNNs, Transformers, and generative models. It provides knowledge and practical skills to design, train, and evaluate deep learning models using optimization, regularization, and transfer learning methods for real-world applications. The course contributes to society by enabling the development of intelligent systems that support advancements in healthcare, automation, natural language processing, and data-driven decision making.

Prerequisites

Machine Learning, Python

Course Outcomes

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

CO 1	Understand and analyze the fundamental concepts of deep learning, including training mechanisms, optimization techniques, regularization methods, and probabilistic graphical models.
CO 2	Design and implement deep learning architectures such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Transformer models for solving real-world problems.
CO 3	Apply generative models and representation learning techniques, including Autoencoders, RBMs, GANs, and word embeddings, for data modeling and feature extraction.
CO 4	Evaluate and implement advanced deep learning techniques such as transfer learning, large language models, and transformer-based approaches for applications in computer vision and natural language processing.

Mapping of Course Outcomes with Program Outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	2	-	3	-	2	-
CO 2	1	2	2	3	2	2
CO 3	2	-	2	2	2	1
CO 4	2	1	3	3	3	2

Assessment Pattern

Bloom's Category	**Continuous Assessment**		**End Semester Examination (% Marks)**
	Test 1 (%Marks)	**Test 2 (%Marks)**	
Remember			
Understand			
Apply	70	70	70
Analyse	30	30	30
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Theory Evaluation	:	30 marks
Self-study (Course based task/Seminar/ Quiz/ Micro project)	:	10 marks
Test paper 1	:	10 marks
Test paper 2	:	10 marks
Lab Evaluation	:	30 marks
Lab work	:	10 marks
Final evaluation Test	:	20 marks

(Note: 50% of Module 1, 2 and 3 may be considered for each test)

End Semester Examination Pattern

The end semester examination should be conducted by the college. The time duration will be 2 Hrs and will contain 6 questions from first three modules, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions

SYLLABUS

MODULE 1 (8 hours)

Fundamentals of Deep Learning: Optimization, Regularization, and Training

Introduction to Deep Learning: Deep feedforward networks, training deep models, setup and initialization issues. Gradient problems: vanishing and exploding gradients. Optimization techniques: AdaGrad, RMSProp, Adam. Regularization techniques: L1 and L2 regularization, early stopping, dataset augmentation, parameter sharing and tying, dropout, ensemble methods. Transfer Learning and Domain Adaptation.

MODULE 2 (10 hours)

Deep Learning Architectures for Sequential and Spatial Data

Convolutional Neural Networks: architecture, convolution and pooling operations, Motivation, Variants of convolution functions, Structured outputs, Data types, efficient convolution algorithms, Case study of Convolutional Architectures– AlexNet, ResNet, VGGnet. Recurrent Neural Networks: computational graphs, RNN design - Language Modeling Example of RNN, Back propagation Through Time, encoder–decoder architecture, Challenges in training RNNs, LSTM and GRU, applications.

MODULE 3 (12 hours)

Foundations of Modern Generative AI and Language Models

Autoencoders, Variational Autoencoders (VAE), undercomplete and overcomplete autoencoder - Regularized Autoencoders, Denoising Autoencoders, Learning Manifolds with Autoencoders. Deep generative models: Boltzmann Machines, Restricted Boltzmann Machines (RBM)- Training of RBM, Contrastive Divergence Algorithm, Deep Belief Networks (DBN), Generative Adversarial Networks (GANs). Introduction to Statistical Language Models - Advanced Smoothing and Evaluation, Word Representation - Word2Vec, Tokenization Strategies, Introduction to Transformers - Self and Multi-Head Attention, Positional Encoding, Pre-Training Strategies: BERT, Prompt Engineering and Instruction Tuning , Knowledge graphs (KGs)- Distinction between graph neural networks and neural KG inference.

MODULE 4 (30 hours) List of Experiments:

1. Analysis of optimization techniques in deep neural networks using Adam, Adagrad.
2. Investigation of regularization methods such as L1, L2, and Dropout on overfitting and generalization performance.
3. Design and implementation of Convolutional Neural Networks (CNNs) for image classification and analysis of architectural parameters.
4. Sequence modeling using Recurrent Neural Networks (RNNs), LSTM and GRU for time-series prediction.
5. Implementation of autoencoders for dimensionality reduction and feature extraction.
6. Implementation of generative models such as Restricted Boltzmann Machines (RBM) and Generative Adversarial Networks (GANs) for data generation.
7. Application of Transformer-based models (e.g., BERT) for Natural Language Processing tasks such as sentiment analysis.
8. Develop a deep learning-based solution for a real-world application such as image classification or text classification. Train and evaluate the model using appropriate performance metrics. Implement model inference on new input data and design a basic web-based deployment using frameworks.

Text Books

1. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018
2. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.

3. Tanmoy Chakraborty, Introduction to Large Language Models, Wiley India, 1st Edition, 2025

Reference Books

1. David Foster. Generative Deep Learning- TeachingMachines to Paint, Write, Compose,andPlay.O'ReillyMedia, Inc.,June2019.
2. Christopher M. Bishop. Pattern recognition and machine learning. Springer 2006.
3. Saman Siadati, Transformers and Large Language Models, 2023
4. Jacob Eisenstein, Natural Language Processing, First edition,The MIT Press, 2019.
5. Dan Jurafsky and James H. Martin, Speech and Language Processing, 2nd edition, Pearson Press, 2008.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	Hours
	Total Hours	29 Hours
Module 1: Fundamentals of Deep Learning (8 hours)		
1.1	Introduction to Deep Learning and Deep Feedforward Networks	1
1.2	Training Deep Models and Initialization Issues	1
1.3	Vanishing and Exploding Gradient Problems	1
1.4	Optimization Techniques: AdaGrad, RMSProp, Adam	1
1.5	Regularization: L1, L2, and Early Stopping	1
1.6	Dropout, Data Augmentation, Ensemble Methods	1
1.7	Parameter Sharing and Model Generalization	1
1.8	Transfer Learning and Domain Adaptation	1
Module 2: Deep Learning Architectures for Sequential and Spatial Data (10 hours)		
2.1	CNN Architecture, Convolution, and Pooling Operations	1
2.2	Variants of Convolution and Efficient Algorithms	1
2.3	Structured Outputs and Data Types in CNNs	1
2.4	Case Studies: AlexNet, VGGNet, ResNet	1
2.5	Introduction to RNN and Computational Graphs	1

2.6	RNN Design and Language Modeling	1
2.7	Backpropagation Through Time (BPTT)	1
2.8	Encoder–Decoder Architecture and Challenges in RNN Training	1
2.9	LSTM	1
2.10	GRU and Applications	1
Module 3: Generative AI and Language Models (12 hours)		
3.1	Autoencoders – Basic Concepts	1
3.2	Variational Autoencoders (VAE)	1
3.3	Regularized and Denoising Autoencoders	1
3.4	Boltzmann Machines and RBM	1
3.5	Training RBM and Contrastive Divergence	1
3.6	Deep Belief Networks (DBN)	1
3.7	Generative Adversarial Networks (GANs)	1
3.8	Statistical Language Models and Smoothing	1
3.9	Word Representation – Word2Vec	1
3.10	Tokenization Strategies	1
3.11	Transformers – Self Attention and Positional Encoding	1
3.12	BERT, Prompt Engineering, and Knowledge Graph Concepts	1
Module 4: Experiments (30 hours)		
4.1	Optimization Techniques	3
4.2	Regularization – L1, L2, Dropout Analysis	3
4.3	CNN Design for Image Classification	3
4.4	RNN, LSTM, GRU for Time Series Prediction	3
4.5	Autoencoders for Feature Extraction	3
4.6	RBM and GAN Implementation	3
4.7	Transformer Models (BERT) for NLP Tasks	3
4.8	Deployment problem on web based platform	9

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1D202

Course Name: DEEP LEARNING AND TRANSFORMER ARCHITECTURE

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Differentiate between any three optimization techniques with adaptive learning rate. (5)

   (b) How does gradient descent with momentum differ from standard gradient descent in terms of weight updates and convergence behavior? Provide the mathematical equations for both methods and illustrate how momentum helps navigate plateaus, saddle points, and regions with slowly varying gradients. (5)

2. (a) Explain how a Recurrent Neural Network (RNN) can be applied to a real-world problem such as time-series prediction or text generation. Briefly describe the model structure and discuss one limitation of basic RNNs. (6)
   Convolutional Neural Network is trained for image classification but shows poor performance on unseen test data. Explain possible reasons for this issue and suggest how architectural components such as convolution layers, pooling, and regularization can be modified to improve performance. (4)

3. (a) Explain how the adversarial loss function creates a minimax game between the generator and discriminator in GANs. Analyze how this competitive objective influences the balance of power between the two networks during training, and discuss the conditions under which this balance leads to successful generation versus training collapse. (5)

(b) Apply a transformer-based model (e.g., BERT) to a natural language processing task such as sentiment analysis. Explain the role of attention mechanisms in improving performance. (5)

4. (a) Illustrate how CNNs are able to automatically learn and extract hierarchical features from raw input images, leading to superior performance in tasks such as object detection, image recognition, and semantic segmentation? (5)

   (b) Analyze the role of different padding strategies in addressing the issue of border effects or boundary distortions that arise when applying convolutional filters to input feature maps. (5)

5. (a) A neural network was trained to classify images into different categories. After training the classifier, observed a large gap between the training accuracy (100%) and the test accuracy (40%). What could be the problem with the training of such a classifier. Discuss any three methods to reduce this gap. (5)

   (b) Discuss why adding more layers to a neural network often leads to worse performance at the start of training, despite the network having higher representational capacity. Focus your analysis on how improper weight initialization and signal propagation through random weights cause the early layers to fail, effectively reducing the network's usable depth. (5)

6. (a) Explain how the adversarial loss in GANs influences the balance between the generator and the discriminator during training. Discuss its impact on training stability, potential challenges, and how it affects the learning dynamics between the two networks. (5)

   (b) Analyze the importance of word embeddings in capturing semantic relationships and apply an appropriate embedding technique to improve a language model. (5)

M24CS1E203A	ADVANCED OPERATING SYSTEMS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

Study of this course enables learners to understand the configuration and functions of the operating system kernel and provides an overview of concepts implemented in modern operating systems. The course focuses on the design and implementation of Linux kernel modules including process management, system calls, interrupts, synchronization, memory management and virtual file systems. This course helps learners analyse kernel mechanisms and suggest improvements to existing architectural features.

Prerequisites

Operating Systems

Course Outcomes

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

CO 1	Illustrate the concepts of process management and scheduling mechanisms used in Linux operating system.
CO 2	Describe system call interfaces and how the kernel manages interrupts.
CO 3	Apply synchronization techniques to develop race-free kernel level programs.
CO 4	Demonstrate kernel memory management and virtual file system implementation.

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	3	3	2	2	-	-
CO2	3	3	2	2	-	-
CO3	3	3	3	3	-	-
CO4	3	3	3	3	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	30	30	30
Apply	40	40	40
Analyse	30	30	30
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/
Data collection and interpretation/
Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

SYLLABUS

MODULE 1 (9 hours)

Process Management and Scheduling:

Linux kernel architecture, Process descriptor (`task_struct`) analysis, Process lifecycle: `fork()`, `clone()`, `exec()`, Kernel threads vs user threads, Completely Fair Scheduler (CFS), Scheduling classes (CFS, Real-Time, Deadline), CPU affinity, Load balancing, NUMA-aware scheduling, Context switching optimization, Real-time scheduling constraints.

Case Study Analysis of Completely Fair Scheduler (CFS) in Linux: Study virtual runtime, red-black tree implementation and performance under mixed workloads.

MODULE 2 (11 hours)

System Calls and Interrupts:

System call interface and ABI, System call table, Fast system calls (`sysenter`, `syscall`), Kernel-user space interaction, Interrupt Descriptor Table (IDT), Interrupt handling flow, Hard IRQ vs Soft IRQ vs Tasklets vs Workqueues, Deferred execution mechanisms, Interrupt latency, Kernel preemption.

Case Study: Interrupt handling in high-performance network systems: Study NAPI mechanism and softirq handling for high packet throughput.

MODULE 3 (9 hours)

Kernel Synchronization:

Concurrency in multi-core systems, Memory barriers, Cache coherence, Fine-grained vs coarse-grained locking, Spinlocks (ticket and queued), Mutexes, Semaphores, Completion variables, Lock-free techniques, Read-Copy Update (RCU), Deadlock handling, Scalability issues.

Case Study: Read-Copy Update (RCU) mechanism in Linux kernel: Analyze its efficiency in read-heavy workloads compared to traditional locking.

MODULE 4 (8 hours)

Memory Management and Virtual File System:

Physical memory management (Zones, Buddy allocator), Slab/SLUB allocator, Virtual memory and paging, Huge pages, NUMA-aware allocation, Page cache, Memory reclaim (LRU, kswapd), VFS architecture (inode, dentry, superblock), File system abstraction.

