



RAMAIAH
Institute of Technology

CURRICULUM

Academic Year 2026 – 2027

**III & IV SEMESTER
B.E.**

**Computer Science and Engineering
(AI&ML)
Batch - 2025**

RAMAIAH INSTITUTE OF TECHNOLOGY

(Autonomous Institute, affiliated to VTU)
(Approved by AICTE, New Delhi & Govt. of Karnataka)
Accredited by NBA & NAAC with A+ Grade

About the Institute

In 1962, Dr. M. S. Ramaiah, a visionary philanthropist, established the Gokula Education Foundation with a noble mission to uplift society through education. The same year marked a pivotal moment in technical education in India with the founding of the M S Ramaiah Institute of Technology (MSRIT).

MSRIT offers an impressive array of 18 undergraduate and 15 postgraduate programs, all approved by the All India Council for Technical Education (AICTE). The National Board of Accreditation (NBA) has accredited all eligible programs at the undergraduate (UG) and postgraduate (PG) levels. In March 2021, MSRIT earned an 'A + ' grade from the National Assessment and Accreditation Council (NAAC), underscoring its unwavering commitment to academic excellence. Since 2007, the institute has proudly held Autonomous Status for its UG and PG programs, a prestigious recognition granted by the University Grants Commission (UGC) and Visvesvaraya Technological University (VTU). According to the Ministry of Education, Government of India's NIRF Ranking Framework, MSRIT ranks 75th among 1,584 leading engineering institutions and 31st among 131 architecture schools in India for 2025, highlighting its remarkable impact and leadership in education. The institute participated in the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. To foster a research culture, the institute has established several specialized centres, including the Centre for Imaging Technologies, the Centre for Advanced Materials Technology, the Centre for Antennas and Radio Frequency Systems (CARFS), the Centre for Cyber Physical Systems, the Schneider Centre of Excellence, the Centre for Bio and Energy Materials Innovation, JSW Centre of Excellence in Power Systems and more. MSRIT boasts a faculty of 380 highly qualified members, 70% of whom hold doctoral degrees, and over 300 scholars currently pursuing Ph.D. degrees. The Entrepreneurship Development Cell (EDC) and "Ramaiah Evolute" have been established on campus to support startup incubation. MSRIT features a dedicated Placement and Training department, a strong mentoring and proctorial system, a fully equipped sports department, and a spacious, air-conditioned library with a wide range of books and subscriptions to both international and national journals. The Digital Library provides access to online e-journals from renowned publishers, including Elsevier ScienceDirect, IEEE, Taylor & Francis, and SpringerLink. Additionally, the Institute is a member of DELNET, CMTI, and the VTU E-Library Consortium. The institute features a state-of-the-art auditorium, a well-equipped recording studio, and multiple advanced conference halls with videoconferencing capabilities. Additionally, MSRIT provides excellent hostel accommodations for both boys and girls, ensuring a comfortable living environment. MSRIT alumni have achieved remarkable success, holding prominent positions in India and internationally. They maintain strong connections with the institute through an engaged and active Alumni Association. Founded on Dr. Ramaiah's unwavering commitment to knowledge and innovation, this remarkable institution continues to inspire generations of students and shape the future of engineering and technology in the country.

About the Department

The Department offers Bachelor of Engineering (B. E) in Computer Science and Engineering (Artificial Intelligence and Machine Learning). The department is started in the year 2021 with an intake of 60 each. Currently intake for B.E. in Computer Science and Engineering (Artificial Intelligence and Machine Learning) is 129. In 2024, M.Tech. in Artificial Intelligence started with an intake of 18 under the department of Computer Science and Engineering (Artificial Intelligence and Machine Learning). The department has experienced faculty members with the doctoral degree. The faculty members of the department are actively involved in the research activities and publishing their research findings in reputed International Journals/Conferences/Book Chapters. The faculty members have authored books with premiere publishing agencies like Springer, Taylor & Francis. The department has state-of-the-art laboratories and classroom facilities. The department regularly conducts Boot camps, Technical Seminars, Workshops, Faculty Development Programs and Hackathons. The department encourages the students to participate in co-curricular and extracurricular activities. The department has established strong collaborations with Industries and premier peer Institutes to design the curriculum to meet the global standards in the domains of AI&ML. The department is partnering with Ramaiah Medical and Dental College to work on projects which has societal impact. The department is having collaborations with Industries like SAP Labs, Unisys, IBM, HPE, Samsung, Microsoft, GE Healthcare, Adobe, Thomson Reuters, Yubi, JP Morgan, Intellytix etc. to support Internships, Projects, Curriculum upgradation, Guest Lectures, and Industry visits.

VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs

MISSION OF THE INSTITUTE

MSRIT shall meet the global socio-economic needs through

- Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
- Establishing research clusters in emerging areas in collaboration with globally reputed organizations
- Establishing innovative skills development, techno-entrepreneurial activities, and consultancy for socio-economic needs

QUALITY POLICY

We at M. S. Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

VISION OF THE DEPARTMENT

To provide quality education, inculcate professionalism, and enhance problem solving and coding, innovative design skills in Computer Science and Engineering especially in the domain of Artificial Intelligence and Machine Learning with a focus to produce professionally competent and socially sensitive engineers capable of working in a global environment.

MISSION OF THE DEPARTMENT

To pursue excellence in Academics, Research and Innovation by:

- Enabling creative and dynamic learning environments to impart quality technical education through continuously improving curriculum and pedagogy techniques.
- Collaborating with the industry, academia and society for strengthening design thinking, research, innovation, and entrepreneurship ecosystem.
- Encouraging extra and co-curricular activities to nurture the leadership qualities with a sense of commitment and accountability and inculcate values and ethics.

KNOWLEDGE PROFILES (WKs):

WK1: Understanding of natural and social sciences.

WK2: Mathematics, numerical analysis, data analysis, and computing.

WK3: Engineering fundamentals.

WK4: Specialized engineering knowledge.

WK5: Engineering design and operations, including sustainability.

WK6: Engineering practice (technology).

WK7: Role of engineering in society, sustainability, and professional responsibility.

WK8: Current research literature and critical thinking.

WK9: Ethics, professional responsibilities, and inclusive behavior.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

A B.E in Computer Science & Engineering (Artificial Intelligence and Machine Learning) graduates of Ramaiah Institute of Technology:

PEO1: Excel in professional career by acquiring knowledge in basic sciences and Computer Science and Engineering, Artificial Intelligence & Machine Learning principles and contribute to the profession as an excellent employee, or as an entrepreneur.

PEO2: Capable of pursuing higher education and research.

PEO3: Adapt to technological advancements in multidisciplinary environments by engaging in lifelong learning with leadership qualities, professional ethics and soft skills.

PROGRAM OUTCOMES (POs):

The Outcomes of the Bachelor of Engineering in Computer Science & Engineering (Artificial Intelligence and Machine Learning) Programme are as follows:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. (WK3)

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. (WK2)

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. (WK3)

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. (WK4)

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. (WK3)

PO6: The engineer and the world: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. (WK1)

PO7: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. (WK9)

PO8: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. (WK9)

PO9: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. (WK9)

PO10: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. (WK5)

PO11: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. (WK6)

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1: Ability to understand and identify problems/opportunities where CSE, AI and ML concepts can be applied and to identify the right AI and ML techniques in such contexts.

PSO2: Ability to perform the data engineering, designing, developing and testing the AI and ML solutions that include both hardware and software.

PSO3: Ability to be aware of technical solutions that are following ethical aspects aligning with social responsibilities both at designing and developmental phases of applications.

Semester wise Credit Breakdown for B.E Degree Curriculum

Batch 2025-29

Semester Course Category	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Total Credits
Applied Science Courses (ASC)	08	08	03	---	---	---	---	---	19
Engineering Science Courses(ESC/ PLC/ETC)	05	10	---	---	---	---	---	---	15
Humanities, Social Sciences and Management (HSMC)	02	01	---	---	03	---	03	---	09
Ability Enhancement Course (AEC)	01	01	01	01	01	---	---	---	05
Skill Development Course (SDC)	---	---	---	---	---	01	---	---	01
Universal Human Values (UHV)	---	---	02	---	---	---	---	---	02
Professional Core Course (PCC)/ Program Specific Course (PSC)	04	---	11	12	11	11	04	---	53
Integrated Professional Core Course (IPCC)	---	---	04	04	04	---	04	---	16
Professional Electives Courses - (PEC)	---	---	---	03	03	03	03	---	12
Open Elective Courses (OEC)	---	---	---	---	---	03	03	---	06
Internship (INT)	---	---	---	---	---	---	---	04	04
Mini Project/ Project Work(PW)	---	---	---	---	---	04	02	12	18
Non Credit Mandatory Courses (NCMC)	---	---	---	Yes	Yes	Yes	---	---	---
Total Credits	20	20	21	20	22	22	19	16	160
Skill lab	---	01	01	01	01	01	---	---	05

B.E. in Computer Science and Engineering (AI & ML)
Scheme of Teaching Batch - 2025
III Semester

B.E. in Computer Science and Engineering (AI & ML) Scheme of Teaching Batch - 2025 III Semester												
Sl. No.	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours/week			
					L	T	P	Total	L	T	P	S
1	25CI31	Transform Techniques and Linear Algebra for Machine Learning	Maths	ASC	2	1	0	3	2	2	0	2
2	25CI32	Computer Networks	CSE(AI ML)	PCC(IC)	3	0	1	4	3	0	2	3
3	25CI33	Data Structures	CSE(AI ML)	PCC	3	0	0	3	3	0	0	3
4	25CI34	Computer Organization and Architecture	CSE(AI ML)	PCC	3	0	0	3	3	0	0	3
5	25CI35	Discrete Mathematical Structures	CSE(AI ML)/ Maths	PCC	3	0	0	3	3	0	0	3
6	25UHV36	Universal Human Value Course	CSE(AI ML)	UHV	2	0	0	2	2	0	0	2
7	25CIAEC37	Ability Enhancement Course- III Object Oriented Programming	CSE(AI ML)	AEC	1	0	0	1	1	0	0	1
8	25CIL38	Data Structures Laboratory	CSE(AI ML)	PCC	0	0	1	1	0	0	2	0
9	25CIL39	Application Development using Java Laboratory	CSE(AI ML)	PCC	0	0	1	1	0	0	2	0
Total					17	1	3	21	17	2	6	17
10	25PE69	Physical Education		NCMC	All students have to register compulsorily for any one of the courses with the concerned							
	25YO69	Yoga										

	25NS69	NSS			coordinator (Yoga Teacher/ Physical Education Director/ NSS Coordinator) in the beginning of the III semester. Attending the registered course from III to VIII semesters. Qualifying is mandatory for the award of the degree.				
11	25AM31	Additional Mathematics - I *	Maths	NCMC	0	0	0	0	-
12	25CISL2	Skill Lab -II		SDC	0	0	1	1	To be evaluated at the end of the semester but shall be reflected in the VIII semester grade card.

NOTE: Minimum of 1 subject should have a Tutorial component of 1 Credit.

Nomenclature: **ASC:** Applied Science Course, **IC:** Integrated Course (Practical Integrated with Theory Course), **PCC:** Professional Core Course, **UHV:** Universal Human Value Course, **AEC:** Ability Enhancement Course, **NCMC:** Non-credit Mandatory Course

Credit Definition:

- 1 credit = 1 hour/week of lecture (L)
- 1 credit = 2 hours/week of tutorial (T)
- 1 credit = 2 hours/week of practical(P)
- Self-Learning Hours (S)

PCC & ASC courses are theory courses with or without tutorial sessions.

- Each theory credit corresponds to one contact hour per week, while each tutorial credit corresponds to two contact hours per week.
- The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.

- The CIE is evaluated for 50 marks through internal tests (30 marks) and other components (20 marks). Each internal test will have three questions and students shall answer any two full questions. Each question shall address all the Course Outcomes (COs) prescribed for that test. The average of the two tests shall be considered for awarding 30 marks. The remaining 20 marks shall be assessed through assignments, tutorial tests, quizzes, surprise tests, mini-projects, or other components as decided by the course instructor.
- The SEE shall be evaluated for 100 marks, which shall be scaled down to 50 marks.
- The SEE examination shall consist of ten questions with internal choice (two questions per unit). Students shall answer any five full questions, selecting at least one question from each unit.

PCC (IC) is an Integrated course, combining theory with practical components.

- Each theory credit corresponds to one contact hour per week, while each practical credit corresponds to two contact hours per week.
- The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.
- The CIE for the theory component shall be conducted through two internal tests of 30 marks each. Each test shall consist of three questions, out of which students shall answer any two full questions. Each question shall address all the Course Outcomes (COs) prescribed for that test. The average of the two tests shall be considered for awarding 30 marks.
- The CIE for the practical component shall be evaluated for 20 marks. Each laboratory experiment shall be evaluated for 10 marks based on the experiment record, conduction of the experiment, and observations, and the cumulative marks shall be scaled down to 15 marks. Another 05 marks from a lab test and viva.
- The SEE shall be evaluated for 100 marks, which shall be scaled down to 50 marks.
- The SEE examination shall consist of ten questions with internal choice (two questions per unit). Students shall answer any five full questions, selecting at least one question from each unit.
- However, questions from the practical component of the Integrated course may be included in the SEE question paper.

AEC is a 1-credit course involving 1 contact hour per week. The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.

- The CIE will comprise of two tests of 30 marks each having Part-A with MCQs for 6 marks and Part-B with Descriptive questions. The remaining 20 marks shall be assessed through assignments, surprise tests, quizzes, or other components as decided by the course instructor.
- The SEE will comprise of Part-A with MCQs (10 marks) and Part-B (5x8=40 marks) with descriptive questions

UHV is a 2-credit course involving 2 contact hours per week. The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.

- The CIE is evaluated for 50 marks through internal tests (30 marks) and other components (20 marks). Each internal test will have three questions and students shall answer any two full questions. Each question shall address all the Course Outcomes (COs) prescribed for that test. The average of the two tests shall be considered for awarding 30 marks. The remaining 20 marks shall be assessed through assignments, tutorial tests, quizzes, surprise tests, mini-projects, or other components as decided by the course instructor.
- The SEE shall be evaluated for 100 marks, which shall be scaled down to 50 marks.
- The SEE examination shall consist of ten questions with internal choice (two questions per unit). Students shall answer any five full questions, selecting at least one question from each unit.

PCC Laboratory is a 1-credit lab course involving 2 hours of lab sessions per week and uses both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) for assessment.

- CIE totals 50 marks, with 30 marks for lab sessions (Each laboratory experiment shall be evaluated for 10 marks based on the experiment record, conduction of the experiment, and observations, and the cumulative marks shall be scaled down to 30 marks.). Another 15 marks from a lab test and 05 marks for viva.
- SEE totals 50 marks, comprising 40 marks for procedure write up, experiment conduction & results and 10 marks for viva voce.

The Non Credit Mandatory Course, Physical Education (Sport and Athletics)/Yoga/National Service Scheme (NSS):

- Student shall select any one of the NCMC's namely, Physical Education (Sport and Athletics)/Yoga/ NSS prescribed for four semesters and shall attend the course from the III semester to VI semester to complete all the formalities of the course and earn requisite CIE score. The Pass/Fail shall be reflected in the VI semester grade card.
- The above mentioned NCMC's shall not be considered for vertical progression as well as for the calculation of SGPA/CGPA but completion of the courses shall be mandatory for the award of degree.
- CIE marks will be allotted by the concerned course teacher based on attendance and performance in the practice sessions/field work every semester (III to VI) for 100 marks and the total 400 marks scored by the student are scaled down to 100 in the VI semester.
- In case, any student fails to secure the minimum 40% of the prescribed marks, he/she shall be deemed to have secured 'F' grade.

*** Lateral Entry Students:**

The Non-Credit Mandatory Course, Additional Mathematics I: is prescribed for III Semester Lateral Entry Diploma students admitted to III Semester of BE Program. The student shall register for this course along with other III semester courses. The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. The CIE shall be evaluated for 100 marks. In case, any student fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured 'F' grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE. In case student fails to register for the said course/ falls short of attendance, he/she will repeat the course whenever it is offered next. Additional Mathematics I shall have CIE component only and **no SEE component**. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

Skill Lab Course: is a 1-credit Lab course with 2 contact hours per week. This course is designed to improve the practical and technical skills of students, focusing on developing industry-relevant and job-oriented skills, and enhance employability of the students. The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. The course shall be evaluated through Continuous Internal Evaluation (CIE) for 100 marks. The result of the course will be reflected in the Grade card of VIII semester.

