KISS

KALINGA INSTITUTE OF SOCIAL SCIENCES

CURRICULUM AND CREDIT FRAMEWORK FOR UNDERGRADUATE PROGRAMME

BACHELOR OF SCIENCE (B.SC.) COMPUTER SCIENCE

(As per NEP-2020, NCrF, NHEQF)

Academic Session 2026-2027



DEPARTMENT OF COMPUTER SCIENCE

SCHOOL OF INDIGENOUS KNOWLEDGE,
SCIENCE AND TECHNOLOGY

KALINGA INSTITUTE OF SOCIAL SCIENCES (KISS)

DEEMED TO BE UNIVERSITY

Higher Education Campus, KISS Campus-3, Bhubaneswar, Odisha, 751024

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I. About the Department / School and Programme

About the School

The School of Indigenous Knowledge, Science and Technology (SIKST), KISS Deemed to be University, was established in 2017–18 to study, revitalize and re-imagine indigenous scientific knowledge and technologies that have evolved in a symbiotic relationship with Nature. Tribal and indigenous communities have historically demonstrated a deep understanding of local ecosystems and sustainable use of natural resources, yet much of this knowledge has remained marginalized in mainstream discourse. In the contemporary context of globalization and rapid technological change, these communities—true custodians of indigenous knowledge and practice—continue to face systemic disadvantages in access to education, technology and opportunities.

The School seeks to enable holistic development of indigenous communities so that they can critically explore, preserve and apply their traditional knowledge for human welfare and sustainable livelihoods. In an era of over-exploitation of natural resources and increasing ecological vulnerability, there is an urgent need to rigorously document, study and validate time-tested indigenous knowledge and tribal technologies. SIKST has therefore been conceived as an innovative academic space to promote, preserve, protect and contemporize indigenous knowledge systems, positioning them as a foundation for sustainable development practice and policy.

The School disseminates advanced knowledge by providing instructional and research facilities in areas such as tribal medicinal systems and phytochemical analysis, geosciences and their impact on health, cosmology and its role in tribal cultures, Vedic mathematical traditions, indigenous nutritional practices, and intellectual property rights for the protection of community knowledge and biodiversity. It also engages with emerging technologies related to natural resources in tribal areas and other relevant domains wherever these intersect with indigenous science and community aspirations.

These courses examine indigenous knowledge and technology using interdisciplinary and multidisciplinary approaches that blend traditional and modern scientific methods, encouraging students to engage critically and respectfully with both knowledge streams. The School

continuously strengthens the knowledge, research and practice components of its academic programmes so that they remain locally grounded while meeting regional, national and international benchmarks of quality.

The curriculum incorporates Multidisciplinary Courses (MDC) and Interdisciplinary offerings open to students of other programmes, in line with NEP-2020's emphasis on holistic and multidisciplinary education and flexible curricular choice.

About the Department

The Department of Computer Science at KISS Deemed to be University was established in the academic session 2017–18 with the objective of providing quality computer science education to tribal students through an inclusive and technology-driven learning environment. The department offers undergraduate, postgraduate, and doctoral programmes in Computer Science, following the National Education Policy (NEP) framework and an outcome-based curriculum. The curriculum encompasses programming, data structures, algorithms, database management systems, artificial intelligence, machine learning, data analytics, cloud computing, cyber security, and software engineering, supported by well-equipped computer laboratories and ICT-enabled classrooms. The department is staffed by qualified and experienced faculty members actively engaged in teaching, research, innovation, and interdisciplinary collaborations. Students are encouraged to participate in research projects, coding competitions, seminars, workshops, internships, and community-oriented technological initiatives. With a strong emphasis on academic excellence, ethical values, innovation, and employability, the department prepares graduates to meet the evolving demands of academia, industry, entrepreneurship, and research while contributing to sustainable societal development.

II. Vision & Mission of the School

Vision

To be an internationally recognized School of excellence in teaching, research, consultancy and outreach that advances Indigenous Science and Technology, fosters skill development and social entrepreneurship, and empowers tribal youth as knowledge leaders and change agents.

Mission

- Foster all-round development of students through multi-faceted, holistic education rooted in indigenous worldviews and scientific inquiry.
- Focus on Indigenous Science and Technology through innovative courses such as Indigenous People and the Science, Vedic Mathematics, Tribal Sports, Nutrition and Health Management, and Indigenous Knowledge and Intellectual Property Rights, as reflected in the School's syllabi and MDC/SEC offerings.
- Engage with local, national and global communities to understand contemporary needs and challenges and to co-create context-specific applications of Indigenous Science and Technology.
- Build capacities for self-employment, entrepreneurship and employment generation so that graduates can contribute to sustainable and dignified livelihoods for themselves and others.

III. Programme Overview

Programme Title:

B.Sc. in Computer Science

Programme Type:

Undergraduate / Honours / Honours with Research / Diploma / Certificate

Programme Description

The B.Sc. (Hons/Hons with Research) in Computer Science with Specialization in Indigenous Knowledge, Science and Technology is a four-year undergraduate programme introduced in the Academic Session 2024–25, designed in accordance with NEP-2020 and the UGC Curriculum and Credit Framework for Undergraduate Programmes (CCFUP). The programme aims to develop human resources with strong core competence in key areas of Computer Science while integrating perspectives, case studies and applications from Indigenous Knowledge, Science and Technology.

This four-year UG programme (introduced in 2024–25) follows the multiple entry–exit structure with certificate, diploma, degree and honours with research options as per NEP-2020 and NCrF. Programme outcomes and course outcomes are benchmarked to NHEQF Levels 5–

7 and aligned with the revised NSQF level descriptors in terms of knowledge, skills, responsibility and autonomy.

Across eight semesters, the curriculum includes core Computer Science courses such as Programming in C, Data Structures, Design and Analysis of Algorithms, Database Management Systems, Object Oriented Programming in Java, Software Engineering, Computer Networks, Web Technologies, Theory of Computation, Computer Graphics and Compiler Design. Students further choose from Discipline Specific Electives listed in the syllabus, including Artificial Intelligence, Data Science, Computer Vision and Image Processing, Natural Language Processing, Big Data Analytics, Machine Learning and Deep Learning, Internet of Things, Blockchain Technologies and Cloud Computing.

In line with the syllabus, students also complete minor courses, internships, and interdisciplinary/open courses offered under the MDC/SEC framework to broaden their exposure. Learning experiences are enriched through labs attached to major theory papers, mini-projects, internships, guest lectures and presentations that expose learners to current industry practices, emerging technologies and socially engaged computing. The overall design follows an outcome-based approach with clearly articulated Programme Outcomes (POs) and Course Outcomes (COs), mapped across all listed courses in the structure and aligned with national qualification and credit frameworks.

The curriculum incorporates lectures, case studies, field works, SWAYAM MOOC Courses, and research projects, ensuring a holistic and experiential learning environment consistent with NEP 2020.

IV. Process of Curriculum Development

All Schools shall follow the standard KISS-DU curriculum development protocol:

1. Formation of Syllabus Committee with domain experts.
2. Consultation with stakeholders (students, alumni, employers, community).
3. Review and approval by School faculty.
4. Vetting by Board of Studies (BoS) with external experts.

5. Final approval by Academic Council.
6. Integration of NEP-2020, CBCS, NCrF, and NHEQF guidelines.

V. Definitions of Components

a) Ability Enhancement Courses (AEC): It refers to the courses enhancing competency in a Modern Indian Language (MIL) and in the English language with special emphasis on language and communication skills not literature, prose, poetry and novel etc.

b) Academic Bank of Credits (ABC): The ABC has been envisaged by the UGC to facilitate the academic mobility of students with the freedom to study across the HEIs in the country with an appropriate 'credit transfer' mechanism from one programme to another, leading to attain a Degree/Diploma/Certificate, etc.

c) Academic Year: Two consecutive semesters constitute one academic year.

d) Choice Based : The students select courses from the prescribed courses i.e., Major, Minor, Multidisciplinary, Ability Enhancement Course (AEC), Skill Enhancement Course (SEC), Value Added Course (VAC), Summer Internship/ Lab/Research.

e) Major is the subject of main focus.

f) Credit Based Semester System (CBSS): Under the CBSS, the requirement for awarding a degree/diploma/Certificate is prescribed in terms of number of credits to be earned.

g) Credit: A unit by which the course work is measured. One credit is equivalent to one hour of lecture or tutorials or two hours of practical work/field work per week in a semester.

h) Minor Course helps a student to gain a broader understanding beyond the major discipline. The subjects mentioned in the minor (in the course structure table) will be offered only if a minimum of 10 students opt for that particular subject.

i) Multidisciplinary: It refers to the courses that a student can opt from other disciplines in order to broaden the intellectual experience.

j) Skills Enhancement Courses (SEC): It refers to the courses aiming at imparting practical skills, hands-on training, soft skills, etc., to enhance the employability of students.

k) Summer Internship/Apprenticeship/Summer Project: It refers to experiential exposure of a student. Summer Internship of 6-8 weeks duration after the completion of the fourth semester, followed by a project report and viva-voce examination during the fifth semester has been made compulsory to enable the students to have hands on experience of real-life business situations.

l) Research has been provided in the Eighth semester (for students securing 7.5 CGPA or above) involving application of knowledge in exploring/critical analysis/solving issues related to a real-life situation.

Value Added Courses: It refers to the courses enabling the students to acquire and demonstrate the knowledge and understanding of contemporary society.

VI. NCrF-Aligned Components (National Credit Framework)

1. Operational Definition of Credit (NCrF Standard)

"1 Credit = 30 Notional Learning Hours."

A standard 4-credit course = 120 Notional Learning Hours.

VII. NCrF-Compliant Course Engagement Table

Component	Operational Definition	Hours (Example for 4-credit course)
Face-to-Face Lectures	Concept delivery, interactive instruction	45
Tutorials / Labs / Field	Hands-on practice, experimentation	30
Independent Self-Study	Pre-reading, journal review	20
Continuous Assessment	Assignments, quizzes, mid-term	12
Final Semester Exam Preparation	Revision, project completion	13
Total Notional Hours	**Must equal 30 hours × credits**	**120**

MOOC Courses (SWAYAM and SWAYAM Plus)

According to the UGC guidelines integrated into the new curriculum structures, Higher Education Institutions (HEIs) are permitted to allow students to take up to 40% of their total courses in a

semester through the national MOOC platform, SWAYAM (or SWAYAM Plus for industry-aligned courses).

Credits earned via SWAYAM are mapped directly against the appropriate NHEQF academic level and digitally stored in the student's Academic Bank of Credits (ABC) to count toward their final degree, diploma, or certificate.

i) NCrF Category Wise Credit Distribution (UGC CCFUP Compatible) (for PG Programme)

Semester	Discipline Specific courses- core		Minor		MDC/IDC		AEC		SEC/ Internship/Dissertation		VAC		Grand Total Credits
	No. Of Papers	Total Credits	No. Of Papers	Total Credits	No. Of Papers	Total Credits	No. Of Papers	Total Credits	No. Of Papers	Total Credits	No. Of Papers	Total Credit	
I	1	4	1	4	1	3	1	2	1	3	4	8	20
II	1	4	1	4	1	3	1	2	1	3	2	4	20
III	2	8	1	4	1	3	1	2	1	3			20
IV	4	14	1	4			1	2					20
V	4	16	1	4					1	2			22
VI	4	16	1	4									20
VII	4	16	1	4									20
VIII	1	4	1	4					1	12			20
Total Credits for the Course		80		32		9		8		23		12	162

These exit awards correspond to progressive NHEQF / NSQF levels and are fully NCrF-compliant for credit accumulation, mobility and re-entry through the Academic Bank of Credits.

Skill Enhancement Courses (SEC), Multidisciplinary Courses (MDC), value-added courses and internships are creditised as per NCrF, recognising vocational, experiential and community-based learning alongside academic coursework. These courses are designed at appropriate NSQF levels, with clear competency descriptors and notional hours.

Selection of Elective Courses:

The available electives are to be selected at the commencement of the V Semester.

1) For a functional area, wherever available a student may opt for Elective Course in semester V.
2) The Elective courses offered from Semester V onwards shall remain the same as those selected in Semester V. Once a group of electives has been chosen, no further change in the selected group will be permitted in subsequent semesters.

Selection of MOOC Courses and Dissertation:

1) Options for MOOC will be floated according to availability of faculty and minimum number of students.
2) In Semester VIII, students may choose either a 12-credit Dissertation/Project Work or opt for subjects/courses carrying a total of 12 credits in place of the dissertation.

Selection of Value-Added Courses:

Students can choose value added courses as per their interest.

ii) Eligibility for Admissions with No. of Seats

As per the admission guidelines and brochure of the KISS Deemed to be University.

iii)Examination Pattern:

The medium of examination is English which will be reflected in their final grade sheet/certificate.Provided that for a language subject answers are to be in that language. Sanskrit may be written in Odia script but language has to be Sanskrit.

Duration of the Examinations-Mid Semester & End Semester:

Duration of examination for all term End examination shall be for 2.5 hours and for all Mid Term examination for 1 hour irrespective of full marks in the course/subjects and irrespective of credit. The practical examinations shall be of 2 hours duration.

Each School shall have a designated faculty as Examination Coordinator to be decided by the Vice Chancellor in addition to the Controller of Examinations of the University.

Continuous Evaluation and Mid Semester Examination:

a) Mid semester examination will be of 1-hour duration for 20/10 marks (20 for subjects having no practical and 10 for subject with practical papers). There shall be no pass mark in Mid Semester examination.

b) The Mid-Semester Examination shall be conducted and valued by the Faculty who are teaching the corresponding paper. A student who fails to appear in a Mid-Semester Examination **will be allowed one more chance to** take the same examination before appearing the concerned term-end examination. There will be no provision to re-appear in the Mid-Semester Examination for improvement.

c) For subjects with practical there will be a Mid-Semester practical examination carrying 10 marks.

d) The University authority of the valuation zones will preserve the answer Script of the End Semester examination for 06 months from the date of publication of result for reference.

e) A student has to appear the mid semester examination positively. Absence in the mid semester examination will be considered as fail however the candidate may be allowed to appear the mid semester examination before commencement of the concerned Term-End examination under special case duly considered by the HoD (for the ***candidates who represent the University or State for Inter- University or inter-state competitions in Games and Sports or attending different recognized National level camps/any critical medical case duly certified by the designated medical officer).***

Distribution of Marks in End Semester and Continuous Evaluation:(Irrespective of credit in a course/Paper)

Course Type	Maximum Marks	Semester-End theory Mark	Continues Evaluation Marks /Sessional	Mid Semester theory Mark	Semester-End and Practical mark	Mid Semester Practical Mark
Without Practical	**100**	**60**	**20**	**20**	**----**	**--**
With Practical	**100**	**50**	**10**	**10**	**20**	**10**
Thesis/ Dissertation/ Seminar/Field Work	**100**	**------**	**-------**	**-------**	**-------**	**-------**

The **modes of evaluation** of **Thesis/ Dissertation/ Seminar/Field Work** shall be as follows:

Literature Review

Synopsis Presentation

Field Work / Data Collection and Data Analysis

Findings and Conclusions

Presentation and Viva-Voce

Distribution of Sessional Marks:(Continuous Evaluation)

Course Type	Maximum Mark	Mid Semester	Attendance	Surprise Test/Quiz/Viva	Assignment/ Presentation
Without Practical	**40**	**20**	**Above 95%- 5 Marks**	**10**	**05**
With Practical	**30**	(Theory 10 + Practical 10)=20	**85%-94%- 4 Marks** **75%-84%- 3 Marks**	**05**	**Nil**

Examination Question Pattern of End Term Examination and Mark Distribution:

The evaluation process may cover summative and formative aspects and assess understanding applications, articulation, program and course outcome.