Case Study: Memory management in large-scale systems: Analyze page reclaim strategies

and Out-Of-Memory (OOM) handling in Linux.

Text Books

1. Robert Love, *Linux Kernel Development*, 3rd Edition, Addison-Wesley.
2. Daniel P. Bovet and Marco Cesati, *Understanding the Linux Kernel*, 3rd Edition, O'Reilly Media.
3. Wolfgang Mauerer, *Professional Linux Kernel Architecture*, Wiley India.

Reference Books

1. Jonathan Corbet, Alessandro Rubini, and Greg Kroah-Hartman, *Linux Device Drivers*, 3rd Edition, O'Reilly Media.
2. Christian Benvenuti, *Understanding Linux Network Internals*, O'Reilly Media.
3. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, *Operating System Concepts*, 10th Edition, Wiley.
4. Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, *Operating Systems: Three Easy Pieces*, Arpaci-Dusseau Books.
5. Love, Robert, *Linux System Programming*, 2nd Edition, O'Reilly Media.
6. Kaiwan N Billimoria, *Linux Kernel Programming*, Packt Publishing.
7. Michael Kerrisk, *The Linux Programming Interface*, No Starch Press.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	40 Hours
Module 1: Process Management and Scheduling (9 hours)		
1.1	Linux Kernel Architecture Overview	1
1.2	Process Descriptor (`task_struct`) Analysis	1
1.3	Process Lifecycle: `fork()`, `clone()`, `exec()`	1

1.4	Kernel Threads vs User Threads	1
1.5	Completely Fair Scheduler (CFS) Internals	1
1.6	Scheduling Classes (CFS, RT, Deadline)	1
1.7	CPU Affinity and Load Balancing	1
1.8	Context Switching and Optimization	1
1.9	Case Study: CFS Scheduler Performance Analysis	1
Module 2: System Calls and Interrupts (11 hours)		
2.1	System Call Interface and ABI	1
2.2	System Call Table and Implementation	1
2.3	Fast System Calls (`sysenter`, `syscall`)	1
2.4	Kernel-User Space Interaction	1
2.5	Interrupt Descriptor Table (IDT)	1
2.6	Interrupt Handling Flow	1
2.7	Hard IRQ vs Soft IRQ	1
2.8	Tasklets and Workqueues	1
2.9	Deferred Execution Mechanisms	1
2.10	Interrupt Latency and Preemption	1
2.11	Case Study: NAPI and Network Interrupt Handling	1
Module 3: Kernel Synchronization (9 hours)		
3.1	Concurrency in Multi-core Systems	1
3.2	Memory Barriers and Cache Coherence	1
3.3	Locking Techniques: Fine vs Coarse Grained	1
3.4	Spinlocks (Ticket and Queued)	1
3.5	Mutexes and Semaphores	1
3.6	Completion Variables	1
3.7	Lock-free Techniques	1
3.8	Read-Copy Update (RCU)	1
3.9	Case Study: RCU in Read-Heavy Workloads	1
Module 4: Memory Management and Virtual File System (8 hours)		
4.1	Physical Memory Management (Zones, Buddy Allocator)	1
4.2	Slab/SLUB Allocator	1

4.3	Virtual Memory and Paging	1
4.4	Huge Pages and NUMA-aware Allocation	1
4.5	Page Cache and Memory Reclaim	1
4.6	VFS Architecture (inode, dentry, superblock)	1
4.7	File System Abstraction	1
4.8	Case Study: Memory Reclaim and OOM Handling	1

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M24CS1E203A

Course Name: ADVANCED OPERATING SYSTEMS

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Explain the structure and role of `task_struct` in Linux. (5)

   (b) Describe the process lifecycle including `fork()`, `clone()`, and `exec()`. (5)

2. (a) Explain the Completely Fair Scheduler (CFS) and its working principles. (5)

   (b) Describe CPU affinity, load balancing, and context switching. (5)

3. (a) Consider three processes with virtual runtimes: P1 = 20, P2 = 10, P3 = 15. Using CFS scheduling, determine the order of execution and explain how the red-black tree helps in selection. (5)

   (b) A system has a page size of 4 KB. If a logical address is 8196, find the page number and offset. Given page table entry maps page 2 to frame 5, find the physical address. (5)

4. (a) Apply synchronization techniques to resolve race conditions using spinlocks or mutexes. (5)

   (b) Analyze the following Linux kernel memory allocation code:

```
struct my_struct *ptr;

ptr = kmalloc(sizeof(struct my_struct), GFP_KERNEL);
if (!ptr) {
    return -ENOMEM;
}

/* use ptr */

kfree(ptr);
```

i. Evaluate the suitability of `kmalloc()` for this allocation and its limitations. (3)

ii. Suggest an alternative allocation method (e.g., `vmalloc()` or slab allocator) and justify. (2)

5. (a) Explain Linux memory management techniques: buddy allocator and slab allocator. (5)

   (b) Discuss virtual memory concepts including paging and NUMA-aware allocation. (5)

6. (a) Explain the architecture and components of the Virtual File System (VFS). (5)

   (b) Describe page cache and memory reclaim mechanisms in Linux. (5)

M26CS1E203B	REINFORCEMENT LEARNING FOR AUTONOMOUS AGENTS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

Reinforcement Learning (RL) is a key paradigm in artificial intelligence that enables autonomous agents to learn optimal decision-making through interaction with dynamic environments. This course provides a strong theoretical foundation in RL, covering core concepts such as Markov Decision Processes, model-free learning, and advanced techniques including deep reinforcement learning and multi-agent systems. It prepares students to analyze, design, and evaluate intelligent autonomous systems in real-world applications.

Prerequisites

Fundamentals of machine learning or artificial intelligence

Course Outcomes

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

CO 1	Model sequential decision-making problems using Markov Decision Processes and Bellman equations.
CO 2	Analyze and apply model-free reinforcement learning algorithms such as Q-learning and SARSA.
CO 3	Evaluate deep reinforcement learning techniques for complex autonomous agent environments.
CO 4	Examine multi-agent systems and assess challenges in real-world reinforcement learning applications.

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	**Test 2 (%Marks)**	
Remember			
Understand	20	20	20
Apply	40	40	40
Analyse	40	40	40
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/
Data collection and interpretation/
Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

SYLLABUS

MODULE 1 (10 hours)

Foundations of Reinforcement Learning:

Introduction to intelligent agents and environment interaction; Elements of reinforcement learning – policy, reward, value function; Exploration vs exploitation; Markov Decision Processes (MDP) – states, actions, transition probabilities, reward function; Bellman equations – value function and optimality; Dynamic Programming – policy evaluation, policy iteration, value iteration..

MODULE 2 (10 hours)

Model-Free Reinforcement Learning:

Monte Carlo methods; Temporal Difference (TD) learning – Temporal Difference Zero, Temporal Difference Lambda; Model-free prediction and control; Q-Learning; SARSA; On-policy and off-policy learning; conceptual understanding of Convergence and its properties .

MODULE 3 (10 hours)

Deep Reinforcement Learning:

Function approximation in reinforcement learning; Neural networks for value function approximation; Deep Q-Network (DQN) – experience replay, target networks; Improvements – Double DQN, Dueling DQN; Policy gradient methods; REINFORCE algorithm; Actor-Critic methods; Proximal Policy Optimization (PPO).

MODULE 4 (10 hours)

Multi-Agent Systems and Advanced Topics:

Multi-Agent Reinforcement Learning (MARL), – cooperative and competitive environments,Agentic AI -type,reward mechanism, decentralized learning; Game-theoretic concepts –introduction to Nash equilibrium ; Safe and ethical reinforcement learning – safe exploration, reward misalignment; Scalability and real-world challenges; Applications in autonomous systems; Emerging trends – human-in-the-loop learning, explainable reinforcement learning,.

Text Books

1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2nd Edition, MIT Press, 2018.

   Modules Covered: Module 1, Module 2

2. Aske Plaat, Deep Reinforcement Learning, Springer, 2022.

   Modules Covered: Module 3, Module 4

Reference Books

1. Csaba Szepesvári, Algorithms for Reinforcement Learning, Morgan Claypool, 2010.
2. Miguel Morales, Grokking Deep Reinforcement Learning, Manning Publications, 2020.
3. Phil Winder, Reinforcement Learning: Industrial Applications of Intelligent Agents, O'Reilly Media, 2020.
4. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	40 Hours
Module 1: Foundations of Reinforcement Learning (10 hours)		
1.1	Intelligent Agents and Environment Interaction	1
1.2	Elements of Reinforcement Learning	1
1.3	Deep Understanding of Value Functions	1
1.4	Exploration vs Exploitation	1
1.5	Markov Decision Process (MDP) – Basics	1
1.6	MDP – Transition and Reward Structure	1
1.7	Bellman Equation – Value Function	1
1.8	Bellman Optimality Equation	1
1.9	Dynamic Programming – Policy Evaluation and Iteration	1

1.10	Value Iteration	1
Module 2: Model-Free Reinforcement Learning (10 hours)		
2.1	Introduction to Reinforcement Learning and Model-Free Methods1	1
2.2	Monte Carlo Methods – Basics	1
2.3	Monte Carlo Prediction and Control	1
2.4	Temporal Difference (TD) Learning – TD(0)	1
2.5	TD(λ)–$TemporalDifferenceLambda$	1
2.6	Model-Free Prediction and Control	1
2.7	Q-Learning	1
2.8	SARSA	1
2.9	On-Policy vs Off-Policy Learning	1
2.10	Convergence and Its Properties	1
Module 3:Deep Reinforcement Learning (10 hours)		
3.1	Function Approximation in Reinforcement Learning	1
3.2	Neural Networks for Value Function Approximation	1
3.3	Deep Q-Network (DQN) – Core Idea	1
3.4	DQN Techniques – Experience Replay and Target Networks	1
3.5	Improvements – Double DQN	1
3.6	Improvements – Dueling DQN	1
3.7	Policy Gradient Methods	1
3.8	REINFORCE Algorithm	1
3.9	Actor–Critic Methods	1
3.10	Proximal Policy Optimization (PPO)	1
Module 4:Multi-Agent Systems and Advanced Topics (10 hours)		
4.1	Introduction to Multi-Agent Reinforcement Learning (MARL),Cooperative vs Competitive Environments	1
4.2	Agentic AI -type,reward mechanism	1
4.3	Decentralized Learning in MARL	1
4.4	Game-Theoretic Concepts – Introduction	1
4.5	Nash Equilibrium	1

4.6	Safe Reinforcement Learning	1
4.7	Ethical Reinforcement Learning	1
4.8	Scalability and Real-World Challenges	1
4.9	Applications in Autonomous Systems	1
4.10	Emerging Trends in Reinforcement Learning	1

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1E203B

Course Name: REINFORCEMENT LEARNING AGENT FOR AUTONOMOUS AGENTS

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) A delivery robot operates in a grid environment where each move has a cost of -1 and reaching the goal gives +50. Formulate this problem as an MDP by defining states, actions, transition probabilities, and reward function. Explain how the Bellman equation helps compute the optimal policy.. (5 marks)

   (b) An online recommendation system must choose between showing popular items or trying new items. Design a strategy using exploration vs exploitation principles, and explain how -greedy would work in this scenario. (5 marks)

2. (a) A game-playing agent learns only after the game ends. Later, you modify it to learn after every move. Identify which methods are being used and compare their impact on learning efficiency and convergence. (5 marks)

   (b) In a risky environment (cliff walking), an agent sometimes falls into a penalty state. Explain how Q-Learning and SARSA behave differently in this scenario and justify which is safer and why. (5 marks)

3. (a) An RL agent fails to converge to an optimal policy despite many iterations. Analyze possible reasons related to:

      i. Learning rate

      ii. Exploration strategy

iii. Environment dynamics

(5 marks)

(b) A self-driving car must operate in a continuous state space (speed, position, angle). Explain why tabular methods fail and how neural network-based function approximation solves this problem. (5 marks)

4. (a) Two competing firms use RL to set prices. Explain how their strategies may converge to a Nash equilibrium, and analyze whether this outcome is optimal for both. (5 marks)

(b) An RL-based healthcare system recommends treatments but exploits loopholes in reward design. Analyze:

i. The issue of reward misalignment

ii. Methods for safe exploration

iii. Ethical implications (5 marks)

5. (a) A DQN agent shows unstable learning and overestimates action values. Propose solutions using:

i. Experience replay

ii. Target network

iii. Double DQN

Explain how each improves performance. (5 marks)

(b) In a robotics task requiring smooth control, value-based methods perform poorly. Explain why policy gradient methods are more suitable and how they directly optimize behavior.. (5 marks)

6. (a) A policy gradient agent suffers from high variance and unstable updates.Explain how Actor-Critic and PPO address these issues and improve training stability. (5 marks)

(b) In a traffic signal system, multiple agents control different intersections.Discuss how cooperative MARL with decentralized learning can optimize traffic flow and identify key challenges. (5 marks)

M25CS1E203C	ALGORITHM FOR COMPUTATIONAL BIOLOGY	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

This course introduces algorithmic techniques used in computational biology for analyzing biological sequences and genomic data. It covers fundamental string processing algorithms, sequence alignment methods, graph-based genome reconstruction, and probabilistic models. The course also explores modern approaches such as machine learning and pangenome representations for biological data analysis.