Lateral Entry Students:AICTE Activity Points Requirement for BE Programs: As per AICTE guidelines (refer Chapter 6 – *AICTE Activity Point Program, Model Internship Guidelines*), in addition to academic requirements, students must earn a specified number of **Activity Points** to be eligible for the award of the degree. The points to be earned is:

1. **Regular students** admitted to a 4-year degree program must earn **100 Activity Points**.
2. **Lateral entry students** (joining from the second year) must earn **75 Activity Points**.
3. **Students transferred** from other universities directly into the V semester must earn **50 Activity Points** from the date of entry into VTU.

These Activity Points are non-credit and will not be considered for the SGPA/CGPA or be used for vertical progression. However, earning Activity Points is mandatory for the award of the degree, and the points earned will be reflected on the eighth semester Grade Card. If a student completes all the semesters (eight or six) at the end of the program but fails to earn the required Activity Points, the VIII semester Grade Card will be withheld until the requirement is fulfilled. Also, the degree will be awarded only after the Grade Card has been released. The hours spent earning the activity points will not be counted for regular attendance requirements. Students can accumulate these points at any time during their program period, including weekends, holidays, and vacations, starting from the year of admission, provided they meet the minimum hours of engagement prescribed for each activity by AICTE.

SCHEME OF TEACHING IV SEMESTER

B.E. in Computer Science and Engineering (AI & ML) Scheme of Teaching Batch - 2025 IV Semester

Sl. No.	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours/week			
					L	T	P	Total	L	T	P	S
1	25CI41	Operating Systems	CSE(AIML)	PCC(IC)	3	0	1	4	3	0	2	3
2	25CI42	Database Management Systems	CSE(AIML)	PCC	3	0	0	3	3	0	0	3
3	25CI43	Design and Analysis of Algorithms	CSE(AIML)	PCC	3	0	0	3	3	0	0	3
4	25CI44	Automata Theory and Compiler Design	CSE(AIML)	PCC	2	1	0	3	2	2	0	2
5	25CIE45x	Program Elective Course -1	CSE(AIML)	PEC	3	0	0	3	3	0	0	3
6	25CIAEC46	Ability Enhancement Course – IV NoSQL Databases	CSE(AIML)	AEC	1	0	0	1	1	0	0	1
7	25CIL47	Algorithms Laboratory	CSE(AIML)	PCC	0	0	1	1	0	0	2	0
8	25CIL48	Data Visualization Laboratory	CSE(AIML)	PCC	0	0	1	1	0	0	2	0
9	25CIL49	Database Management Systems Laboratory	CSE(AIML)	PCC	0	0	1	1	0	0	2	0
Total					15	1	4	20	15	2	8	15
10	25AM41	Additional Mathematics II*		NCMC	0	0	0	0	-			
11	25CISL3	Skill Lab -III		SDC	0	0	1	1	To be evaluated at the end of the semester but shall be reflected in the			

									VIII semester grade card.
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NOTE: Minimum of 1 subject should have a Tutorial component of 1 Credit.

PROGRAM ELECTIVE – 1							
SL. NO.	COURSE CODE	COURSE NAME	Credits				Total contact hours /week
			L	T	P	Total	
1.	25CIE451	Probability, Statistical Inference and Optimization	3	0	0	3	3
2.	25CIE452	Probability and Queueing Theory	3	0	0	3	3
3.	25CIE453	Applied Numerical Methods and Algorithms	3	0	0	3	3

NOTE: Minimum of 1 subject should have a Tutorial component of 1 Credit.

Nomenclature: **IC:** Integrated Course (Practical Integrated with Theory Course), **PCC:** Professional Core Course, **PEC:** Professional Elective Course, **AEC:** Ability Enhancement Course, **NCMC:** Non-credit Mandatory Course

Credit Definition:

- 1 credit = 1 hour/week of lecture (L)
- 1 credit = 2 hours/week of tutorial (T)
- 1 credit = 2 hours/week of practical(P)
- Self-Learning Hours (S)

PCC(IC) is an Integrated course, combining theory with practical components.

- Theory sessions shall be conducted for 3 hours per week, while the practical sessions shall be conducted for 2 hours per week.

- Theory components shall be evaluated through both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE).
- The practical component shall be assessed only through CIE (No SEE).
- The CIE shall consist of two internal test of 30 marks each. Each test will have three questions and student shall answer any two full questions. Each question shall have all CO's addressed for that test. An average of two test shall be taken to award 30 marks.
- The CIE for the practical component shall be evaluated for 20 marks. Each laboratory experiment shall be evaluated for 10 marks based on the experiment record, conduction of the experiment, and observations, and the cumulative marks shall be scaled down to 15 marks. Another 05 marks from a lab test and viva.
- The SEE shall be evaluated for 100 marks, which shall be scaled down to 50 marks.
- The SEE examination shall consist of 10 questions with internal choice and student shall answer any five full questions.
- However, questions from the practical component of the Integrated course (IC) can be included in the SEE question paper.

PCC & PEC courses are theory courses with or without tutorial sessions.

- Each theory credit corresponds to one contact hour per week, while each tutorial credit corresponds to two contact hours per week.
- The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.
- The CIE is evaluated for 50 marks through internal tests (30 marks) and other components (20 marks). Each internal test will have three questions and students shall answer any two full questions. Each question shall address all the Course Outcomes (COs) prescribed for that test. The average of the two tests shall be considered for awarding 30 marks. The remaining 20 marks shall be assessed through assignments, tutorial tests, quizzes, surprise tests, mini-projects, or other components as decided by the course instructor.
- The SEE shall be evaluated for 100 marks, which shall be scaled down to 50 marks.
- The SEE examination shall consist of ten questions with internal choice (two questions per unit). Students shall answer any five full questions, selecting at least one question from each unit.

AEC is a 1-credit course involving 1 contact hour per week. The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.

- The CIE will comprise of two tests of 30 marks each having Part-A with MCQs for 6 marks and Part-B with Descriptive questions. The remaining 20 marks shall be assessed through assignments, surprise tests, quizzes, or other components as decided by the course instructor.
- The SEE will comprise of Part-A with MCQs (10 marks) and Part-B (5x8=40 marks) with descriptive questions.

*** Lateral Entry Students:**

The Non-Credit Mandatory Course, Additional Mathematics II: is prescribed for IV Semester Lateral Entry Diploma students admitted to III Semester of BE Program. The student shall register for this course along with other IV semester courses. The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. The CIE shall be evaluated for 100 marks. In case, any student fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured 'F' grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE. In case student fails to register for the said course/ falls short of attendance, he/she will repeat the course whenever it is offered next. Additional Mathematics II shall have CIE component only and **no SEE component**. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

Skill Lab Course: is a 1-credit Lab course with 2 contact hours per week. This course is designed to improve the practical and technical skills of students, focusing on developing industry-relevant and job-oriented skills, and enhance employability of the students. The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. The course shall be evaluated through Continuous Internal Evaluation (CIE) for 100 marks. The result of the course will be reflected in the Grade card of VIII semester.

Lateral Entry Students:

AICTE Activity Points Requirement for BE Programs: As per AICTE guidelines (refer Chapter 6 – *AICTE Activity Point Program, Model Internship Guidelines*), in addition to academic requirements, students must earn a specified number of **Activity Points** to be eligible for the award of the degree. The points to be earned is:

1. **Regular students** admitted to a 4-year degree program must earn **100 Activity Points**.
2. **Lateral entry students** (joining from the second year) must earn **75 Activity Points**.

3. **Students transferred** from other universities directly into the V semester must earn **50 Activity Points** from the date of entry into VTU.

These Activity Points are non-credit and will not be considered for the SGPA/CGPA or be used for vertical progression. However, earning Activity Points is mandatory for the award of the degree, and the points earned will be reflected on the eighth semester Grade Card. If a student completes all the semesters (eight or six) at the end of the program but fails to earn the required Activity Points, the VIII semester Grade Card will be withheld until the requirement is fulfilled. Also, the degree will be awarded only after the Grade Card has been released. The hours spent earning the activity points will not be counted for regular attendance requirements. Students can accumulate these points at any time during their program period, including weekends, holidays, and vacations, starting from the year of admission, provided they meet the minimum hours of engagement prescribed for each activity by AICTE.

TRANSFORM TECHNIQUES AND LINEAR ALGEBRA FOR MACHINE LEARNING	
Course Code: 25CI31	Credits: 2:1:0:2
Pre – requisites: Calculus and Basics of Linear Algebra	Contact Hours: 30L+15T+30S
Course Coordinator: Dr. S Ramprasad & Dr. Y. S. Kalyan Chakravarthy	

COURSE CONTENTS

Unit I

Laplace Transforms: Definition, transforms of elementary functions, properties of Laplace transforms, existence conditions, transform of derivatives, integrals, multiplication by t^n , division by t , evaluation of integrals by Laplace transforms, transform of periodic function. Unit–step function, unit–impulse function. inverse transforms, convolution theorem.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links:<https://nptel.ac.in/courses/111/105/111105134/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/107625/1030>

Unit II

Application of Laplace Transforms and Z transforms: Solution of linear differential equations and simultaneous linear differential equations using Laplace transforms. Z-transform of Standard functions, Properties of Z-transforms, Convergence of Z-transforms, Inverse Z-transform, Application of Z-transforms to solve difference equations, linear recurrence relations.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links:<https://nptel.ac.in/courses/111/105/111105134/>
<https://nptel.ac.in/courses/111106111>
- Impartus recording:<https://a.impartus.com/ilc/#/course/107625/1030>

Unit III

Orthogonal Projections: Review of vector space, complement subspaces, orthogonality of four fundamental subspaces and its dimensions, QR-factorization, the complete solution to $Ax = b$, least-squares approximations, constraint optimization. Quadratic forms, positive definite matrices.

- Pedagogy / Course delivery tools: Chalk and talk, Power point Presentation, Videos.
- Links:<https://nptel.ac.in/courses/111/105/111105035/>
<https://nptel.ac.in/courses/111/102/111102152/>
- Impartus Recording:<https://a.impartus.com/ilc/#/course/621524/1030>
<https://a.impartus.com/ilc/#/course/619570/1030>

Unit IV

Applications of Eigenvalue Decomposition: Review of eigenvalues and eigenvectors. Symmetric matrices, complex matrices, Hermitian and unitary matrices, similarity and orthogonal diagonalization, the singular value decomposition (SVD), principal component analysis (PCA), applications to linear recurrence relations, Fibonacci sequence, stability of the differential equations.

- Pedagogy / Course delivery tools: Chalk and talk, Power point Presentation, Videos.
- Links: <https://nptel.ac.in/courses/111/105/111105035/>
<https://nptel.ac.in/courses/111/102/111102152/>
- Impartus Recording: <https://a.impartus.com/ilc/#/course/621524/1030>
<https://a.impartus.com/ilc/#/course/619570/1030>

Unit V

Vector calculus and Matrix differentiation: Review of partial derivatives, gradients and directional derivatives, Jacobian, Hessian, Gradients of vector valued functions, Matrix derivatives – AX , $A^T AX$, Trace, Norm.

Continuous Optimization: Maxima, Minima, Notion of objective/cost functions, Least square solutions and pseudo inverse, Gradient descent Algorithm, Constrained optimization and Lagrangian multipliers.

- Pedagogy / Course delivery tools: Chalk and talk, Power point Presentation, Videos.
- Links: <https://nptel.ac.in/courses/111105100>

Text Books:

1. **B. S. Grewal** – Higher Engineering Mathematics – Khanna Publishers – 45th edition – 2024.
2. **David C. Lay, Steven R. Lay and Judi J. Mc. Donald** – Linear Algebra and its Applications – Global Edition. Pearson – 6th edition – 2024.
3. **Gilbert Strang**, Linear Algebra and its Applications, 5th Edition (2016).
4. **Kreyszig, Erwin** - Advanced Engineering Mathematics - John Wiley & Sons - 11th edition-2025

Reference Books:

1. **Peter V. O'Neil** – Advanced Engineering Mathematics – Cengage learning – 7th edition – 2011.
2. **Gareth Williams** – Linear Algebra with Applications, Jones and Bartlett Press – 9th edition – 2017.

Course Outcomes

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

1. Evaluate Laplace and inverse Laplace transforms and apply them to solve linear differential equations (PO-1,2 & PSO – 2,3)
2. Solve differential equations, difference equations, and recurrence relations using Laplace and Z-transform techniques. (PO-1,2 & PSO – 2,3)
3. Analyze vector spaces, orthogonality, least-squares approximations, QR factorization, and positive definite matrices. (PO-1,2 & PSO – 2,3)
4. Apply eigenvalue decomposition, orthogonal diagonalization, SVD, and PCA in data analysis and dynamical system applications. (PO-1,2 & PSO – 1,3)
5. Utilize vector calculus, matrix differentiation, and optimization methods to formulate and solve engineering optimization problems. (PO-1,2 & PSO – 1,3)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50

Assessment Tool	Marks	Course outcomes addressed
Internal test – I	30	CO1,CO2,CO3
Internal test – II	30	CO3,CO4,CO5
Average of the two internal tests will be taken for 30 marks.		
Other components	Marks	Course outcomes addressed
Quiz	10	CO1,CO2,CO3
Assignment	10	CO3,CO4,CO5
Semester End Examination (SEE)	100	CO1,CO2,CO3,CO4,CO5

COMPUTER NETWORKS

Course Code: 25CI32

Credits: 3:0:1:3

Pre – requisites: Nil

**Contact Hours:
45L+15P+45S**

Course Coordinator: Dr. Sahana Lokesh R

Course Contents

Unit I

Data communication Fundamentals: Introduction, components, Data Flow; Networks – Network criteria, Physical Structures, Network Models, Categories of networks. **Network Models** -Layered tasks; The OSI model – Layered architecture, Peer-to-Peer Process, Encapsulation; Layers in the OSI model; TCP/IP Protocol suite; Addressing. **Digital Transmission Fundamentals (with problems to solve):** Transmission Impairment – Attenuation, Distortion and Noise; Data rate limits – Nyquist Bit Rate, Shannon Capacity; Performance

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos, Case Study, Tool-Based Demonstration
- Links: nptel.ac.in/courses/106106091?utm_source=chatgpt.com

Unit II

Digital Transmission (with problems to solve): Digital-to-Digital conversion - Line coding, Line coding schemes (unipolar, polar, bipolar), **Error detection & correction (with problems to solve):** Cyclic codes – CRC, Polynomials, **Multiple Access:** Random Access (CSMA, CSMA/CD, CSMA/CA), Controlled Access (Reservation, Polling, Token Passing).

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos, Case Study, Tool-Based Demonstration
- Links: https://www.coursera.org/learn/odc-tcpip-and-internet?utm_source=chatgpt.com

Unit III

Network layer: Logical addressing - IPV4 addresses, Address space, notations, classful and classless addressing with problem solving, NAT, IPV6 addresses; IPV6 addresses; **Network layer: Internet protocol** - IPV4 datagram, fragmentation, checksum and options; IPV6 packet format, advantages; Transition from IPV4 to IPV6

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos, Case Study, Tool-Based Demonstration
- Links: https://www.coursera.org/learn/computer-networking?utm_source=chatgpt.com

Unit IV

Address mapping, Error reporting, & Multicasting - Address mapping, ARP, RARP, BOOTP and DHCP; ICMP, IGMP, Network layer: Delivery, Forwarding, & Routing – Direct Vs Indirect delivery, Forwarding Techniques, Forwarding Process, Routing Table. Unicast routing protocols with problem solving – Optimization, Intra and Inter domain routing, distance vector routing, link state routing.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos, Case Study, Tool-Based Demonstration
- Links: https://www.nptel.ac.in/courses/106105183?utm_source=chatgpt.com

Unit V

Transport Layer - Process-to-Process delivery, User Datagram Protocol, Transmission Control Protocol, Congestion Control- Data Traffic congestion, Congestion control, Congestion Control in TCP. **Application Layer: Domain Name System** - Namespace, Domain name space, Distribution of Name space, DNS in internet, Resolution. **Remote logging** – TELNET; Electronic mail – Architecture, FTP, **Network Management: SNMP** – Simple Network management system (Basic Overview).