Question Pattern		**With Practical**	**Without Practical**
Part-I –Objective	**Answer in MCQ/ in one word/in one sentence as directed**	**1x5=5**	**1x6=6**
Part-II- Very Short Type	**Answer within 50 words. Answer any 3 out of 5 questions (with practical) and Answer any 5 out of 7 question (without practical)**	**2x3=6**	**2x5=10**
Part-III- Short Type	**Answer within 250 words Answer any 3 out of 5 questions (with practical) and Answer any 4 out of 6 question (without practical)**	**5x3=15**	**5x4=20**
Part-IV- Long Type	**Answer within 800 words. Answer any 3 out of 5 questions**	**8x3=24**	**8x3=24**
Total		**50**	**60**
For Practical Paper		**One Major Experiment-10 Record- 05 Viva voce-05**	**---------**

Examination Question Pattern of Mid Semester Examination and Mark Distribution

Question Pattern		With Practical	Without Practical
Part-I –Objective	Answer in MCQ/ in one word/in one sentence as directed	1x3=3	1x6=6
Part-II- Very Short Type	Answer within 50 words. Answer any 1out of 2 questions (with practical) and Answer any 2 out of 3 question (without practical)	2x1=2	2x2=4
Part-III- Short Type	Answer within 250 words Answer any 1 out of 2 questions (with practical) and Answer any 2 out of 3 question (without practical)	5x1=5	5x2=10
Total		10	20
For Practical Paper		One Major Experiment-5 Record- 02 Viva voce-03	---------

Award of Degree:

A Degree certificate under the official seal of the university and signed by the Vice-Chancellor shall be presented at the Convocation or in absentia to each of the successful students of particular degree. The Controller of Examinations shall issue the mark/grade sheet of each semester to the candidates in the sheet of each semester to the candidates in the prescribed format.

• Duration and Types of Courses and Process of Multiple Entry and Exit

NHEQF-Aligned Components (National Higher Education Qualifications Framework)

1. **NHEQF Level Mapping for Multi-Entry / Multi-Exit**

"This programme is structured according to the multi-entry, multi-exit parameters defined by UGC. The progressive qualification bands map directly onto the National Higher Education Qualifications Framework (NHEQF)."

Insert the following table:

Milestone / Year Completed	**Exit Award**	**NHEQF Level**	**Standard Credit Range**
Year 1 (Sem I–II)	UG Certificate	Level 4.5	~40 + 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.
Year 2 (Sem III–IV)	UG Diploma	Level 5.0	~80 + 4 credit in skill based vocational courses offered during first year or second year summer term
Year 3 (Sem V–VI)	UG Degree (3-Year)	Level 5.5	~120
Year 4 (Sem VII–VIII) **Year 1(Sem I-II)**	UG Honours / Honours with Research Post-Graduate Diploma	Level 6.0	~160
Year 2(Sem III-V)	Master's degree (e.g. M.A., M.Com., M.Sc., etc.)	Level 6.5	80 Credits

Milestone / Year Completed	Exit Award	NHEQF Level	Standard Credit Range
	Doctoral Degree	Level 8.0	Credits for coursework and, a thesis and published work

IX. Programme Educational Objectives (PEO)

(Schools may adapt these based on discipline.)

The Objective of this program is to ensure career path of the students. Students can be self-employed in the tribal community or elsewhere; or become a social entrepreneur; or can adopt research studies to enhance their skills for sustainable livelihood and become a researcher; they can pursue higher studies; or become a professional for policy making and its execution.

PEO1: Graduates will establish themselves as competent computing professionals by applying strong analytical, problem-solving, and technical skills to address real-world challenges in diverse professional environments.

PEO2: Graduates will become successful entrepreneurs and industry professionals by leveraging technical expertise, creativity, and industry-academia collaboration to develop innovative products, services, and technology-driven ventures.

PEO3: Graduates will demonstrate research aptitude and innovation by developing sustainable, interdisciplinary solutions to local and global challenges through scientific inquiry, critical thinking, and emerging technologies.

PEO4: Graduates will uphold professional ethics, leadership, and social responsibility while designing inclusive, sustainable, and technology-enabled solutions to multidisciplinary societal and industrial challenges.

PEO5: Graduates will integrate indigenous knowledge systems, traditional wisdom, and local community needs with modern computing technologies to create culturally relevant, sustainable, and socially impactful digital solutions.

a.Programme Outcomes (PO)

(Aligned with NEP-2020 Graduate Attributes)

PO1	Moral & Ethical Values	Apply ethical principles and commit to professional ethics and responsibilities and norms of the software professional practices.
PO2	Disciplinary Knowledge	Obtain and apply the knowledge of mathematics and computer science to solve real life problems.
PO3	Communication Skills	To develop an understanding of, and ability with the different forms of communication - writing, reading, speaking, listening-including visual and graphical, within science and beyond and the ability to apply these appropriately and effectively for different audiences.
PO4	Critical Thinking, Problem solving & analytical reasoning	Gain an ability to think and work creatively, including the capacity for self-starting, and the ability to apply science skills to unfamiliar applications. It encompasses skills such as understanding risk management and risk-taking, "thinking outside the box", and questioning the norm to suggest new solutions for old problems and also develop an understanding of the scientific method of evidence-based knowledge acquisition, deduction, induction including problem-solving, critical thinking & analysis and the ability to discover new knowledge.
PO5	Indian Knowledge Systems (IKS)	Understand the relevance of Indian Knowledge Systems in areas such as scientific thought, linguistics, logic, astronomy, mathematics, sustainability, and knowledge representation.
PO6	Research-Related Skills	Use application-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO7	Cooperation/Teamwork	Function effectively as an individual, and as a member or in diverse teams, and in multidisciplinary settings.
PO8	Digital Literacy	Create, select, and apply appropriate techniques, resources, and modern IT tools to model complex solutions with an understanding of their limitations.
PO9	Experiential & Life – long learning	Develop the capacity to engage in reflection and learning beyond formal educational contexts, that is based on the ability to make effective judgments about one's own work and to undertake self-directed, curiosity motivated, learning. The capacity to learn in, and from, new disciplines to enhance the application of scientific knowledge and skills in professional contexts.
PO10	Leadership Qualities	To acquire skills to function as a leader which includes not only subject specific skills such as laboratory skills, computing skills or quantitative

		data handling skills, but also more generic skills such time management, personal organization, teamwork and negotiation.
PO11	Professional & Decision-making Skills	To acquire, develop, employ, and integrate a range of technical, practical and professional skills, in appropriate and ethical ways within a professional context, autonomously and collaboratively and across a range of disciplinary and professional areas.
PO12	Environment Awareness and Sustainability	To build an awareness of the role of science within a global culture and willingness to contribute to the shaping of community views on complex issues where the methods and findings of science are relevant. This includes an understanding of how science underpins society, the applications of science in different cultures and identifying and engaging with current and future challenges.

b. Programme Specific Outcomes (PSO)

PSO1: Ability to demonstrate a degree of mastery in computer applications through the advanced knowledge of data acquisition, data mining, knowledge discovery and artificial intelligence

PSO2: Ability to independently carry out research/investigation and developmental work to solve practical problems.

PSO3: Develop sound knowledge and skill sets to develop and expand professional careers in fields related to human-computer interaction and management of industrial processes for the design and implementation of intelligent systems.

PSO4: To cater to the demands of the IT and IT-enabled sectors through strong theoretical foundation with high quality teaching complemented with extensive practical training.

c. Course Structure of the Undergraduate Programme

SEMESTER – I

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS10001	Programming in C	3	0	1	4
Minor (Opted by students from other departments)	CS12001	Introduction to Programming in C	3	0	1	4
Multidisciplinary (Opted by students from other departments)	CS13001	Computational Thinking for All	2	0	1	3
Ability Enhancement Course (AEC) (Choose any one)	AE14001	Modern Indian Language (Odia)	2	0	0	2
	AE14003	Modern Indian Language (Hindi)	2	0	0	2
	AE14005	Modern Indian Language (Sanskrit)	2	0	0	2

	AE14007	Modern Indian Language (Santali)	2	0	0	2
	AE14009	Alternative English	2	0	0	2
Skill Enhancement Course (Opted by students from other departments)	CS15001	Information Technology and Communication	2	0	1	3
Skill Enhancement Course (Lab) or (any other course from Arts or Science stream offered by University)	CS15003	Introduction to Web Development	2	0	1	3
Value Added Course	VA16201	Environment Education and Disaster Management	3	0	1	4
		Total				**20**

SEMESTER – II

Course Category	**Course Code**	**Course Title**	**Credits**			**Total Credit**
			L	**T**	**P**	
Core Course (Major)	CS10002	Data Structures	3	0	1	4
Minor (Opted by students from other departments)	CS12002	Data Structures in C	3	0	1	4
Multidisciplinary (Opted by students from other departments)	CS13002	Data Analytics	2	1	0	3
Ability Enhancement Course (AEC) (Choose any one)	AE14002	Translation Studies (Odia)	2	0	0	2
	AE14004	Translation Studies (Hindi)	2	0	0	2

	AE14006	Translation Studies (Sanskrit)	2	0	0	2
	AE14008	Translation Studies (Santali)	2	0	0	2
	AE14010	Translation Studies (English)	2	0	0	2
Skill Enhancement Course (Lab) or (any other course from Arts or Science stream offered by University)	CS15002	Introduction to Programming using Python	2	0	1	3
Value Added Course (Choose TWO Course)	VA16148	Indian Mathematical Heritage and Knowledge Systems	2	0	0	2
	VA16156	Physics in Indian Knowledge Systems	2	0	0	2
	VA16158	Indian Knowledge System and Computing	2	0	0	2
	VA16202	Renewable Energy and Sustainable Technologies	2	0	0	2
	VA16204	Water Pollution and Treatment Technologies	2	0	0	2
	VA16302	Introduction to Methods of Applied Mathematics	2	0	0	2

	VA16394	Flutter Application Development	1	0	1	2
	VA16432	Chemistry of Medicines and Everyday Health	2	0	0	2
		Total				**20**

Students exiting the programme after securing 40 credits will be awarded a **UG Certificate in Computer Science,** provided they **secure 4 credits in work-based vocational courses offered during the summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during the first and second semester**.

SEMESTER – III

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS20001	Discrete Mathematics for Computer Science	3	1	0	4
	CS20003	Design and Analysis of Algorithms	3	0	1	4
Minor (Opted by students from other departments)	CS22001	Analysis and Design of Algorithms	3	1	0	4
Multidisciplinary (Opted by students from other departments)	CS23001	Introduction to Artificial Intelligence and Machine Learning	2	1	0	3

Ability Enhancement Course (AEC)	AE24001	Communicative English	2	0	0	2
Skill Enhancement Course (Lab) or (any other course from Arts or Science stream offered by University) Choose ONE	CS25001	Prompt Engineering and AI Tools	2	0	1	3
	CS25003	Digital Storytelling	2	0	1	3
	CS25005	Design Thinking	2	0	1	3
	CS25007	Social Media Analytics	2	0	1	3
		Total				**20**

SEMESTER – IV

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS20002	Computer Systems and Architecture	3	1	0	4
	CS20004	Operating Systems	3	0	1	4
	CS20006	Database Management Systems	3	0	1	4
	CS20008	Cyber Security	2	0	0	2
Minor (Opted by students from other departments)	CS22002	Database Systems	3	0	1	4

Ability Enhancement Course (AEC)	AE24002	Professional Communication	2	0	0	2
		Total				**20**

Students exiting the programme after securing 80 credits will be awarded a **UG Diploma Computer Science** provided they secure an additional **4 credits in skill-based vocational courses offered during the first year or second year summer term**.

SEMESTER – V (Single Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS30001	Object Oriented Programming in Java	3	0	1	4
	CS30003	Software Engineering	3	1	0	4
	CS30005	Computer Networks	3	1	0	4
Minor (Opted by students from other departments)	CS32001	Computer Networks Fundamentals	3	1	0	4
Electives (Choose ONE)	CS30051	Artificial Intelligence	3	0	1	4
	CS30053	Data Science	3	0	1	4
Internship	IP37081	Internship	0	0	2	2
		Total				**22**

SEMESTER – V (Double Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
	CS30001	Object Oriented Programming in	3	0	1	4

Core Course (Major)		Java				
	CS30003	Software Engineering	3	1	0	4
	CS30005	Computer Networks	3	1	0	4
Minor(Opted by students from other departments)	CS32001	Computer Networks Fundamentals	3	0	1	4
Electives (Choose ONE)	CS30051	Artificial Intelligence	3	0	1	4
	CS30053	Data Science	3	0	1	4
Double Major I (Opted by students from other departments)	CS30001	Object Oriented Programming in Java	3	0	1	4
Double Major II (Opted by students from other departments)	CS30003	Software Engineering	3	1	0	4
Double Major III (Opted by students from other departments)	CS30005	Computer Networks	3	1	0	4
Internship	IP37081	Internship	0	0	2	2
		Total				**34**

SEMESTER – VI (Single Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS30002	Web Technologies	3	0	1	4
	CS30004	Theory of Computation	3	1	0	4
Minor (Opted by students from other departments)	CS32002	Web Designing	3	0	1	4

Electives (Choose ONE Set)	CS30052	Machine Learning	3	0	1	4
	CS30054	Neural Networks	3	0	1	4
	OR					
	CS30056	Data Mining	3	0	1	4
	CS30057	Data Visualization	3	0	1	4
		Total				**20**

Students who want to undertake a 3-year UG programme will be awarded **a UG Degree in Computer Science** upon completing 120 credits.

SEMESTER – VI (Double Major)

Course Category	**Course Code**	**Course Title**	**Credits**			**Total Credit**
			L	**T**	**P**	
Core Course (Major)	CS30002	Web Technologies	3	0	1	4
	CS30004	Theory of Computation	3	1	0	4
Minor (Opted by students from other departments)	CS32002	Web Designing	3	0	1	4
Electives (Choose ONE Set)	CS30052	Machine Learning	3	0	1	4
	CS30054	Neural Networks	3	0	1	4
	OR					
	CS30056	Data Mining	3	0	1	4
	CS30057	Data Visualization	3	0	1	4
Double Major IV (Opted by students from other departments)	CS30002	Web Technologies	3	0	1	4

Double Major V (Opted by students from other departments)	CS30004	Theory of Computation	3	1	0	4
Double Major VI (Opted by students from other departments) **Choose ONE**	CS30052	Machine Learning	3	0	1	4
	CS30054	Neural Networks	3	0	1	4
		Total				**32**

SEMESTER – VII (Single Major)

Course Category	**Course Code**	**Course Title**	**Credits**			**Total Credit**
			L	**T**	**P**	
Core Course (Major)	CS40001	Computer Graphics	3	1	0	4
	IK40051	Scientific Research Methods	3	0	1	4
Minor (Opted by students from other departments)	CS42001	Introduction to Computer Graphics	3	1	0	4
Electives (Choose ONE Set)	CS40051	Computer Vision and Image Processing	3	0	1	4
	CS40053	Natural Language Processing	3	0	1	4
	OR					
	CS40055	Big Data Analytics	3	0	1	4
	CS40057	Machine Learning and Deep Learning	3	0	1	4
		Total				**20**

SEMESTER – VII (Double Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS40001	Computer Graphics	3	1	0	4
	IK40051	Scientific Research Methods	3	0	1	4
Minor (Opted by students from other departments)	CS42001	Introduction to Computer Graphics	3	1	0	4
Electives (Choose ONE set)	CS40051	Computer Vision and Image Processing	3	0	1	4
	CS40053	Natural Language Processing	3	0	1	4
	OR					
	CS40055	Big Data Analytics	3	0	1	4
	CS40057	Machine Learning and Deep Learning	3	0	1	4
Double Major VII (Opted by students from other departments)	CS40001	Computer Graphics	3	1	0	4
		Total				**24**

SEMESTER – VIII (Single Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS40002	Compiler Design	3	1	0	4
	RD40082	Research and Dissertation	0	0	12	12

Minor (Opted by students from other departments)	CS42002	Compiler Development	3	1	0	4
Without Dissertation	CS40004	Internet of Things	3	1	0	4
	CS40006	Blockchain Technologies	3	1	0	4
	CS40008	Cloud Computing	3	0	1	4
		Total				**20**

Students will be awarded **UG Degree (Honours) with Research in Computer Science** provided they secure 160 credits. **Honours students not undertaking research will do 3 courses for 12 credits instead of a research project / Dissertation**.