Prerequisites

Nil

Course Outcomes

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

CO 1	Apply string processing algorithms for biological sequence analysis.
CO 2	Design and analyze sequence alignment algorithms using dynamic programming and heuristics.
CO 3	Apply graph algorithms for genome reconstruction and biological data modeling.
CO 4	Analyze probabilistic models and modern computational techniques for genomic data interpretation.

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	**Test 2 (%Marks)**	
Remember	-	-	-
Understand	20	20	20
Apply	60	60	60
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/ Data collection and interpretation/Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

SYLLABUS

MODULE 1 (10 hours)

Foundations and String Algorithms:

Review of molecular biology and genetics: DNA, RNA, proteins, central dogma. Biological sequence representation. Overview of bioinformatics tools, databases, and applications. String matching concepts. Z-algorithm and its applications. Suffix arrays: construction and applications. Introduction to suffix trees and their applications in sequence analysis.

MODULE 2 (10 hours)

Advanced String Processing and Sequence Alignment:

Burrows-Wheeler Transform (BWT), BWT index, rank and select operations. Succinct data structures. Dynamic programming concepts for sequence alignment. Edit distance computation. Global alignment (Needleman-Wunsch algorithm). Local alignment (Smith-Waterman algorithm). Gap penalties and affine gap models. Statistical significance of alignments.

MODULE 3 (10 hours)

Heuristic Alignment and Genome Reconstruction:

Heuristic approaches to sequence alignment. Maximal Unique Matches (MUMs). Co-linear chaining and gap incorporation. Applications in mutation detection and disease diagnosis. Genome reconstruction problem formulation. Shortest Common Superstring problem. Greedy algorithms for genome assembly. Overlap graphs and de Bruijn graphs.

MODULE 4 (10 hours)

Advanced Topics in Computational Genomics:

Multiple sequence alignment: exact and approximate methods. Phylogenetic tree construction: distance-based and parsimony methods. Gene prediction techniques. Hidden Markov Models (HMMs). Machine learning approaches in genomics. Large language models for biological sequences. Pangenome graphs and sequence alignment on graphs.

Text Books

1. Dan Gusfield, *Algorithms on Strings, Trees and Sequences*, Cambridge University Press.

2. Phillip Compeau and Pavel Pevzner, *Bioinformatics Algorithms: An Active Learning Approach*, Vol. 1 & 2.

3. Neil C. Jones and Pavel Pevzner, *An Introduction to Bioinformatics Algorithms*, MIT Press.

4. Richard Durbin et al., *Biological Sequence Analysis*, Cambridge University Press.

5. Ion Mandoiu and Alexander Zelikovsky, *Bioinformatics Algorithms*, Wiley.

Reference Books

1. Michael S. Waterman, *Introduction to Computational Biology*, Chapman & Hall.

2. David Mount, *Bioinformatics: Sequence and Genome Analysis*, Cold Spring Harbor.

3. Pierre Baldi and Soren Brunak, *Bioinformatics: The Machine Learning Approach*, MIT Press.

4. Pavel Pevzner, *Computational Molecular Biology*, MIT Press.

5. Warren Ewens and Gregory Grant, *Statistical Methods in Bioinformatics*, Springer.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	40 Hours
Module 1: Foundations and String Algorithms (10 hours)		
1.1	Introduction to molecular biology: DNA, RNA, proteins, central dogma	2
1.2	Biological sequence representation and bioinformatics tools	2
1.3	String matching basics and Z-algorithm	3
1.4	Suffix arrays: construction and applications	2
1.5	Introduction to suffix trees and applications	1
Module 2: Advanced String Processing and Sequence Alignment (10 hours)		
2.1	Burrows-Wheeler Transform and indexing	3
2.2	Rank/select operations and succinct data structures	1

2.3	Dynamic programming fundamentals and edit distance	2
2.4	Global alignment (Needleman-Wunsch algorithm)	2
2.5	Local alignment (Smith-Waterman), gap models and statistical significance	2
Module 3: Heuristic Alignment and Genome Reconstruction (10 hours)		
3.1	Heuristic alignment approaches and motivation	1
3.2	Maximal Unique Matches (MUMs)	2
3.3	Co-linear chaining and gap incorporation	2
3.4	Applications: mutation detection and disease diagnosis	1
3.5	Genome reconstruction and shortest common superstring	2
3.6	Overlap graphs and de Bruijn graphs	2
Module 4: Advanced Topics in Computational Genomics (10 hours)		
4.1	Multiple sequence alignment methods	2
4.2	Phylogenetic tree construction techniques	2
4.3	Hidden Markov Models and gene prediction	3
4.4	Machine learning approaches in genomics	1
4.5	Large language models and pangenome graphs	2

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, APRIL 2027

Course Code: M25CS1E203C

Course Name: ALGORITHM FOR COMPUTATIONAL BIOLOGY

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Construct the Z-array for the string AABAACAABAA and identify all pattern occurrences. (5)

   (b) Apply the suffix array construction for the string BANANA$ and show the sorted suffixes. (5)

2. (a) Compute the edit distance between the sequences GATTACA and GCATGCU using dynamic programming. (5)

   (b) Apply the Needleman–Wunsch algorithm to perform global alignment for:

   Sequence 1: AGTACGCA

   Sequence 2: TATGC (5)

3. (a) Given two DNA sequences: S1 = ACGTACGTGAC S2 = TACGTAGAC Identify all Maximal Unique Matches (MUMs) between the sequences. (5)

   (b) A set of matching substrings between two sequences is given as intervals: (1,3), (2,5), (4,7), (6,9) Apply the co-linear chaining algorithm to determine the optimal chain and compute its score. (5)

4. (a) Given the sequences: S1 = ATGCA S2 = ATGGA S3 = ATGCC Apply a progressive alignment approach to construct a multiple sequence alignment. (5)

   (b) Given the following distance matrix, apply the UPGMA algorithm to construct the phylogenetic tree.

	A	B	C	D
A	0	5	9	9
B	5	0	10	10
C	9	10	0	8
D	9	10	8	0

(5)

5. (a) Given the fragments: AGT, GTT, TTC, TCG Construct the overlap graph and determine the sequence assembly path. (5)

   (b) Construct a de Bruijn graph (k=3) from the following k-mers: ATG, TGC, GCA, CAT, ATC Reconstruct the sequence using an Eulerian path. (5)

6. (a) Construct a suffix tree for the string ATAAATG$ and show how a pattern is searched. (5)

   (b) Apply the suffix array construction for the string BANANA$ and show the sorted suffixes. (5)

M26CS1E203D	BRAIN COMPUTER INTERFACE	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

Brain-Computer Interface (BCI) is an interdisciplinary field that enables direct communication between the brain and external devices through neural signal interpretation. This course introduces the fundamental concepts of EEG-based BCI systems, including signal acquisition, preprocessing, feature extraction, and classification techniques. It also covers essential signal processing and machine learning methods for brain signal analysis, along with an overview of real-world applications such as assistive technologies and human-computer interaction. The course equips postgraduate students with the foundational knowledge required for advanced study and research in neural engineering and intelligent systems.

Prerequisites

Basic knowledge of signals and systems, digital signal processing, linear algebra, and introductory machine learning.

Course Outcomes

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

CO 1	Explain the neurophysiological basis of brain signals and the technical architecture of various BCI systems.
CO 2	Apply signal processing fundamentals, including sampling theory and spectral analysis, to digitize and interpret EEG data.
CO 3	Implement preprocessing pipelines and artifact removal techniques to enhance the signal-to-noise ratio of neural recordings.
CO 4	Design and evaluate machine learning models for the classification of EEG signals within standard BCI paradigms.

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	-	-	-
Understand	20	20	20
Apply	60	60	60
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/
Data collection and interpretation/
Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

SYLLABUS

MODULE 1 (10 hours)

INTRODUCTION TO BRAIN–COMPUTER INTERFACES:

Definition and overview of Brain–Computer Interfaces; Historical development of BCI systems; Components and architecture of BCI systems; Types of BCI – invasive, semi-invasive, and non-invasive; Applications of BCI – assistive technologies, neurorehabilitation, human–computer interaction, and cognitive monitoring; Ethical and societal considerations in neural interfacing.

MODULE 2 (10 hours)

FUNDAMENTALS OF NEUROSCIENCE AND BRAIN SIGNAL ACQUISITION:

Organization of the human brain; Functional roles of major brain lobes; Neurons, synapses, and neural communication; Generation of bioelectric brain signals; Brain rhythms and EEG frequency bands. Brain Signal Acquisition Techniques Electroencephalography (EEG); Magnetoencephalography (MEG); Functional MRI (fMRI); Functional Near Infrared Spectroscopy (fNIRS). EEG Instrumentation: EEG hardware components; EEG data acquisition systems; Experimental design for EEG studies; 10–20 EEG electrode placement system; EEG recording environments and experimental setups.

MODULE 3 (10 hours)

SIGNAL PROCESSING TECHNIQUES FOR EEG ANALYSIS:

Signals and Systems Fundamentals: Introduction to signals and systems; Continuous-time an discrete-time signals; Linear Time-Invariant (LTI) systems. Sampling and Digitization of EEG Signals: Analog-to-digital conversion; Sampling rates in EEG acquisition; Nyquist sampling theorem; Aliasing and anti-aliasing filtering. EEG Signal Preprocessing: Nature of EEG signals and common sources of noise; Types of artifacts in EEG recordings; Importance of preprocessing. Frequency Domain Analysis: Fourier Transform; FFT; Power Spectral Density (PSD); Spectral characteristics of EEG signals. Spectral Estimation Techniques:

Windowing methods; Spectral leakage. Time–Frequency Analysis: Spectrograms; STFT; Introduction to Wavelet Transform.

MODULE 4 (10 hours)

FEATURE EXTRACTION AND MACHINE LEARNING FOR BCI:

EEG Feature Extraction: Time-domain features; Frequency-domain features; Time–frequency features. Feature Selection and Dimensionality Reduction: Feature optimization; Dimensionality reduction techniques. Machine Learning for BCI: Supervised learning methods; Unsupervised learning methods; Classification algorithms for EEG signals. Common BCI Paradigms: Event Related Potentials (ERP); P300-based BCI systems; Steady-State Visually Evoked Potentials (SSVEP); Motor Imagery based BCI.

Text Books

1. Jonathan R. Wolpaw and Elizabeth Winter Wolpaw, "Brain-Computer Interfaces: Principles and Practice", Oxford University Press, 2012.
2. Rajesh P. N. Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, 2013.
3. Saeid Sanei and J. A. Chambers, "EEG Signal Processing", Wiley, 2007.
4. Aamir Saeed Malik, "Designing EEG Experiments for Studying the Brain: An Introduction to EEG and BCI", Academic Press, 2017.