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos, Case Study, Tool-Based Demonstration
- Links: https://www.nptel.ac.in/courses/106106091?utm_source=chatgpt.com

Lab Experiments:

Students need to use OPNET Simulator to simulate the following experiments:

1. Simulate a 3-node point-to-point network with duplex links in between them. Set the Queue size and vary the bandwidth and find the number of packets dropped.
2. Simulate a 4-node point-to-point network and connect the link as follows: -No-n2, n1-n2 and n2-n3. Apply TCP agent between n0-n3 and UDP n1-n3. Apply relevant applications over TCP and UDP agents changing the parameters and determining the no. of packets sent by TCP/UDP.
3. Simulate the different types of internet traffic such as FTP and TELNET over the network and analyze the throughput.
4. Simulate the transmission of a PING message over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion.
5. Simulate an Ethernet LAN using N nodes (6-10), change error rate and data rate and compare Throughput.
6. Simulate an Ethernet LAN using N nodes and set multiple traffic nodes and determine collision across different nodes.
7. Simulate an Ethernet LAN using N nodes and set multiple traffic nodes and plot congestion window for different source/destination.
8. Simulate simple ESS and with transmitting nodes in WIRELESS LAN by simulation and determine the performance with respect to the transmission of packets.

Suggested Learning Resources

Text Books:

1. Behrouz A. Forouzan, Data Communications and Networking, Fifth Edition, Tata McGraw-Hill, 2012
2. Wayne Tomasi, Introduction to Data Communications and Networking, Pearson Education, 2005.
3. Alberto Leon-Garcia and Indra Widjaja, Communication Networks – Fundamental Concepts and Key architectures, Second Edition, Tata McGraw-Hill, 2004.

Course Outcomes (COs):

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

1. Distinguish different communication models/protocol stacks (OSI & TCP/IP) and analyze the usage of appropriate network topology for a given scenario. (PO- 1, 2, 3, PSO-1,2)
2. Handle the issues associated with digital data signals and solve the problems on data transmission by measuring the performance parameters. (PO-1, 2, 3, PSO-1, 2)
3. Discuss different transport layer protocols and analyze different techniques to improve QOS (PO-1, 2, 3) (PSO-2, 3)
4. Describe the working of various application layer services. (PO-1,2, 3) (PSO-2)
5. Analyze various network management protocols. (PO-1, 2, 3) (PSO-1, 2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Lab test 1	10	CO1, CO2, CO3, CO4, CO5
Lab test 2	10	CO1,CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4,CO5

DATA STRUCTURES	
Course Code: 25CI33	Credits: 3:0:0:3
Pre – requisites: Nil	Contact Hours: 45L+45S
Course Coordinator: Ms. Kavya Natikar	

Course Contents

Unit I

Basics of Data structures: Pointers and arrays (Reference book-2, ch-5), Dynamic Memory Allocation, allocating a Block of Memory: *malloc*, allocating a multiple blocks of memory: *calloc*, Releasing the used space: Free, Altering the size of block. Introduction to data Structures, Classification of data structures, Operations on data structures.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://www.digimat.in/nptel/courses/video/106105151/L17.html>
<https://www.digimat.in/nptel/courses/video/106105151/L18.html>

Unit II

Stacks: Introduction to Stacks, Array Representation of Stacks, Operations on a Stack, multiple stacks, Applications of Stacks. **Queues:** Introduction to Queues, Array Representation of Queues, Types of Queues, Circular Queues, Basics of Deques and Priority Queues, Applications of Queues.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106106127>
<https://nptel.ac.in/courses/106103069>

Unit III

Linked Lists: Structures and Functions, Self-Referential Structures, Introduction to Linked List, Introduction, Singly Linked Lists, Circular Linked Lists, Doubly Linked Lists, Circular Doubly Linked Lists, Linked Representation of Stack, Linked Representation of Queues.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/10610306>
<https://www.youtube.com/watch?v=zWg7U0OEAoE&list=PLBF3763AF2E1C572F>

Unit IV

Trees: Introduction, Types of trees, Traversing a Binary Tree, Binary Search Trees, Operations on Binary Search Trees, Basics of Threaded Binary Trees and AVL Trees, Applications of Trees

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106103069>
<https://www.youtube.com/watch?v=zWg7U0OEAoE&list=PLBF3763AF2E1C572F>

Unit V

Multi-way Search Trees: Introduction, B Trees: Searching for an Element, Insertion, Deletion, Applications of B Trees. B+ trees: Searching for an Element, Insertion, Deletion. **Hashing and Collision:** Introduction, Hash Tables, Different Hash, Functions, Collisions, Collision resolution techniques.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106103069>
<https://www.youtube.com/watch?v=zWg7U0OEAoE&list=PLBF3763AF2E1C572F>

Suggested Learning Resources

Text Book:

1. Reema Thareja, Data Structures using C, Second edition, Oxford press, 2014.

Reference Books:

1. Horowitz, Sahni, Anderson, Freed, Fundamentals of Data Structures in C, Second edition, 2014
2. Brian W. Kernighan and Dennis M. Ritchie, The 'C' Programming Language, Prentice Hall of India
3. Yedidyah Langsam & Moshe J. Augenstein, Aaron M. Tanenbaum, Data Structures using C, Second Edition, Pearson Education, 2017.

Course Outcomes (COs):

At the end of Course, Student will be able to:

1. Illustrate arrays, pointers and structures with programming solutions. (PO-1,2,3 PSO-1,2)
2. Understand the concepts of stack, queues and its various operations. (PO-1,2,3 PSO-1,2)
3. Describe the concepts of linked list and its applications. (PO-1,2,3, PSO-1,2)
4. Demonstrate the concepts of trees and perform tree traversal. (PO-1,2,3 PSO-1,2)

5. Apply appropriate data structures and hashing techniques to solve problems efficiently. (PO- 1,2,3,5 PSO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Certification	10	CO1, CO2, CO3
Case Study	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

COMPUTER ORGANIZATION AND ARCHITECTURE

Course Code: 25CI34

Credits: 3:0:0:3

Pre – requisites: Nil

Contact Hours: 45L+45S

Course Coordinator: Mrs. Akshatha G C

Course Contents

Unit I

Fundamentals of Digital Logic and Logic Circuits: Binary Logic, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard form's, Digital Logic Gates, Introduction, The Map Method, Two and Three-Variable Map, Don't-Care Conditions, NAND and NOR Implementation, combinational circuits, Binary Adder-Subtractor, Sequential Circuits, Storage elements: Latches, Storage Elements: Flip ·Flops.

Textbook-1: Chapter 2-1.9,2.4,2.5,2.6,2.8

Textbook-1: Chapter 3-3.1,3.2,3.6,3.7

Textbook-1: Chapter 4-4.2

Textbook-1: Chapter 5-5.2,5.3,5.4

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://nptel.ac.in/courses/106106092>
- Impartus recording: <https://a.impartus.com/ilc/#/course/83041/295>

Unit II

Basic Structure of Computers: Basic Operations Concepts, Bus Structures, Performance- Processor clock, Basic Performance Equation, clock rate, Performance measurement.

Machine Instructions and Programs: Memory Location and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes, Assembly Language, Basic Input and Output Operations, Stack and Queues, Subroutines- Subroutine Nesting and Processor Stack, Parameter Passing Additional Instructions.

Textbook 2: Chapter 1 – 1.3, 1.4, 1.6 (1.6.1,1.6.2,1.6.3,1.6.4, 1.6.7).

Textbook 2: Chapter 2 – 2.2 to 2.9 (2.9.1, 2.9.2), 2.10.

- Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation
- Links: <https://nptel.ac.in/courses/106106092>
- Impartus recording: <https://a.impartus.com/ilc/#/course/83041/295>

Unit III

Input and Output Organization: Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices; Direct Memory Access, Buses, Standard I/O Interfaces – PCI Bus.

Arithmetic: Numbers, Arithmetic Operations and Character- Number Representation, Addition of Positive Numbers, Addition and Subtraction of Signed Numbers, Overflow in Integer Arithmetic. Addition and Subtraction of Signed Numbers, Design of Fast Adders.

Textbook 2: Chapter 4 – 4.1, 4.2 (4.2.1, 4.2.2, 4.2.3), 4.4, 4.5, 4.7(4.7.1)

Textbook 2: Chapter 2-2.1 (2.1.1,2.1.2,2.1.3,2.1.4), Chapter 6– 6.1, 6.2.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://nptel.ac.in/courses/106106092>
- Impartus recording: <https://a.impartus.com/ilc/#/course/83041/295>

Unit IV

The Memory System: Basic Concepts, Semiconductor RAM Memories-Internal Organization of Memory chips, Static Memory, Structure of Larger Memories; Read Only Memories, Speed, Size, and Cost, Cache Memories – Mapping Functions.

Arithmetic: Multiplication of Positive Numbers, Signed Operand Multiplication, Fast Multiplication, Integer Division.

Textbook 2: Chapter 5 – 5.1,5.2 (5.2.1,5.2.2,5.2.5),5.3, 5.4, 5.5 (5.5.1).

Textbook 2: Chapter 6 – 6.3, 6.4, 6.5, 6.6.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://nptel.ac.in/courses/106106092>
- Impartus recording: <https://a.impartus.com/ilc/#/course/83041/295>

Unit V

Basic processing unit: Some Fundamental Concepts, Execution of a Complete Instruction, Multiple Bus Organization, Hard-wired Control, Microprogrammed Control-Microinstructions.

Pipelining: Basic concepts of Pipelining- Role of Cache memory, Pipeline performance, Data Hazard, Instruction Hazard.

Textbook 2: Chapter 7-7.1, 7.2, 7.3, 7.4, 7.5(7.5.1)

Textbook 2: Chapter 8 – 8.1(8.1.1,8.1.2),8.2,8.3

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://nptel.ac.in/courses/106106092>
- Impartus recording: <https://a.impartus.com/ilc/#/course/83041/295>

Text Books:

1. M. Morris Mano & Michael D. Ciletti, Digital Design With an Introduction to Verilog Design, 5e, Pearson Education.
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer Organization, 5th Edition, TMH, 2018

Reference Book:

1. Computer Organization & Architecture, William Stallings, 7th Edition, PHI, 2006.
2. John L. Hennessy and David A. Patterson, Computer architecture: A quantitative approach, 6th edition, Morgan Kaufmann, 2017

Course Outcomes (COs):

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

1. Understand the principles of digital logic, Boolean algebra, and the operation of combinational and sequential logic circuits. (PO-1, PSO-1)
2. Describe the organization and operation of computer systems, including processor architecture, instruction execution, addressing modes, and assembly language concepts. (PO-1, PO-2, PSO-1)
3. Apply computer arithmetic and logic design principles to perform arithmetic operations and implement digital circuits. (PO-1, PO-2, PO3)
4. Apply memory and input/output organization concepts to explain data transfer, storage, and communication within a computer system. (PO-1, PO2, PO3, PO5, PSO-1)
5. Apply processor control and pipelining concepts to illustrate instruction execution and performance enhancement techniques in computer systems. (PO-1, PO2, PO3, PO5, PSO-1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Tool based problem solving	10	CO1, CO2, CO3
Assignments	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

DISCRETE MATHEMATICAL STRUCTURES	
Course Code: 25CI35	Credits: 3:0:0:3
Pre – requisites: Basic Mathematics	Contact Hours: 45L+45S
Course Coordinator: Dr. S. H. C. V. Subba Bhatta	

Course Contents

Unit I

Mathematical Logic: Introduction to Logic. Propositional Logic, Truth Tables, Predicates and Quantifiers, Mathematical Proofs, Mathematical induction.

- Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
- Links: <https://nptel.ac.in/courses/106106183>
<https://nptel.ac.in/courses/106108227>

Unit II

Relations: Properties of Binary Relations, Equivalence Relation, Partial ordering relations, Lattices, Hasse diagram, Boolean Algebra. Recurrence Relations: Linear
Recurrence Relations - Methods of solutions, solving recurrence relation by substitution, Characteristics roots solution in homogeneous Recurrence Relations.

- Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
- Links: <https://nptel.ac.in/courses/106106183>
<https://nptel.ac.in/courses/106108227>

Unit III

Graph Theory - I: Introduction to Graph Theory- Definitions, Sub Graphs, Walks, paths and circuits. Connected graphs, disconnected graphs and components, Euler graph, operation on graphs, Hamilton Paths and circuits, matrix representation of graphs

- Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
- Links: <https://nptel.ac.in/courses/106106183>
<https://nptel.ac.in/courses/106108227>

Unit IV

Graph Theory - II: Trees, Properties of Trees, Spanning Trees, algorithm for shortest spanning tree-Kruskal, Prim's algorithm, Cut-sets, properties of cut-sets.

- Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation, Videos
- Links: <https://nptel.ac.in/courses/106106183>
<https://nptel.ac.in/courses/106108227>

Unit V

Abstract Algebra: Binary Operations, Semi Groups, Monoid, Submonoid Groups, Subgroups, properties of Groups and subgroups. Homomorphism, Isomorphism

- Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation
- Links: <https://nptel.ac.in/courses/106106183>
<https://nptel.ac.in/courses/106108227>

Textbooks:

1. Kenneth Rossen, Discrete Mathematics and its Application, 7th Edition, McGraw-Hill, 2011.
2. Thomas Koshy: Discrete Mathematics with Applications. 1st Edition, Elsevier Science, 2012.
3. Narsingh Deo. Graph theory with applications to Engineering and Computer science. PHL Learning Pvt. Ltd. 2013.

References:

1. R.P. Grimaldi, B.V. Ramana, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th Edition, Pearson, 2008.
2. Alan Tucker, Elements of Discrete Mathematics, C. L Liu, McGraw-Hill Inc, 1985. Applied Combinatorics, 2007.
3. Huth, M. and Ryan, M., “ Logic in Computer Science: Modeling and Reasoning About Systems”, Cambridge University Press. 2005.
4. Douglas B. West, Introduction to Graph Theory, Second Edition, Prentice- Hall

Course Outcomes (COs):

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

1. Write an argument using logical notation and determine if the argument is valid or invalid. (PO-1,2 & PSO-2)
2. Demonstrate an understanding of relations and be able to determine their properties and to formulate problems and solve them using recurrence relations (PO-1,2 & PSO-2)
3. Analyze different types of graphs and perform operations on graphs. (PO-1,2 & PSO-2)
4. Demonstrate knowledge of fundamental concepts in graphs using various modelling techniques. (PO-1,2, 5,10, PSO-2)
5. Demonstrate knowledge of homomorphism and isomorphism. (PO-1, 2 & PSO-2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

UNIVERSAL HUMAN VALUES	
Course Code: 25UHV36	Credits: 2:0:0:2
Pre – requisites: Nil	Contact Hours: 30L+30S
Course Coordinator: Dr. Mohan Kumar S	

Course Contents

Unit I

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Understanding the need, basic guidelines, content and process for Value Education
 2. Self-Exploration–what is it? - its content and process; ‘Natural Acceptance’ and Experiential Validation- as the mechanism for self-exploration
 3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
 4. Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority
 5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
 6. Method to fulfill the above human aspirations: understanding and living in harmony at various levels
- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
 - Lab component / Practical Topics: Survey/polls for self-exploration
 - Links: Holistic Development and Role of Education <https://youtu.be/sGZtTPe-lhQ>

Unit II

Understanding Harmony in the Human Being - Harmony in Myself

1. Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’
2. Understanding the needs of Self (‘I’) and ‘Body’ - Sukh and Suvidha
3. Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of ‘I’ and harmony in ‘I’
5. Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail
6. Programs to ensure Sanyam and Swasthya

Practice Exercises and Case Studies will be taken up in Practice Sessions.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab component / Practical Topics: Survey/polls for self-exploration
- Links: Harmony in Human Being- Self and Body
<https://youtu.be/0ERSMkRPQBM>
- Links: Harmony in Human Being- Self <https://youtu.be/83oGJ4oDeIg>
- Links: Harmony between Self and Body Prosperity
https://youtu.be/aJ_BU2OgpKs

Unit III

Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

1. *Understanding Harmony in the family – the basic unit of human interaction*
2. Understanding values in human-human relationship; meaning of *Nyaya* and program for its fulfillment to ensure *Ubhay-tripti*;
3. Trust (*Vishwas*) and Respect (*Samman*) as the foundational values of relationship
4. Understanding the meaning of *Vishwas*; Difference between intention and competence
5. Understanding the meaning of *Samman*, Difference between respect and differentiation; the other salient values in relationship
6. Understanding the harmony in the society (society being an extension of family):
7. *Samadhan, Samridhi, Abhay, Sah-astitva* as comprehensive Human Goals
8. Visualizing a universal harmonious order in society- Undivided Society (*Akhand Samaj*), Universal Order (*Sarvabhaum Vyawastha*)- from family to world family!