SEMESTER – VIII (Double Major)

Course Category	**Course Code**	**Course Title**	**Credits**			**Total Credit**
			L	**T**	**P**	
Core Course (Major)	CS40002	Compiler Design	3	1	0	4
	RD40082	Research and Dissertation	0	0	12	12
Minor (Opted by students from other departments)	CS42002	Compiler Development	3	1	0	4
Without Dissertation	CS40004	Internet of Things	3	1	0	4
	CS40006	Blockchain Technologies	3	1	0	4

	CS40008	Cloud Computing	3	0	1	4
Double Major VIII (Opted by students from other departments)	CS40002	Compiler Design	3	1	0	4
		Total				**24**

SEMESTER – I

Course Category	**Course Code**	**Course Title**	**Credits**			**Total Credit**
			L	**T**	**P**	
Core Course (Major)	CS10001	Programming in C	3	0	1	4
Minor (Opted by students from other departments)	CS12001	Introduction to Programming in C	3	0	1	4
Multidisciplinary (Opted by students from other departments)	CS13001	Computational Thinking for All	2	0	1	3
Ability Enhancement Course (AEC)	AE14001	Modern Indian Language (Odia)	2	0	0	2

(Choose any one)	AE14003	Modern Indian Language (Hindi)	2	0	0	2
	AE14005	Modern Indian Language (Sanskrit)	2	0	0	2
	AE14007	Modern Indian Language (Santali)	2	0	0	2
	AE14009	Alternative English	2	0	0	2
Skill Enhancement Course (Opted by students from other departments)	CS15001	Information Technology and Communication	2	0	1	2
Skill Enhancement Course (Lab) or (any other course from Arts or Science stream offered by University)	CS15003	Introduction to Web Development	2	0	1	3
Value Added Course	VA16201	Environment Education and Disaster Management	3	0	1	4
		Total				**20**

Course Title: Programming in C

Code	Course Title	Credit	L-T-P
CS10001	Programming in C	4	3-0-1

Course Objectives:

Equip students with a comprehensive understanding and practical skills in C programming, enabling them to tackle complex computational problems, develop critical and analytical thinking, and prepare for advanced studies in computer science as per UGC NET and GATE standards.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- CO1 (Knowledge/Remember): Recall and describe the fundamental concepts of C programming, data types, operators, control structures, functions, arrays, pointers, and memory management.
- CO2 (Understanding): Explain and interpret the principles of structured programming, modular programming, functions, pointers, file handling, and dynamic memory allocation in C.
- CO3 (Application): Apply C programming concepts, algorithms, and appropriate programming techniques to develop solutions for computational and real-world problems.
- CO4 (Analysis): Analyze and compare different programming approaches, algorithms, data structures, and optimization techniques to develop efficient, reliable, and maintainable C programs.
- CO5 (Synthesis/Evaluation): Design, implement, and evaluate robust C programs by integrating appropriate programming constructs, algorithms, file processing, and debugging techniques to solve complex computational problems.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	2	-	2
CO2	-	3	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	3	-	-	-	-	-	-	-	-	-	-	2	2
CO4	-	-	-	-	-	-	-	-	-	3	-	-	2	-	-	-
CO5	-	-	3	-	-	-	-	-	-	-	-	-	-	-	2	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Basics of C Programming [8 Classroom Contact Hours]

Introduction to C, Structure of a C program, Variables, data types, and operators, Input/output operations

Unit 2: Control Structures and Functions [10 Classroom Contact Hours]

Conditional statements, Loops and iteration, Functions and recursion, Scope and lifetime of variables

Unit 3: Arrays, Pointers, and Strings [10 Classroom Contact Hours]

Arrays and multidimensional arrays, Pointers and dynamic memory allocation, Strings and string manipulation functions

Unit 4: Structured Data Types [9 Classroom Contact Hours]

Structures and unions, File handling in C, Enumerations and typedef

Unit 5: Advanced Concepts in C [8 Classroom Contact Hours]

Pre-processor directives, Command-line arguments, Introduction to libraries and modular programming

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Program to calculate the factorial of a number using recursion.
2. Program to sort an array using the quicksort algorithm.
3. Program to manage student records using structures and file I/O.
4. Program to implement a dynamic queue using linked lists.
5. Program to simulate a simple calculator using command-line arguments.
6. Program to create and manipulate linked lists.
7. Program to convert temperatures between Celsius and Fahrenheit.
8. Program to perform matrix multiplication.
9. Program to find the greatest common divisor of two numbers.
10. Program to reverse a string without using library functions.
11. Program to implement binary search on an array of integers.
12. Program to check if a number is prime or not.
13. Program to perform file operations such as read, write, and append.
14. Program to count the number of vowels and consonants in a string.
15. Program to demonstrate the use of enumerated types.
16. Program to display the Fibonacci series up to n terms.
17. Program to merge two sorted arrays into a single sorted array.

18. Program to find the sum of digits of a number.
19. Program to check if a given string is a palindrome.
20. Program to illustrate the use of command-line arguments.

- **Textbook**:
  1. "C Programming Language (2nd Edition)" by Brian W. Kernighan and Dennis M. Ritchi

- **Reference Books**:
  1. "Programming in ANSI C" by E. Balagurusamy
  2. "Let Us C" by Yashavant Kanetkar

SWAYM Course:

Problem Solving Through Programming in C. -https://onlinecourses.nptel.ac.in/noc24_cs123/preview

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Builds core computational thinking and problem-solving skills
SDG 8	Decent Work and Economic Growth	Improves employability through foundational programming competence
SDG 9	Industry, Innovation and Infrastructure	Enables software-based innovation using C for systems and tools

Course Title: Introduction to Programming in C

Code	Course Title	Credit	L-T-P
CS12001	Introduction to Programming in C	4	3-0-1

Course Objectives:

This course introduces students to the fundamentals of programming using the C language. It develops logical thinking, problem-solving, and algorithm design skills while enabling students to write, compile, debug, and execute C programs. The course provides a strong foundation in structured programming and prepares learners for advanced computing and software development courses.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1** (Knowledge/Remember)**:** Explain the fundamentals of C programming, including its syntax, data types, operators, and program structure.
- **CO2** (Understanding)**:** Develop algorithms and implement solutions using decision-making, looping, and modular programming concepts.
- **CO3** (Application)**:** Apply arrays, functions, pointers, strings, and file handling techniques to solve computational problems.
- **CO4** (Analysis)**:** Design, debug, test, and execute structured C programs for real-world applications.
- **CO5** (Evaluation/Create)**:** Analyze programming problems and develop efficient, readable, and maintainable C programs following standard coding practices.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	2	-	2
CO2	2	3	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	3	-	-	-	-	-	-	-	-	-	-	2	2
CO4	2	-	-	-	-	-	-	-	-	3	-	-	2	-	-	-
CO5	-	-	3	-	-	1	-	-	-	-	-	-	-	-	2	3

Course Duration: 45 hours

Course Syllabus:

Unit I: Introduction to C Programming [9 Classroom Contact Hours]

History and features of C, structure of a C program, character set, tokens, keywords, identifiers, constants, variables, data types, operators and expressions, input/output functions (printf() and scanf()), compilation and execution process, and writing simple C programs.

Unit II: Decision Making and Looping [9 Classroom Contact Hours]

Operators, conditional statements (if, if-else, nested if, switch), looping statements (for, while, do-while), jump statements (break, continue, goto), nested loops.

Unit III: Functions, Arrays, and Strings [9 Classroom Contact Hours]

Function declaration, definition, function calling, recursion, scope and storage classes, one-dimensional and two-dimensional arrays, string handling functions, passing arrays to functions, and applications involving matrices and string processing.

Unit IV: Pointers, Structures, and Dynamic Memory Allocation [9 Classroom Contact Hours]
Pointers, pointer arithmetic, pointers and arrays, pointers to functions, structures, unions, enumerated data types, dynamic memory allocation (malloc(), calloc(), realloc(), free()), and applications of pointers with structures.

Unit V: File Handling and Applications [9 Classroom Contact Hours]
File concepts, file opening and closing, text and binary files, reading and writing files, file operations using standard library functions, command-line arguments.

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Writing and executing basic C programs.
2. Programs using arithmetic, relational, and logical operators.
3. Programs based on conditional statements and loops.
4. Programs using functions and recursion.
5. Programs on one-dimensional and two-dimensional arrays.
6. String manipulation programs.
7. Pointer and dynamic memory allocation programs.
8. Programs using structures and unions.
9. File handling programs.

- **Textbook**:
  2. "C Programming Language (2nd Edition)" by Brian W. Kernighan and Dennis M. Ritchi

- **Reference Books**:
  3. "Programming in ANSI C" by E. Balagurusamy
  4. "Let Us C" by Yashavant Kanetkar

SWAYM Course:

Problem Solving through Programming in C. -https://onlinecourses.nptel.ac.in/noc24_cs123/preview

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Builds core computational thinking and problem-solving skills
SDG 8	Decent Work and Economic Growth	Improves employability through foundational programming competence
SDG 9	Industry, Innovation and Infrastructure	Enables software-based innovation using C for systems and tools

Course Title: Computational Thinking for All

Code	Course Title	Credit	L-T-P
CS13001	Computational Thinking for All	4	2-0-1

Course Objectives:

This course introduces students to computational thinking as a systematic approach to problem-solving. It develops skills in logical reasoning, decomposition, pattern recognition, abstraction, algorithm design, data representation, and basic programming. The course enables learners to apply computational methods across disciplines while promoting digital literacy.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of computational thinking, including decomposition, pattern recognition, abstraction, algorithmic thinking, and data representation.
- **CO2 (Understanding):** Explain the principles of computational problem-solving, algorithm design, flowcharts, pseudocode, and the role of computational thinking across various disciplines.
- **CO3 (Application):** Apply computational thinking techniques to analyze problems, design algorithms, and develop simple computational solutions using a beginner-friendly programming language.

- **CO4 (Analysis):** Analyze real-world problems by applying logical reasoning, data organization, searching and sorting concepts, and evaluate the efficiency of computational solutions.
- **CO5 (Evaluation/Create):** Design and implement computational solutions for practical applications while demonstrating responsible computing practices, ethical decision-making, cybersecurity awareness, and effective use of emerging technologies.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	1	-	1
CO2	2	2	-	2	1	-	-	-	-	-	-	-	2	2	-	-
CO3	-	-	3	2	-	-	-	-	-	-	-	-	-	-	1	2
CO4	2	2	-	-	-	-	-	-	-	1	-	-	2	-	2	-
CO5	-	-	2	-	-	1	-	-	-	-	-	-	-	-	2	2

Course Duration: 34 hours

Course Syllabus:

Unit I: Introduction to Computational Thinking (7 Hours)

What is Computational Thinking, Evolution of Computing, Characteristics of Computational Thinking, Computational Thinking vs Programming , Applications in Science, Commerce, Humanities, Healthcare, Agriculture and Social Sciences.

Unit II: Problem Solving using Computational Thinking (6 Hours)

Problem Identification, Decomposition, Pattern Recognition, Abstraction, Algorithmic Thinking, Designing Efficient Solutions, Flowcharts, Pseudocode, Decision Making and Logical Reasoning

Unit III: Data Representation and Algorithm Design (7 Hours)

Data and Information, Number Systems (Binary, Decimal), Text, Images and Multimedia Representation, Variables and Data Types, Sequential, Selection and Iteration Concepts, Searching Concepts, Sorting Concepts, Efficiency of Algorithms (Basic Idea)

Unit IV: Introduction to Programming (8 Hours)

(Using Python or any beginner-friendly language)

Programming Environment, Variables, Input and Output, Operators, Conditional Statements, Loops, Functions, Lists, Strings, Simple Problem Solving Programs

Unit V: Computational Thinking in Everyday Life (6 Hours)

Computational Thinking in Healthcare, Computational Thinking in Education, Smart Cities , Financial Technologies, Social Media Analytics, Artificial Intelligence and Machine Learning (Introduction).

Total Practical / Lab Experiments: [22 Lab Contact Hours]

1. Flowchart Design
2. Pseudocode Development
3. Pattern Recognition Activities
4. Algorithm Design
5. Simple Python Programs
6. Data Representation Exercises
7. Mini Computational Thinking Project
8. Problem-solving Case Studies

- **Textbook**:

1. Peter J. Denning & Matti Tedre, Computational Thinking, MIT Press, 2019.
2. Karl Beecher, Computational Thinking: A Beginner's Guide to Problem Solving and Programming, BCS Learning & Development Ltd., 2017.
3. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2nd Edition, O'Reilly Media, 2015.
4. John V. Guttag, Introduction to Computation and Programming Using Python, 3rd Edition, MIT Press, 2021.
5. David Riley & Kenny Hunt, Computational Thinking for the Modern Problem Solver, CRC Press, 2014.

- **Reference Books**:

1. Jeannette M. Wing, Computational Thinking (Selected Articles and Essays), Communications of the ACM.
2. Y. Daniel Liang, Introduction to Programming Using Python, Pearson, Latest Edition.
3. David Joyner, Introduction to Computing and Programming in Python: A Multimedia Approach, Pearson, Latest Edition.
4. Charles R. Severance, Python for Everybody: Exploring Data Using Python 3, CreateSpace Independent Publishing Platform, 2016.
5. Paul Curzon & Peter W. McOwan, The Power of Computational Thinking: Games, Magic and Puzzles to Help You Become a Computational Thinker, World Scientific Publishing, 2017.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Promotes computational thinking, digital literacy, problem-solving, and lifelong learning skills essential for quality education and employability.
SDG 8	Decent Work and Economic Growth	Develops computational and digital competencies that enhance employability, innovation, and workforce readiness.
SDG 9	Industry, Innovation and Infrastructure	Encourages algorithmic thinking, programming, and innovation to address real-world problems using digital technologies.
SDG 10	Reduced Inequalities	Provides equal opportunities for students from diverse disciplines and backgrounds to acquire computational and digital skills.

Course Title: Modern Indian Language (Odia)

Code	Course Title	Credit	L-T-P
AE14001	Modern Indian Language (Odia)	2	2-0-0

NB: Refer to Odia Department

Course Title: Modern Indian Language (Hindi)

Code	Course Title	Credit	L-T-P
AE14003	Modern Indian Language (Hindi)	2	2-0-0

NB: Refer to Hindi Department

Course Title: Modern Indian Language (Sanskrit)

Code	Course Title	Credit	L-T-P
AE14005	Modern Indian Language (Sanskrit)	2	2-0-0

NB: Refer to Sanskrit Department

Course Title: Modern Indian Language (Santali)

Code	Course Title	Credit	L-T-P
AE14007	Modern Indian Language (Santali)	2	2-0-0

NB: Refer to Santali Department

Course Title: Alternative English

Code	Course Title	Credit	L-T-P
AE14009	Alternative English	2	2-0-0

NB: Refer to English Department

Information Technology and Communication

Code	Course Title	Credit	L-T-P
CS15001	Information Technology and Communication	3	2-0-1

Course Objectives:

1. To make them aware about the basics of computers and its evolution.

2. Provide knowledge of different units of computer like processing unit, I/O units, and storage unit.
3. Learn about number systems and softwares.
4. Gain knowledge of networking concepts, data communication, internet etc.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of Information Technology, including computer hardware, software, operating systems, databases, computer networks, and information systems.
- **CO2 (Understanding):** Explain and interpret the principles of number systems, data representation, binary arithmetic, logic gates, and digital data processing.
- **CO3 (Application):** Apply the concepts of computer networks, Internet technologies, intranets, extranets, communication systems, and productivity software to solve basic computing and communication problems.
- **CO4 (Analysis):** Analyze and compare different communication technologies, network architectures, information systems, and IT infrastructure to identify appropriate solutions for organizational and personal computing needs.
- **CO5 (Synthesis/Evaluation):** Design, evaluate, and demonstrate the effective use of Information Technology tools, communication systems, and digital resources to enhance information management, collaboration, productivity, and decision-making in diverse application domains.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO5	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	2

Course Duration: 34 hours

Course Syllabus:

Unit I: Introduction to Information Technology [9 Classroom Contact Hours]

What is Computer, Evolution and Types of Computer, Basic Applications of Computer, Components of Computer System, Functional Unit of Computer, Input/Output Devices, Computer Memory: Types of memory, RAM, ROM, Registers, Concepts of Hardware and Software, Computer Languages.