Reference Books

1. Steven W. Smith, "The Scientist and Engineer's Guide to Digital Signal Processing", California Technical Publishing, 1997.
2. Paul L. Nunez and Ramesh Srinivasan, "Electric Fields of the Brain: The Neurophysics of EEG", Oxford University Press, 2006.
3. Kevin Warwick, Rajiv Nagarajan, and Daniel G. Feil-Seifer, "Brain-Computer Interfaces", Imperial College Press, 2012.
4. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
5. Andrea L. Goldberger et al., "Biomedical Signal Processing and Signal Modeling", Wiley, 2000.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
Module 1: INTRODUCTION TO BRAIN–COMPUTER INTERFACES (10 hours)		
1.1	Definition, history, and architecture of BCI systems	2
1.2	Types of BCI: invasive, semi-invasive, and non-invasive	3
1.3	BCI Applications: assistive tech, HCI, and neurorehabilitation	2
1.4	Ethical and societal considerations in neural interfacing	3
Module 2: NEUROSCIENCE AND BRAIN SIGNAL ACQUISITION (10 hours)		
2.1	Brain organization, neurons, and generation of bioelectric signals	2
2.2	Brain rhythms, EEG frequency bands, and acquisition (MEG, fMRI)	2
2.3	EEG hardware, 10–20 electrode system, and data acquisition	3
2.4	Experimental design and EEG recording environments	3
Module 3: SIGNAL PROCESSING TECHNIQUES FOR EEG (10 hours)		
3.1	LTI systems, sampling theorem, Nyquist rate, and digitization	2
3.2	EEG preprocessing: nature of signals and artifact types	2
3.3	Frequency analysis: FFT, Power Spectral Density (PSD), and windowing	3
3.4	Time–frequency analysis: STFT, spectrograms, and wavelets	3
Module 4: FEATURE EXTRACTION AND ML FOR BCI (10 hours)		
4.1	EEG Feature extraction (time, frequency, time-frequency domains)	2
4.2	Feature selection and dimensionality reduction techniques	2
4.3	Supervised and unsupervised machine learning for EEG classification	3
4.4	BCI Paradigms: ERP, P300, SSVEP, and Motor Imagery	3
	Total Hours	40 Hours

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1E203D

Course Name: BRAIN COMPUTER INTERFACE

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Compare invasive, semi-invasive, and non-invasive BCI systems based on signal quality and clinical risk. (5)

   (b) Explain the generation of bioelectric brain signals and the frequency bands associated with EEG. (5)

2. (a) Discuss various brain signal acquisition techniques including MEG, fMRI, and fNIRS. (5)

   (b) Explain the 10–20 EEG electrode placement system and the role of differential amplifiers in EEG hardware. (5)

3. (a) Define the Nyquist sampling theorem and discuss the consequences of aliasing in EEG digitization. (5)

   (b) Explain the mathematical basis of the Fourier Transform and its application in calculating Power Spectral Density (PSD). (5)

4. (a) Describe the use of Short-Time Fourier Transform (STFT) and spectrograms for time-frequency analysis of non-stationary EEG. (5)

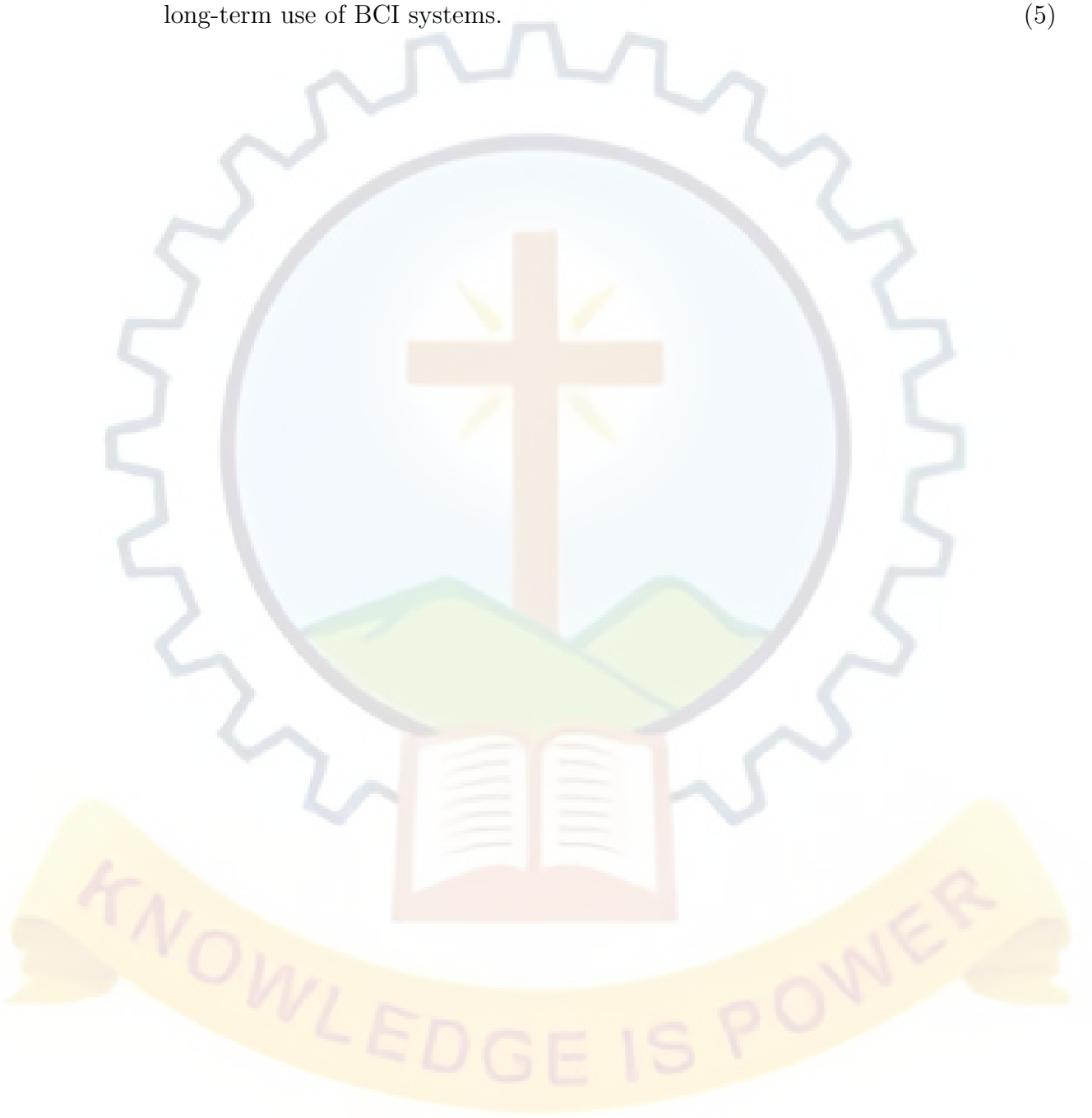
   (b) Discuss dimensionality reduction techniques and their importance in improving BCI classifier performance. (5)

5. (a) Explain the P300 and SSVEP paradigms in the context of communication-based BCI systems. (5)

(b) Elaborate on the Motor Imagery (MI) paradigm and the typical feature extraction methods used for it. (5)

6. (a) Outline a complete BCI pipeline for a real-time assistive technology application, highlighting artifact mitigation steps. (5)

(b) Discuss the ethical and societal considerations regarding neural privacy and the long-term use of BCI systems. (5)



M26CS1E203E	WIRELESS SENSOR NETWORKS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

This course introduces the fundamentals of Wireless Sensor Networks (WSNs) and their applications in real-time scenarios, covering sensor hardware, communication protocols (MAC and routing), localization, deployment, coverage, and security, enabling learners to design and develop WSN protocols and applications.

Prerequisites

Nil

Course Outcomes

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

CO 1	Describe the architecture, key characteristics, and challenges of Wireless Sensor Networks (WSNs), along with the basic principles of wireless communication technologies.(Cognitive knowledge:Understand)
CO 2	Analyze the concepts of Ad hoc and sensor networks, including their architecture, working principles, types, and real-world applications(Cognitive knowledge: Analyze).
CO 3	Evaluate different MAC protocols and routing protocols used in wireless ad hoc and sensor networks based on design issues and performance metrics.(Cognitive knowledge: Evaluate)
CO 4	Assess QoS requirements and energy management techniques in wireless sensor networks and propose suitable solutions for efficient network operation.(Cognitive knowledge: Evaluate)

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	30	30	30
Apply	30	30	30
Analyse	40	40	40
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/
Data collection and interpretation/
Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The end semester examination will be conducted by the College. Total duration of the examination will be 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks and can have maximum 2 sub-divisions.

SYLLABUS

MODULE 1 (9 hours)

Introduction

Introduction: Architecture for WSNs,Types of Sensors, Types of WSNs, Characteristic requirements for WSN - Challenges for WSNs – Fundamentals of wireless communication technology - Electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.

MODULE 2 (8 hours)

Introduction to Adhoc/sensor networks

Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, WSN vs Adhoc Networks - Ad hoc Network - Working- Features -Architecture, Operations - Types of Wireless Ad hoc Networks , unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering.

MODULE 3 (13 hours)

MAC Protocols and Routing Protocols

MAC Protocols : Fundamentals of (wireless) MAC protocols, Contention based protocols, Schedule based protocols, The IEEE 802.15.4 MAC protocol, Issues in designing MAC protocols for adhoc wireless networks, design goals, MAC protocols for sensor network, location discovery, quality, ML based MAC Protocols, Hybrid protocol.
Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on- demand, hybrid, flooding, hierarchical, and power aware routing protocols

MODULE 4 (10 hours)

QoS and Energy Management

QoS and Energy Management: QoS Requirements in WSNs, Issues and Challenges in providing QoS, Classifications, QoS-based routing protocols, SAR, SPEED, Energy-Aware QoS, MMSPEED , MGR , MAC, network layer solutions, QoS frameworks, need for energy management, battery, transmission power, and system power management schemes.

Text Books

1. Dr. Manish Gupta, Mr Deepak Sharma, Ms Neha Gupta, Dr. Naresh Kumar, "A Complete guide to Wireless sensor networks", Notion Press 2021
2. C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education – 2008
3. C. de Morais Cordeiro and D. P. Agrawal, Ad Hoc and Sensor Networks: Theory and Applications, Singapore: World Scientific, 2006.

Reference Books

1. Shashikant V. Athawale, Ad-Hoc and Wireless Sensor network, Pearson, 2022.
2. Feng Zhao and Leonides Guibas, "Wireless sensor networks ", Elsevier publication – 2005
3. William Stallings, "Wireless Communications and Networks ", Pearson Education – 2013

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	40 Hours
Module 1: Introduction (9 hours)		
1.1	Introduction: Architecture for WSNs	1
1.2	Types of Sensors, Types of WSNs, Characteristic requirements for WSN - Challenges for WSNs	1
1.3	Fundamentals of wireless communication technology	2
1.4	Electromagnetic spectrum radio propagation	1
1.5	characteristics of wireless channels	1
1.6	modulation techniques	1
1.7	multiple access techniques, wireless LANs, PANs, WANs, and MANs	1
1.8	Wireless Internet	1

Module 2: Introduction to Adhoc/sensor networks (8 hours)		
2.1	Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks	1
2.2	WSN vs Adhoc Networks - Ad hoc Network	1
2.3	Working- Features -Architecture, Operations -	1
2.4	Types of Wireless Ad hoc Networks	1
2.5	unique constraints and challenges, advantages of ad-hoc/sensor network	1
2.6	driving applications, issues in adhoc wireless networks	1
2.7	issues in design of sensor network .	1
2.8	sensor network architecture, data dissemination and gathering	1
Module 3: MAC Protocols and Routing Protocols (13 hours)		
3.1	MAC Protocols : Fundamentals of (wireless) MAC protocols	1
3.2	Contention based protocols	1
3.3	Schedule based protocols	1
3.4	The IEEE 802.15.4 MAC protocol	1
3.5	Issues in designing MAC protocols for adhoc wireless networks, design goals	1
3.6	MAC protocols for sensor network, location discovery, quality	1
3.7	ML based MAC Protocols	1
3.8	Hybrid protocol	1
3.9	Routing Protocols: Issues in designing a routing protocol	1
3.10	classification of routing protocols	1
3.11	table-driven protocols	1
3.12	on- demand, hybrid, flooding protocols	1
3.13	hierarchical, and power aware routing protocols	1
Module 4: QoS and Energy Management (10 hours)		
4.1	QoS Requirements in WSNs, QoS and Energy Management	1
4.2	Issues and Challenges in providing QoS, classifications	1
4.3	QoS-based routing protocols, SAR, SPEED	2

4.4	Energy-Aware QoS, MMSPEED , MGR , MAC	1
4.5	MAC, network layer solutions	1
4.6	QoS frameworks	1
4.7	need for energy management	1
4.8	battery, transmission power	1
4.9	system power management schemes.	1

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M26CS1E203E

Course Name: WIRELESS SENSOR NETWORKS

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. (a) Explain the architecture of Wireless Sensor Networks (WSNs) and discuss the different types of sensors used in WSN applications. (5)

   (b) A smart agriculture system uses WSNs for monitoring soil and weather conditions. Apply suitable types of WSNs, sensors, and wireless communication techniques for this application and justify your choices. (5)

2. (a) Explain the key definitions of ad hoc and sensor networks. Compare Wireless Sensor Networks (WSNs) with Ad hoc networks in terms of architecture and features. (5)

   (b) A disaster recovery scenario requires rapid deployment of a communication network. Apply the concepts of ad hoc networks to design a suitable solution, including network type, architecture, and data dissemination method. (5)

3. (a) Explain the fundamentals of wireless MAC protocols. Differentiate between contention-based and schedule-based MAC protocols with suitable examples. (5)

   (b) A wireless sensor network is deployed for environmental monitoring with limited energy resources. Apply suitable MAC and routing protocols to ensure efficient communication and justify your selection. (5)

4. (a) Explain the concept of Quality of Service (QoS) in wireless sensor networks. Discuss the need for energy management in WSNs. (5)

(b) A healthcare monitoring system requires reliable data transmission with minimum energy consumption. Apply suitable QoS frameworks and energy management schemes (battery and transmission power) to design an efficient solution. (5)

5. (a) Describe the challenges faced in WSNs due to wireless channel characteristics and radio propagation. How do these factors affect network performance? (5)

(b) Explain the unique constraints and challenges in ad hoc and sensor networks. How do these challenges affect the design and operation of such networks? (5)

6. (a) What are the issues involved in designing MAC and routing protocols for ad hoc wireless networks. How do these issues influence the performance of the network? (5)

(b) Explain the challenges in providing QoS in wireless sensor networks. How do MAC and network layer solutions help in addressing these challenges? (5)

M24CS1S204	CLOUD INFRASTRUCTURE ENGINEERING	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		4	0	0	5	4	2026

Preamble

Learners will gain a comprehensive understanding of cloud services, including their benefits, pricing models,and use cases. They will develop skills in managing Cloud infrastructure, such as docker,container and kubernets.The learners will be able to apply DevOps principles and methodologies to bridge the gap between development and operations teams.