Practice Exercises and Case Studies will be taken up in Practice Sessions.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab component / Practical Topics: Survey/polls for self-exploration
- Links: Harmony in Family- Trust <https://youtu.be/F2KVV4WNnS8>
- Links: Harmony in family- Respect https://youtu.be/iLqNRPUv0_8
- Links: Harmony in family- Other Feeling Justice
<https://youtu.be/TcYJB7reKnM>
- Links: Harmony in the Society <https://youtu.be/BkWgFinrnPw>

Unit IV

Understanding Harmony in the Nature and Existence - Whole existence as

Co-existence

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfillment among the four orders of nature recyclability and self-regulation in nature
3. Understanding Existence as Co-existence (*Sah-astitva*) of mutually interacting units in all-pervasive space
4. Holistic perception of harmony at all levels of existence

Practice Exercises and Case Studies will be taken up in Practice Sessions.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab component / Practical Topics: Survey/polls for self-exploration
- Links: Harmony in Nature: https://youtu.be/K1Jpd_ojydw
- Links: Harmony in Existence: https://youtu.be/mormUeZ_RUE

Unit V

Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics:
 - develop appropriate technologies and management patterns for Ability to utilize the professional competence for augmenting universal human order
 - Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems,
 - Ability to identify above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order:
 - At the level of individual: as socially and ecologically responsible engineers, technologists and managers
 - At the level of society: as mutually enriching institutions and organization

Suggested Learning Resources:

1. Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
2. Lab component / Practical Topics: Survey/polls for self-exploration

Text Books:

1. **R.R Gaur, R Sangal, G P Bagaria**, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2

Reference Books:

1. **B L Bajpai**, 2004, *Indian Ethos and Modern Management*, New Royal Book Co., Lucknow. Reprinted 2008.
2. **PL Dhar, RR Gaur**, 1990, *Science and Humanism*, Commonwealth Publishers.
3. **Sussan George**, 1976, *How the Other Half Dies*, Penguin Press. Reprinted 1986, 1991
4. **Ivan Illich**, 1974, *Energy & Equity*, The Trinity Press, Worcester, and HarperCollins, USA
5. **Donella H. Meadows, Dennis L. Meadows, Jorgen Randers**, William W. Behrens III, 1972, *limits to Growth*, Club of Rome's Report, Universe Books.
6. **Subhas Palekar**, 2000, *How to practice Natural Farming*, Pracheen(Vaidik) Krishi Tantra Shodh, Amravati.
7. **A Nagraj**, 1998, *Jeevan Vidya ek Parichay*, Divya Path Sansthan, Amarkantak.
8. **E.F. Schumacher**, 1973, *Small is Beautiful: a study of economics as if people mattered*, Blond & Briggs, Britain.
9. **A.N. Tripathy**, 2003, *Human Values*, New Age International Publishers.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
- <https://www.youtube.com/watch?v=P4vjfE-YnVk&list=PLWDeKF97v9SP7wSlapZcQRrT7OH0ZIGC4>
- **Course handouts:**
https://drive.google.com/drive/folders/1zioX_4L2fCNX4Agw282PN86pcZZT3Osr?usp=sharing

- **Presentation slides:**

https://drive.google.com/drive/folders/1rMUKh1s0HPRBlpp_b1mpS-duNRcwS6YH?usp=sharing

Course Outcomes (COs):

At the end of the course, Students will be able to:

1. Apprehend the need of Value Education over Human aspirations (PO-6)
2. Assimilate Harmony over the physical needs and to overcome the self- needs for a prosperous life. (PO-6)
3. Recognize the need of Harmony in the Family and Society for a better World. (PO-6)
4. Explain the need of mutual understanding for Holistic Harmony in all the Levels of Human Existence. (PO-6)
5. Explain the Holistic understanding of Harmony and Professional Ethics at Individual Level and Society. (PO-6, PO-8)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests will be taken for 30 marks.		
Other components		
1. Assignment 2. Quiz 3. Presentation 4. Model / mini project 5. Any other	20 (10 +10)	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

ABILITY ENHANCEMENT COURSE - III	
Course Code: 25CIAEC37	Credits: 1:0:0:1
Pre – requisites: Nil	Contact Hours: 15L+15S
Course Coordinator: Mr. Prashanth Reddy C	

Ability Enhancement Courses (AEC) are the generic skill courses which are basic and needed by all to pursue any career. These courses are designed to help students enhance their skills in communication, language, and personality development. They also promote a deeper understanding of subjects like social sciences and ethics, culture and human behaviour, human rights and the law.

Every student shall register for AEC course under the supervision of his/her proctor. For III, IV & V semester, the student shall select the Ability Enhancement Course online such that the selected course does not overlap with any professional core/ elective course offered by the parent department of the student. After selection, the registration of the course has to be done by the student at his/her parent department.

OBJECT ORIENTED PROGRAMMING

Course Code: 25CIAEC37	Credits: 1:0:0:1
Pre – requisites: Nil	Contact Hours: 15L+15S
Course Coordinator: Mr. Prashanth Reddy C	

Course Contents

Unit I

An Overview of Java: Java's Magic: The Bytecode, Object-Oriented Programming, A First Simple Program, A Second Short Program, Two Control Statements.

Data Types, Variables, and Arrays: Java Is a Strongly Typed Language, The Primitive Types, Integers, Floating-Point Types, Characters, Booleans, A Closer Look at Literals, Variables, Type Conversion and Casting, Automatic Type Promotion in Expressions, Arrays, Local Variable Type Inference.

Textbook: Chapter 1, Chapter 2, Chapter 3

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint Presentation, Hands-on Lab Exercises
- Links: <https://nptel.ac.in/courses/106105191>

Unit II

Operators: Arithmetic Operators, The Bitwise Operators, Relational Operators, Boolean Logical Operators, The Assignment Operator, The ? Operator, Operator Precedence.

Control Statements: Java's Selection Statements, Switch Expressions, Iteration Statements, The For-Each Version of the for Loop, Jump Statements.

Textbook: Chapter 4, Chapter 5

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint Presentation, Hands-on Lab Exercises
- Links: <https://nptel.ac.in/courses/106105191>

Unit III

Introducing Classes: Class Fundamentals, Declaring Objects, Introducing Methods, Constructors, The this Keyword, Garbage Collection.

A Closer Look at Methods and Classes: Overloading Methods, Using Objects as Parameters, A Closer Look at Argument Passing, Returning Objects, Recursion, Introducing Access Control, Understanding static, Introducing final, The Object Class.

Textbook: Chapter 6, Chapter 7

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint Presentation, Hands-on Lab Exercises
- Links: <https://nptel.ac.in/courses/106105191>

Unit IV

Inheritance: Inheritance Basics, Using super, Creating a Multilevel Hierarchy, When Constructors Are Called, Method Overriding, Dynamic Method Dispatch, Using Abstract Classes, Using final with Inheritance.

String Handling: The String Constructors, String Length, Special String Operations, Character Extraction, String Comparison, Searching Strings, Modifying a String, StringBuilder.

Textbook: Chapter 8, Chapter 16

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint Presentation, Hands-on Lab Exercises
- Links: <https://nptel.ac.in/courses/106105191>

Unit V

Packages: Packages, Importing Packages.

Interfaces: Defining an Interface, Implementing Interfaces, Applying Interfaces, Variables in Interfaces, Interfaces Can Be Extended, Default Interface Methods, Use static Methods in an Interface, Multiple Inheritance Issues.

Exception Handling: Exception-Handling Fundamentals, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch Clauses, throw, throws, finally, Java's Built-In Exceptions, Creating Exception Subclasses, Three Additional Exception Features.

Textbook: Chapter 9, Chapter 10

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint Presentation, Hands-on Lab Exercises
- Links: <https://nptel.ac.in/courses/106105191>

Text Books:

1. Herbert Schildt, *Java: The Complete Reference*, 13th Edition, McGraw-Hill Education, 2024.

Reference Book:

1. Cay S. Horstmann, *Core Java, Volume I — Fundamentals*, 12th Edition, Oracle Press, 2022.
2. Bruce Eckel, *Thinking in Java*, 4th Edition, Prentice Hall, 2006.

Course Outcomes (COs):

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

1. Describe the Java execution model, core OOP principles, and Java's type system including primitive types, arrays, and local variable type inference. (PO 1,2,3, PSO 1,2)
2. Apply Java operators and control flow constructs including switch expressions and the for-each loop to develop programs. (PO 1,2,3, PSO 1,2)
3. Implement Java classes with methods, constructors, the Object class, access modifiers, and static members demonstrating encapsulation and method overloading. (PO 1,2,3,4, PSO 1,2)
4. Build Java applications using inheritance, polymorphism, abstract classes, and string manipulation with String and StringBuilder. (PO 1,2,3,4, PSO 1,2)
5. Design programs using packages, interfaces with default methods, and handle runtime errors using Java's exception handling framework. (PO 1,2,3, PSO 1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Assignment-1	10	CO1, CO2, CO3
Assignment-2	10	CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

DATA STRUCTURES LABORATORY

Course Code: 25CIL38	Credits: 0:0:1:0
Pre – requisites: Nil	Contact Hours: 15P
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

Sl. No.	List of Programs
1.	Design, Develop and Implement a menu driven Program in C for the following array operations. a) Creating an array of N Integer Elements b) Display of array Elements with Suitable Headings c) Inserting an Element (ELEM) at a given valid Position (POS) d) Deleting an Element at a given valid Position (POS) e) Exit. Support the program with functions for each of the above operations.
2.	Define an EMPLOYEE structure with members Emp_name, Emp-id, Dept-name and Salary. Read and display data of N employees. Employees may belong to different departments. Write a function to find total salary of employees of a specified department. Use the concept of pointer to structure and allocate the memory dynamically to EMPLOYEE instances
3.	STACK of Integers (Array Implementation of Stack with maximum size MAX) a) Push an Element on to Stack b) Pop an Element from Stack c) Demonstrate how Stack can be used to check Palindrome d) Demonstrate Overflow and Underflow situations on Stack e) Display the status of Stack f) Exit Support the program with appropriate functions for each of the above operations
4.	Write a C program to convert and print a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and binary operators + - * /. Apply the concept of stack data structure to solve this problem
5.	Write a C program to evaluate a valid postfix expression using stack. Assume that the postfix expression is read as a single line consisting of non-negative single digit operands and binary operators. The operators are + - * and /.

6.	Write recursive functions for the following and demonstrate their use. a) Binary Search b) Tower of Hanoi problem.
7.	A Call center phone system has to hold the phone calls from customers and provide service based on the arrival time of the calls. Write a C program to simulate this system using appropriate data structure. Program should have options to add and remove the phone calls in appropriate order for their service.
8.	Write a C program to simulate the working of a circular Queue of integers. Represent circular queue element as a structure and use array of structures as your implementation method. Start and end of the circular queue must be identified by an empty array element.
9.	Write a program to create a singly linked list that maintains a list of names in alphabetical order. Implement the following operations on the list. a) Insert a new name b) Delete a specified name
10.	Write a C program to maintain a stack of integers using linked implementation method.
11.	Write a C program to support the following operations on a circular linked list. a) Insert a new node to the left of the node whose key value is read as an input. b) Delete a node with given data, if it is found otherwise display appropriate error message.
12.	Write a C program to support the following operations on a doubly linked list. a) Insert a new node to the left of the node whose key value is read as an input. b) Delete a node with given data, if it is found otherwise display appropriate error message.
13.	Write a C program a) To construct a binary tree of integers. b) To traverse the tree using inorder, preorder and postorder traversal methods

Suggested Learning Resources

Reference Books:

1. Data Structures using C, Reema Thareja, Second edition, Oxford press, 2014.
2. Fundamentals of Data Structures in C, Horowitz, Sahani, Anderson, Freed, Second edition, 2014
3. Data Structures using C, Yedidyah Langsam & Moshe J. Augenstein, Aaron M. Tanenbaum Second Edition, Pearson Education, 2017.

Course Outcomes (COs):

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

1. Simulate stack and queue operations and implement its applications. (PO- 1,2,3, PSO-1,2)
2. Develop C programs on linked list and its variations. (PO-1,2,3, PSO-1,2)
3. Construct C programs on Binary tree and its applications. (PO-1,2,3, PSO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO3
Weekly Evaluation + Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)	50	CO1, CO2, CO3

APPLICATION DEVELOPMENT USING JAVA LABORATORY

Course Code: 25CIL39

Credits: 0:0:1:0

Pre – requisites: Nil

Contact Hours: 15P

Course Coordinator: Mr. Prashanth Reddy C

Course Contents

Sl. No.	List of Programs
1.	Write a Java program to implement a Menu-Driven Scientific Calculator Application that performs the following operations: - Addition, subtraction, multiplication, and division of two numbers. Power and square root of a number. - Modulo operation on two integers. - Handle division-by-zero using try-catch and loop the menu until the user chooses to exit.
2.	Write a Java program to implement an Employee Records Application that: - Defines an Employee class with fields: name, empId, department, age, designation, and salary. Includes a parameterized constructor and appropriate getter/setter methods (encapsulation). - Creates an array of at least five Employee objects. Reads and displays the details of all employees. - Calculates and displays the total salary of all employees in the "Sales" department. - Retrieves and displays the details of the highest-paid "Manager" in the "Purchase" department.
3.	Write a Java program to implement a Complex Number Application using encapsulation and constructors. The class should: - Define a ComplexNumber class with real and imaginary parts; provide a default constructor, a parameterized constructor, and a copy constructor. - Add two complex numbers and display the result. - Subtract two complex numbers and display the result. - Multiply two complex numbers and display the result. - Compare two complex numbers and display whether they are equal or not.
4.	Write a Java program to implement a University Management Application using inheritance. - Define a base class Person with fields name, age, and gender, and methods to read and display data. - Derive class Employee from Person adding empId, department, and salary; override the display method.

	c) Derive class Student from Person adding usn, semester, and marks; override the display method. e) Create at least five Employee objects and five Student objects; read and display all details using the overridden methods.
5.	Write a Java program to implement a Geometry Calculator Application using polymorphism. a) Demonstrate compile-time polymorphism by defining overloaded methods calculateArea() for a circle (radius), rectangle (length, breadth), and triangle (base, height). d) Demonstrate runtime polymorphism by defining a base class Shape with overridable methods area() and perimeter(); derive classes Circle, Rectangle, and Triangle that override these methods. Create Shape references pointing to derived-class objects and invoke the methods dynamically.
6.	Write a Java program to implement a Banking Application using abstract classes and runtime polymorphism. a) Define an abstract class Bank with fields customerName, accountNumber, and balance, concrete methods to read and display customer details, and an abstract method calculateInterest(). b) Derive three classes — CityBank (8% p.a.), SBIBank (6.5% p.a.), and CanaraBank (7% p.a.) — each overriding calculateInterest() to compute and display the interest for all account holders. c) Create an array of Bank references, assign derived-class objects, and invoke calculateInterest() to demonstrate dynamic method dispatch.
7.	Write a Java program to implement a Conversion Application using interfaces. a) Define an interface Compute with an abstract method convert(double value); implement it in class GigabytesToBytes (1 GB = 1,073,741,824 bytes) and class EuroToRupees (use a current fixed rate); demonstrate conversions using interface references. b) Define an interface Payable with an abstract method calculatePay(); implement it in classes FullTimeEmployee (fixed monthly salary) and ContractEmployee (hourly rate × hours worked); demonstrate multiple interface implementation and compute pay for both employee types.
8.	Write a Java program to implement a Robust Application using Exception Handling. a) Define a user-defined exception InvalidAgeException (thrown when age < 18 or > 60); use it in an employee registration scenario. b) Define a user-defined exception InsufficientFundsException; use it in a bank account withdrawal scenario.

	c) Demonstrate the use of try, catch, finally, throw, throws, multi-catch block, and chained exceptions across both scenarios.
9.	Write a Java program to implement a Multithreading Application. a) Demonstrate thread creation by extending the Thread class and by implementing the Runnable interface; compare the behavior of both approaches. b) Implement the Producer-Consumer problem: a Producer thread generates items and places them in a shared bounded buffer; a Consumer thread retrieves and processes them. Use synchronized, wait(), and notify() to ensure thread-safe communication and prevent race conditions.
10.	Write a Java program to implement a Student Grade Book Application using the Collections Framework. a) Use an ArrayList<Student> to store student records (name, USN, marks); add at least five records and sort them by marks in descending order using Comparator with a lambda expression. b) Use a HashMap<Integer, String> to map roll numbers to grade letters; perform lookup, update, and display all entries. c) Traverse the ArrayList using an Iterator and the HashMap using an enhanced for-loop; display formatted output for both.
11.	Write a Java program to implement a File-Based Student Record Management Application. a) Write the details of at least five students (name, USN, marks) to a text file using FileWriter and BufferedWriter. b) Read and display all student records from the file using FileReader and BufferedReader. c) Accept a USN from the user; search for the record in the file and display the matching student details, or display "Record Not Found" if absent. Handle all IOExceptions appropriately.
12.	Write a Java Servlet-based Web Application for user access control. a) Create an HTML page with a form that accepts a user's name and age. Submit the form to a Servlet. If age < 18, respond with "Hello <name>, you are not authorized to visit this site." Otherwise, respond with "Welcome to this site, <name>." b) Extend the application with login system: the HTML form accepts username and password; Servlet validates credentials against predefined map and redirects to success page or returns error page accordingly. Deploy and test on Apache Tomcat.
13.	Write a JSP-based Web Application for student registration with session management. a) Create a student registration form (JSP) with fields: name, USN, age, gender, department, phone number, and semester; on submission, process the data in a result JSP and display all entered details. b) Implement a session-based welcome flow: on login, store the

	student's name and login time in the session; display the name and current start time at the top-right of the welcome page along with a Logout button.
	c) On clicking Logout, display a "Thank You <name>" page showing the total session duration; invalidate the session.