Unit II: Computer Number Systems [8 Classroom Contact Hours]

Introduction to number system: Binary, Octal, Decimal, Hexadecimal (characteristics of each number system), Conversion from one number system to other Complements of number systems and arithmetic operations, Computer codes (BCD, EBCDIC, ASCII, Code, Gray code, Excess-3 code and Unicode)

Unit III: Software Concept [7 Classroom Contact Hours]

Software, Types of software: System software, Application Software, Utility Software, System software: Operating System, Needs for OS, Functions of OS, Language processors (Assembler, Interpreter, Compiler), Application Software: General purpose application (word processor, spreadsheet package, presentation software). Specific purpose application software (Payroll systems, HRMS-Human Resource Management System), Utility Software: Compression tools, Disk Defragmenter, Antivirus

Unit IV: Introduction to Computer Network [10 Classroom Contact Hours]

Data Communication: Definition, Types of data and communication modes- simplex, half duplex, full duplex, Topology, Network: LAN, MAN, WAN, PAN, Internet Architecture: Introduction, History, Internet Architecture Components, Internet Application, Internet open issues, Intranets, Extranets, Websites,

Total Practical / Lab Experiments: [22 Contact Hours]

1. Perform basic computer operations, file and folder management, and operating system configuration.
2. Create professional documents using a word processing tool with formatting, tables, images, references, and mail merge.
3. Design spreadsheets using formulas, functions, charts, conditional formatting, and PivotTables for data analysis.

4. Develop effective multimedia presentations using presentation software with animations, transitions, hyperlinks, and multimedia elements.
5. Create online forms and conduct surveys using cloud-based collaboration tools such as Google Forms or Microsoft Forms.
6. Configure and use cloud storage and collaboration platforms for file sharing, document editing, and team collaboration.
7. Perform internet-based information retrieval using advanced search techniques and evaluate the credibility of online resources.
8. Configure and use email services, video conferencing, instant messaging, and collaborative communication tools for professional communication.
9. Demonstrate cybersecurity practices by implementing password management, encryption, antivirus tools, phishing awareness, and safe internet usage.
10. Develop a mini project integrating office productivity tools, cloud services, digital communication platforms, and internet resources to solve a real-world problem.

- **Textbooks:**
  1. Sinha, P. K. , Computer Fundamentals, BPB Publications
  2. Curtin P. G., Foley K., Sen. Morin G, Information Technology

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Foundational digital and communication literacy
SDG 5	Gender Equality	Safer, empowering online participation
SDG 8	Decent Work and Economic Growth	ICT skills for employability
SDG 10	Reduced Inequalities	Bridging digital divides (rural/tribal learners)
SDG 16	Peace, Justice & Institutions	Responsible online citizenship, e-governance use

Course Title: Introduction to Web Development

Code	Course Title	Credit	L-T-P
CS15003	Introduction to Web Development	3	2-0-1

Course Objectives:

1. To equip students with the foundational skills in web programming, enabling them to develop and apply complex problem-solving strategies.
2. Enhance critical thinking, and utilize analytical reasoning.
3. The course will promote research-related skills, foster cooperative teamwork, and cultivate leadership readiness, while advancing digital literacy, multicultural competence, and effective communication skills. It also aims to instil environmental awareness, sustainability, and the principles of autonomy, responsibility, accountability, and self-directed lifelong learning.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of web programming, web architecture, HTML, CSS, JavaScript, client-server communication, and web technologies.
- **CO2 (Understanding):** Explain and interpret the principles of responsive web design, server-side scripting, database connectivity, web frameworks, and web security concepts.
- **CO3 (Application):** Apply web programming languages, frameworks, and database technologies to design, develop, and deploy interactive and dynamic web applications.
- **CO4 (Analysis):** Analyze and compare web technologies, development frameworks, database integration methods, and security mechanisms to identify appropriate solutions for web-based applications.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate secure, responsive, and scalable web applications by integrating front-end technologies, back-end programming, databases, APIs, and modern web development practices.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4

CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	2	2	-
CO2	-	3	-	2	1	3	-	-	-	-	-	-	2	3	-	2
CO3	-	-	3	2	-	-	3	-	-	-	-	-	-	-	3	-
CO4	-	-	-	-	-	-	-	-	-	3	-	2	2	2	-	2
CO5	-	-	3	-	-	-	-	-	-	-	-	-	2	-	2	3

Course Duration: 34 hours

Course Syllabus:

Unit 1: Introduction to Web Technologies [6 Classroom Contact Hours]

Overview of the Internet and Web, Basics of HTML and CSS, Introduction to JavaScript and DOM manipulation

Unit 2: Advanced HTML and CSS [6 Classroom Contact Hours]

HTML5 features and APIs, Advanced CSS for responsive design, CSS preprocessors like SASS or LESS

Unit 3: Client-Side Scripting [7 Classroom Contact Hours]

JavaScript programming fundamentals, Event handling and asynchronous program, Introduction to front-end frameworks (e.g., React, Angular)

Unit 4: Server-Side Programming [8 Classroom Contact Hours]

Basics of server-side scripting with Node.js, Understanding HTTP protocol and RESTful services, Introduction to databases and server-client interaction

Unit 5: Full-Stack Web Development [7 Classroom Contact Hours]

Integrating client-side and server-side technologies, Web application deployment and hosting, Security considerations in web development

Total Practical / Lab Experiments: [22 Lab Contact Hours]

1. Create a personal portfolio page using HTML and CSS
2. Implement a responsive layout with media queries
3. Develop a to-do list application using JavaScript
4. Create a dynamic content gallery with JavaScript and DOM
5. Build a basic Node.js server
6. Develop a RESTful API with Node.js

7. Connect a web application to a database
8. Implement user authentication and authorization
9. Create a single-page application with a front-end framework
10. Deploy a web application to a cloud service
11. Perform form validation using JavaScript
12. Build a web application with CRUD operations
13. Integrate third-party APIs into a web project
14. Develop a chat application using WebSockets
15. Create an interactive map using an external mapping API
16. Implement state management in a front-end application
17. Optimize web application performance
18. Ensure web accessibility standards are met
19. Conduct unit testing for a web application
20. Collaborate on a group web development project using version control

- **Textbook:**
  1. "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics" by Jennifer Niederst Robbins

- **Reference Books:**
  1. "Eloquent JavaScript: A Modern Introduction to Programming" by Marijn Haverbeke
  2. "HTML and CSS: Design and Build Websites" by Jon Duckett
  3. "JavaScript and JQuery: Interactive Front-End Web Development" by Jon Duckett

SWAYAM Courses

CIT-003: Web Based Technologies and Multimedia Applications:
https://onlinecourses.swayam2.ac.in/nou24_cs12/preview

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Skills for creating educational and community web resources

SDG 8	Decent Work and Economic Growth	Employable front-end / junior full-stack web development skills
SDG 9	Industry, Innovation and Infrastructure	Web apps as digital infrastructure for services and innovation
SDG 12	Responsible Consumption and Production	Efficient, responsible digital products

Course Title: Environment Education and Disaster Management

Code	Course Title	Credit	L-T-P
VA16201	Environment Education and Disaster Management	4	3-0-1

Course Objectives:

The objective is to make students aware about the environmental functions and issues.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Students will develop a comprehensive understanding of the complex interactions between humans and the environment, tracing historical developments, analyzing contemporary challenges, and exploring sustainable solutions..
- **CO2 (Understanding):** Students will be able to critically analyze the impact of human activities on natural resources, biodiversity, ecosystems, and the climate, evaluating the effectiveness of conservation efforts and mitigation strategies.
- **CO3 (Application):** Students will gain an interdisciplinary perspective by integrating knowledge from fields such as ecology, geography, sociology, economics, and policy studies to address environmental issues holistically.
- **CO4 (Analysis):** Students will cultivate problem-solving skills by applying scientific principles, analytical tools, and ethical considerations to devise innovative solutions for environmental challenges at local, regional, and global scales.
- **CO5 (Synthesis/Evaluation):** Students will develop the capacity for active engagement and advocacy in environmental stewardship, recognizing their role as

responsible global citizens and agents of positive change in promoting sustainability and resilience.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	3	-	2	-	–	-	-	-	-	-	-	3	1	1	1
CO2	-	3	-	2	-	2	-	-	-	-	-	-	3	2	1	1
CO3	-	2	-	3	-	3	-	-	-	-	-	-	2	3	2	2
CO4	-	2	-	3	-	2	-	-	-	-	-	-	2	3	2	2
CO5	-	2	-	3	-	2	-	-	-	-	-	-	2	3	2	2

Course Duration: 45 hours

Course Syllabus:

UNIT- I: Humans and the Environment [6 Classroom Contact Hours]

The man-environment interactions: Human as hunger-gatherers; Origin of agriculture; Great ancient civilizations and the environment; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Concept of sustainable development, Sustainable Development Goals (SDGs).

UNIT-II: Natural Resources and Sustainable Development [7 Classroom Contact Hours]

Overview of natural resources, renewable and non-renewable resources. Biotic resources: Major type of biotic resources-forests, grassland, wetlands, wildlife. Water resources: Types of water resources-fresh water and marine; Availability and use of water resources; Environmental impact of over-exploitation, issues and challenges; Conflicts over water.Soil and mineral resources: Energy resources: Renewable and non-renewable sources of energy; Non-conventional energy sources-solar, wind, tidal, hydro, geothermal, biomass, hydrogen and fuel cells; Implications of energy use on the environment.

UNIT-III: Conservation of Biodiversity and Ecosystems [5 Classroom Contact Hours]

Biodiversity as a natural resource; Biodiversity in India and the world; Biodiversity hotspots; Endangered species, Red data book. Threats to biodiversity and ecosystems: Commercial exploitation of species; Invasive species. Major conservation policies: in-situ conservation approaches; Major protected areas; National and International initiatives for biodiversity conservation; the role of traditional knowledge, community-based conservation. Land use and Land cover change: deforestation, desertification, urbanization, Loss of Biodiversity and it's impact.

UNIT- IV: Environmental Pollution [7 Classroom Contact Hours]

Environmental issues at local, regional, and global levels. Air, noise, water, soil, thermal and radioactive pollution. Point sources and non-point sources of pollution. Air pollution: Sources of air pollution; Primary and secondary pollutants; particulate matter and sulphur dioxide; Volatile Organic compounds (VOCs), Polycyclic aromatic hydrocarbons (PAHs) and Persistent organic pollutants (POPs); acid rain; smog, Ozone hole. National Ambient Air Quality Standards. Water pollution: Sources of water pollution; River, lake and marine pollution, groundwater pollution; water quality, Water quality parameters and standards; adverse health impacts of water pollution on human and aquatic life. Soil pollution: Soil pollutants and their sources; Solid waste and their recycling. Noise pollution: Definition of noise; Unit of measurement of noise pollution; Mineral exploitation; Environmental problems due to extraction of minerals and use; Degradation of soil quality and impact on agriculture productivity. Noise pollution; Noise standards; adverse impact of noise on human health. Thermal and Radioactive pollution: Sources and impact on human health and ecosystems.

UNIT-V: Climate Change: Impacts, Adaptation and Mitigation [6 Classroom Contact Hours]

Understanding climate change, Projections of global climate change with reference to temperature, rainfall, climate variability and extreme events; Climate change projections for the Indian sub-continent. Impacts of climate change on ocean and land systems; Sea level rise, changes in marine and costal ecosystems; Impacts on forests and natural ecosystem; Impacts on animal species, agriculture, health, urban infrastructure; Climate-resilient development; Indigenous knowledge for adaption to climate change. Mitigation of climate change: Green House Gas (GHG) Reduction vs. sink enhancement; Concept of carbon intensity, energy intensity and carbon neutrality; Energy efficiency measures; Renewable energy sources; Carbon capture and storage.

UNIT-VI: Environmental Management [5 Classroom Contact Hours]

Introduction to environmental laws and regulations: Constitutional provisions- Article 48A, Article 51A (g) and other environmental rights, Environmental legislations on the forest, wildlife and pollution control. Environmental audit and impact assessment; Waste Management- Concept of 3R (Reduce, Recycle and Recycle) and sustainability.

UNIT-VII: Environmental Treaties and Legislation [9 Classroom Contact Hours]

Major International Environmental Agreements: UN Conference on Human Environment 1972, Convention on Biological Diversity (CBD); Cartagena Protocol on Biosafety; Nagoya Protocol on Access and Benefit-sharing ; Convention on International Trade in Endangered Species of Wild Flora and Fauna(CITES); Ramsar Convention on Wetlands of International Importance; United Nations Convention to Combat Desertification (UNCCD); Vienna Convention for the Protection of the Ozone Layer; Montreal Protocol on Substances that Deplete the Ozone Layer and the Kigali Amendment; Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal; Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; Stockholm Convention on Persistent Organic Pollutants; Minamata Convention on Mercury; United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Paris Agreement; India's status as a party to major conventions

Major Indian Environmental Legislations: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air(Prevention and Control of Pollution) Act, 1981 The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006; Noise Pollution (Regulation and Control) Rules, 2000; Industry-specific environmental standards; Waste management rules, National Green Tribunal. Major International organizations and initiatives: United Nations Environment Programme (UNEP), International Union for Conservation of Nature (IUCN), World Commission on Environment and Development (WCED), United Nations Educational, Scientific and Cultural Organization (UNESCO), Intergovernmental Panel on Climate Change (IPCC), and Man and the Biosphere(MAB) programme.

Total Practical / Lab Experiments: [30 Lab Contact Hours]

Concept of Hazards, Disasters, Natural and man-made hazards, Types of hazards, Concept of disaster management, Vulnerability and risk. Nature and characteristics of hazards: Flood, Cyclone, Drought, and Earthquake. Man-made hazards – Industrial and Fire. Disaster management cycle, Pre disaster management, during disaster management, Post Disaster review and management, Preventing, mitigation, preparedness, Adaptation. Disaster Management Plan at National Level, State Level, District Level and Community Level.

Text book:

1. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

Reference book:

1. Das, M.C. Text Book of Ecology, Tata Mc Graw Hills, New Delhi.
2. Central Pollution Control Board Web page for various pollution standards. https://cpcb.nic.in/standards/.
3. Chiras, D. D and Reganolds, J.P. (2010) . Natural Resource Conservation : Management for a Sustainable Future. 10th edition, Upper Saddle River, N.J. Benjamin/Cummins/Person.
4. Fisher, Michael H. (2018) An Environmental History of India-Form Earliest Times to the Twenty-First Century, Cambridge University Press.
5. Harris, France (2012) Global Environmental Issues, 2nd Edition. Wiley-Blackwell.
6. John W. Twidell and Anthony D. (2015). Renewable Energy Sources, 3rd Edition, Weir Publisher (ELBS).
7. Kanchi Kohli and Manju Menon (2021) Development of Environment Laws in India, Cambridge University Press.
8. Krishnamurthy, K.V.(2003) Textbook of Biodiversity, Science Publishers, Plymouth, UK.
9. Ministry of Environment, Forest and Climate Change (2019) A Handbook on International Environment Conventions & Programmes. https://moef.govt.in/wp-content/uploads/2020/02/convention-V-16-CURVE-web.pdf.
10. Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press.
11. Annual Reports of Ministry of Env., Forests and Climate Change, Govt of India, New Delhi.