Prerequisites

Nil

Course Outcomes

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

CO 1	Apply DevOps principles and methodologies to bridge the gap between development and operations teams. (Blooms Level Apply)
CO 2	Master the fundamentals of DevOps culture,including collaboration, communication,and shared responsibility. (Blooms Level Apply)
CO 3	Analyze Linux system basics,including essential commands,user management,file permissions,and package management. (Blooms Level Analyze)
CO 4	Analyze core technologies like Python scripting and Git version control for efficient development workflows.(Blooms Level Analyze)

Mapping of Course Outcomes with Program Outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	10	10	10
Apply	60	60	60
Analyse	30	30	30
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	60	40	2 hours

Continuous Internal Evaluation Pattern:

Self-study (Seminar*) : 10 marks

Course based task/Micro Project/
Data collection and interpretation/
Case study : 20 marks

Test paper 1 (Module 1 and Module 2): 15 marks

Test paper 2 (Module 3 and Module 4): 15 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern

The examination will be conducted by the College with the question paper provided by the Industry. The examination will be for 2 Hrs and will contain 6 questions, with minimum one question from each module of which student should answer any four. Each question can carry 10 marks. The valuation of the answer scripts shall be done by the expert in the Industry handling the course.

SYLLABUS

MODULE 1(6 hours)

Fundamental of DevOps:

DevOps Foundations Agile,People,Process,Culture,Technology/Product.Linux-Basic Commands, TextEditors:Vim, Users and Groups,File permissions,Package Management, Services, Processes.Networking Basics-Basic Concepts,Networking Commands in Linux, IPs and ports,SSL TLS basics.Python Basics,Shell Programming,Basic Git Operations

MODULE 2 (7 hours)

Application Architecture and CICD:

Monolithic/Microservices. Microservices communication-sync vs async(restapi, queue), service discovery,api gateway,event driven.Backend-Database management, Authentication/Authorization,Caching,server side languages and frameworks.Frontend - static hosting,CDN,Build packages.Why CI/CD? Fundamentals and sample setup using github actions.Scalability and performance.

MODULE 3 (7 hours)

Containerization and Orchestration:

Introduction to containers,need of containers,Containers vs Virtual Machines,Container implementation,Advantages.Docker Overview-Docker,Main Docker Commands,Docker networking,Docker volumes,Container Registry.Docker in Practice-Developing with Containers,Docker file-Building our own Docker image,pushing our built Docker Image into a private Registry(AWS/Self hosted),Debugging a Container,Persist data in Docker (volumes).Docker compose-Running multiple services,what is docker compose,how to use it-Create the Docker Compose File,Docker Networking in Docker Compose.Container Orchestration-What is orchestration,Different orchestration tools,Intro to Kubernetes.

MODULE 4 (7 hours)

Observability and Infrastructure as Code(IAC):

Introduction observability,Importance of observability in modern software development and operations.Observability Pillars-Exploring the pillars of observability:Monitoring,Logging, and Tracing,Real-world use cases and benefits.Monitoring Logging Tools.Metrics and Alerting. Application Performance Monitoring(APM).Service Level Objectives(SLOs)and SLIs, Setting and measuring SLOs with observability metrics. Introduction to IaC Principles,Overview of IaC-Understanding the concept of treating infrastructure as code.Benefits of IaC,Discussing the advantages of automating infrastructure provisioning

and management.IaC Tools and Frameworks,Popular IaC Tools-Introducing common IaC tools such as Terraform,Ansible,Chef,and Puppet.

Text Books

1. K. Hightower, B. Burns, and J. Beda, Kubernetes: Up Running: Dive into the Future of Infrastructure. Sebastopol, CA, USA: O'Reilly Media, 2017.
2. K. Morris, Infrastructure as Code: Managing Servers in the Cloud. Sebastopol, CA, USA: O'Reilly Media, 2016.

Reference Books

1. James F. Kurose and Keith W. Ross, Computer Networking A Top-Down Approach, Pearson, 8th edition, 2022.
2. G. Kim, J. Humble, P. Debois, and J. Willis, The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations. Portland, OR, USA: IT Revolution Press, 2016.
3. B. Beyer, C. Jones, J. Petoff, and N. R. Murphy, Site Reliability Engineering: How Google Runs Production Systems. Sebastopol, CA, USA: O'Reilly Media, 2016.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial Hours
	Total Hours	40 Hours
Module 1: Fundamental of DevOps (9 hours)		
1.1	DevOps Foundations-Agile,People,Process,Culture, Technology/Product	2
1.2	Linux-Basic Commands,Text Editors:Vim,Users and Groups, File permissions,Package Management,Services, Processes.	2
1.3	Networking Basics-Basic Concepts,Networking Commands in Linux	2

1.4	IPs and ports,SSL,TLS basics.Python Basics,Shell Programming,Basic Git Operations	3
Module 2: Application Architecture and CICD (10 hours)		
2.1	Monolithic/Microservices. Microservices communication	2
2.2	sync vs async(restapi,queue),service discovery,api gateway,event driven	2
2.3	Backend-Database management, Authentication/Authorization,Caching,server-side languages and frameworks.	2
2.4	Front end-static hosting,CDN,Build packages.	2
2.5	Why CI/CD?Fundamentals and sample setup using github actions.	1
2.6	Scalability and Performance	1
Module 3: Containerization and Orchestration (10 hours)		
3.1	Introduction to containers,need of containers,Containers vs Virtual Machines,How is it done,Container Advantages	2
3.2	Docker Overview-Docker,Main Docker Commands, Docker networking,Docker volumes,Container Registry.	2
3.3	Docker in Practice-Developing with Containers,Docker file - Building our own Docker image,pushing our built Docker Image into a private Registry(AWS/Self hosted)	2
3.4	Debugging a Container,Persist data in Docker(volumes). Docker compose-Running multiple services	2
3.5	what is docker compose,how to use it-Create the Docker Compose File,Docker Networking in Docker Compose.	1
3.6	Container Orchestration-What is orchestration,Different orchestration tools,Intro to Kubernetes	1
Module 4: Observability and Infrastructure as Code(IAC) (11 hours)		
4.1	Introduction-observability,Importance of observability in modern software development and operations	2
4.2	Observability Pillars-Exploring the pillars of observability: Monitoring, Logging,and Tracing,Real-world use cases and benefits	2
4.3	Monitoring and Logging Tools.Metrics and Alerting	2
4.4	Application Performance Monitoring(APM).Service Level Objectives(SLOs)and SLIs	2

4.5	Setting and measuring SLOs with observability metrics, Practical examples and case studies.Incident Response and Management	1
4.6	Introduction to IaC Principles,Overview of IaC-Understanding the concept of treating infrastructureas code	1
4.7	Benefits of IaC,Discussing the advantages of automating infrastructure provisioning and management	1
4.8	IaC Tools and Frameworks,Popular IaC Tools-Introducing common IaC tools such as Terraform, Ansible,Chef,and Puppet	1

MODEL QUESTION PAPER

QP CODE: **Pages: 4**

Reg.No.: .....

Name: .....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2026

Course Code: M24CS1S204

Course Name: Cloud Infrastructure Engineering

Max. Marks: 40 Duration: 2 hours

Answer any four questions. Each question carries 10 marks.

1. You are responsible for maintaining a high availability database cluster in a cloud environment:
   (a) Describe differen strategies for achieving database redundancy and failover.(5)
   (b) Discuss how IaC tools can be used to automate the provisioning and configuration of your database cluster.(5)
2. (a) Describe the three pillars of observability: Monitoring, Logging, and Tracing.(5)
   (b) How can these tools be used to diagnose performance issues in a cloud-native application? (5)
3. (a) Explain the concept of Git branching strategies like forking, rebasing, and cherry picking.(5)
   (b) How can Git be used to effectively manage code versions and collaboration within a DevOps team? (5)
4. (a) Discuss the differences between containerization and virtualization.(5)
   (b) Provide a step-by-step guide on how to containerize a simple Node.js application using Docker.(5)
5. (a) Explain how to monitor application performance using tools like APM (Application Performance Monitoring). How would you define and measure Service Level Objectives (SLOs) to ensure service reliability? (5)
   (b) Your web application faces traffic spikes. Design a solution using auto-scaling and load balancers. Explain how to maintain performance and control costs. (5)

6. (a) How can observability metrics be used to define and track Service Level Indicators (SLIs)? Provide examples related to response time and error rate. (5)
   (b) Design a basic incident response workflow that uses observability tools for root cause analysis.(5)

M26CS1P205	MINI PROJECT	CATEGORY	L	T	P	S	CREDIT
		PROJECT	0	0	4	6	2

Preamble

Mini project can help to strengthen the understanding of student's fundamentals through application of theoretical concepts and to boost their skills and widen the horizon of their thinking. The aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem solving skills.

The introduction of mini projects ensures preparedness of students to undertake dissertation. Students should identify a topic of interest in consultation with PG programme coordinator that should lead to their dissertation/research project. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Course Outcome

After completing mini project student should be able to

CO1: Identify and define an Engineering problem: Students will be able to select a relevant and feasible problem based on real-world needs, demonstrating originality and clarity in problem definition.

CO2: Conduct Literature review and develop a methodology: Students will develop the ability to critically review and synthesize existing literature to identify research gaps and establish the context for their study.

CO3: Implement the proposed methodology and analyze results: Students will be able to execute the methodology, develop a prototype/model/simulation, and analyze the results to validate the objectives.

CO4: Communicate the project outcomes effectively: Students will be able to prepare a structured report and present the work clearly, demonstrating technical knowledge, understanding, and involvement.

Course Outcome (CO)	**Mapped Program Outcome (PO)**	**Justification**
CO1: Identify and define an Engineering problem	PO1: Ability to independently carry out research/investigation and development work	Identifying a research topic requires independent exploration, critical thinking, and decision-making, forming the foundation for research activities.
	PO3: Demonstrate mastery over the specialization area	Topic selection reflects an understanding of advanced concepts beyond undergraduate level.
CO2: Conduct literature review and develop a methodology	PO1: Ability to independently carry out research/investigation and development work	Literature analysis develops the ability to critically evaluate existing work and identify research gaps.
	PO3: Demonstrate mastery over the specialization area	Analyzing literature demonstrates depth of knowledge in the chosen field.
CO3: Implement the proposed methodology and analyze results	PO1: Ability to independently carry out research/investigation and development work	Defining a problem and planning methodology are key steps in executing independent and systematic research.
	PO4: Apply stream knowledge to design or develop solutions for real-world problems	A well-formulated problem and methodology enable the application of domain knowledge to address practical engineering challenges.
	PO5: Identify, select, and apply appropriate techniques, resources, and tools	Developing methodology involves selecting suitable tools, techniques, and resources required for effective problem-solving.

Course Outcome (CO)	Mapped Program Outcome (PO)	Justification
CO4: Communicate the project outcomes effectively	PO2: Ability to communicate effectively, write and present technical reports	Preparing a structured report enhances technical writing, presentation, and communication skills for conveying research ideas clearly.
	PO6: Engage in life-long learning with consideration of sustainability, societal aspects	A proposal often encourages awareness of broader impacts, fostering continuous learning.

Continuous Internal Evaluation

The evaluation committee comprises

1. Project coordinator
2. A senior faculty
3. Project supervisor

Course Outcome (CO)	Marks Allocated	Justification
CO1: Identify and define an Engineering problem	25	Topic selection is foundational stage requiring creativity and basic exploration of relevant problems
CO2: Conduct literature review and develop a methodology	25	Literature review is essential for understanding existing work and identifying research gaps through critical analysis.
CO3: Implement the proposed methodology and analyze results	25	Defining the problem is a pivotal step, formulating objectives and methodology demands detailed planning and technical understanding
CO4: Communicate the project outcomes effectively	25	Proposal preparation integrates all prior work into a concise document, focusing on communication
Total	**100**	

Detailed Breakdown and Rationale:

1. **CO1: Identify and define an Engineering problem (25 marks)**

- This involves identifying a feasible and innovative topic. It's an essential starting point but less complex than subsequent analytical tasks.
- Assessment: Relevance, originality, and feasibility of the topic.