Suggested Learning Resources

Reference Books:

1. Herbert Schildt, *Java: The Complete Reference*, Thirteenth Edition, McGraw-Hill, 2024. (*Java SE 21*)
2. Cay S. Horstmann, *Core Java, Volume I – Fundamentals*, Twelfth Edition, Pearson, 2022.

Course Outcomes (COs):

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

1. Develop applications using object-oriented features in Java. (PO 1,2,3,5 PSO 1,2)
2. Develop advanced Java applications using exception handling, multithreading, the Collections Framework, and file I/O. (PO 1,2,3,5, PSO 1,2)
3. Develop web applications using Java Servlets and JSP with session management. (PO1,2,3,5, PSO 1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Lab Test-I	10	CO1
Lab Test-II	10	CO2, CO3
Weekly Evaluation + Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)	50	CO1, CO2, CO3

PHYSICAL EDUCATION	
Course Code: 25PE69	Credits: NCMC
Pre – requisites: Nil	
Course Coordinator: Dr. Kiran Kumar H K	

Course Learning Objectives:

1. To introduce students to the importance of physical fitness for success in any career.
2. To instill in them concepts of team spirit and team building
3. To develop positive thinking, goal setting and decision-making abilities under duress.
4. To harness values and skills like leadership, communication and sacrifice.
5. To inculcate in students, the ability to handle success and failures with equanimity.

Selection Process: A Student shall select any one of the following Sports based on his/her interest and the facility available. The details of **Sports Facilities available (both indoor and outdoor) at institute campus** are as below:

Outdoor Games		Indoor Games		Athletics	
Games	No. of Students	Games	No. of Students	Events	No. of Students
Volleyball	12 x 4 = 48	Badminton	30	Sprint - 100mt, 200mt, 400mt	60
Basketball	12 x 4 = 48	Table Tennis	30	Middle distance running – 800mt, 1,500mt	
Kabaddi	12 x 4 = 48	Chess	30	Long distance running – 5,000mt, 10,000mt	
Kho Kho	12 x 4 = 48	Weight Training [Gym]	35	Jumping Events – Long Jump Triple Jump High Jump	30
Throw ball	12 x 4 = 48			Throwing Events Shot Put Discuss Javelin	30
Football	16 x 4 = 64	Note: Students should bring their own sports attires			
Hockey	16 x 4 = 64				
Cricket	16 x 4 = 64				

Contact Sessions: A student shall abide by the following during the sessions scheduled in the semester.

Session 1

Fundamentals of Physical Education, value addition to personality through fitness education, discipline and team building activities, Orientation towards particular sports and skill training

Session 2

Formation of teams based on student's orientation and preference. Team practice and skill enhancement.

Session 3

Conduction of matches in all sporting events registered by Students. Evaluation of each student shall be based on their performance either in team or individual. The student representing the Institute at University/State/National/International Level will be awarded additional marks during evaluation.

Course Outcomes (COs):

1. Develop interest and skill in playing particular sports.
2. Understand the process of organizing sporting events.
3. Appreciate the role of fitness for a better lifestyle.
4. Derive lessons from sports activities for effective planning and discipline in Life.
5. Analyze situations and optimize end results.

Course Assessment and Evaluation:

1. A committee consisting of Sports Director and Coaches of respective Sports will be formed to observe and evaluate the students for CIE in each semester.
2. Students shall follow the schedules, rules and regulations as prescribed by the Committee.
3. Students shall mandatorily have 85% attendance to be eligible for evaluation.
4. All the Sessions and evaluation process will be common for all semesters of the academic year.
5. The final result will be reflected on the grade card of 8th Semester.
6. The final marks shall be calculated after scaling down CIE to 50 marks & combining with 50 marks for SEE.

YOGA	
Course Code: 25YO69	Credits: NCMC
Pre – requisites: Nil	
Course Coordinator: Dr. Hari Chandra B P & Dr. Parimala P	

Course Learning Objectives:

1. To introduce to the students, the fundamental theoretical aspects of yoga.
2. To inculcate in students a habit of practicing yoga.
3. To be able to demonstrate basic yoga asanas.
4. To be able to practice fundamental breathing practices and mudras.
5. To understand the relevance of yoga and research in modern times.

Course Content

Introduction: Definition of yoga, benefits, astangas of yoga, Relevance of yoga and yoga-research in modern times. **Asanas:** Kriyathmakachalanas, Suryanamaskar, Superbrain yoga, Vrikshasana, Trikonasana, Veerabhadrasana, Paschimotasana, Purvotthanasana, Bharadwajasana, Amruthasana, Parivruttha Trikonasana, Parsvakonasana, Ustrasana, Padmasana, Jaaanushirshasana, Navasana, Ardhashakrasana, Ardhakatichakrasana, Jataraparivarthanasana, Sethubandasana, Sarvangasana, Mathyasana, Dhanurasana, Shirshasana. **Pranayamas:** Anuloma-Viloma, Suryanuloma, Chandranuloma, Brahmari, Suryanbedhana, Chandrabedhana, Sheetal, Seethkari, Sadantha, bastrika.

Mudras: Chinmudra-Jnanamudra, Praana mudra, panchaprana mudras, panchabhoota mudras, Pruthvi mudra, Shoonya mudra, Surya mudra, Jalodharanashaka mudra, Kundalini mudra, shoonyaavaayu mudra, shakti mudra, sandhi mudra, vajra mudra and garuda mudra.

Course Outcomes (COs):

At the end of the course, a student will

1. Understand the fundamental and theoretical aspects of yoga.
2. Develop a habit of practicing yoga.
3. Demonstrate basic yoga asanas.
4. Demonstrate fundamental breathing practices.
5. Understand the relevance of yoga and its research in modern times.

Reference Books:

1. Light on yoga, B K S Iyengar, Publisher -Thorsons, UK, 2006
2. Light on pranayama, B K S Iyengar, Publisher - Element; First Edition
3. The Essential Yoga Mudras for Healing, Dr. Aasoori K. Rangaraja Iyengar, Saranga Publishing; First Edition 2021

Pedagogy:

- Chalk and talk, demonstration, videos, ppt.

Contact Sessions:

There would be one introduction class, and five contact classes in each semester.

The candidates shall practice yoga on a daily basis, or in the worst case on alternate days at their place of residence and maintain a short diary in the format provided by yoga teacher. The same shall be brought to the classes.

Online Reference Sources:

- Yoga for beginners part 1: <https://www.youtube.com/watch?v=VwPeThpwfWI>
- Yoga for beginners part 2: https://www.youtube.com/watch?v=s_pnJTcOp8A
Suryanamaskar: <https://www.youtube.com/watch?v=nUdlucNd6go&t=133s>
- Yoga for anxiety and stress: https://www.youtube.com/watch?v=hJbRpHZr_d0
- Common yoga protocol: https://www.youtube.com/watch?v=Av5ib_XRKT4
- Relevance of yoga in modern times: www.youtube.com/watch?v=HUzBCts7BT0

Course Assessment & Evaluation:

1. A committee consisting of Yoga Instructors will be formed to observe and evaluate the students for CIE in each semester.
2. Students shall follow the schedules, rules, and regulations as prescribed by the Committee.
3. Students shall mandatorily have 85% attendance to be eligible for evaluation.
4. All the Sessions and evaluation processes will be common for all semesters of the academic year.
5. The final result will be reflected on the grade card of 8th Semester.
6. The final marks shall be calculated after scaling down CIE to 50 marks & combining it with 50 marks for SEE.

Scheme of SEE

Practical Demonstration	30 marks
Write-up	10 marks
Viva	10 marks
Total	50 marks

NATIONAL SERVICE SCHEME	
Course Code: 25NS69	Credits: NCMC
Pre – requisites: Nil	
Course Coordinator: Dr. Puttabore Gowda & Dr. Siddaraju C	

Course Content

Course Learning Objectives:

1. To introduce students to the importance of national service
2. To harness values and skills like leadership, teamwork and sacrifice.
3. To serve society through educational services and health
4. To work towards rural and local development through technological services
5. To inculcate in students, the ability to handle socially relevant projects.

Students shall involve in activities related to national and regional technical and non-technical services, as listed below.

- Serving society by bringing awareness on education and cleanliness.
- Blood donation camps
- Developing technologies for rural masses.
- Conduction and participation in camps for a social cause.
- Educating towards health and well-being of individuals/society.
- Cultural and educational programs for society.
- Contributing towards the improvement of civil services and bringing certain shortcomings to the notice of higher authorities for suitable remedial actions.
- Contribution towards traffic management and other public services.
- Clean up and development of water sources around public places.
- Services during a disaster or other needy situations.
- Camps for the rejuvenation of lakes and water bodies.
- Serving nature and agriculture.
- Awareness programs on health and food adulteration.
- Presenting papers/talks in various fora on the above topics.
- Developing technologies for rural masses beyond academic requirements.
- Plantation programs.
- Conducting programs for self-sustainability, and human and national development.
- Contribution towards orphans and challenged individuals through well-

recognized organizations.

- Carrying out designated activities in villages.
- Development and implementation of strategies for solid waste, E-waste etc. Education towards pollution control and traffic management.
- Production of documentaries and short films/videos for motivating people on any of the above causes.

Course Outcomes (COs):

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

1. Understand the importance of national service.
2. Gain skills like leadership and teamwork.
3. Volunteer towards educational services and health.
4. Contribute to rural and local development through technical services.
5. Comprehend socially relevant projects

Contact Sessions:

The students shall attend the review and contact sessions as scheduled by the course coordinator.

Course Assessment and Evaluation:

1. The candidates shall maintain a record of activities in a Diary, and get them endorsed during the contact sessions at least 3 times in a semester.
2. A detailed project report should be submitted during the last fortnight of the semester
3. Evaluation will be done during each semester based on the nature of the contribution.
4. The final marks shall be calculated after scaling down CIE to 50 marks & combining with 50 marks for SEE

ADDITIONAL MATHEMATICS - I	
Course Code: 25AM31	Credits: 0:0:0:0
Pre – requisites: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Shashi Prabha Gogate S	

Course Content

Unit I

Differential Calculus: Successive differentiation, nth derivatives of some standard functions, Leibnitz theorem, Polar curves. Angle between the radius vector and the tangent, angle between curves, length of the perpendicular from pole to the tangent, pedal equations. Taylor's and Maclaurin's expansions.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105121/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/107625/1030>

Unit II

Integral Calculus: Introduction, Reduction formula, Reduction formula for $\int \sin^n x \, dx$, $\int \cos^n x \, dx$ and $\int \sin^n x \cos^m x \, dx$. Evaluation of double and triple integrals.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105121/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/107625/1030>

Unit III

Vector Algebra: Scalar and vectors. Vector addition and subtraction. Multiplication of vectors (Dot and Cross products). Scalar and vector triple product-simple problems. Vector functions of a single variable. Derivative of a vector function, geometrical interpretation. Velocity and acceleration.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105134>
- Impartus recording: <https://a.impartus.com/ilc/#/course/107625/1030>

Unit IV

Vector Differentiation:

Scalar and vector fields, gradient of a scalar field, directional derivative, divergence of a vector field, solenoidal vector, curl of a vector field, irrotational vector. Laplace's operator. Vector identities connected with gradient, divergence and curl.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105134>
- Impartus recording: <https://a.impartus.com/ilc/#/course/107625/1030>

Unit V

First Order Differential Equations: Solution of first order and first degree differential equations, variable separable methods, homogeneous equations, linear and Bernoulli's equations, exact differential equations.

- Pedagogy / Course delivery tools: Chalk and talk, Power Point Presentation
- Links: <https://nptel.ac.in/courses/111/105/111105121/>
- Impartus recording: <https://a.impartus.com/ilc/#!/course/59742/295>

Text Books:

1. **B.S. Grewal** – Higher Engineering Mathematics, Khanna Publishers, 44th edition, 2017.
2. **Erwin Kreyszig** – Advanced Engineering Mathematics – Wiley Publication, 10th Edition, 2015.

Reference Books:

1. **H. K. Dass** – Higher Engineering Mathematics – S Chand Publications, 1998.
2. **B. V. Ramana** – Engineering Mathematics – Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2008.

Course Outcomes (COs):

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

1. Solve problems related to nth derivative to some standard functions, polar curves and power series expansions. (PO-1,2)
2. Apply the concept of reduction formula to determine the length, area, volume of revolution of an arc of the curve. (PO-1,2)
3. Solve the problems related to velocity and acceleration. (PO-1,2)
4. Apply vector differentiation to identify solenoidal and irrotational vectors. (PO-1,2)
5. Apply the concept of various methods to solve first order first degree differential equations. (PO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	Marks	Course outcomes addressed
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Total	50	

IV Semester

OPERATING SYSTEMS	
Course Code: 25CI41	Credits: 3:0:1:3
Pre – requisites: Nil	Contact Hours: 45L+15P+45S
Course Coordinator: Mrs. Akshatha G C	

Course Contents

Unit I

Introduction: What operating systems do; Computer System organization; Computer System architecture; Operating System structure; Operating System operations; **Operating system structures:** operating system services, user operating system Interface, System calls, Types of system calls, Operating system structure, System boot

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106105214>
- Impartus recording: <https://a.impartus.com/ilc/#/course/148805/703>

Unit II

Process Management: Basic concept; Process scheduling; Operations on processes; Inter process Communication.

Threads: Overview; Multithreading models;

Process scheduling: Basic concepts, Scheduling criteria, scheduling algorithms, multiple processor scheduling, Algorithm evaluation.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106105214>
- Impartus recording: <https://a.impartus.com/ilc/#/course/148805/703>

Unit III

Process Synchronization: Synchronization, The Critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization; Monitors. **Deadlocks:** System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106105214>
- Impartus recording: <https://a.impartus.com/ilc/#!/course/148805/703>

Unit IV

Memory Management Strategies: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation.

Virtual Memory Management: Background; Demand paging; Copy-on write; Page replacement; Allocation of frames; Thrashing.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106105214>
- Impartus recording: <https://a.impartus.com/ilc/#!/course/148805/703>

Unit V

File System: File concept; Access methods; Directory structure; File system mounting; file sharing; protection.

Secondary Storage Structures: Disk scheduling; FCFS Scheduling, SSTF scheduling, SCAN, C-SCAN scheduling, Look Scheduling, CLOOK scheduling.