Note: Latest edition of the text books should be used.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 3	Good Health and Well-being	Safety, health impacts of disasters and pollution
SDG 11	Sustainable Cities and Communities	Resilient infrastructure, disaster-risk reduction strategies
SDG 13	Climate Action	Climate literacy, adaptation and mitigation concepts
SDG 15	Life on Land	Biodiversity, forests, indigenous ecological knowledge

SEMESTER – II

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS10002	Data Structures	3	0	1	4
Minor (Opted by students from other departments)	CS12002	Data Structures in C	3	0	1	4
Multidisciplinary (Opted by students from other departments)	CS13002	Data Analytics	2	1	0	3
Ability Enhancement Course (AEC) (Choose any one)	AE14002	Translation Studies (Odia)	2	0	0	2
	AE14004	Translation Studies (Hindi)	2	0	0	2
	AE14006	Translation Studies (Sanskrit)	2	0	0	2

	AE14008	Translation Studies (Santali)	2	0	0	2
	AE14010	Translation Studies (English)	2	0	0	2
Skill Enhancement Course (Lab) or (any other course from Arts or Science stream offered by University)	CS15002	Introduction to Programming using Python	2	0	1	3
Value Added Course (Choose TWO Course)	VA16148	Indian Mathematical Heritage and Knowledge Systems	2	0	0	2
	VA16156	Physics in Indian Knowledge Systems	2	0	0	2
	VA16158	Indian Knowledge System and Computing	2	0	0	2
	VA16202	Renewable Energy and Sustainable Technologies	2	0	0	2
	VA16204	Water Pollution and Treatment Technologies	2	0	0	2
	VA16302	Introduction to Methods of Applied Mathematics	2	0	0	2
	VA16394	Flutter Application Development	1	0	1	2

	VA1643 2	Chemistry of Medicines and Everyday Health	2	0	0	2
		Total				**20**

Course Title: Data Structures

Code	Course Title	Credit	L-T-P
CS10002	Data Structures	4	3-0-1

Course Objectives:

1. To provide students with a thorough understanding of data structures, their design, implementation, and analysis.
2. Enabling them to apply this knowledge to solve complex problems.
3. Develop critical and analytical thinking, and prepare for higher education and competitive exams like UGC NET and GATE.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of data structures, abstract data types, arrays, linked lists, stacks, queues, trees, graphs, and hashing.
- **CO2 (Understanding):** Explain and interpret the principles of linear and non-linear data structures, searching, sorting, recursion, and algorithm efficiency.
- **CO3 (Application):** Apply appropriate data structures and algorithms to design and implement efficient solutions for computational and real-world problems.
- **CO4 (Analysis):** Analyze and compare different data structures and algorithms with respect to time complexity, space complexity, and suitability for specific applications.

- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate optimized data structure-based solutions by integrating appropriate data organization techniques, searching and sorting algorithms, and performance optimization strategies for complex computational problems.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	3	-	-
CO2	-	3	-	3	1	-	-	-	-	-	-	-	2	-	-	2
CO3	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO5	-	-	3	-	-	-	-	2	-	-	-	-	2	-	-	2

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Data Structures [8 Classroom Contact Hours]

Basic concepts and overview, Complexity analysis, Abstract data types (ADTs), Recursion and its applications

Unit 2: Linear Data Structures [12 Classroom Contact Hours]

Arrays and strings, Stacks and queues, Linked lists, Implementation and applications

Unit 3: Non-Linear Data Structures [10 Classroom Contact Hours]

Trees, binary trees, and binary search trees, Heaps and priority queues, Graphs and graph algorithms

Unit 4: Advanced Data Structures [10 Classroom Contact Hours]

Balanced search trees (AVL, Red-Black), Hash tables and hash functions, Disjoint set unions

Unit 5: Algorithms and Problem Solving [5 Classroom Contact Hours]

Sorting and searching algorithms, Algorithm design techniques (divide and conquer, greedy, dynamic programming), Complexity classes and NP-completeness

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Implement a linked list and perform insertion and deletion operations.
2. Create a stack using arrays and linked lists.
3. Develop a queue and demonstrate enqueue and dequeue operations.
4. Write a program to perform binary search on a sorted array.
5. Implement a binary search tree and conduct in-order traversal.
6. Design a heap and implement heap sort.
7. Create a graph using adjacency lists and perform DFS and BFS.
8. Write a program for hashing with chaining.
9. Implement AVL tree insertion and deletion.
10. Develop a disjoint set data structure and perform union and find operations.
11. Write a program to sort an array using quicksort.
12. Implement a priority queue using heaps.
13. Develop a program to check for balanced parentheses using stacks.
14. Write a program for recursive file listing in a directory.
15. Implement a red-black tree.
16. Develop a program for the huffman coding algorithm.
17. Write a program to detect cycles in a graph using disjoint sets.
18. Implement a radix sort algorithm.
19. Develop a program for finding the shortest path in a graph using Dijkstra's algorithm.
20. Write a program to perform merge sort on a linked list.

Textbook:

1. "Data Structures and Algorithms in C" by Mark Allen Weiss

Reference Books:

1. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
2. "Algorithms in C, Parts 1-5" by Robert Sedgewick

SWAYAM Course

Data Structure using C Programming - https://onlinecourses.swayam2.ac.in/nou24_cs15/

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Deepens algorithmic reasoning and abstraction
SDG 8	Decent Work and Economic Growth	Core skill for software and data engineering roles
SDG 9	Industry, Innovation and Infrastructure	Efficient data handling for scalable digital systems

Course Title: Data Structures in C

Code	Course Title	Credit	L-T-P
CS12002	Data Structures in C	4	3-0-1

Course Objectives:

This course introduces students to fundamental data structures and their implementation using the C programming language. It develops skills in designing efficient algorithms, organizing and managing data, analyzing time and space complexity, and applying linear and non-linear data structures to solve computational problems, forming a foundation for advanced computer science studies.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- CO1 (Knowledge/Remember): Recall and describe the fundamental concepts of data structures, abstract data types, arrays, linked lists, stacks, queues, trees, graphs, hashing, and algorithm complexity.
- CO2 (Understanding): Explain and interpret the principles of linear and non-linear data structures, searching and sorting techniques, recursion, hashing, tree traversals, graph representations, and memory management in C.

- CO3 (Application): Apply appropriate data structures and algorithms to design, implement, and test efficient solutions for computational problems using the C programming language.
- CO4 (Analysis): Analyze the performance of different data structures and algorithms by evaluating their time and space complexities and selecting suitable techniques for real-world applications.
- CO5 (Evaluation/Create): Design, develop, and optimize programs using linear and non-linear data structures while applying standard programming practices to create efficient, scalable, and maintainable software solutions.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	1	-	-	-	-	1	-	-	-	-	2	3	1	-
CO2	2	3	-	3	1	-	-	-	-	-	-	-	2	1	-	2
CO3	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO4	2	-	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO5	-	-	3	-	-	-	-	2	-	-	-	-	2	-	1	2

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Data Structures [8 Classroom Contact Hours]

Basic concepts of data structures and their importance in problem solving; classification of data structures (linear and non-linear); primitive and non-primitive data structures; abstract data types (ADTs); algorithm design and analysis; asymptotic notations (Big O, Big Omega, and Big Theta); time and space complexity analysis.

Unit 2: Linear Data Structures [12 Classroom Contact Hours]

Arrays and strings: one-dimensional and two-dimensional arrays, memory representation, array operations, sparse matrices, and string manipulation. Stacks: implementation using arrays and linked lists, stack operations, applications of stacks including expression evaluation, infix to postfix conversion, postfix evaluation, and recursion. Queues: simple queue, circular queue, priority queue, deque, implementation using arrays and linked lists.

Unit 3: Linked Lists and Searching & Sorting Techniques [10 Classroom Contact Hours]

Linked lists: singly linked list, doubly linked list, circular linked list, insertion, deletion, traversal, searching, and applications. Searching techniques: linear search and binary search. Sorting techniques: bubble sort, selection sort, insertion sort, merge sort, quick sort, and an introduction to heap sort.

Unit 4: Non-Linear Data Structures [8 Classroom Contact Hours]

Trees: terminology, binary trees, binary tree traversals (preorder, inorder, postorder), binary search trees, insertion, deletion, searching, threaded binary trees, AVL trees, and applications. Graphs: graph terminology, graph representation using adjacency matrix and adjacency list, graph traversal algorithms (Breadth First Search and Depth First Search).

Unit 5: Hashing and Advanced Data Structures [7 Classroom Contact Hours]

Hashing concepts, hash functions, collision resolution techniques (linear probing, quadratic probing, double hashing, and chaining), hash tables and their applications. Introduction to heaps and heap operations, priority queues.

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Recursive function implementation (factorial, Fibonacci, GCD, Tower of Hanoi).
2. Array operations and string manipulation programs.
3. Stack implementation using arrays and linked lists.
4. Queue and circular queue implementation.
5. Singly, doubly, and circular linked list operations.
6. Searching algorithms (Linear and Binary Search).
7. Sorting algorithms (Bubble, Selection, Insertion, Merge, Quick).
8. Binary Search Tree implementation and traversals.
9. Graph traversal using BFS and DFS.
10. Hash table implementation using collision resolution techniques.
11. Mini-project using appropriate data structures.

SWAYAM Course

Data Structure using C Programming - https://onlinecourses.swayam2.ac.in/nou24_cs15/

- **Textbook**:

1. Ellis Horowitz, Sartaj Sahni, and Susan Anderson-Freed, Fundamentals of Data Structures in C, 2nd Edition, Universities Press.
2. Reema Thareja, Data Structures Using C, 3rd Edition, Oxford University Press.
3. Aaron M. Tenenbaum, Yedidyah Langsam, and Moshe J. Augenstein, Data Structures Using C, Pearson Education.
4. Yashavant Kanetkar, Data Structures Through C, BPB Publications.

- **Reference Books**:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education.
2. Seymour Lipschutz, Schaum's Outline of Data Structures with C, McGraw-Hill Education.
3. Robert L. Kruse and Bruce P. Leung, Data Structures and Program Design in C, Pearson Education.
4. Debasis Samanta, Classic Data Structures, 2nd Edition, PHI Learning.
5. Alfred V. Aho, John E. Hopcroft, and Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Deepens algorithmic reasoning and abstraction
SDG 8	Decent Work and Economic Growth	Core skill for software and data engineering roles
SDG 9	Industry, Innovation and Infrastructure	Efficient data handling for scalable digital systems

Data Analytics

Code	Course Title	Credit	L-T-P

CS13002	Data Analytics	4	3-1-0

Course Objectives:

Upon successful completion of this course, students will be able to apply data analytics techniques to solve real-world problems, critically analyze data, and communicate their findings effectively.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of data analytics, data types, data collection methods, data preprocessing, statistical analysis, and analytical workflows.
- **CO2 (Understanding):** Explain and interpret the principles of exploratory data analysis, statistical techniques, data visualization, hypothesis testing, and data quality assessment.
- **CO3 (Application):** Apply statistical methods, computational tools, programming libraries, and data analytics techniques to collect, preprocess, analyze, and visualize data for solving real-world problems.
- **CO4 (Analysis):** Analyze and compare data analysis methods, predictive models, visualization techniques, and analytical tools to identify meaningful patterns, trends, and insights for evidence-based decision-making.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate comprehensive data analytics solutions by integrating statistical analysis, visualization techniques, ethical data practices, and effective communication to present actionable insights through reports and presentations.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	2	-	2	2
CO2	-	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-
CO3	-	-	-	3	2	-	-	-	-	-	-	-	-	3	-	-
CO4	-	-	-	-	-	3	-	-	-	-	-	-	2	2	2	-
CO5	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-	2

Course Duration: 45 hours

Course Syllabus:

UNIT I: Introduction to Data Analytics [10 Classroom Contact Hours]

Overview of data analytics, its importance, and applications, Data types (structured, unstructured) and data sources, Data preprocessing: cleaning, transformation, and normalization, Introduction to Python/R for data analysis

UNIT II: Descriptive Analytics [11 Classroom Contact Hours]

Summary statistics: mean, median, variance, etc., Data visualization: histograms, scatter plots, box plots, Exploratory data analysis (EDA), Case study: analyzing a real-world dataset

UNIT III: Predictive Analytics [12 Classroom Contact Hours]

Regression analysis: linear regression, multiple regression, Classification: logistic regression, decision trees, k-nearest neighbors, Model evaluation and validation, Hands-on exercises using scikit-learn or similar libraries.

UNIT IV: Prescriptive Analytics [12 Classroom Contact Hours]

Optimization techniques: linear programming, integer programming, Decision support systems, Case study: optimization in supply chain management

UNIT IV: Advanced Topics in Data Analytics [10 Classroom Contact Hours]

Time series analysis, Clustering techniques: k-means, hierarchical clustering, Text mining and sentiment analysis, Ethical considerations in data analytics

- **Textbook:**
  1. "Data Science for Business" by Foster Provost and Tom Fawcett

- **Reference Books:**
  1. "Python for Data Analysis" by Wes McKinney
  2. "Introduction to Statistical Learning" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani

SDG Mapping for this Course

SDG	Title	Contribution
3	Good Health and Well-being	Health and nutrition data analysis
4	Quality Education	Data literacy across disciplines
9	Industry, Innovation and Infra	Analytics for innovation
10	Reduced Inequalities	Studying disparities (tribal, gender, region)
13	Climate Action	Climate/agri analytics

Course Title: Translation Studies (Odia)

Code	Course Title	Credit	L-T-P
AE14002	Translation Studies (Odia)	2	2-0-0

NB: Refer to Odia Department

Course Title: Translation Studies (Hindi)

Code	Course Title	Credit	L-T-P
AE14004	Translation Studies (Hindi)	2	2-0-0

NB: Refer to Hindi Department

Course Title: Translation Studies (Sanskrit)

Code	Course Title	Credit	L-T-P
AE14006	Translation Studies (Sanskrit)	2	2-0-0

NB: Refer to Sanskrit Department

Course Title: Translation Studies (Santali)

Code	Course Title	Credit	L-T-P
AE14008	Translation Studies (Santali)	2	2-0-0

NB: Refer to Santali Department

Course Title: Translation Studies (English)

Code	Course Title	Credit	L-T-P
AE14010	Translation Studies (English)	2	2-0-0

NB: Refer to English Department

Course Title: Introduction to Programming using Python

Code	Course Title	Credit	L-T-P
CS15002	Introduction to Programming using Python	3	2-0-1

Course Objectives:

1. To provide students with a foundational understanding of Python programming, enabling them to **develop** problem-solving skills, **enhance** critical thinking, and **apply** analytical reasoning.
2. The course aims to **foster** research-related skills, **encourage** cooperative teamwork, and **cultivate** leadership readiness, while promoting digital literacy, multicultural competence, and effective communication skills.
3. It also seeks to instill environmental awareness, sustainability, and the principles of autonomy, responsibility, accountability, and self-directed lifelong learning.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of Python programming, data types, operators, control structures, functions, modules, file handling, and object-oriented programming.
- **CO2 (Understanding):** Explain and interpret the principles of Python programming, data structures, exception handling, packages, libraries, and programming paradigms used in software development.
- **CO3 (Application):** Apply Python programming concepts, standard libraries, and development tools to design and implement solutions for computational, scientific, and real-world applications.
- **CO4 (Analysis):** Analyze and compare Python programming techniques, algorithms, data structures, and libraries to develop efficient, reliable, and optimized software solutions.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate Python-based applications by integrating appropriate programming techniques, libraries, file processing, and object-oriented principles to solve complex computational problems.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	3	-	2
CO2	-	3	-	3	2	-	-	-	-	-	-	-	3	3	2	-
CO3	-	-	-	3	-	-	3	-	-	-	-	-	3	3	-	2
CO4	-	-	2	-	-	-	-	-	-	-	-	-	2	-	2	-
CO5	-	-	3	-	-	-	-	2	-	-	-	-	3	3	-	3

Course Duration: 34 hours

Course Syllabus:

Unit 1: Introduction to Python [6 Classroom Contact Hours]

Python history and applications, Setting up the Python environment, Basic syntax, variables, and data types

Unit 2: Control Structures and Functions [8 Classroom Contact Hours]

Conditional statements and loops, Writing and calling functions, Understanding scope and namespaces

Unit 3: Data Structures [8 Classroom Contact Hours]

Lists, tuples, sets, and dictionaries, Comprehensions and iterations, Manipulating data structures

Unit 4: Modules and File Handling [7 Classroom Contact Hours]

Importing modules and exploring the standard library, Reading from and writing to files, Exception handling and debugging

Unit 5: Object-Oriented Programming [5 Classroom Contact Hours]

Classes and objects, Inheritance and polymorphism, Special methods and data encapsulation

Total Practical / Lab Experiments: [22 Lab Contact Hours]

1. Write a Python script to display "Hello, World!"
2. Create a program that calculates the factorial of a number
3. Develop a Python program to sort a list of elements
4. Implement a Python function to check if a number is prime
5. Write a Python class representing a bank account
6. Develop a command-line application to manage a to-do list
7. Create a Python script that handles file I/O operations
8. Implement error handling in a Python program
9. Develop a Python program using list comprehensions
10. Write a Python program that uses dictionaries to store student grades
11. Create a Python module for mathematical operations
12. Implement a text-based game using Python
13. Develop a Python program that uses command-line arguments
14. Write a Python script to parse and process CSV files
15. Create a simple web scraper using Python
16. Develop a Python program that uses regular expressions
17. Implement a basic calculator using Python's math module
18. Write a Python program to visualize data using matplotlib