2. **CO2: Conduct literature review and develop a methodology (25 marks)**
   - A thorough literature review needs significant effort to survey existing work, analyze gaps, and establish context.
   - Assessment: Depth, breadth, and critical evaluation of sources.
3. **CO3: Implement the proposed methodology and analyze results (25 marks)**
   - Involves defining a clear and specific problem, along with formulating objectives and methodology, requiring planning and technical understanding.
   - Assessment: Clarity, specificity, and significance of the problem statement.
4. **CO4: Communicate the project outcomes effectively (25 marks)**
   - The proposal synthesizes all prior work into a structured document. While important for communication, it's less intensive than analysis or planning, hence a slightly lower weight.
   - Assessment: Structure, clarity, and completeness of the proposal

Evaluation Committee – Programme Coordinator, One Senior faculty and Guide.

Table 18: *

Sl. No	**Type of evaluations**	**Marks**	**Evaluation criteria**
1	Interim evaluation I	30	Problem identification, literature base, clarity of objectives
2	Interim evaluation II	30	Methodology, progress achieved, depth of knowledge
3	Final evaluation by a Committee	25	Completion level and demonstration of functionality/ specifications, clarity of presentation, oral examination, work knowledge and involvement
4	Report	10	The committee will be evaluating for the technical content, adequacy of references, templates followed and permitted plagiarism level (not more than 25%)
5	Supervisor/Guide	5	Initiative, regularity, involvement
Total Marks		**100**	

Rubrics for Interim Evaluation I (30 Marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Problem Identification (CO1) (10 marks)	Clearly defined, relevant, innovative, aligned with real-world issues	Relevant but limited innovation	Basic problem, limited relevance	Problem unclear or irrelevant
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Literature Review (CO2) (10 marks)	Comprehensive, recent sources, critical analysis, gap identified	Adequate review with some analysis	Limited sources, mostly descriptive	Very poor or no literature review
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Clarity of Objectives (CO3) (10 marks)	Well-defined, measurable and achievable	Clear but partially measurable	Vague or broad objectives	Objectives not defined
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)

Rubrics for Interim Evaluation II (30 Marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Problem statement (CO1) (5 marks)	Clearly defined, relevant, innovative, aligned with real-world issues	Relevant but limited innovation	Basic problem, limited relevance	Problem unclear or irrelevant
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Literature Review (CO2) (5 marks)	Comprehensive, recent sources, critical analysis, gap identified	Adequate review with some analysis	Limited sources, mostly descriptive	Very poor or no literature review
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Methodology (CO3) (5 marks)	Well-structured, appropriate tools/techniques, justified	Suitable methodology with minor gaps	Basic methodology, limited justification	Inappropriate or unclear methodology
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Depth of Knowledge (CO2) (10 marks)	Strong conceptual and technical understanding	Good understanding with minor gaps	Basic understanding	Poor understanding
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Progress Achieved (CO3) (5 marks)	Significant progress with validated results	Moderate progress with partial results	Limited progress	Minimal or no progress
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

Rubrics for Final Evaluation (25 Marks)

Parameter	Excellent	Good	Average	Poor
Relevance of problem statement (CO1) (5 marks)	Clearly defined, relevant, innovative, aligned with real-world issues	Relevant but limited innovation	Basic problem, limited relevance	Problem unclear or irrelevant
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Implementation of methodology (CO3) (5 marks)	Well-structured, appropriate tools/techniques, justified	Methodology implemented with minor gaps	Basic methodology, limited justification	Inappropriate or unclear methodology
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Knowledge & Involvement (CO4) (10 marks)	Demonstrates good understanding and active involvement throughout the project	Good understanding with consistent involvement	Basic understanding with moderate involvement	Poor understanding; minimal involvement
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Presentation & Viva (CO4) (5 marks)	Clear, confident, logical, excellent responses	Good presentation, answers most questions	Less communication, limited clarity	Poor communication, unable to answer
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

Rubrics for Miniproject report (10 Marks)

Parameter	Excellent	Good	Average	Poor
Technical Depth (CO4) (5 marks)	Comprehensive, well-analyzed content	Good technical content	Basic description	Poor/ incomplete
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Organization & Format (CO4) (5 marks)	Well-structured, follows guidelines	Minor deviations	Inconsistent format	Poor structure
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

INTERNSHIP

Slot	Course Code	Course	Marks		L-T-P-S	Hours	Credit
			CIA	ESE			
K	M26CS1I302	Internship	50	50	–	–	10

Internship - mandatory internship of minimum 16 weeks duration

Internships are educational and career development opportunities, providing practical experience in a field or discipline. They are structured, short-term, supervised placements often focused around particular tasks or projects with defined timescales. An internship may be compensated or non-compensated by the organization providing the internship. The internship has to be meaningful and mutually beneficial to the intern and the organization. It is important that the objectives and the activities of the internship program are clearly defined and understood. The internship offers the students an opportunity to gain hands-on industrial or organizational exposure; to integrate the knowledge and skills acquired through the coursework; interact with professionals and other interns; and to improve their presentation, writing, and communication skills. Internship often acts as a gateway for final placement for many students.

A student shall opt for carrying out the Internship at an Industry/Research Organization or at another institute of higher learning and repute (Academia). The organization for Internship shall be selected/decided by the students on their own with prior approval from the faculty advisor/respective PG Programme Coordinator/Guide/Supervisor. Every student shall be assigned an internship Supervisor/Guide at the beginning of the Internship. The training shall be related to their specialization after the second semester for a minimum duration of 16 weeks. On completion of the course, the student is expected to be able to develop skills in facing and solving the problems experiencing in the related field.

Objectives

- Exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn understand and sharpen the real time technical / managerial skills required at the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Create conducive conditions with quest for knowledge and its applicability on the job.
- Understand the social, environmental, economic and administrative considerations that influence the working environment.
- Expose students to the engineer's responsibilities and ethics.

Benefits of Internship

Benefits to Students

- An opportunity to get hired by the Industry/ organization.

- Practical experience in an organizational setting & Industry environment.
- Excellent opportunity to see how the theoretical aspects learned in classes are integrated into the practical world. On-floor experience provides much more professional experience which is often worth more than classroom teaching.
- Helps them decide if the industry and the profession is the best career option to pursue.
- Opportunity to learn new skills and supplement knowledge.
- Opportunity to practice communication and teamwork skills.
- Opportunity to learn strategies like time management, multi-tasking etc in an industrial setup.
- Makes a valuable addition to their resume.
- Enhances their candidacy for higher education/placement.
- Creating network and social circle and developing relationships with industry people.
- Provides opportunity to evaluate the organization before committing to a full time position.

Benefits to the Institute

- Build industry academia relations.
- Makes the placement process easier.
- Improve institutional credibility & branding.
- Helps in retention of the students.
- Curriculum revision can be made based on feedback from Industry/students.
- Improvement in teaching learning process.

Benefits to the Industry

- Availability of ready to contribute candidates for employment.
- Year round source of highly motivated pre-professionals.
- Students bring new perspectives to problem solving.
- Visibility of the organization is increased on campus.
- Quality candidate's availability for temporary or seasonal positions and projects.
- Freedom for industrial staff to pursue more creative projects.
- Availability of flexible, cost-effective workforce not requiring a long term employer commitment.

- Proven, cost-effective way to recruit and evaluate potential employees.
- Enhancement of employer's image in the community by contributing to the educational enterprise.

Types of Internships

- Industry Internship with/without Stipend
- Govt / PSU Internship (BARC/Railway/ISRO etc)
- Internship with prominent education/research Institutes
- Internship with Incubation centres /Start-ups

Guidelines

- All the students need to go for internship for minimum duration of 16 weeks.
- Students can take mini projects, assignments, case studies by discussing it with concerned authority from industry and can work on it during internship.
- All students should compulsorily follow the rules and regulations as laid by industry.
- Every student should take prior permissions from concerned industrial authority if they want to use any drawings, photographs or any other document from industry.
- Student should follow all ethical practices and Standard Operating Procedure of industry.
- Students have to take necessary health and safety precautions as laid by the industry.
- Student should contact his /her Guide/Supervisor from college on weekly basis to communicate the progress.
- Each student has to maintain a diary/log book
- After completion of internship, students are required to submit
    - Report of work done
    - Internship certificate copy
    - Feedback from employer / internship mentor
    - Stipend proof (in case of paid internship).

Total Marks 100: The marks awarded for the Internship will be on the basis of (i) Evaluation done by the Industry (ii) Internal evaluation & Student's diary (iii) Internship Report and (iv) Comprehensive Viva Voce.

Continuous Internal Evaluation: 50 marks

Internal evaluation & Student's diary	–	25 Marks
Evaluation done by the Industry	–	25 Marks

Internal evaluation committee comprises of Programme coordinator, Project coordinator and a senior faculty.

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit. Student's diary will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary
- Adequacy & quality of information recorded
- Drawings, design, sketches and data recorded
- Thought process and recording techniques used
- Organization of the information.

The format of student's diary

Name of the Organization/Section: _____

Name and Address of the Section Head: _____

Name and Address of the Supervisor: _____

Name and address of the student: _____

Internship Duration: From ..... To .....

Brief description about the nature of internship:

Day	**Brief write up about the Activities carried out: Such as design, sketches, result observed, issues identified, data recorded, etc.**
1	
2	
3	

Signature of Industry Supervisor *Signature of Section Head/HR Manager*

Attendance Sheet

Name of the Organization/Section: _____

Name and Address of the Section Head: _____

Name and Address of the Supervisor: _____

Name and address of the student: _____

Internship Duration: From ..... To .....

Month & Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	...
Month & Year																
Month & Year																

Signature of Industry Supervisor *Signature of Section Head/HR Manager*

Note:

- Student's Diary shall be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
- Attendance Sheet should remain affixed in daily training diary. Do not remove or tear it off.
- Student shall sign in the attendance column. Do not mark 'P'.
- Holidays should be marked in red ink in the attendance column. Absent should be marked as 'A' in red ink.

Evaluation done by the Industry (Marks 25)

Format for Supervisor Evaluation of Intern

Student Name : _____ Date: _____ Supervisor Name : _____
Designation: _____

Company/Organization : _____

Internship Address: _____ Dates of Internship: From _____ To _____

Please evaluate intern by indicating the frequency with which you observed following parameters:

Parameters	**Marks Rating (0–10 mark)**
Behavior	
Performs in a dependable Manner	
Cooperates with coworkers and supervisor	
Shows interest in work	
Learns quickly	
Shows initiative	
Produces high quality work	
Accepts responsibility	
Accepts criticism	
Demonstrates organizational skills	
Uses technical knowledge and expertise	
Shows good judgment	
Demonstrates creativity/originality	
Analyzes problems effectively	
Is self-reliant	
Communicates well	
Writes effectively	
Has a professional attitude	
Is punctual	
Uses time effectively	

Overall performance of student:

Intern (Tick one): Needs improvement (0 – 1 mark) / Satisfactory (2 mark) / Good (3 mark) / Very Good (4 mark) / Excellent (5 mark)

Additional comments, if any:

Signature of Industry Supervisor *Signature of Section Head/HR Manager*

End Semester Evaluation (External Evaluation): 50 Marks

Internship Report	–	25 Marks
Viva Voce	–	25 Marks

Internship Report: After completion of the internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period and should be submitted to the faculty Supervisor. The student may contact Industrial Supervisor/ Faculty Mentor for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor, Programme Coordinator and Faculty Mentor.

The Internship report (25 Marks) will be evaluated on the basis of following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

Viva Voce (25 Marks) will be done by a committee comprising Project coordinator, Programme Coordinator and an external expert (from Industry or research/academic Institute). This committee will be evaluating the internship report also.

Rubrics for Students diary and Internal Evaluation (25 Marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Regularity & Completeness (5 marks)	Diary maintained regularly with complete and consistent entries	Mostly regular with minor gaps	Irregular entries; some missing records	Rarely maintained; major gaps
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Application of Concepts (5 marks)	Strong real-world application	Moderate application	Limited application	No application
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Understanding of Work (5 marks)	Thorough understanding, confident	Good understanding	Basic knowledge	Poor understanding
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Organization & Clarity (5 marks)	Well-structured, clear and logical	Minor issues in organization	Poor structure	Disorganized
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Presentation skills (5 marks)	Clear and well structured	Good presentation	Average clarity	Poor communication
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

Rubrics for External Evaluation (Viva Voce) (25 Marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Understanding of Work (10 marks)	Thorough understanding, confident	Good understanding	Basic knowledge	Poor understanding
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Integration with theory (5 marks)	Strong linkage with academic concepts	Moderate linkage	Weak linkage	No linkage
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Application of Concepts (5 marks)	Strong real-world application	Moderate application	Limited application	No application
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Presentation skills (5 marks)	Clear and well structured	Good presentation	Average clarity	Poor communication
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

Rubrics for Internship report (25 Marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Technical Depth (10 marks)	Comprehensive, well-analyzed, industry relevance	Good technical content	Basic description	Poor/ incomplete
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Organization & Format (10 marks)	Well-structured, follows guidelines	Minor deviations	Inconsistent format	Poor structure
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Originality (5 marks)	Highly original work	Some originality	Limited originality	Copied/ plagiarized
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

DISSERTATION PHASE I

Slot	Course Code	Course	L-T-P-S	Credit
P	**M26CS1P303**	**Dissertation Phase I**	0-0-12-18	8

Dissertation Phase I may be undertaken either in the college or in the industry. Dissertation Phase I can be linked with internship. Such students are expected to have the following skills: Technical Skills, Research Skills, Communication Skills, Critical Thinking Skills, and Problem-Solving Skills.