System Protection: Goals of protection, Principles of protection, Domain of protection, Access matrix.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106105214>
- Impartus recording: <https://a.impartus.com/ilc/#!/course/148805/703>

Lab Experiments:

Students will execute the following contents as part of practical component:

1. Study of Unix/Linux general purpose utility command list: man, who, cat, cd, cp, ps, ls, mv, rm, mkdir, rmdir, echo, more, date, time, kill, history, chmod, chown, finger, pwd, cal, logout, shutdown.
2. Write a c/c++ program that outputs the contents of its environment list.
3. Write a c/c++ program to check the following limit:
 - a. No of clock ticks
 - b. Maximum number of child process
 - c. Maximum path length

- d. Maximum no of characters in a filename
 - e. Maximum no of open files/processes
4. Write a C program to create a child process and allow the parent to display “parent” and the child to execute copy command to copy the content of the file specified as command line argument while executing the program.
 5. Write a C/C++ program to fetch the termination status from the child and display whether it terminated normally or abnormally.
 6. Write C/C++ program that illustrate communication between two unrelated processes using named pipe (FIFO file).
 7. Write a c program to demonstrate and avoid race condition.
 8. Write a C/C++ program to demonstrate FCFS/SJF/SRTF and priority CPU scheduling policies.
 9. Write a c program to demonstrate synchronization between producer consumer processes that share a common buffer and performs a read and write operation to and from the buffer. Propose a solution that satisfies all the three requirements of the solution to critical section problem.
 10. Write a C/C++ program to query and display the different attributes associated with a file.
 11. Write a C/C++ program to implement banker’s algorithm.
 12. Consider the last 100 bytes as a region. Write a C/C++ program to check whether the region is locked or not. If the region is locked, print pid of the process which has locked. If the region is not locked, lock the region with an exclusive lock, read the last 50 bytes and unlock the region.
 13. Write a program to implement FIFO, LRU and optimal page replacement algorithms.
 14. Write a C/C++ program to implement user defined cat, ls commands which works similar to built-in cat and ls commands.

Suggested Learning Resources

Text Books:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne Operating System Principles, 8th edition Wiley- India,2011.

Reference Books:

1. D.M Dhamdhare Operating systems - A concept-based Approach, 2nd Edition, Tata McGraw-Hill, 2002
2. Harvey M Deital Operating systems, 3rd Edition, Addison Wesley, 1990.
3. Operating Systems: Principles and Practice (2nd Edition), by Thomas Anderson and Michael Dahlin.

Course Outcomes (COs):

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

1. Describe the structure of the computer system and services provided by the Operating system. (PO-1,2, PSO-1,2)
2. Apply different scheduling algorithms for Process/Memory/Disk Management. (PO-1,2,3,4, PSO-1,2)
3. Describe Process management and need for controlled access to computing resources by co-operative processes. (PO-1,2,3,4, PSO-1,2)
4. Apply deadlock detection and prevention algorithms to solve the given problem. (PO-1,2,3,4, PSO-1,2,3)
5. Illustrate memory management strategies and operating system principles for achieving protection and security. (PO-1,2,3,4, PSO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I (CIE-I)	30	CO1, CO2
Internal Test-II CIE-II)	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Lab Test	10	CO1, CO2, CO3, CO4, CO5
Weekly evaluation	10	CO1, CO2, CO3, CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Lab test + Marks scored in Weekly evaluation		
Semester End Examination (SEE)	100	CO1, CO2, CO3 CO4, CO5

DATABASE MANAGEMENT SYSTEMS	
Course Code: 25CI42	Credits: 3:0:0:3
Pre – requisites: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

Unit I

Introduction: Characteristics of Database approach, Actors on the Scene, Workers behind the scene, Advantages of using DBMS approach, Data models, schemas and instances, Three-schema architecture and data independence, Database languages and interfaces, the database system environment, Entity-Relationship Model: Conceptual Database using high-level Conceptual data models for Database Design, A Sample Database Application, Entity types, Entity sets Attributes and Keys Relationship types, Relationship Sets, Roles and Structural Constraints Weak Entity Types.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106105175>
<https://nptel.ac.in/courses/106106220>

Unit II

Relational Database: Design Using ER- to-Relational Mapping, Relational Model and Relational Algebra: Relational Model Concepts, Relational Model Constraints and Relational Database Schema Update Operations, Transactions and Dealing with Constraint violations, Unary Relational operations, Relational Algebra Operations from Set Theory, Binary Relational Operations, JOIN and DIVISION, Additional Relational Operations, Examples of Queries in Relational Algebra.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106105175>
<https://nptel.ac.in/courses/106106220>

Unit III

Introduction to SQL: Overview of the SQL Query Language, SQL Data Definition, Basic structure of SQL Queries, Additional Basic Operations, Null values, Aggregate Functions, nested Sub queries, Modification of the Database, Join Expressions, Views, Integrity Constraints, SQL Data Types and Schemas.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation,

Videos

- Links: <https://nptel.ac.in/courses/106105175> <https://nptel.ac.in/courses/106106220>

Unit IV

Database Design: Informal Design Guidelines for Relation Schemas, Functional Dependencies, Inference Rules, Equivalence and Minimal Cover, Normal Forms based on Primary Keys, First Normal Form, General Definitions of 2nd and 3rd Normal Forms, Boyce Codd Normal Form, Properties of Relational Decomposition, Algorithms for relational database schema design- Non-Additive Join Property(Lossless Join Decomposition), Relational Synthesis Algorithms.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106105175>
<https://nptel.ac.in/courses/106106220>

Unit V

Transaction Management: Transaction Concept, a Simple Transaction Model, Transaction Atomicity and Durability, Serializability, Transaction Isolation and Atomicity, Transaction Isolation Levels. Concurrency Control: Lock-Based Protocols, Deadlock Handling. Recovery System: Failure Classification, Recovery and Atomicity, Recovery Algorithm.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106105175>
<https://nptel.ac.in/courses/106106220>

Suggested Learning Resources

Text Books:

1. Ramez Elmasri and Shamkant B. Navathe: Fundamentals of Database Systems, 7th Edition, Pearson, 2016.
2. Silberschatz, Korth and Sudharshan: Data base System Concepts, 7th Edition, Mc-GrawHill, 2021.

Reference Books:

1. C.J. Date, A. Kannan, S. Swamynatham, An Introduction to Database Systems, 8th Edition, Pearson Education, 2009.
2. Raghu Ramakrishnan and Johannes Gehrke: Database Management Systems, 3rd Edition, McGraw-Hill, 2003.

Course Outcomes (COs):

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

1. Design entity-relationship diagrams to represent simple database applications and convert them to a Relational model. (PO-2, 3, 4, 5, PSO-2)
2. Construct relational algebraic expressions for queries using the concepts of relational database theory. (PO-1, 2, 4, PSO-2)
3. Formulate using SQL, solutions to a broad range of query and data update problems. (PO-1,2,3,4,5,7,8,9 ,PSO-1,2,3)
4. Apply Normalization to improve database design strategies. (PO-1, 2,3 PSO-2)
5. Interpret the basic issues of transaction processing, concurrency control, and recovery techniques. (PO-1,2,3, PSO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Case study	10	CO1, CO2, CO3
project	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

DESIGN AND ANALYSIS OF ALGORITHMS	
Course Code: 25CI43	Credits: 3:0:0:3
Pre – requisites: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

Unit I

Asymptotic Bounds and Representation problems of Algorithms: Computational Tractability: Some Initial Attempts at Defining Efficiency, Worst-Case Running Times and Brute-Force Search, Polynomial Time as a Definition of Efficiency, Asymptotic Order of Growth: Properties of Asymptotic Growth Rates, Asymptotic Bounds for Some Common Functions, A Survey of Common Running Times: Linear Time, $O(n \log n)$ Time, $O(n^k)$ Time, Beyond Polynomial Time. Substitution Method, Some Representative Problems, A First Problem: Stable Matching. (Textbook 1)

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106106131>
<https://nptel.ac.in/courses/106102064>
<https://www.geeksforgeeks.org/fundamentals-of-algorithms/?ref=shm>

Unit II

Graphs & Divide and Conquer: Graph Connectivity and Graph Traversal, Breadth-First Search: Exploring a Connected Component, Depth-First Search, Implementing Graph Traversal Using Queues and Stacks: Implementing Breadth-First Search, Implementing Depth-First Search, An Application of Breadth-First Search and Depth-First Search, Directed Acyclic Graphs and Topological Ordering. Divide and Conquer Technique: Masters Theorem for recurrence relations, The Merge sort Algorithm, Quick Sort Algorithm. (Textbook 2)

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106106131>
<https://nptel.ac.in/courses/106102064>
<https://www.geeksforgeeks.org/fundamentals-of-algorithms/?ref=shm>

Unit III

Transform and Conquer: Heaps and Heapsort. (Textbook 2) **Greedy Algorithms:** Interval Scheduling: The Greedy Algorithm Stays Ahead: Designing a Greedy

Algorithm, Analyzing the Algorithm, Scheduling to Minimize Lateness: An Exchange Argument: The Problem, Designing the Algorithm. (Textbook 1)
Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees and Codes. (Textbook 2)

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106106131>
<https://nptel.ac.in/courses/106102064>
<https://www.geeksforgeeks.org/fundamentals-of-algorithms/?ref=shm>

Unit IV

Dynamic Programming: Weighted Interval Scheduling: A Recursive Procedure, Subset Sums and Knapsacks: Adding a Variable: The Problem, Designing the Algorithm. (Textbook 1)

Dynamic Programming: Warshall's and Floyd's Algorithm. (Textbook 2)

Iterative Improvement: The Simplex Method, The Maximum-Flow Problem. (Textbook 2)

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106106131>
<https://nptel.ac.in/courses/106102064>
<https://www.geeksforgeeks.org/fundamentals-of-algorithms/?ref=shm>

Unit V

NP and Computational Intractability: Polynomial-Time Reductions NP-Complete Problems: Circuit Satisfiability: A First NP-Complete Problem, General Strategy for Proving New Problems NP Complete, Sequencing Problems: The Traveling Salesman Problem, The Hamiltonian Cycle Problem.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://www.geeksforgeeks.org/fundamentals-of-algorithms/?ref=shm>

Suggested Learning Resources

Text Books:

1. Algorithm Design, Jon Kleinberg and Eva Tardos, Pearson, 1st Edition 2013.
2. Introduction to the Design & Analysis of Algorithms, Anany Levitin, 3rd Edition, Paperback Publication -2017, Pearson education

Reference Books:

1. Design and Analysis of Algorithms, Michael. T. Goodrich, Roberto Tamassia, An Indian Adaptation, Wiley, 2023
2. Introduction to Algorithms, H., Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein Thomas, 3rd Edition, 2009, MIT press.
3. Fundamentals of Computer Algorithms, Horowitz E., Sartaj Sahni S., Rajasekaran S, 2008, Galgotia Publications.

Course Outcomes (COs):

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

1. Understand the basic concepts and analyse worst-case running times of algorithms using asymptotic analysis. (PO-1,2,3 PSO-1,2)
2. Analyze the design techniques for graph traversal using representative algorithms. (PO-1,2,3 PSO-1,2)
3. Demonstrate divide and conquer, transform and conquer techniques and analyse the complexity of the methods by solving recurrence. (PO-1,2,3 PSO-1,2)
4. Illustrate Greedy paradigm and Dynamic programming paradigm using representative algorithms. (PO-1,2,3,4 PSO-1,2,3)
5. Describe the classes P, NP, and NP-Complete and be able to prove that a certain problem is NP-Complete. (PO-1,2,3,4 PSO-1,2,3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I (CIE-I)	30	CO1, CO2
Internal Test-II CIE-II)	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Case study	10	CO1, CO2, CO3
AI Tool Based Assignment	10	CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Assessment Test +Marks scored in Assignment		
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

AUTOMATA THEORY AND COMPILER DESIGN	
Course Code: 25CI44	Credits: 2:1:0:2
Pre – requisites: Nil	Contact Hours: 30L+15T+30S
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

Unit I

Introduction to Automata Theory: Central Concepts of Automata theory, Deterministic Finite Automata (DFA), Non- Deterministic Finite Automata (NFA), NFA to DFA Conversion, Minimization of DFA. **Introduction to Compiler Design:** Language Processors, Phases of Compilers, Compiler Construction Tools.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106104148>
<https://nptel.ac.in/courses/106108113>

Unit II

Regular Expressions and Languages: Regular Expressions, Finite Automata and Regular Expressions. **Push Down Automata:** Definition of the Pushdown Automata, The Languages of a PDA. **Lexical analysis Phase of Compiler Design:** The Role of Lexical Analyzer, Input Buffering, Specifications of Tokens, Recognition of Tokens.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106104148>
<https://nptel.ac.in/courses/106108113>

Unit III

Context Free Grammars: Formal Definition of a Context Free Grammar, Derivations, Parse Trees, Ambiguity, writing a Grammar: Elimination of Ambiguity, Elimination of Left Recursion, Left Factoring.

Syntax Analysis: The role of the Parser, Top-down Parsing, First and Follow, LL (1) Grammars, Non-Recursive Predictive Parsing, Error Recovery in Predictive Parsing. Bottom-up Parsing, Introduction to LR Parsing: Simple LR parser. More Powerful LR Parsers: Canonical LR (1) items, Constructing LR (1) set of items, Canonical LR (1) parse tables, Constructing LALR parsing tables

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106108113>

Unit IV

Introduction to Turing Machine: Problems that Computers Cannot Solve, The Turing machine.

Syntax-Directed Translation: Syntax-Directed Definitions, Evaluation order for SDDs, Applications of Syntax-Directed translation, Syntax-Directed Translation Schemes

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106104148>
<https://nptel.ac.in/courses/106108113>

Unit V

Intermediate Code Generation: Variants of syntax trees, Three-address code, Types and Declarations, Translation of expressions, Type Checking: Rules of Type Checking, Type Conversions, Control flow: Boolean Expressions, Short-Circuit Code, Flow of Control statements, Control Flow Translation of Boolean Expressions, Avoiding Redundant Gotos, Back patching: One pass Code generation Using backpatching, Backpatching for Boolean Expressions.

Code Generation: Issues in the Design of a Code Generator, Target Language, A Simple Code Generator.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Videos
- Links: <https://nptel.ac.in/courses/106108113>

Suggested Learning Resources

Text Books:

1. John E Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, “Introduction to Automata Theory, Languages and Computation”, Third Edition, Pearson Education India, 2011.
2. Alfred V.Aho, Monica S.Lam, Ravi Sethi, Jeffrey D. Ullman, “ Compilers Principles, Techniques and Tools”, Second Edition, Pearson Education India, 2013

Reference Books:

1. Elain Rich, “Automata, Computability and complexity”, 1st Edition, Pearson Education, 2018.
2. K.L.P Mishra, N Chandrashekar, 3rd Edition, ‘Theory of Computer Science’, PHI, 2012.
3. Peter Linz, “An introduction to Formal Languages and Automata”, 3rd Edition, Narosa Publishers, 1998
4. K Muneeswaran, “ Compiler Design”, Oxford University Press 2013

Course Outcomes (COs):

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

1. Understand the core concepts in automata theory and compiler design. (PO-1,2, PSO-1,2)
2. Design and develop lexical analysers, parsers and code generators. (PO-1,2,PSO-1,2)
3. Design Grammars and Automata (recognizers) for different language classes and become knowledgeable about restricted models of Computation (Regular, Context Free) and their relative powers. (PO-1,2,3,4, PSO-1,2)
4. Demonstrate the structure of a Compiler and Apply the concepts of automata theory and Theory of Computation to design Compilers.(PO-1,2,3,4, PSO-1,2)
5. Design syntax directed computation models for problems in Automata theory and adaptation of such models in the field of compilers. (PO-1,2,3,4, PSO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Active Learning: Technical Paper Writing, Game Based Learning	10	CO1, CO2, CO3
Tutorial Assignment	10	CO1, CO2, CO3, CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Assessment Test +Marks scored in Assignment		
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

ABILITY ENHANCEMENT COURSE - IV	
Course Code: 25CIAEC46	Credits: 1:0:0:1
Pre – requisites: Nil	Contact Hours: 15L+15S
Course Coordinator: Mr. Subash N	

Ability Enhancement Courses (AEC) are the generic skill courses which are basic and needed by all to pursue any career. These courses are designed to help students enhance their skills in communication, language, and personality development. They also promote a deeper understanding of subjects like social sciences and ethics, culture and human behaviour, human rights and the law.

Every student shall register for AEC course under the supervision of his/her proctor. For III, IV & V semester, the student shall select the Ability Enhancement Course online such that the selected course does not overlap with any professional core/ elective course offered by the parent department of the student. After selection, the registration of the course has to be done by the student at his/her parent department.