19. Create a Python class hierarchy representing geometric shapes
20. Develop a Python program that interacts with an external API

- **Textbook:**
  1. "Python Crash Course" by Eric Matthes

- **Reference Books:**
  1. "Automate the Boring Stuff with Python" by Al Sweigart
  2. "Learning Python" by Mark Lutz

SWAYAM Courses

- The Joy of Computing using Python - https://onlinecourses.nptel.ac.in/noc24_cs113/preview
- Scientific Computing using Python - https://onlinecourses.nptel.ac.in/noc24_ph36/preview

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Widely used, modern programming foundation
SDG 8	Decent Work and Economic Growth	Python skills for data / software / AI jobs
SDG 9	Industry, Innovation and Infrastructure	Rapid prototyping and analytics for innovation
SDG 13	Climate Action	Potential to work with climate / environment datasets

Course Title: Indian Mathematical Heritage and Knowledge Systems

Code	Course Title	Credit	L-T-P

VA16148	Indian Mathematical Heritage and Knowledge Systems	2	2-0-0

Course Objectives:

1. This course aims to introduce students to the rich heritage of Indian mathematics within the framework of Indian Knowledge Systems (IKS) and to familiarize them with the pioneering contributions of eminent Indian mathematicians to mathematics, astronomy, science, and technology.
2. It develops computational and problem-solving skills through the study of Vedic Mathematics and traditional Indian mathematical methods while fostering an appreciation of their relevance in contemporary education, research, and innovation.
3. The course also promotes ethical values, scientific temper, critical thinking, and the preservation of India's intellectual heritage in alignment with the objectives of NEP 2020.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Explain the historical development of Indian mathematics, including the concepts of the decimal place-value system, zero, Sulba Sutras, and the mathematical traditions of Ancient India.
- **CO2 (Understanding):** Describe the major contributions of eminent Indian mathematicians such as Aryabhata, Brahmagupta, Bhaskaracharya, Mahavira, and Madhava to mathematics and astronomy.
- **CO3 (Application):** Apply the principles of Vedic Mathematics and traditional computational techniques to perform rapid calculations and solve mathematical problems efficiently.
- **CO4 (Analysis):** Analyze the significance of Indian mathematical concepts in modern science, engineering, computational sciences, architecture, astronomy, and calendar systems.
- **CO5 (Synthesis/Evaluation):** Evaluate the relevance of Indian Knowledge Systems in mathematics for contemporary education, research, innovation, and the preservation of India's scientific heritage.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	–	3	1	2	3	1	–	–	2	–	–	1	3	–	2	1
CO2	1	3	2	2	3	2	–	–	2	–	–	–	3	1	2	2
CO3	–	2	1	3	2	1	–	2	2	–	1	–	2	3	2	3
CO4	–	3	2	3	3	2	–	2	2	1	1	1	3	2	3	3
CO5	2	2	2	2	3	3	1	1	3	2	2	2	2	1	2	2

Course Duration: 30 hours

Course Syllabus:

Unit 1: Indian Knowledge Systems and Mathematical Heritage [8 Classroom Contact Hours]
Introduction to Indian Knowledge Systems (IKS): Concept and philosophy, Historical development of mathematics in Ancient India, Mathematics in the Vedas and Vedangas, Sulba Sutras and geometric constructions, Decimal place-value system and invention of zero, Ancient Indian education and mathematical traditions

Unit 2: Contributions of Indian Mathematicians [8 Classroom Contact Hours]
Aryabhata and the Aryabhatiya , Brahmagupta and Brahmasphutasiddhanta , Bhaskaracharya (Bhaskara II) and *Lilavati* , Mahavira and *Ganita Sara Sangraha*, Madhava and the Kerala School of Mathematics, Contributions to algebra, trigonometry, infinite series, astronomy, and computational mathematics

Unit 3: Vedic Mathematics and Traditional Computational Methods [7 Classroom Contact Hours]
Introduction to Vedic Mathematics, Sixteen Sutras and selected Sub-Sutras, Rapid multiplication and division, Squaring, square roots, cubes, and cube roots, Mental arithmetic techniques, Applications in competitive examinations and computational thinking

Unit 4: Modules and File Handling [7 Classroom Contact Hours]
Importing modules and exploring the standard library, Reading from and writing to files, Exception handling and debugging

Unit 5: Contemporary Relevance of Indian Mathematical Knowledge [7 Classroom Contact Hours]

Applications of Indian mathematics in modern science and engineering, Mathematics in temple architecture, art, astronomy, and calendars, Indian mathematical ideas and computational sciences, Indian Knowledge Systems under NEP 2020, Future research opportunities and preservation of India's mathematical heritage

- **Reference Books:**
  1. K.S. Shukla & K.V. Sarma (Eds.) – *Aryabhatiya of Aryabhata* (Critical Edition with English Translation), Indian National Science Academy (INSA), New Delhi.
  2. Bibhutibhusan Datta & Avadhesh Narayan Singh – *History of Hindu Mathematics* (Vol. I & II), Asia Publishing House / Motilal Banarsidass.
  3. Tirthaji Maharaj (Bharati Krishna Tirtha) – *Vedic Mathematics*, Motilal Banarsidass Publishers, New Delhi.
  4. C.K. Raju – *Cultural Foundations of Mathematics: The Nature of Mathematical Proof and the Transmission of the Calculus from India to Europe in the 16th Century*, Pearson Longman.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	**Quality Education**	Promotes understanding of Indian Knowledge Systems, mathematical heritage, logical reasoning, computational thinking, and lifelong learning in accordance with NEP 2020.
SDG 9	**Industry, Innovation and Infrastructure**	Develops analytical and problem-solving skills through Indian mathematical innovations, algebra, trigonometry, infinite series, and their applications in science, engineering, and computational technologies.
SDG 11	**Sustainable Cities and Communities**	Preserves and promotes India's mathematical and cultural heritage, including applications in temple architecture, astronomy, traditional calendars, and indigenous knowledge systems.
SDG 8	**Decent Work and Economic Growth**	Enhances mental arithmetic, computational efficiency, and quantitative aptitude through Vedic Mathematics, improving employability and competitive examination preparedness.
SDG 17	**Partnerships for the Goals**	Encourages interdisciplinary research, collaboration, and global dissemination of Indian mathematical knowledge, fostering academic partnerships and preservation of indigenous scientific heritage.

Course Title: Physics in Indian Knowledge Systems

Code	Course Title	Credit	L-T-P
VA16156	Physics in Indian Knowledge Systems	2	2-0-0

Course Objectives:

1. This course aims to introduce students to selected concepts of physical science and technological practices rooted in Indian Knowledge Systems.
2. It familiarizes them with India's contributions to astronomy, measurement, timekeeping, materials, and traditional technologies while relating these practices to the fundamental principles of modern physics.
3. The course also fosters an appreciation of sustainable, locally adapted indigenous technologies and promotes evidence-based scientific inquiry to understand their relevance in the contemporary world.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Explain the fundamental concepts of Indian Knowledge Systems (IKS), traditional scientific methods, and the contributions of ancient Indian scholars to physics, mathematics, and astronomy.
- **CO2 (Understanding):** Describe the basic principles of Indian astronomy, traditional timekeeping systems, astronomical instruments, and the scientific contributions of Aryabhata, Varahamihira, and Bhaskara.
- **CO3 (Application):** Analyze the physical principles underlying traditional Indian technologies, materials, agricultural tools, water-management systems, pottery, metalworking, and musical instruments.
- **CO4 (Analysis):** Apply the concepts of physics to explain indigenous practices related to energy conservation, traditional architecture, water harvesting, and sustainable resource utilization.

- **CO5 (Synthesis/Evaluation):** Evaluate the relevance of traditional Indian scientific knowledge and indigenous technologies in promoting sustainable development and addressing contemporary environmental challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	3	1	2	3	1	–	–	2	–	–	–	3	–	2	–
CO2	–	3	1	3	3	2	–	1	2	–	–	–	3	1	2	1
CO3	–	3	1	3	3	2	–	1	2	–	1	1	2	3	3	3
CO4	1	2	1	3	3	2	–	2	3	–	2	3	2	2	3	3
CO5	3	2	1	3	3	3	–	1	3	1	2	3	2	2	3	3

Course Duration: 30 Hours

Course Syllabus:

UNIT-I: Introduction to Physics and Indian Knowledge Systems [7 Classroom Contact Hours]

Introduction to Indian Knowledge Systems (IKS); nature and scope of scientific knowledge in Indian traditions; observation, measurement, and experimentation; traditional units of length, mass, and time; overview of contributions of selected Indian scholars to mathematics, astronomy, and physical thought; importance of critically studying historical scientific knowledge using evidence and modern scientific methods.

UNIT-II: Indian Astronomy and Timekeeping [8 Classroom Contact Hours]

Systems of linear equations, Matrix operations and inverse of a matrix, Determinants and applications, Introduction to eigenvalues and eigenvectors, Applications in engineering and data analysis

UNIT-III: Physics in Traditional Technologies and Materials [8 Classroom Contact Hours]

Physics principles in traditional Indian technologies; simple machines and traditional agricultural tools; water-lifting and water-management systems; basic physics of pottery and metalworking; heat transfer in traditional cooking methods; thermal properties of commonly

used natural materials; acoustics of selected Indian and tribal musical instruments; principles of sound, vibration, and resonance in traditional instruments.

UNIT-IV: Indigenous Knowledge, Energy and Sustainable Living [7 Classroom Contact Hours]

Traditional approaches to natural lighting, ventilation, heating, and cooling; basic physics of traditional and vernacular architecture; use of locally available materials; traditional water harvesting and conservation systems; solar energy in everyday practices; energy-efficient traditional practices; indigenous technologies and sustainable use of natural resources; relevance of traditional knowledge to contemporary sustainable living.

- **Reference Books:**

1. Mahadevan, B., Bhat, V. R. & Pavana, N., *Introduction to Indian Knowledge System: Concepts and Applications*, PHI Learning.
2. Subbarayappa, B. V., *Indian Astronomy: An Historical Perspective*, Nehru Centre.
3. Bose, D. M., Sen, S. N. & Subbarayappa, B. V. (Eds.), *A Concise History of Science in India*, Indian National Science Academy.
4. Selected resources on Indian Knowledge Systems from the IKS Division, Ministry of Education, Government of India.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	**Quality Education**	Promotes understanding of Indian Knowledge Systems by integrating traditional scientific knowledge with modern physics, fostering scientific inquiry and critical thinking.
SDG 7	**Affordable and Clean Energy**	Introduces traditional energy-efficient practices, natural lighting, ventilation, and the use of solar energy, encouraging sustainable energy utilization.
SDG 9	**Industry, Innovation and Infrastructure**	Highlights indigenous technologies, traditional engineering practices, materials, and astronomical instruments, inspiring innovation through traditional scientific knowledge.
SDG 11	**Sustainable Cities and Communities**	Explores vernacular architecture, traditional water management, and locally adapted technologies that contribute to sustainable communities and preservation of cultural heritage.

SDG 12	**Responsible Consumption and Production**	Encourages the sustainable use of natural resources, indigenous technologies, and environmentally responsible traditional practices for resource conservation.
SDG 13	**Climate Action**	Emphasizes environmentally sustainable practices, energy conservation, and indigenous knowledge that support climate resilience and sustainable living.

Course Title: Indian Knowledge System and Computing

Code	Course Title	Credit	L-T-P
VA16158	Indian Knowledge System and Computing	2	2-0-0

Course Objectives:

1. Understand the foundations of Indian Knowledge Systems.
2. Recognize India's contributions to mathematics, astronomy, logic, and linguistics.
3. Relate ancient Indian concepts to modern computing technologies.
4. Appreciate the role of Indian knowledge in solving contemporary technological challenges.
5. Develop critical thinking by comparing traditional and modern computational approaches.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of the Indian Knowledge System (IKS), its historical evolution, contributions to mathematics, science, logic, linguistics, and their relevance to computing.
- **CO2 (Understanding):** Explain and interpret the principles of Indian mathematical and computational traditions, ethical values, knowledge representation, and their influence on modern computing and interdisciplinary applications.

- **CO3 (Application):** Apply concepts from the Indian Knowledge System to analyze computational problems, mathematical reasoning, algorithmic thinking, and sustainable technology solutions in diverse application domains.
- **CO4 (Analysis):** Analyze the contributions of ancient Indian scholars and knowledge systems in relation to modern computing, artificial intelligence, data science, cybersecurity, and digital technologies.
- **CO5 (Synthesis/Evaluation):** Evaluate and propose innovative computing solutions by integrating Indian Knowledge System principles, ethical practices, and contemporary technologies to address societal and sustainable development challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	-	-	-	2	1	2	-	–	–	–	2	–	-	–
CO2	2	3	-	1	-	3	2	1	2	–	–	–	2	1	-	-
CO3	2	3	-	2	2	2	2	1	2	–	-	2	2	2	2	1
CO4	2	2	2	3	2	2	2	2	3	–	-	2	2	2	2	2
CO5	2	2	3	2	3	3	2	1	3	2	2	3	3	2	3	2

Course Duration: 30 Hours

Course Syllabus:

UNIT-I: Indian Mathematics and Computing [8 Classroom Contact Hours]

What is Indian Knowledge System, Evolution of science and technology in ancient India, Major knowledge traditions, Nalanda, Takshashila, Vikramashila, Contributions of Indian scholars.

UNIT-II: Indian Astronomy and Timekeeping [8 Classroom Contact Hours]

Decimal number system, Zero and place value, Aryabhata's mathematical contributions, Brahmagupta's rules, Bhaskara's algorithms, Pingala's binary representation and combinatorics, Ancient algorithms and computational thinking

UNIT-III: Sanskrit, Logic and Artificial Intelligence [8 Classroom Contact Hours]
Panini's grammar, Rule-based systems, Formal language theory, Sanskrit and Natural Language Processing, Nyaya logic, Knowledge representation, AI inspired by Indian logic.

UNIT-IV: Computing, Ethics and Sustainable Development [6 Classroom Contact Hours]
Ethics in Indian philosophy, Responsible AI, Indigenous knowledge and digital preservation, AI for Indian languages, Preservation of manuscripts using digital technologies, Future of IKS in Computer Science

- **Text Books**

1. B. Mahadevan, Vinayak Rajat Bhat, and Nagendra Pavana R., Introduction to Indian Knowledge System: Concepts and Applications**,** PHI Learning, 2022.
2. B. Mahadevan and Vinayak Rajat Bhat, Indian Knowledge Systems, PHI Learning.
3. Kapil Kapoor and Avadesh Kumar Singh (Eds.), Indian Knowledge Systems: Knowledge Traditions and Practices, Indian Institute of Advanced Study (IIAS), Shimla.
4. S. Balachandra Rao, Indian Mathematics and Astronomy: Some Landmarks, Jnana Deep Publications.

- **Reference Books:**

1. Michel Danino, The Lost River: On the Trail of the Sarasvati, Penguin Random House India.
2. Subhash Kak, The Astronomical Code of the Rigveda, Munshiram Manoharlal Publishers.
3. Dharampal, Indian Science and Technology in the Eighteenth Century, Other India Press.
4. D. P. Chattopadhyaya (Ed.), History of Science, Philosophy and Culture in Indian Civilization, Centre for Studies in Civilizations.
5. B. B. Chaudhuri (Ed.), History of Science, Philosophy and Culture in Indian Civilization, Pearson/CSC (selected volumes).
6. V. Lakshmikantham and S. Leela, Indian Scientific Heritage, Universities Press.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	**Quality Education**	Promotes interdisciplinary learning by integrating Indian Knowledge Systems with modern computing, fostering critical thinking, innovation, and lifelong learning.
SDG 8	**Decent Work and Economic Growth**	Develops ethical, computational, and problem-solving skills that enhance employability and support innovation-driven economic growth.
SDG 9	**Industry, Innovation and Infrastructure**	Encourages the application of traditional knowledge and computational techniques to develop innovative, sustainable, and technology-driven solutions.
SDG 10	**Reduced Inequalities**	Promotes inclusive education by recognizing diverse knowledge traditions and encouraging equitable access to scientific and technological learning.
SDG 11	**Sustainable Cities and Communities**	Highlights the relevance of indigenous knowledge and computational tools in preserving cultural heritage and supporting sustainable community development.