Objectives

The objectives of Phase I of an M.Tech dissertation typically focus on laying a strong foundation for the research work to be conducted in subsequent phases. While specific objectives can vary depending on the institution, discipline, and project, the following are common goals for Phase 1:

1. **Topic Identification and Selection**: To identify a relevant, feasible, and innovative research topic aligned with the student's area of interest and the field's current trends or challenges.
2. **Literature Review**: To conduct a preliminary review of existing research and literature to understand the state of the art, identify gaps, and establish the context for the proposed work.
3. **Problem Definition**: To clearly define the research problem or question that the dissertation aims to address, ensuring it is specific, measurable, and researchable.
4. **Objective Formulation**: To establish clear and achievable objectives for the overall dissertation, outlining what the research intends to accomplish.
5. **Feasibility Assessment**: To evaluate the practicality of the proposed research in terms of available resources, time constraints, and technical requirements.
6. **Methodology Outline**: To develop a preliminary plan for the research methodology, including the tools, techniques, or approaches that will be used to investigate the problem.
7. **Synopsis Preparation**: To prepare and submit a concise synopsis or proposal summarizing the research topic, objectives, significance, and planned approach for approval by the academic supervisor or committee.
8. **Background Knowledge Building**: To deepen the student's understanding of the chosen domain and related concepts, ensuring a solid theoretical foundation for the research.

These objectives are designed to set the stage for Phase 2 and beyond, where the focus typically shifts to implementation, experimentation, and analysis. Phase 1 is critical for ensuring that the research is well-planned and directed toward a meaningful contribution to the field.

Course Outcome

After completing dissertation phase 1 student should be able to

CO1: Demonstrate Research Topic Selection Skills: Students will be able to identify and select a research topic that is innovative, relevant, and feasible within the scope of their M.Tech program.

CO2: Conduct Effective Literature Analysis: Students will develop the ability to critically review and synthesize existing literature to identify research gaps and establish the context for their study.

CO3: Define a Clear Research Problem, formulate objectives and methodology: Students will acquire the skill to articulate a well-defined research problem or question, ensuring it is specific, measurable, and aligned with their dissertation goals.

CO4: Prepare a Comprehensive Research Proposal: Students will gain the capability to create a structured synopsis or proposal, effectively communicating the significance, objectives, and planned approach of their research for evaluation.

Course Outcome (CO)	**Mapped Program Outcome (PO)**	**Justification**
CO1: Demonstrate Research Topic Selection Skills	PO1: Ability to independently carry out research/investigation and development work	Selecting a research topic requires independent exploration and judgment, aligning with research skills.
	PO3: Demonstrate mastery over the specialization area	Topic selection reflects an understanding of advanced concepts beyond undergraduate level.
CO2: Conduct Effective Literature Analysis	PO1: Ability to independently carry out research/investigation and development work	Literature analysis is a core research skill, requiring independent critical thinking.
	PO3: Demonstrate mastery over the specialization area	Analyzing literature demonstrates depth of knowledge in the chosen field.
CO3: Define a Research Problem, formulate objectives and methodology	PO1: Ability to independently carry out research/investigation and development work	Defining a research problem is a fundamental step in independent research.
	PO4: Apply stream knowledge to design or develop solutions for real-world problems	A well-defined problem often addresses real-world challenges using specialized knowledge.
	PO5: Identify, select, and apply appropriate techniques, resources, and tools	Outlining methodology involves selecting suitable techniques and tools for the research.
CO4: Prepare a Comprehensive Research Proposal	PO2: Ability to communicate effectively, write and present technical reports	Writing a proposal requires clear communication and presentation skills for technical audiences.
	PO6: Engage in life-long learning with consideration of sustainability, societal aspects	A proposal often reflects awareness of broader impacts, fostering

Continuous Internal Evaluation

Evaluation committee comprises of

1. Project coordinator
2. A senior faculty

3. Project supervisor / Industry mentor

Course Outcome (CO)	**Marks Allocated**	**Justification**
CO1: Demonstrate Research Topic Selection Skills	25	Topic selection is foundational but less intensive than later stages; it requires creativity and initial research.
CO2: Conduct Effective Literature Analysis	25	Literature review is critical, time-intensive, and requires critical thinking to identify gaps.
CO3: Define a Clear Research Problem; formulate objectives and Methodology	25	Defining the problem is a pivotal step, requiring clarity and alignment with research goals; formulating objectives and methodology demands detailed planning and technical understanding
CO4: Prepare a Comprehensive Research Proposal	25	Proposal preparation integrates all prior work into a concise document, focusing on communication
Total	**100**	

Detailed Breakdown and Rationale:

1. **CO1: Demonstrate Research Topic Selection Skills (25 marks)**
    - This involves identifying a feasible and innovative topic. It's an essential starting point but less complex than subsequent analytical tasks.
    - Assessment: Relevance, originality, and feasibility of the topic.
2. **CO2: Conduct Effective Literature Analysis (25 marks)**
    - A thorough literature review is a cornerstone of Phase 1, requiring significant effort to survey existing work, analyze gaps, and establish context.
    - Assessment: Depth, breadth, and critical evaluation of sources.
3. **CO3: Define a Clear Research Problem, formulate objectives and methodology (25 marks)**
    - Involves defining a clear and specific research problem and formulating objectives and methodology, requiring critical thinking, planning, and technical understanding as it sets the direction for the dissertation.
    - Assessment: Clarity, specificity, and significance of the problem statement.
4. **CO4: Prepare a Comprehensive Research Proposal (25 marks)**

- The proposal synthesizes all prior work into a structured document. While important for communication, it's less intensive than analysis or planning, hence a slightly lower weight.
- Assessment: Structure, clarity, and completeness of the proposal.

M.Tech Dissertation Phase 1 (Industry-Based)

Overview

- **Target Students**: Those who have completed a long-term internship ($\geq$16 weeks) and aim to conduct their dissertation in industry.
- **Focus**: In-depth research, industry-relevant problem-solving, and collaboration with industrial mentors.
- **Total Marks**: 100 (for Phase 1).

Evaluation Process

- **Industry Mentor Involvement**: The industry mentor (from the internship or dissertation site) provides feedback and assesses feasibility.
- **Academic Supervisor**: Ensures academic rigor and alignment with M.Tech standards.
- **Expert Committee Review**: Evaluates the final proposal.
- **Deliverables**:
  - Interim report (literature review, problem statement) – Mid-Phase 1.
  - Final proposal (synopsis) – End of Phase 1.

Evaluation of Dissertation Phase I

Rubrics for Zeroth presentation (30 Marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Topic Selection (10 marks) (CO1)	Relevant to current research/industry, strong SDG alignment	Relevant with some novelty	Limited relevance	Irrelevant/ unclear
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Literature Review & Analysis (10 marks) (CO2)	Comprehensive, recent, critically analyzed; clear research gap	Adequate review with some analysis	Limited, descriptive	Poor/no review
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Problem Definition (5 marks) (CO3)	Clearly defined, specific, research-worthy	Defined but lacks depth	Vague or broad	Not defined
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Presentation & Communication (5 marks) (CO4)	Highly clear, logical, confident delivery	Good clarity	Basic clarity	Poor communication
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

Rubrics for Interim presentation (30 Marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Relevance of Topic (5 marks) (CO1)	Highly innovative, relevant to current research/industry, strong SDG alignment	Relevant with some novelty	Limited relevance	Irrelevant/ unclear
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Literature Review & Analysis (10 marks) (CO2)	Comprehensive, recent, critically analyzed; clear research gap	Adequate review with some analysis	Limited, descriptive	Poor/no review
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Objectives & Methodology (10 marks) (CO3)	Well-defined objectives; robust, feasible, justified methodology	Suitable with minor gaps	Basic methodology	Inappropriate/ missing
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Progress Achieved (5 marks) (CO4)	Significant progress with validated results	Moderate progress with partial results	Limited progress	Minimal or no progress
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

Rubrics for Final presentation (College based) (40 Marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Topic Selection & Novelty (10 marks) (CO1)	Topic is highly relevant, innovative, and aligned with current research/industry needs; clear demonstration of originality	Topic is relevant with some degree of novelty; partial alignment with current trends	Topic is basic with limited originality; minimal relevance to current trends	Topic is outdated, irrelevant, or lacks clarity; no evidence of novelty
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Literature Review & Analysis (5 marks) (CO2)	Comprehensive, recent, critically analyzed; clear research gap	Adequate review with some analysis	Limited, descriptive	Poor/no review
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Definition of Research Problem, Formulation of Research (10 marks) (CO3)	Problem is clearly defined, Objectives are clear, measurable, and research-worthy; well-justified with appropriate tools/techniques	Problem is defined and relevant, Objectives are clear; methodology is suitable with minor gaps in justification	Problem is vague, Objectives are basic or partially aligned; methodology is limited or lacks clarity	Problem and objectives are unclear, irrelevant, or not defined
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Report (10 marks) (CO4)	Well-structured, technically sound, excellent clarity, proper references	Good documentation with minor issues	Average documentation	Poor/ incomplete
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Presentation & Communication (5 marks) (CO4)	Highly clear, logical, confident delivery	Good clarity	Basic clarity	Poor communication
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

Rubrics for Final presentation (Industry based) (40 Marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Topic Selection & Novelty (10 marks) (CO1)	Topic is highly relevant, innovative, and aligned with current research/industry needs; clear demonstration of originality	Topic is relevant with some degree of novelty; partial alignment with current trends	Topic is basic with limited originality; minimal relevance to current trends	Topic is outdated, irrelevant, or lacks clarity; no evidence of novelty
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Literature Review & Analysis (5 marks) (CO2)	Comprehensive, recent, critically analyzed; clear research gap	Adequate review with some analysis	Limited, descriptive	Poor/no review
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Definition of Research Problem, Formulation of Objectives (5 marks) (CO3)	Problem is clearly defined, Objectives are clear, measurable, and research-worthy; well-justified with appropriate tools/techniques	Problem is defined and relevant, Objectives are clear; methodology is suitable with minor gaps in justification	Problem is vague, Objectives are basic or partially aligned; methodology is limited or lacks clarity	Problem and objectives are unclear, irrelevant, or not defined
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
*Feedback from industry (5 marks) (CO3)	Excellent	Good	Satisfactory	Needs improvement
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Report (10 marks) (CO4)	Well-structured, technically sound, excellent clarity, proper references	Good documentation with minor issues	Average documentation	Poor/ incomplete
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Presentation & Communication (5 marks) (CO4)	Highly clear, logical, confident delivery	Good clarity	Basic clarity	Poor communication
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

*Feedback from industry may be taken in 5-point scale

Feedback from Industry (Marks 25)

Format for Supervisor Evaluation of Intern

Student Name : _____ Date: _____ Supervisor Name : _____
Designation: _____

Company/Organization : _____

Internship Address: _____ Dates of Internship: From _____ To _____

Please evaluate intern by indicating the frequency with which you observed following parameters:

Parameters	**Marks Rating (0–10 mark)**
Behavior	
Performs in a dependable Manner	
Cooperates with coworkers and supervisor	
Shows interest in work	
Learns quickly	
Shows initiative	
Produces high quality work	
Accepts responsibility	
Accepts criticism	
Demonstrates organizational skills	
Uses technical knowledge and expertise	
Shows good judgment	
Demonstrates creativity/originality	
Analyzes problems effectively	
Is self-reliant	
Communicates well	
Writes effectively	
Has a professional attitude	
Is punctual	
Uses time effectively	

Overall performance of student:

Intern (Tick one): Needs improvement (0 – 1 mark) / Satisfactory (2 mark) / Good (3 mark) / Very Good (4 mark) / Excellent (5 mark)

Additional comments, if any:

Signature of Industry Supervisor *Signature of Section Head/HR Manager*

DISSERTATION PHASE II

Slot	Course Code	Course Name	Marks		L-T-P-S	Credit
			CIE	ESE		
P	**M26CS1P401**	**Dissertation Phase II**	100	100	0-0-24-26	20
Total			**100**	**100**		**20**

- **Duration**: Typically the final semester (e.g., fourth semester of M.Tech).
- **Focus**: Implementation, experimentation, analysis, and conclusion of the research initiated in Phase 1.
- **Common Objectives**:
    1. Execute the proposed methodology.
    2. Analyze results and draw meaningful conclusions.
    3. Demonstrate technical proficiency and problem-solving.
    4. Document and present findings effectively.