NOSQL Databases	
Course Code: 25CIAEC46	Credits: 1:0:0:1
Pre – requisites: Nil	Contact Hours: 15L+15S
Course Coordinator: Mr. Subash N	

Course Contents

Unit I

Introduction: Why NoSQL? The Value of Relational Databases, RDBMS vs NoSQL, CAP Theorem, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Tool-Based Demonstration, Videos, Coding and Lab Hands-on Exercises
- Links: <https://www.coursera.org/search?query=nosql&xdpModal=course%7ESWrM-lpYEEuMkArab-7zbw>

Unit II

Introduction and CRUD Operations in MongoDB: MongoDB Datatypes, Where Clause, AND, OR operations in MongoDB, Insert, Query, Update, Delete, Remove and Projection, limit, skip and find method. Query selectors: comparison selectors, logical selectors, Geospatial selectors, Sort method, Aggregation functions

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Tool-Based Demonstration, Videos, Coding and Lab Hands-on Exercises
- Links: <https://www.mongodb.com/resources/basics/databases/nosql-explained>

Unit III

Hbase: Introduction, Architecture, Hbase vs RDBMS, Shell Commands, Create Table, Insert & Retrieve Data, Performance Bottlenecks **Hive:** Introduction, Data types, Create & Drop Database, Create/Alter/Drop Table, Static Partitioning, Dynamic Partitioning. **HiveQL:** Operators, Functions, Group by and Having, Order By, Sort By, Joins

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Tool-Based Demonstration, Videos, Coding and Lab Hands-on Exercises
- Links: <https://hadoop.apache.org/>

Unit IV

Cassandra: Architecture & Replication Factor Strategy, Features, Cassandra Key space: Create, Alter & Drop Key space in Cassandra. Cassandra Table — Create, Alter, Drop & Truncate. **Redis:** Introduction, Features, Datatypes, Keys, String.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Tool-Based Demonstration, Videos, Coding and Lab Hands-on Exercises
- Links: <https://hadoop.apache.org/>

Unit V

Graph Databases: Introduction, Features, Graph data in a relational database, querying graph data using MySQL, Neo4j in NoSQL space, Key-value stores, Column-family stores Data modeling in Neo4j, Neo4j CQL Read/Write Clauses: Set Clause, delete clause, Remove clause, Match clause, Where clause, Count Function, Order by clause, Limit, skip, String Functions, Aggregate Function.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation, Tool-Based Demonstration, Videos, Coding and Lab Hands-on Exercises
- Links: <https://neo4j.com/>

Text Book:

1. Manu Sharma, “MongoDB Complete Guide”, 1e, bpb publication, 2023.
2. Edward Capriolo, Dean Wampler, Jason Rutherglen, "Programming Hive", O'Reilly Media, Inc., 2012.
3. Jeff Carpenter and Eben Hewitt, “Cassandra: The Definitive Guide”, 3rd Edition, O'Reilly Media, Inc., April 2020.
4. Eric Redmond and Jim R. Wilson, "Seven Databases in Seven Weeks: A Guide to Modern Databases and the Nosql Movement", O'Reilly; 1st edition, 2012.

References:

1. Kristina chodorow, “MongoDB: The Definitive Guide”, 2e, O'REILLY, 2013.
2. Kyle Banker, Peter Bakkum, Shaun Verch, Doug Garrett and Tim Hawkins, “MongoDB in Action” by 2e, Manning publication, 2016.
3. Edward Capriolo, Dean Wampler and Jason Rutherglen, Programming Hive, O'Reilly Media, Inc., 2012.
4. <https://neo4j.com/docs/cypher-manual>.

Course Outcomes (COs):

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

1. Understand the fundamentals of NoSQL databases and their comparison with RDBMS. **PO** (1, 2, 5), **PSO** (1, 2)
2. Gain proficiency in performing CRUD operations and queries in MongoDB. **PO** (1, 2, 3), **PSO** (1, 2)
3. Understand and apply the principles of HBase and Hive for large-scale data storage and retrieval. **PO** (1, 2,3, 5), **PSO** (1, 2)
4. Gain proficiency in working with Cassandra, focusing on architecture, key space, and table operations. **PO** (1, 2, 3), **PSO** (1, 2)
5. Learn and implement Graph Databases using Neo4j and understand the key-value and column-family store concepts. **PO** (1, 2, 3), **PSO** (1, 2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I (CIE-I)	30	CO1, CO2
Internal Test-II (CIE-II)	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Case study	10	CO1, CO2, CO3
Assignment	10	CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Case Study +Marks scored in Assignment		
Semester End Examination (SEE)	50	CO1, CO2, CO3 CO4, CO5

ALGORITHMS LABORATORY	
Course Code: 25CIL47	Credits: 0:0:1:0
Pre – requisites: Nil	Contact Hours: 15P
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

Design & Develop algorithms and implement the following concepts using C/C++/Java:

Sl. No.	Lab Course Contents
1.	Asymptotic bounds and functions: Best Case, Average Case and Worst-Case Complexity
2.	Sorting and searching algorithms with Brute Force technique
3.	Stable matching algorithm using Iterative Improvement
4.	Graph Traversal: Breadth first search with time complexity
5.	Graph Traversal: Depth first search with time complexity
6.	Divide and Conquer Technique: Merge sort algorithm
7.	Divide and Conquer Technique: Quick sort algorithm
8.	Minimum Spanning Tree using Greedy Technique: Prim's and Kruskal algorithm
9.	Single Source Shortest Path using Greedy Technique: Dijkstra's algorithm
10.	Greedy approach: Interval scheduling for optimal set of intervals
11.	Dynamic Programming: Subset sum problem
12.	Dynamic Programming approach: Knapsack problem
13.	Branch and Bound Technique: Travelling Salesman Problem

Lab experiments will be scenario-based implementation for the algorithm techniques specified in the course contents.

Suggested Learning Resources

Reference Books:

1. Algorithm Design - Jon Kleinberg and Eva Tardos, Tsinghua University Press (2005).
2. Anany Levitin: Introduction to the Design & Analysis of Algorithms, 2nd Edition, Pearson Education, 2007.

Course Outcomes (COs):

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

1. Define the basic concepts and analyze worst-case running times of algorithms using asymptotic analysis. (PO-1,2,3,4, PSO-1,2)
2. Recognize the design techniques for graph traversal, divide and conquer, greedy and dynamic programming paradigm using representative algorithms. (PO-1,2,3, 4,5, 7, PSO-1,2,3)
3. Illustrate Branch and bound paradigm through NP complete problems. (PO-1, 3, 4, PSO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO3
Weekly Evaluation +Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)	50	CO1, CO2, CO3

DATA VISUALIZATION LABORATORY	
Course Code: 25CIL48	Credits: 0:0:1:0
Pre – requisites: Nil	Contact Hours: 15P
Course Coordinator: Ms. Shrilaxmi Gidd	

Sl. No.	Lab Course Contents
	PART A (Data Visualization with Python)
1.	Write a Python program using NumPy to create a one-dimensional array and demonstrate indexing and slicing operations.
2.	Write a Python program using NumPy to Perform matrix addition and multiplication and Find transpose and determinant of a matrix.
3.	Write a Python program using Pandas to create a Series from a list and a dictionary
4.	Write a Python program using Pandas to load a dataset, generate a statistical summary, and identify missing values.
5.	Write a program to create a Line chart, Bar chart, Pie Chart and 3D plot using Matplotlib
6.	Write a program to create a scatter plot, histogram boxplot and violin plot using Seaborn
7.	Write a program to create a time series visualization using Pandas and Matplotlib.
8.	Write a program to create an interactive dashboard using Plotly.
	PART B: (Data Visualization with Power BI)
1.	Create a Tableau dashboard using a simple dataset containing sales data for different regions and products. - A bar chart for Sales by Region. - A pie chart for Sales Distribution by Product. - An interactive filter to allow users to switch between regions. - Combine these charts into a dashboard and add interactive filters.

2.	Create a Power BI dashboard using a dataset of employee salaries. a. A bar chart to show Total Salary by Department. b. A slicer to filter data based on Department. c. A card visual to display the Average Salary d. Combine these charts into a dashboard and add interactive filters.
3.	Use Tableau to visualize sales trends over time for a company and create an interactive dashboard. a. Load a dataset with columns: Date, Sales, Category. b. Create a line chart showing Sales over Time. c. Add a filter for Category to visualize sales trends for different categories.
4.	Create a Power BI dashboard using a dataset containing monthly revenue and expenses. a. A line chart to show Revenue vs Expenses over Time. b. A bar chart for Monthly Profit. c. Use DAX to calculate Profit = Revenue - Expenses. Add a date slicer to filter by specific months.

Reference Books:

1. Wes McKinney (2017). Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython (2nd ed.). O'Reilly Media.
2. Joshua N. Milligan (2022). Learning Tableau 2022: Tools for Business Intelligence, Data Preparation, and Analytics (4th ed.). Packt Publishing.
3. Brett Powell (2020). Microsoft Power BI Cookbook: Creating Business Intelligence Solutions of Analytical Data Models, Reports, and Dashboards (2nd ed.). Packt Publishing.

Course Outcomes (COs):

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

1. Data Visualization with Python Create static and interactive visualizations using Python (Matplotlib, Seaborn, Plotly). PO (1, 2, 3, 5) PSO (1, 2).
2. Design and develop effective static and interactive data visualizations using Matplotlib, Seaborn, Plotly, and time-series analysis techniques. PO (1, 2, 3, 5) PSO (1, 2).
3. Create professional and interactive dashboards using Power BI and Tableau to analyse business data and support data-driven decision making. PO (1, 2, 3, 5) PSO (1, 2).

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO3
Weekly Evaluation+Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)	50	CO1, CO2, CO3

DATABASE MANAGEMENT SYSTEMS LABORATORY

Course Code: 25CIL49

Credits: 0:0:1:0

Pre – requisites: Nil

Contact Hours: 15P

Course Coordinator: Dr. Sini Anna Alex

Course Contents

Sl. No.	Lab Course Contents
1.	Construct Entity Relationship Diagram for the scenario given below Consider a movie database in which data is recorded about the movie industry. The data requirements are summarized as follows: • Each movie has a title, year of release, group of actors, one director and production company. Each movie has different genre. It is required to keep track of the name, the address and the owner of the production company. • Data to be kept about directors and actors are name, SSN, date of birth, address, mobile phone number. An actor may also be a director.
2.	Construct Entity Relationship Diagram for the scenario given below. The data requirements are summarized as follows: Employees work in departments; each department is managed by an employee; a child must be identified uniquely by name when the parent (who is an employee; assume that only one parent works for the company) is known. We are not interested in information about a child once the parent leaves the company.
3.	Construct Entity Relationship Diagram for the scenario given below The data requirements are summarized as follows: • Galleries keep information about artists, their names (which are unique), birthplaces, age, and style of art. For each piece of artwork, the artist, the year it was made, its unique title, its type of art (e.g., painting, lithograph, sculpture, photograph), and its price must be stored. Pieces of artwork are also classified into groups of various kinds, for example, portraits, still lifes, works by Picasso, or works of the 19th century; a given piece may belong to more than one group. • Each group is identified by a name (like those just given) that

	describes the group. Finally, galleries keep information about customers. For each customer, galleries keep that person's unique name, address, total amount of dollars spent in the gallery (very important!), and the artists and groups of art that the customer tends to like.
4.	Convert ER to Relational Schema for the following scenarios - Consider a movie database in which data is recorded about the movie industry. The data requirements are summarized as follows: Each movie has a title, year of release, group of actors, one director and production company. Each movie has different genre. It is required to keep track of the name, the address and the owner of the production company. Data to be kept about directors and actors are name, SSN, date of birth, address, mobile phone number. An actor may also be a director. - Construct the employee database given. The data requirements are summarized as follows: Employees work in departments; each department is managed by an employee; a child must be identified uniquely by name when the parent (who is an employee; assume that only one parent works for the company) is known. We are not interested in information about a child once the parent leaves the company.
5.	Consider the Bank database given below. The primary keys are underlined. Assume relevant data types for attributes BRANCH (<u>branch_name</u>, branch_city, assets) CUSTOMER (<u>customer_name</u>, customer_street, customer_city) ACCOUNT (<u>account_number</u>, branch_name, amount) LOAN (<u>loan_number</u>, branch_name, amount) DEPOSITOR (<u>customer_name</u>, <u>account_number</u>) BORROWER (<u>customer_name</u>, <u>loan_number</u>) EMPLOYEE (<u>employee_name</u>, branch_name, salary) Creation of table with the appropriate constraints, CREATE, ALTER and DROP commands in SQL.

6.	Consider the Bank database given below. The primary keys are underlined. Assume relevant data types for attributes BRANCH (<u>branch_name</u>, branch_city, assets) CUSTOMER (<u>customer_name</u>, customer_street, customer_city) ACCOUNT (<u>account_number</u>, branch_name, amount) LOAN (<u>loan_number</u>, branch_name, amount) DEPOSITOR (<u>customer_name</u>, <u>account_number</u>) BORROWER (<u>customer_name</u>, <u>loan_number</u>) EMPLOYEE (<u>employee_name</u>, branch_name, salary) Insertion of tuple in each of the table (INSERT Command).
7.	Consider the Bank database given below. The primary keys are underlined. Assume relevant data types for attributes BRANCH (<u>branch_name</u>, branch_city, assets) CUSTOMER (<u>customer_name</u>, customer_street, customer_city) ACCOUNT (<u>account_number</u>, branch_name, amount) LOAN (<u>loan_number</u>, branch_name, amount) DEPOSITOR (<u>customer_name</u>, <u>account_number</u>) BORROWER (<u>customer_name</u>, <u>loan_number</u>) EMPLOYEE (<u>employee_name</u>, branch_name, salary) Insertion of tuple in each of the table (DELETE and UPDATE Command).
8.	Consider the Employee database given below. The primary keys are underlined. Assume relevant data types for attributes. EMPLOYEE (<u>employee-name</u>, street, city) WORKS (<u>employee-name</u>, <u>company-name</u>, salary) COMPANY (<u>company-name</u>, city) MANAGES (<u>employee-name</u>, <u>manager-name</u>) Create the above tables in SQL. Specify primary and foreign keys properly. Enter at least 5 tuples in each table with relevant data. Solve the following queries. - Find the names of all employees in the database who do not work for 'First Bank Corporation ' - Find the names of all employees in the database who earn more than every employee of 'Small Bank Corporation'. Assume that all people work for at most one company. - Find the names, street address, and cities of residence for all employees who work for 'First Bank Corporation' and earn more than \$10,000 and less than \$20,000.

	- Find the names of all employees in the database who live in the same cities as the companies for which they work. - Assume that all people work for at most one company. - Find the names, street address, and cities of residence for all employees who work for 'First Bank Corporation' and earn more than \$10,000. - Find the names of all employees in the database who live in the same cities and on the same streets as do their managers.
9.	Consider the Order-Shipment database given below. The primary keys are underlined. Assume relevant data types for attributes. CUSTOMER (<u>cust#</u>, cname, city) ORDER (<u>order#</u>, odate, cust#, ord-Amt) ORDER – ITEM (<u>order#</u>, <u>item#</u>, qty) ITEM (<u>item#</u>, unit price) SHIPMENT (<u>order#</u>, <u>warehouse#</u>, ship-date) WAREHOUSE (<u>warehouse#</u>, city) Create the above tables in SQL. Specify primary and foreign keys properly. Enter at least 5 tuples in each table with relevant data. Solve the following queries. Illustrate aggregate functions in SQL. - List the no. of order placed by customer no. 5. - List customer details who have the largest order amount. - List the names of customers who have ordered at least 5 items. - List item numbers and their quantity for order number 5.
10.	Consider the Bank database given below. The primary keys are underlined. Assume relevant data types for attributes. BRANCH (<u>branch_name</u>, branch_city, assets) CUSTOMER (<u>customer_name</u>, customer_street, customer_city) ACCOUNT (<u>account_number</u>, branch_name, amount) LOAN (<u>loan_number</u>, branch_name, amount) DEPOSITOR (<u>customer_name</u>, <u>account_number</u>) BORROWER (<u>customer_name</u>, <u>loan_number</u>) EMPLOYEE (<u>employee_name</u>, branch_name, salary) Create the above tables in SQL. Specify primary and foreign keys properly. Enter at least 5 tuples in each table with relevant data. Solve the following queries. Illustrate aggregate functions in SQL. - Find the names of all customers whose balance is less than 500. - Find all employees whose salary is greater than 1400 and working branch is not 'Downtown' - Calculate the average salary of all employees and display the

	average salary as “Avg_Salary” • Find the names of all customers whose city is not Brooklyn. • Find the names of all customers who have taken loans. • Display all account numbers, branch name and corresponding branch city. • Display all loan numbers sorted by branch. • Display the names of Employees who earn the maximum salary.
11.	Consider the Order-Shipment database given below. The primary keys are underlined. Assume relevant data types for attributes. CUSTOMER (<u>cust#</u>, cname, city) ORDER (<u>order#</u>, odate, cust#, ord-Amt) ORDER – ITEM (<u>order#</u>, <u>item#</u>, qty) ITEM (<u>item#</u>, unit price) SHIPMENT (<u>order#</u>, <u>warehouse#</u>, ship-date) WAREHOUSE (<u>warehouse#</u>, city) Create the above tables in SQL. Specify primary and foreign keys properly. Enter at least 5 tuples in each table with relevant data. Solve the following queries. 1. Display the average order amount for day wise orders. 2. List the number of orders placed by each customer. 3. List the number of orders placed by each customer. 4. List the customer names who have not ordered for item no. 5. 5. List the names of customers who have ordered at least 5 items.
12.	Demonstration of creating and deleting views for the database given BRANCH (branch_name, branch_city, assets) BRANCH (<u>branch_name</u>, branch_city, assets) CUSTOMER (<u>customer_name</u>, customer_street, customer_city) ACCOUNT (<u>account_number</u>, branch_name, amount) LOAN (<u>loan_number</u>, branch_name, amount) DEPOSITOR (<u>customer_name</u>, <u>account_number</u>) BORROWER (<u>customer_name</u>, <u>loan_number</u>) EMPLOYEE (<u>employee_name</u>, branch_name, salary)

Suggested Learning Resources

Reference Books:

1. Ramez Elmasri and Shamkant B. Navathe: Fundamentals of Database Systems, 7th Edition, Pearson, 2016.
2. Silberschatz, Korth and Sudharshan: Data base System Concepts, 7th Edition, Mc-GrawHill, 2021.