Course Title: Renewable Energy and Sustainable Technologies

Code	Course Title	Credit	L-T-P
VA16202	Renewable Energy and Sustainable Technologies	2	2-0-0

Course Objectives:

This course aims to introduce students to the rich heritage of Indian mathematics and its significant contributions to the development of mathematical knowledge and scientific thought. It provides an understanding of the pioneering works of renowned Indian mathematicians and their contributions to algebra, geometry, trigonometry, astronomy, and computational mathematics. The course familiarizes students with the principles and techniques of Vedic Mathematics to enhance mental calculation, logical reasoning, and problem-solving abilities. It also highlights the relevance of Indian mathematical knowledge in modern science, engineering, computational sciences, and technology while fostering an appreciation of India's intellectual heritage and encouraging its preservation and application in contemporary education and research.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Explain the various forms of energy, classify conventional and non-conventional energy resources, and describe the principles of sustainable development and clean energy.
- **CO2 (Understanding):** Describe the principles, components, applications, advantages, and limitations of solar thermal and photovoltaic energy systems used in everyday life.
- **CO3 (Application):** Compare the working principles, benefits, limitations, and applications of different renewable energy sources, including wind, hydropower, biomass, geothermal, tidal, and wave energy.
- **CO4 (Analysis):** Apply the concepts of energy conservation, energy efficiency, green technologies, and energy storage to promote sustainable energy management in homes and communities.
- **CO5 (Synthesis/Evaluation):** Evaluate the importance of renewable energy technologies and sustainable practices in addressing environmental challenges and supporting sustainable development.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	3	1	2	3	-	-	-	2	-	-	-	3	-	2	-
CO2	-	3	1	2	3	1	-	-	2	-	-	-	3	1	2	1
CO3	-	3	1	3	2	1	-	2	3	-	1	-	2	3	3	2
CO4	-	2	1	3	3	2	-	2	3	-	1	1	2	2	3	3
CO5	2	2	1	3	3	2	-	1	3	1	2	2	2	2	3	3

Course Duration: 30 Hours

Course Syllabus:

UNIT-I: Energy Resources and Sustainability [7 Classroom Contact Hours]

Introduction to energy and its forms; conventional and non-conventional energy sources; renewable and non-renewable resources; fossil fuels and their environmental impacts; need for renewable energy; basic concept of sustainable development; role of clean energy in sustainable living.

UNIT-II: Solar Energy [8 Classroom Contact Hours]

Sun as a source of energy; solar radiation—basic concept; solar thermal and solar photovoltaic energy; basic principle of solar cells; solar panels; solar cooker; solar water heater; advantages and limitations of solar energy; common applications of solar energy in daily life.

UNIT-III: Renewable Energy Sources [8 Classroom Contact Hours]
Wind energy—basic principle and wind turbines; hydropower—principle and types; biomass and biogas energy; basic concepts of geothermal, tidal and wave energy; advantages, limitations and applications of different renewable energy sources.

UNIT-IV: Energy Conservation and Sustainable Technologies [7 Classroom Contact Hours]
Energy conservation and energy efficiency; energy-efficient lighting and appliances; basic concept of energy audit; green buildings; electric vehicles—basic concept; energy storage and batteries—basic introduction; smart energy use; role of individuals and communities in energy conservation and sustainable development.

- **Reference Books:**

1. Rai, G. D., Non-Conventional Energy Sources, Khanna Publishers.
2. Khan, B. H., Non-Conventional Energy Resources, McGraw Hill Education.
3. Twidell, J. & Weir, T., Renewable Energy Resources, Routledge.
4. Boyle, G., Renewable Energy: Power for a Sustainable Future, Oxford University Press.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Develops fundamental knowledge of energy resources, renewable energy technologies, energy conservation, and sustainable development while promoting scientific awareness and responsible decision-making.
SDG 7	Affordable and Clean Energy	Provides comprehensive understanding of renewable energy sources including solar, wind, hydropower, biomass, geothermal, tidal, and wave energy, emphasizing clean, affordable, and sustainable energy solutions.
SDG 9	Industry, Innovation and Infrastructure	Introduces modern energy technologies such as solar photovoltaic systems, energy storage, green buildings, electric vehicles, and energy-efficient technologies that support sustainable industrial development and innovation.

SDG 11	Sustainable Cities and Communities	Promotes sustainable urban development through energy-efficient buildings, smart energy use, clean transportation, and community participation in energy conservation.
SDG 12	Responsible Consumption and Production	Encourages efficient utilization of energy resources, energy audits, conservation practices, and responsible consumption through the adoption of sustainable technologies.
SDG 13	Climate Action	Highlights the environmental impacts of fossil fuels, the importance of renewable energy, clean energy technologies, and energy conservation strategies to mitigate climate change and reduce greenhouse gas emissions.

Course Title: Water Pollution and Treatment Technologies

Code	Course Title	Credit	L-T-P
VA16204	Water Pollution and Treatment Technologies	2	2-0-0

Course Objectives:

This course aims to provide students with a fundamental understanding of water resources, water quality, and the importance of safe and sustainable water use. It introduces the causes, effects, and control measures of water pollution, along with the basic principles of water treatment and purification technologies. The course develops awareness of water conservation techniques, including rainwater harvesting, groundwater recharge, and water reuse for sustainable management. It also highlights the role of traditional and indigenous water conservation practices in India and encourages students to adopt responsible water management practices for environmental protection and sustainable development.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Explain the sources, properties, and quality parameters of water, and describe their importance in ensuring safe and sustainable water resources.

- **CO2 (Understanding):** Describe the causes, types, and impacts of water pollution on human health, aquatic ecosystems, and the environment, along with measures for its prevention and control.
- **CO3 (Application):** Analyze the principles and applications of various water treatment and purification methods used for drinking water and wastewater management.
- **CO4 (Analysis):** Apply the concepts of water conservation, rainwater harvesting, groundwater recharge, and water reuse for sustainable management of water resources.
- **CO5 (Synthesis/Evaluation):** Evaluate the significance of sustainable water management practices, including traditional and indigenous water conservation methods, in addressing present and future water challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	–	3	1	2	–	1	–	–	2	–	–	1	3	1	2	1
CO2	1	3	1	3	–	2	–	–	2	–	1	3	3	2	2	3
CO3	–	3	1	3	–	3	–	2	2	–	1	3	3	3	3	3
CO4	1	2	1	3	1	2	1	1	3	1	3	3	2	2	3	3
CO5	3	2	1	3	2	3	–	1	3	1	3	3	2	2	3	3

Course Duration: 30 Hours

Course Syllabus:

UNIT-I: Water Resources and Water Quality [7 Classroom Contact Hours]

Sources and importance of water; surface water and groundwater; basic physical and chemical properties of water; water quality parameters—pH, turbidity, hardness, dissolved oxygen (DO), BOD and COD; importance of clean and safe water.

UNIT-II: Water Pollution [8 Classroom Contact Hours]

Meaning and types of water pollution; sources—domestic, industrial and agricultural; common water pollutants; effects of water pollution on human health, aquatic life and environment; groundwater contamination; prevention and control of water pollution.

UNIT-III: Water Treatment Methods [8 Classroom Contact Hours]

Basic principles of water treatment; screening, sedimentation, coagulation and filtration; disinfection methods—chlorination, UV treatment and ozonation; basic concept of reverse osmosis (RO); domestic water purification methods; introduction to wastewater and sewage treatment.

UNIT-IV: Water Conservation and Sustainable Management [7 Classroom Contact Hours]
Importance of water conservation; rainwater harvesting; groundwater recharge; reuse and recycling of water; traditional and indigenous water conservation practices in India; sustainable water management; individual and community roles in protecting water resources.

- **Reference Books:**

1. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. *Environmental Engineering*. McGraw-Hill Education.
2. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. *Chemistry for Environmental Engineering and Science*. McGraw-Hill Education..
3. Rao, C. S. *Environmental Pollution Control Engineering*. New Age International (P) Ltd., New Delhi.
4. P. Aarne Vesilind, Susan M. Morgan, & Lauren G. Heine. *Introduction to Environmental Engineering*. Cengage Learning.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	**Quality Education**	Develops fundamental knowledge of water resources, water quality, pollution, treatment technologies, and sustainable water management while promoting environmental awareness and scientific literacy.
SDG 6	**Clean Water and Sanitation**	Provides understanding of water quality assessment, water pollution, water treatment methods, wastewater management, rainwater harvesting, groundwater recharge, and safe access to clean water.
SDG 11	**Sustainable Cities and Communities**	Promotes sustainable urban and rural water management through water conservation, reuse, recycling, and community participation in protecting water resources.
SDG 12	**Responsible Consumption and Production**	Encourages efficient use of water resources, water conservation, recycling, and sustainable consumption practices to minimize water wastage and environmental impact.

SDG 13	**Climate Action**	Highlights the role of sustainable water resource management, groundwater conservation, and climate-resilient water practices in addressing the impacts of climate change.
SDG 15	**Life on Land**	Emphasizes the protection of freshwater ecosystems, prevention of groundwater contamination, and conservation of natural water resources to support terrestrial biodiversity and ecosystem health.

Course Title: Introduction to Methods of Applied Mathematics

Code	Course Title	Credit	L-T-P
VA16302	Introduction to Methods of Applied Mathematics	2	2-0-0

Course Objectives:

1. To introduce fundamental mathematical tools used in real-world problem solving
2. To develop analytical and quantitative thinking skills
3. To apply mathematical methods to physical, biological, economic, and engineering problems
4. To enhance problem-solving and modeling skills

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Remember the concepts, and basic ideas.
- **CO2 (Understanding):** Formulate simple mathematical models.
- **CO3 (Application):** Apply mathematical techniques to practical problems.
- **CO4 (Analysis):** Solve basic differential equations and matrix problems.
- **CO5 (Synthesis/Evaluation):** Use mathematical tools in applied domains.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4

CO1	3	3	-	2	-	-	-	-	-	-	-	-	1	1	3	1
CO2	2	3	-	3	3	-	-	-	-	-	-	-	-	2	-	3
CO3	-	2	-	3	-	3	-	-	-	-	-	-	3	3	2	-
CO4	-	3	2	–	-	-	3	-	-	2	-	-	2	-	-	2
CO5	-	2	3	2	-	-	-	3	-	-	-	-	-	2	-2	2

Course Duration: 30 Hours

Course Syllabus:

UNIT-I Mathematical Modeling [6 Classroom Contact Hours]

Meaning and importance of applied mathematics, Mathematical modeling: formulation and validation, Linear and nonlinear models, Applications in population growth, finance, and science

UNIT-II Linear Algebra Techniques [6 Classroom Contact Hours]

Systems of linear equations, Matrix operations and inverse of a matrix, Determinants and applications, Introduction to eigenvalues and eigenvectors, Applications in engineering and data analysis

UNIT-III Calculus for Applications [5 Classroom Contact Hours]

Functions and limits, Differentiation and its applications, Maxima and minima, Optimization problems in economics and science

UNIT-IV Differential Equations [3 Classroom Contact Hours]

Formation of differential equations, First-order differential equations, Applications: growth and decay, Newton's law of cooling, Introduction to second-order differential equations

UNIT V:Basics of Probability and Statistics [3 Classroom Contact Hours]

Elementary probability concepts, Random variables and distributions, Mean, variance, and standard deviation, Correlation and regression, Applications in real-life data analysis

- **Textbook:**

1."Kreyszig, E. – *Advanced Engineering Mathematics*

- **Reference Books:**

1. Stewart, J. – *Calculus* “Learning Python” by Mark Lutz
2. Edwards & Penney – *Differential Equations and Linear Algebra*
3. Gupta, S.C. & Kapoor, V.K. – *Fundamentals of Mathematical Statistics*

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Develops mathematical reasoning, analytical thinking, and problem-solving skills that support quality education and lifelong learning.
SDG 8	Decent Work and Economic Growth	Equips students with quantitative and analytical skills required in science, engineering, finance, and technology-driven industries.
SDG 9	Industry, Innovation and Infrastructure	Provides mathematical tools for modeling, optimization, simulation, and innovation in engineering, scientific research, and industrial applications.
SDG 13	Climate Action	Facilitates mathematical modeling and data analysis for climate studies, environmental monitoring, and prediction of natural phenomena.
SDG 17	Partnerships for the Goals	Encourages interdisciplinary collaboration by applying mathematical methods to solve real-world scientific and societal problems.

Course Title: Flutter Application Development

Code	Course Title	Credit	L-T-P
VA16394	Flutter Application Development	2	1-0-1

Course Objectives:

1. To empower students with the skills to design, develop, and deploy cross-platform mobile applications using Flutter.
2. Fostering critical thinking, problem-solving, and digital literacy aligned with current industry standards.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of Flutter, Dart programming, widget architecture, user interface components, and cross-platform mobile application development.
- **CO2 (Understanding):** Explain and interpret the principles of Flutter widgets, state management, navigation, layouts, asynchronous programming, and application lifecycle.
- **CO3 (Application):** Apply Flutter development tools, Dart programming, and third-party packages to design and implement cross-platform mobile applications with interactive user interfaces and backend integration.
- **CO4 (Analysis):** Analyze and compare Flutter architectures, state management techniques, performance optimization methods, and testing strategies to develop efficient, scalable, and maintainable mobile applications.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate feature-rich, secure, and responsive Flutter applications by integrating APIs, databases, cloud services, and modern development practices to address real-world mobile computing challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-
CO2	-	3	-	3	3	-	-	-	-	-	-	-	-	2	-	3
CO3	-	-	-	3	-	3	-	-	-	-	-	-	3	-	2	-
CO4	-	-	2	-	-	-	3	-	-	-	-	-	2	-	-	2
CO5	-	-	3	-	-	-	-	3	-	-	-	-	-	2	-2	2

Course Duration: 30 Hours

Course Syllabus:

Unit 1: Introduction to Flutter and Dart [8 Classroom Contact Hours]

Flutter architecture, Dart programming language, Setting up the development environment , Basic widgets, Layout design

Unit 2: State Management and Navigation [8 Classroom Contact Hours]

Stateful vs. stateless widgets, State management techniques, Navigation and routing, Data passing between screens.

Unit 3: Advanced Flutter Concepts [7 Classroom Contact Hours]

Asynchronous programming in Dart, Advanced UI components, third-party integrations, Package management, Deployment strategies.

Total Practical / Lab Experiments: [15 Lab Contact Hours]

1. Set up a Flutter development environment and create a “Hello World” application.
2. Design a login screen with form validation.
3. Implement a to-do list application with state management.
4. Create a multi-page application with bottom navigation.
5. Integrate a REST API to fetch and display data in a Flutter app.
6. Install and configure the Flutter SDK, Android Studio/VS Code, emulator, and create a basic Flutter application.
7. Design a user interface using Flutter widgets such as Text, Container, Row, Column, Image, and Button.
8. Develop responsive layouts using ListView, GridView, Stack, and Expanded widgets.
9. Implement navigation between multiple screens using named routes and the Navigator widget.
10. Design input forms with TextFormField, validation, checkboxes, radio buttons, dropdowns, and date/time pickers.
11. Develop stateful applications using StatefulWidget and implement state management using Provider or Riverpod.
12. Integrate local data storage using SQLite or Shared Preferences for persistent data management.

13. Develop a Flutter application that consumes REST APIs using the http package and displays JSON data.
14. Integrate Firebase Authentication and Cloud Firestore to develop a user login and data management application.
15. Develop and deploy a mini-project (e.g., To-Do List, Expense Tracker, Student Management System, Weather App, or E-Commerce App) incorporating responsive UI, navigation, local/cloud database, and API integration.