Scheme for Dissertation Phase II (College-Based)

Course Outcomes (COs)

1. **CO1**: Implement the research methodology proposed in Phase 1 using appropriate tools and techniques (Technical Skills, Problem-Solving Skills).
2. **CO2**: Conduct experiments or simulations to generate data or validate the approach (Research Skills, Critical Thinking Skills).
3. **CO3**: Analyze results and interpret findings to address the research problem (Critical Thinking Skills, Research Skills).
4. **CO4**: Prepare a comprehensive dissertation report that systematically documents the research process, outcomes, and effectively present the work (Communication Skills, Technical Skills).

Evaluation Scheme

1. Continuous Internal Evaluation (CIE) – 100 Marks

- Assessed by the project coordinator throughout the semester.
- Focus: Progress, effort, and intermediate deliverables.

Paper publication/acceptance (10 marks): Awarded only if at least one paper (authored by the student) is published or accepted in:

- A recognized national/international conference or,
- An indexed journal
- Proof required: Acceptance letter/publication link/DOI/conference proceedings page

Component	**Marks**	**CO Assessed**	**Justification**
Methodology Implementation Progress	25	CO1	Monitors execution of the proposed plan in a college lab or simulation setup.
Experimental/Simulation Work	25	CO2	Assesses data collection or validation efforts in a controlled academic setting.
Interim Result Analysis	25	CO3	Evaluates preliminary analysis and critical thinking during the semester.
Draft Report Submission, Presentation	25	CO4	Checks documentation quality and adherence to academic standards; assesses communication and ability to discuss progress with the supervisor.
Total			**100**

Rubrics for Interim Presentation I (30 marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Implementation of Methodology (10 marks) (CO1)	Methodology implemented	Implementation initiated with good progress	Partial implementation with limited clarity	No meaningful progress
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Experimental/Analytical Work (10 marks) (CO2)	Results are well-validated and critically analyzed	Results interpreted with some validation	Basic interpretation	No meaningful interpretation
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Validation & Interpretation of Results (5 marks) (CO3)	Strong validation with comparison and justification	Adequate validation	Limited validation	No validation
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Presentation & Viva (5 marks) (CO4)	Excellent communication and defense	Good communication	Average	Poor
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

Rubrics for Interim Presentation II (30 marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Execution of the Proposed Methodology (5 marks) (CO1)	Complete, accurate, well-executed	Minor gaps in execution/accuracy	Partially complete, limited accuracy	Incomplete, incorrect implementation
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Progress Achieved (5 marks) (CO2)	Significant progress with validated results	Moderate progress with partial results	Limited progress	Minimal or no progress
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Quality of Results/Data & Analysis (5 marks) (CO3)	Robust results, deep analysis, strong conclusions	Good results, adequate analysis	Basic results, limited analysis	Weak/invalid results, poor analysis
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Depth of Knowledge (5 marks) (CO3)	Strong conceptual and technical understanding	Good understanding with minor gaps	Basic understanding	Poor understanding
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)
Presentation Skills (5 marks) (CO4)	Highly professional and confident	Good	Average	Poor
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

Rubrics for Final Internal Presentation (40 marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Proposed Methodology (10 marks) (CO1)	Complete, accurate, well-executed	Minor gaps in execution/accuracy	Partially complete, limited accuracy	Incomplete, incorrect implementation
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Understanding of Work (10 marks) (CO2)	Thorough understanding, confident	Good understanding	Basic knowledge	Poor understanding
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Validation & Results (10 marks) (CO3)	Strong validation with comparison and justification	Adequate validation	Limited validation	No validation
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Report (10 marks) (CO4)	Excellent technical report with proper structure and references	Good clarity	Basic clarity	Poor communication
Range of marks	(9–10 marks)	(7–8 marks)	(5–6 marks)	(0–4 marks)
Presentation skill (5 marks) (CO4)	Clear & confident presentation	Good communication	Average	Poor
Range of marks	(5 marks)	(4 marks)	(3 marks)	(0–2 marks)

2. End Semester Evaluation (ESE) – 100 Marks

- Assessed by a panel (Project coordinator + supervisor + external examiner) at the semester's end.
- Focus: Final output, rigor, and presentation.

Component	**Marks**	**CO Assessed**	**Justification**
Final Methodology Implementation	25	CO1	Evaluates completeness and technical accuracy of the implemented solution.
Quality of Results/Data, Depth of Analysis and Conclusions	30	CO2	Assesses the robustness and validity of experimental or simulation outcomes, examines the interpretation and significance of findings.
Final Dissertation Report	20	CO3	Judges the quality, structure, and clarity of the written report.
Viva Voce/Presentation	25	CO4	Tests ability to defend work and communicate findings to an academic panel.
Total	**100**		

Rubrics for End Semester Evaluation

Parameter	Excellent	Good	Average	Poor
Methodology Implementation (25 marks) (CO1)	Complete, accurate, well-executed	Minor gaps in execution/accuracy	Partially complete, limited accuracy	Incomplete, incorrect implementation
Range of marks	(20–25 marks)	(15–19 marks)	(10–14 marks)	(0–9 marks)
Quality of Results/Data & Analysis (30 marks) (CO2)	Robust results, deep analysis, strong conclusions	Good results, adequate analysis	Basic results, limited analysis	Weak/invalid results, poor analysis
Range of marks	(25–30 marks)	(20–24 marks)	(10–19 marks)	(0–9 marks)
Dissertation Report (20 marks) (CO3)	Clear, well-structured, high quality	Good structure with minor issues	Adequate but lacks clarity/flow	Poorly written, unstructured
Range of marks	(15–20 marks)	(10–14 marks)	(5–9 marks)	(0–4 marks)
Viva Voce / Presentation (25 marks) (CO4)	Confident, clear, presentation with in-depth knowledge	Clear with minor gaps	Basic explanation, weak defense	Unclear, unable to defend
Range of marks	(20–25 marks)	(15–19 marks)	(10–14 marks)	(0–9 marks)

Scheme for Dissertation Phase II (Industry-Based)

Course Outcomes (COs)

1. **CO1**: Implement the industry-oriented methodology proposed in Phase 1 using industry tools/resources (Technical Skills, Problem-Solving Skills).
2. **CO2**: Perform industry-relevant experiments, validations, or prototypes (Research Skills, Critical Thinking Skills).
3. **CO3**: Analyze results and draw conclusions applicable to the industry problem (Critical Thinking Skills, Research Skills).
4. **CO4**: Prepare a comprehensive dissertation report that systematically documents the research process and outcomes, and effectively present and defend the work before an academic audience (Communication Skills, Technical Skills).

1. Continuous Internal Evaluation (CIE) – 100 Marks

- Assessed jointly by the Project coordinator, supervisor / industry mentor during the semester.
- Focus: Industry collaboration, progress, and practical application.

Component	**Marks**	**CO Assessed**	**Justification**
Methodology Implementation Progress	25	CO1	Tracks execution of the plan in an industry environment using real-world tools.
Industry Validation/Prototype Work, result Analysis	30	CO2	Evaluates practical outputs (e.g., prototypes, tests) relevant to industry needs, assesses industry-applicable insights derived during the process.
Draft Report Submission	20	CO3	Ensures documentation meets both academic and industry standards.
Industry Feedback/Interaction	25	CO4	Gauges communication with industry mentor and progress updates.
Total	**100**		

Rubrics for Internal Evaluation (100 marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Methodology Implementation (25 marks) (CO1)	Systematic, on-time, effective use of tools	Good progress, minor gaps	Partial progress, some delays	Poor progress, inadequate execution
Range of marks	(20–25 marks)	(15–19 marks)	(10–14 marks)	(0–9 marks)
Industry Validation / Prototype & Analysis (30 marks) (CO2)	High-quality validation, deep analysis, strong relevance	Good validation and analysis	Basic validation, limited analysis	No meaningful validation or analysis
Range of marks	(25–30 marks)	(20–24 marks)	(10–19 marks)	(0–9 marks)
Draft Report (20 marks) (CO3)	Clear, structured, comprehensive	Good with minor issues	Adequate, lacks depth/clarity	Poor, incomplete, unstructured
Range of marks	(15–20 marks)	(10–14 marks)	(5–9 marks)	(0–4 marks)
Industry Feedback / Interaction (25 marks) (CO4)	Proactive, regular updates, effective feedback use	Good interaction, periodic updates	Limited interaction, partial feedback use	Poor communication, no feedback use
Range of marks	(20–25 marks)	(15–19 marks)	(10–14 marks)	(0–9 marks)

Feedback from Industry (Marks 25)

Format for Supervisor Evaluation of Intern

Student Name : _____ Date: _____ Supervisor Name : _____
Designation: _____

Company/Organization : _____

Internship Address: _____ Dates of Internship: From _____ To _____

Please evaluate intern by indicating the frequency with which you observed following parameters:

Parameters	**Marks Rating (0–10 mark)**
Behavior	
Performs in a dependable Manner	
Cooperates with coworkers and supervisor	
Shows interest in work	
Learns quickly	
Shows initiative	
Produces high quality work	
Accepts responsibility	
Accepts criticism	
Demonstrates organizational skills	
Uses technical knowledge and expertise	
Shows good judgment	
Demonstrates creativity/originality	
Analyzes problems effectively	
Is self-reliant	
Communicates well	
Writes effectively	
Has a professional attitude	
Is punctual	
Uses time effectively	

Overall performance of student:

Intern (Tick one): Needs improvement (0 – 1 mark) / Satisfactory (2 mark) / Good (3 mark) / Very Good (4 mark) / Excellent (5 mark)

Additional comments, if any:

Signature of Industry Supervisor *Signature of Section Head/HR Manager*

2. End Semester Evaluation (ESE) – 100 Marks

- Assessed by a panel (Project coordinator, supervisor/industry mentor, external examiner).
- Focus: Final deliverables, industry relevance, and dual-audience presentation.

Component	**Marks**	**CO Assessed**	**Justification**
Final Methodology Implementation	25	CO1	Evaluates the technical success of the industry-implemented solution.
Quality of Industry Outputs/Results, depth of Analysis and Industry Impact	30	CO2	Assesses the practical utility and quality of industry-specific deliverables, examines conclusions and their relevance to industry challenges.
Final Dissertation Report	20	CO3	Judges the report's ability to address academic rigor and industry needs.
Viva Voce/Presentation (Dual Audience)	25	CO4	Tests communication to both academic and industry evaluators.
Total	**100**		

Rubrics for End Semester Evaluation (100 marks)

Parameter	**Excellent**	**Good**	**Average**	**Poor**
Methodology Implementation (25 marks) (CO1)	Innovative, well-executed, validated	Appropriate, minor gaps	Acceptable, limited depth/validation	Poor, unclear, or irrelevant
Range of marks	(20–25 marks)	(15–19 marks)	(10–14 marks)	(0–9 marks)
Results, Analysis & Industry Impact (30 marks) (CO2)	Highly relevant, deep analysis, strong impact	Relevant, good analysis	Limited relevance, basic analysis	Irrelevant, weak/no analysis
Range of marks	(25–30 marks)	(20–24 marks)	(10–19 marks)	(0–9 marks)
Final Dissertation Report (20 marks) (CO3)	Well-structured, clear, technically strong	Good structure, minor issues	Adequate, lacks clarity/depth	Poorly written, unstructured
Range of marks	(15–20 marks)	(10–14 marks)	(5–9 marks)	(0–4 marks)
Viva Voce / Presentation (25 marks) (CO4)	Confident, clear, presentation with in-depth knowledge	Clear with minor gaps	Basic, limited clarity	Unclear, unable to defend
Range of marks	(20–25 marks)	(15–19 marks)	(10–14 marks)	(0–9 marks)

EVALUATION COMMITTEES AT A GLANCE

MINI PROJECT (100 Marks)

Continuous Internal Evaluation (CIE) – 100 Marks
Evaluation committee comprises Project coordinator, senior faculty and Project supervisor. Final evaluation by a Committee of Project coordinator, Project supervisor and a senior faculty.

INTERNSHIP (100 Marks)

Internal evaluation committee (25 Marks) comprises of Programme coordinator, Project coordinator and a senior faculty.
Viva Voce (25 Marks) will be done by a committee comprising Programme Coordinator, Project coordinator and an external expert (from Industry or research/academic Institute)

DISSERTATION PHASE I (100 Marks)

Continuous Internal Evaluation (CIE) – 100 Marks
Evaluation committee comprises of Project coordinator, senior faculty and project supervisor / Industry mentor

DISSERTATION PHASE II (200 Marks)

Continuous Internal Evaluation (CIE) – 100 Marks
Assessed jointly by the Project coordinator, supervisor / industry mentor and senior faculty during the semester.

End Semester Evaluation (ESE) – 100 Marks
Assessed by a panel of Project coordinator, supervisor and external examiner at the semester end.