Course Outcomes (COs):

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

1. Design Entity relationship model for the real world scenario using modern IDE tools .(PO1, 2, 3,5 and PSO- 2).
2. Create an Enterprise Application using CRUD operation and DDL commands PO-1, 2,3, 4, 5 and PSO-2).
3. Design and Develop a database application and perform operations Using SQL (PO-1,2,3, 4, 5, and PSO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO3
Weekly Evaluation + Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)	50	CO1, CO2, CO3

ADDITIONAL MATHEMATICS - II	
Course Code: 25AM41	Credits: 0:0:0:0
Pre – requisites: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Veena B N	

Course Contents

Unit I

Differential Calculus- I: Partial differentiation, Euler’s theorem, total differential coefficient, differentiation of composite and implicit functions.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105121/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/107625/1030>

Unit II

Differential Calculus- II: Jacobian and Properties. Taylor’s theorem for function of two variables, maxima and minima for functions of two variables.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105121/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/107625/1030>
<https://a.impartus.com/ilc/#/course/59742/295>

Unit III

Vector Integration: Line integrals, surface integrals and volume integrals. Green’s theorem, Stokes’ and Gauss divergence theorem (without proof) and problems, orthogonal curvilinear coordinates.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105134/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/619570/1030>

Unit IV

Higher Order Differential Equations: Higher order linear differential equations, method of variation of parameters, Cauchy’s and Legendre’s homogeneous differential equations.

- Pedagogy / Course delivery tools: Chalk and talk

- Links: <https://nptel.ac.in/courses/111/105/111105121/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/96127/452>
- <https://a.impartus.com/ilc/#/course/59742/295>

Unit V

Probability: Introduction. Sample space and events. Axioms of probability. Addition and multiplication theorems. Conditional probability- illustrative examples. Bayes theorem – examples.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/107/111107119/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/283623/703>

Text Books:

1. **B.S. Grewal** – Higher Engineering Mathematics, Khanna Publishers, 44th edition, 2017.
2. **Erwin Kreyszig** – Advanced Engineering Mathematics – Wiley Publication, 10th Edition, 2015.

Reference Books:

1. **H. K. Dass** – Higher Engineering Mathematics – S Chand Publications, 1998
2. **B. V. Ramana** – Engineering Mathematics – Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2008.

Course Outcomes (COs):

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

1. To carryout differentiation of function of several variables. (PO-1,2)
2. Solve the problems related to Jacobians, the extreme values of a function and Taylors series. (PO-1,2)
3. Exhibit the interdependence of line, surface and volume integrals using integral theorems. (PO-1,2)
4. Find the solution of second and higher order ODEs with constant and variable coefficients. (PO-1,2)
5. Solve the problems on conditional probability and Baye's theorem. (PO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components	Marks	Course outcomes addressed
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5

Program Elective Course -1
(Elective – I)

PROBABILITY, STATISTICAL INFERENCE AND OPTIMIZATION	
Course Code: 25CIE451	Credits: 3:0:0:3
Pre – requisites: Calculus and Basics of Probability	Contact Hours: 45L+45S
Course Coordinator: Dr. S Ramprasad & Dr. Y. S. Kalyan Chakravarthy	

Unit I

Correlation and Regression Analysis: Curve fitting by the method of least squares, Fitting linear, quadratic and geometric curves. Correlation and Regression.

Random Variables and Discrete Probability Distributions: Random variables, Binomial and Poisson distributions.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105035/>
- Impartus recording: <https://nptel.ac.in/courses/111/105/111105035/>
<https://a.impartus.com/ilc/#/course/619570/1030>

Unit II

Probability Distributions: Uniform distribution, Exponential distribution, Gamma distribution and Normal distribution.

Joint probability distribution: Joint probability distribution (both discrete and continuous), conditional probability, conditional expectation.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105035/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/96127/452>

Unit III

Stochastic Processes: Introduction, Classification of stochastic processes, Stationary stochastic processes, Autocorrelation, Ergodicity.

Markov Chain: Probability vectors, Stochastic matrices, Regular stochastic matrices, Markov processes, Markov chains, Higher transition probabilities, Stationary distribution of regular Markov chains and absorbing states.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111103022>
- Impartus recording: <https://a.impartus.com/ilc/#/course/96127/452>

Unit IV

Sampling and Statistical Inference: Sampling distributions, central limit theorem, concepts of standard error and confidence interval, level of significance, type I and type II errors, one tailed and two tailed tests, Z-test: for single mean, for single proportion and for difference between means, Student's t –test: for single mean and for difference

between two means, F – test for equality of two variances, Chi-square test: for goodness of fit and for independence of attributes.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105035/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/96151/1112>

Unit V

Linear Programming: Introduction to linear programming problem (LPP), formulation of the problem, graphical method, general, canonical and standard forms of LPP, simplex method, big-M method, Two-phase simplex method and duality in linear programming.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111104027>

Text Books:

1. **R.E. Walpole, R. H. Myers, R. S. L. Myers and K. Ye** – Probability and Statistics for Engineers and Scientists – Pearson Education – Delhi – 9th edition – 2012.
2. **B.S.Grewal** - Higher Engineering Mathematics - Khanna Publishers – 45th edition – 2024.
3. **T. Veerarajan** - Probability, Statistics and Random processes – Tata McGraw-Hill Education - 3rd edition -2017.
4. **Kanti Swarup, P. K. Gupta, and Man Mohan** - Operations Research - Sultan Chand & Sons - 20th revised edition – 2022

Reference Books:

1. **Sheldon M. Ross** - Probability models for Computer Science – Academic Press, Elsevier– 2009.
2. **Kishore S. Trivedi** - Probability & Statistics with Reliability – Queuing and Computer Science Applications – John Wiley & Sons – 2nd edition – 2008.

Course Outcomes

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

1. Apply curve fitting, correlation, regression, and discrete probability distributions to analyze data (PO-1,2 & PSO – 2,3)
2. Evaluate probabilities and expectations associated with continuous and joint probability distributions (PO-1,2 & PSO – 2,3)
3. Apply stochastic processes and Markov chains to model and analyze random systems (PO-1,2 & PSO – 2,3)
4. Apply sampling theory and hypothesis testing techniques for statistical inference and decision-making. (PO-1,2 & PSO – 1,3)
5. Formulate and solve linear programming problems using graphical, simplex, and duality methods. (PO-1,2 & PSO – 1,3)

Course Assessment and Evaluation:**Continuous Internal Evaluation: 50**

Assessment Tool	Marks	Course outcomes addressed
Internal test – I	30	CO1,CO2,CO3
Internal test – II	30	CO3,CO4,CO5
Average of the two internal tests will be taken for 30 marks.		
Other components	Marks	Course outcomes addressed
Quiz	10	CO1,CO2,CO3
Assignment	10	CO3,CO4,CO5
Semester End Examination (SEE)	100	CO1,CO2,CO3,CO4,CO5

(Elective – II)

PROBABILITY AND QUEUEING THEORY	
Course Code: 25CIE452	Credits: 3:0:0:3
Pre – requisites: Calculus and Basics of Probability	Contact Hours: 45L+45S
Course Coordinator: Dr. S Ramprasad & Dr. Y. S. Kalyan Chakravarthy	

Unit I

Correlation and Regression Analysis: Curve fitting by the method of least squares, Fitting linear, quadratic and geometric curves. Correlation and Regression.

Random Variables and Discrete Probability Distributions: Random variables, Binomial and Poisson distributions.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105035/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/96127/452>
<https://a.impartus.com/ilc/#/course/619570/1030>

Unit II

Probability Distributions: Uniform distribution, Exponential distribution, Gamma distribution and Normal distribution.

Joint probability distribution: Joint probability distribution (both discrete and continuous), conditional probability, conditional expectation.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/105/111105035/>
- Impartus recording: <https://a.impartus.com/ilc/#/course/96127/452>

Unit III

Markov Chain: Introduction to stochastic process, probability vectors, stochastic matrices, regular stochastic matrices, Markov chains, higher transition probabilities, stationary distribution of regular Markov chains and absorbing states.

Markov processes: Chapman -Kolmogorov equations, Mean time spent in transient states. Applications—Models for Algorithmic efficiency, The Gambler's ruin problem.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: [//nptel.ac.in/courses/111/103/111103158](https://nptel.ac.in/courses/111/103/111103158)

Unit IV

Queuing theory - I: Introduction, symbolic representation of a queuing model, single server Poisson queuing model with infinite capacity ($M/M/1 : \infty /FIFO$), single server Poisson queuing model with finite capacity ($M/M/1 : N/FIFO$).

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/103/111103159>

Unit V

Queuing theory - II: Multiple server Poisson queuing model with infinite capacity (M/M/S : ∞ /FIFO), Multiple server Poisson queuing model with finite capacity (M/M/S : N/FIFO), introduction to M/G/1 queuing model.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111/103/111103159>

Text Books:

1. **R.E. Walpole, R. H. Myers, R. S. L. Myers and K. Ye** – Probability and Statistics for Engineers and Scientists – Pearson Education – Delhi – 9th edition – 2012.
2. **B.S.Grewal** - Higher Engineering Mathematics - Khanna Publishers – 45th edition – 2024.
3. **T. Veerarajan** - Probability, Statistics and Random processes – Tata McGraw-Hill Education - 3rd edition -2017.

Reference Books:

1. **Sheldon M. Ross** - Probability models for Computer Science – Academic Press, Elsevier– 2009.
2. **Kishore S. Trivedi** - Probability & Statistics with Reliability – Queuing and Computer Science Applications – John Wiley & Sons – 2nd edition – 2008.

Course Outcomes

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

1. Apply curve fitting, correlation, regression, and discrete probability distributions to analyze data. (PO-1,2 & PSO – 2,3)
2. Solve problems involving discrete and continuous probability distributions. (PO-1,2 & PSO – 2,3)
3. Analyze Markov chains and Markov processes to model stochastic systems. (PO-1,2 & PSO – 2,3)
4. Analyze single-server queuing models with finite and infinite capacities. (PO-1,2 & PSO – 1,3)
5. Analyze multi-server queuing models and the M/G/1 queuing system. (PO-1,2 & PSO – 1,3)

Course Assessment and Evaluation:
Continuous Internal Evaluation: 50

Assessment Tool	Marks	Course outcomes addressed
Internal test – I	30	CO1,CO2,CO3
Internal test – II	30	CO3,CO4,CO5
Average of the two internal tests will be taken for 30 marks.		
Other components	Marks	Course outcomes addressed
Quiz	10	CO1,CO2,CO3
Assignment	10	CO3,CO4,CO5
Semester End Examination (SEE)	100	CO1,CO2,CO3,CO4,CO5

(Elective – III)

APPLIED NUMERICAL METHODS AND ALGORITHMS	
Course Code: 25CIE453	Credits: 3:0:0:3
Pre – requisites: Calculus	Contact Hours: 45L+45S
Course Coordinator: Dr. S Ramprasad & Dr. Y. S. Kalyan Chakravarthy	

Unit I

Numerical Solution of Algebraic & Transcendental equations: Review of Bisection, Regula Falsi and Newton-Raphson methods. Fixed point iteration method. Aitken's Δ^2 method, Horner's method, Graeffe's root squaring method. Birge-Vietta method. Newton-Raphson method for system of non-linear equations.

- Pedagogy / Course delivery tools: Chalk and talk, Power Point Presentation
- Links: <https://nptel.ac.in/courses/111105134>
- Impartus recording: <https://a.impartus.com/ilc/#/course/2583981/1205>
<https://a.impartus.com/ilc/#/course/619570/1030>

Unit II

Interpolation: Piecewise linear, quadratic and cubic interpolation, Cubic spline interpolation. Hermite interpolation.

Curve Fitting: Curve fitting by the method of least squares, fitting linear, quadratic and geometric curves.

- Pedagogy / Course delivery tools: Chalk and talk, Power Point Presentation
- Links: <https://nptel.ac.in/courses/111106101>
- Impartus recording: <https://a.impartus.com/ilc/#/course/3111313/1447>
<https://a.impartus.com/ilc/#/course/119635/593>

Unit III

Bivariate Interpolation: Lagrange's bivariate interpolation. Newton's bivariate interpolation.

Numerical Differentiation: Derivatives using finite differences of higher order.

Numerical Integration: Review of Newton-Cotes quadrature technique. Gauss Legendre one point, two point and three point techniques. Romberg integration.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111105134>
<https://a.impartus.com/ilc/#/course/3111313/1447>

Unit IV

Numerical solution of PDE's: Finite difference approximation of partial derivatives. Solution of one dimensional heat equation by explicit (Schmidt method) and implicit (Crank-Nicolson) techniques. Numerical Solution of one dimensional wave equation. Numerical solution of two dimensional Laplace equation and Poisson equation.

- Pedagogy / Course delivery tools: Chalk and talk
- Links: <https://nptel.ac.in/courses/111106101>
<https://a.impartus.com/ilc/#/course/2583981/1205>

Unit V

Applications of Graph theory: Review of basic concepts of Graph theory. Travelling salesman problem, Shortest path problems – Breadth first search algorithm, Depth first search algorithm, Dijkstra's algorithm. Graph coloring, Seating arrangement problem.

Text Books:

1. **Richard. L. Burden, J. Douglas Faires, Annette M. Burden** - Numerical Analysis, Brooks Cole - 10th edition, 2015.
2. **M.K. Jain, S.R.K. Iyengar and R.K. Jain** – Numerical methods for scientific and Engineering computation – New Age International Publisher – 6th edition, 2012.
3. **Douglas B. West** - Introduction to Graph Theory, 2nd Edition, Prentice Hall, 2001.

Reference Books:

1. **Anthony Ralston, Philip Rabinowitz** – A first course in Numerical Analysis – McGraw Hill Publication – 2nd edition, 2001.
2. **Steven C. Chapra and Raymond P. Canale** - Numerical Methods for Engineers, 8th Edition, McGraw-Hill Education, 2021.
3. **Narsingh Deo** – Graph theory with application to Engineering and Computer Science, PHI Learning Private Limited, 2010.

Course Outcomes

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

1. Apply numerical methods to solve algebraic, transcendental, and nonlinear systems of equations. **(PO-1, 2 & PSO-1 ,2)**
2. Construct interpolation and curve fitting models for numerical data analysis.**(PO-1, 2 & PSO-1 ,2)**
3. Apply numerical differentiation, integration, and bivariate interpolation techniques to solve computational problems. **(PO-1, 2 & PSO-1 ,2)**
4. Compute numerical solution of 1D heat and wave equations and 2D Laplace and Poisson equations.**(PO-1, 2 & PSO-1, 2)**
5. Apply graph-theoretic algorithms and concepts to solve routing, coloring, and optimization problems.. **(PO-1, 2 & PSO-1 ,2)**

Course Assessment and Evaluation:
Continuous Internal Evaluation: 50

Assessment Tool	Marks	Course outcomes addressed
Internal test – I	30	CO1,CO2,CO3
Internal test – II	30	CO3,CO4,CO5
Average of the two internal tests will be taken for 30 marks.		
Other components	Marks	Course outcomes addressed
Quiz	10	CO1,CO2,CO3
Assignment	10	CO3,CO4,CO5
Semester End Examination (SEE)	100	CO1,CO2,CO3,CO4,CO5