- **Textbook:**
  1. "Beginning Flutter: A Hands-On Guide to App Development" by Marco L. Napoli

- **Reference Books:**
  1. "Flutter for Beginners: An introductory guide to building cross-platform mobile applications with Flutter and Dart 2" by Alessandro Biessek
  2. "Flutter Recipes: Mobile Development Solutions for iOS and Android" by Fu Cheng

SDG Mapping for this Course

SDG	Rationale
SDG 4	High-quality technical education
SDG 8	Python skills for data / software / AI jobs
SDG 9	Innovation in visualization and simulation
SDG 11	Sustainable Cities and Communities
SDG 13	Potential to work with climate / environment datasets

Course Title: Chemistry of Medicines and Everyday Health

Code	Course Title	Credit	L-T-P
VA16432	Chemistry of Medicines and Everyday Health	2	1-0-1

Course Objectives:

The course aims to introduce students to the basic chemistry of medicines and their vital role in maintaining human health and healthcare systems. It provides fundamental knowledge of commonly used medicines, their classification, and their therapeutic functions. The course also helps students understand the importance of antiseptics, disinfectants, antibiotics, vitamins, and minerals in the prevention and treatment of diseases. In addition, it creates awareness about the safe, rational, and responsible use of medicines, emphasizing the importance of avoiding misuse and promoting good health practices.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Explain the basic concepts of medicinal chemistry, sources of medicines, different dosage forms, and the role of chemistry in the development of medicines.
- **CO2 (Understanding):** Describe the classification, functions, and appropriate uses of commonly used medicines, including analgesics, antipyretics, antacids, antihistamines, and antibiotics, while distinguishing between generic and branded medicines.
- **CO3 (Application):** Analyze the role of antiseptics, disinfectants, soaps, detergents, sanitizers, vitamins, minerals, and antioxidants in promoting health, hygiene, and disease prevention.
- **CO4 (Analysis):** Apply the principles of safe medicine use, including correct dosage, proper storage, interpretation of medicine labels, and appropriate disposal of expired or unused medicines.
- **CO5 (Synthesis/Evaluation):** Evaluate the importance of responsible medication practices, the risks of self-medication and antibiotic resistance, and the role of chemistry in improving healthcare and quality of life.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	–	3	1	2	–	1	–	–	2	–	–	–	3	2	2	1
CO2	1	3	1	2	–	1	–	–	2	–	1	–	3	3	2	2
CO3	2	3	1	3	–	2	–	–	2	–	1	2	3	3	3	2

CO4	3	2	1	3	–	2	–	–	3	–	3	2	2	3	3	3
CO5	3	2	1	3	–	3	–	–	3	1	3	2	2	2	3	3

Course Duration: 30 Hours

Course Syllabus:

Unit 1: Introduction to Chemistry of Medicines [7 Classroom Contact Hours]

Introduction to medicines and drugs; sources of medicines—natural and synthetic; basic concept of medicinal chemistry; active ingredients and excipients; different forms of medicines—tablets, capsules, syrups, creams and injections; basic concept of drug action; importance of chemistry in the development of medicines.

Unit 2: Common Medicines and Their Uses [8 Classroom Contact Hours]

Introduction and general uses of analgesics and antipyretics; antacids; antihistamines; basic concept of antibiotics and their role; examples of commonly used medicines such as aspirin and paracetamol; importance of correct dosage; generic and branded medicines—basic concept; over-the-counter and prescription medicines.

Unit 3: Chemistry for Health and Hygiene [8 Classroom Contact Hours]

Antiseptics and disinfectants—basic concepts and differences; common examples and their uses; soaps and detergents in personal hygiene; sanitizers and their basic composition; vitamins and minerals and their importance for health; basic concepts of antioxidants; role of chemistry in maintaining health and hygiene.

Unit 4: Safe Use of Medicines [7 Classroom Contact Hours]

Importance of proper use and storage of medicines; expiry date and medicine labels; basic awareness of side effects and allergic reactions; risks of self-medication; misuse and overuse of medicines; basic awareness of antibiotic resistance; importance of consulting qualified healthcare professionals; proper disposal of unused and expired medicines; role of chemistry in improving healthcare and quality of life.

- **Reference Books:**

1. NCERT, *Chemistry, Class XII, Part II*, Unit on Chemistry in Everyday Life.

2. Patrick, G. L., *An Introduction to Medicinal Chemistry*, Oxford University Press.
3. Chatwal, G. R., *Medicinal Chemistry*, Himalaya Publishing House.
4. Selected educational resources on medicines, health, and pharmaceutical chemistry.

SDG Mapping for this Course

SDG	Rationale
SDG 4	High-quality technical education
SDG 8	Python skills for data / software / AI jobs
SDG 9	Innovation in visualization and simulation
SDG 11	Sustainable Cities and Communities
SDG 13	Potential to work with climate / environment datasets

SEMESTER – III

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS20001	Discrete Mathematics for Computer Science	3	1	0	4
	CS20003	Design and Analysis of Algorithms	3	0	1	4
Minor (Opted by students from other departments)	CS22001	Analysis and Design of Algorithms	3	1	0	4
Multidisciplinary (Opted by students from other departments)	CS23001	Introduction to Artificial Intelligence and	2	1	0	3

		Machine Learning				
Ability Enhancement Course (AEC)	AE24001	Communicative English	2	0	0	2
Skill Enhancement Course (Lab) or (any other course from Arts or Science stream offered by University)	CS25001	Prompt Engineering and AI Tools	2	0	1	3
	CS25003	Digital Storytelling	2	0	1	3
	CS25005	Design Thinking	2	0	1	3
	CS25007	Social Media Analytics	2	0	1	3
		Total				**20**

Course Title: Discrete Mathematics for Computer Science

Code	Course Title	Credit	L-T-P
CS20001	Discrete Mathematics for Computer Science	4	3-1-0

Course Objectives:

1. To provide students with a foundational understanding of discrete mathematics as it applies to computer science
2. Enabling them to develop problem-solving skills, critical thinking, and analytical reasoning in line with UGC NET and GATE standards.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of discrete mathematics, including sets, relations, functions, logic, proof techniques, and algebraic structures.
- **CO2 (Understanding):** Explain and interpret the principles of combinatorics, recurrence relations, graph theory, trees, Boolean algebra, and discrete mathematical reasoning.
- **CO3 (Application):** Apply discrete mathematical concepts, counting techniques, graph algorithms, and algebraic methods to solve computational and real-world problems.
- **CO4 (Analysis):** Analyze and compare discrete mathematical structures, graph models, combinatorial techniques, and algebraic systems to identify appropriate solutions for complex computational problems.
- **CO5 (Synthesis/Evaluation):** Design, evaluate, and optimize mathematical models using discrete structures, graph theory, combinatorics, and algebraic techniques for applications in computer science, algorithms, networks, and cryptography.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	3	-	-	-	-	-	-	-	-	3	2	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	3	-	2
CO3	-	-	-	3	-	-	-	-	-	-	-	-	3	2	-	-
CO4	-	-	2	-	3	-	-	-	-	-	-	-	2	-	2	-
CO5	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Duration: 45 hours

Course Syllabus:

Unit 1: Fundamental Concepts [9 Classroom Contact Hours]

Introduction to discrete mathematics, Sets, relations, and functions, Logic and proofs

Unit 2: Combinatorics [9 Classroom Contact Hours]

Basic counting techniques, Permutations and combinations, Pigeonhole principle

Unit 3: Graph Theory [9 Classroom Contact Hours]

Introduction to graphs, Trees and connectivity, Eulerian and Hamiltonian paths

Unit 4: Algebraic Structures [9 Classroom Contact Hours]

Groups, rings, and fields, Finite fields and error-correcting codes, Polynomials and their roots

Unit 5: Advanced Topics [9 Classroom Contact Hours]

Introduction to computability and complexity, Algorithms and their complexity, Recurrence relations and generating functions

- **Textbook**:
  1. "Discrete Mathematics and Its Applications" by Kenneth H. Rosen
- **Reference Books**:
  1. "Discrete Mathematics" by Seymour Lipschutz
  2. "Concrete Mathematics: A Foundation for Computer Science" by Ronald L. Graham, Donald E. Knuth, and Oren Patashnik

SWAYAM Course

Discrete Mathematics - https://onlinecourses.nptel.ac.in/noc24_cs98/preview

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Logical foundations for CS, algorithms, security
SDG 9	Industry, Innovation and Infrastructure	Basis for robust digital systems

Course Title: Design and Analysis of Algorithms

Code	Course Title	Credit	L-T-P
CS20003	Design and Analysis of Algorithms	4	3-0-1

Course Objectives:

1. To equip students with the ability to design, analyze, and implement algorithms efficiently.
2. Fostering skills in complex problem-solving, critical thinking, and analytical reasoning in accordance with UGC NET and GATE standards.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of algorithm design techniques, asymptotic analysis, complexity measures, recursion, and algorithmic paradigms.
- **CO2 (Understanding):** Explain and interpret the principles of divide-and-conquer, greedy, dynamic programming, backtracking, branch-and-bound, and graph algorithms.
- **CO3 (Application):** Apply algorithm design techniques and appropriate data structures to develop efficient solutions for computational and optimization problems.
- **CO4 (Analysis):** Analyze and compare algorithms with respect to time complexity, space complexity, correctness, and computational efficiency to determine the most suitable approach for a given problem.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate optimized algorithms by integrating advanced algorithmic paradigms and data structures to solve complex real-world computational problems.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	3	-	-	-	-	-	-	-	-	-	3	3	-	-
CO2	-	3	-	3	2	-	-	-	-	-	-	-	2	-	2	2
CO3	-	-	-	3	1	-	-	-	-	-	-	-	-	2	-	2
CO4	-	-	2	-	-	-	3	-	-	-	-	-	2	2	-	-
CO5	-	-	3	-	-	-	-	2	-	-	-	-	-	-	2	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Algorithm Fundamentals [8 Classroom Contact Hours]

Introduction to algorithms and complexity, Asymptotic analysis, Recurrence relations and master theorem, Elementary data structures review

Unit 2: Design Techniques [10 Classroom Contact Hours]

Divide and conquer, Dynamic programming, Greedy algorithms, Backtracking

Unit 3: Graph Algorithms [9 Classroom Contact Hours]

Graph traversal (BFS and DFS), Shortest paths (Dijkstra's and Bellman-Ford), Minimum spanning trees (Kruskal's and Prim's), Network flows and matching

Unit 4: Advanced Data Structures [12 Classroom Contact Hours]

Heaps and priority queues, Disjoint sets, Balanced search trees (AVL, Red-Black), Hash tables

Unit 5: Complexity Theory [6 Classroom Contact Hours]

Time and space complexity classes, P vs NP problem, NP-complete and NP-hard problems, Approximation algorithms

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Implement merge sort and analyze its complexity.
2. Develop a dynamic programming solution for the knapsack problem.
3. Design a greedy algorithm for the activity selection problem.
4. Write a backtracking solution for the N-Queen problem.
5. Implement BFS and DFS for graph traversal.
6. Develop Dijkstra's algorithm for shortest paths.
7. Create Kruskal's algorithm for minimum spanning trees.
8. Write a program for disjoint set operations.
9. Implement AVL tree insertion and deletion.
10. Develop a hash table with chaining for collision resolution.
11. Write a program for matrix-chain multiplication using dynamic programming.
12. Implement Huffman coding using a greedy approach.
13. Develop a program for the traveling salesman problem using approximation algorithms.
14. Write a program for the Ford-Fulkerson method for network flows.
15. Implement a red-black tree.

16. Develop a program for solving recurrence relations using the master theorem.
17. Write a program for the Bellman-Ford algorithm.
18. Implement a priority queue using heaps.
19. Develop a program for graph coloring using backtracking.
20. Write a program to detect cycles in a graph using disjoint sets.

- **Textbook**:
  1. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein

- **Reference Books**:
  1. "Algorithm Design" by Jon Kleinberg and Éva Tardos
  2. "Algorithms" by Robert Sedgewick and Kevin Wayne

SWAYAM Course

Design and Analysis of Algorithms - https://onlinecourses.nptel.ac.in/noc24_cs79/preview

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Advanced algorithmic literacy
SDG 8	Decent Work and Economic Growth	Core competence for software/tech roles
SDG 9	Industry, Innovation and Infrastructure	Efficient computation in large-scale systems
SDG 12	Responsible Consumption and Production	Optimization for resource efficiency

Course Title: Analysis and Design of Algorithms

Code	Course Title	Credit	L-T-P
CS22001	Analysis and Design of Algorithms	4	3-1-0

Course Objectives:

This course introduces students to the principles of algorithm analysis and design. It develops algorithmic thinking, problem-solving, and complexity analysis skills through fundamental

design techniques. Students learn to design efficient algorithms, evaluate their performance, and apply appropriate strategies to solve computational problems, preparing them for advanced computer science and software development.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of algorithm design techniques, asymptotic analysis, complexity measures, recursion, and algorithmic paradigms.
- **CO2 (Understanding):** Explain and interpret the principles of algorithm analysis, time and space complexity, divide-and-conquer, greedy method, dynamic programming, backtracking, branch and bound, and graph algorithms.
- **CO3 (Application):** Apply appropriate algorithm design techniques and data structures to develop efficient solutions for computational problems and implement algorithms using suitable programming tools.
- **CO4 (Analysis):** Analyze the correctness, efficiency, and computational complexity of algorithms, compare alternative solutions, and select appropriate algorithms for different problem domains.
- **CO5 (Evaluation/Create):** Design, evaluate, and optimize algorithms for real-world applications by applying suitable algorithmic paradigms and complexity analysis while following standard problem-solving and programming practices.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	-	3	-	-	-	-	-	-	-	-	-	2	3	-	-
CO2	-	3	-	2	2	-	-	-	-	-	-	-	2	-	2	2
CO3	-	-	-	2	1	-	-	-	-	-	-	-	-	2	-	2
CO4	-	-	2	-	-	-	3	-	-	-	-	-	2	2	-	-
CO5	-	-	2	-	-	-	-	2	-	-	-	-	-	-	2	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Algorithm Fundamentals [9 Classroom Contact Hours]

Introduction to algorithms and their characteristics, time and space complexity, asymptotic notations (Big O, Big Omega, Big Theta), best, average, and worst-case analysis, recurrence relations: Master Theorem (basic applications).

Unit 2: Algorithm Design Techniques [11 Classroom Contact Hours]

Fundamental algorithm design paradigms including divide and conquer, greedy method, dynamic programming, binary search, merge sort, quick sort, Huffman coding, knapsack problem, longest common subsequence.

Unit 3: Searching, Sorting, and Graph Algorithms [10 Classroom Contact Hours]

Searching algorithms: linear search and binary search. Sorting algorithms: bubble sort, selection sort, insertion sort, merge sort, quick sort, and heap sort. Introduction to graphs, graph representations, graph traversal techniques (Breadth First Search and Depth First Search).

Unit 4: Advanced Algorithm Concepts [9 Classroom Contact Hours]

Algorithm optimization techniques, approximation algorithms (introduction), string matching algorithms, introduction to NP-complete and NP-hard problems.

Unit 5: Algorithm Applications and Emerging Trends [6 Classroom Contact Hours]

Applications of algorithms in artificial intelligence, machine learning, cyber security, cloud computing, networking, data science, bioinformatics, and business analytics.

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Complexity analysis of simple algorithms.
2. Implementation of searching algorithms.
3. Implementation of sorting algorithms.
4. Divide and conquer algorithms (Binary Search, Merge Sort, Quick Sort).
5. Greedy algorithms (Activity Selection, Huffman Coding).
6. Dynamic programming algorithms (Longest Common Subsequence, Knapsack).
7. Backtracking problems (N-Queens, Sudoku Solver).
8. Graph traversal using BFS and DFS.

- **Textbook**:

1. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein

- **Reference Books**:
  1. "Algorithm Design" by Jon Kleinberg and Éva Tardos
  2. "Algorithms" by Robert Sedgewick and Kevin Wayne

SWAYAM Course

Design and Analysis of Algorithms - https://onlinecourses.nptel.ac.in/noc24_cs79/preview

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Advanced algorithmic literacy
SDG 8	Decent Work and Economic Growth	Core competence for software/tech roles
SDG 9	Industry, Innovation and Infrastructure	Efficient computation in large-scale systems
SDG 12	Responsible Consumption and Production	Optimization for resource efficiency

Introduction to Artificial Intelligence and Machine Learning

Code	Course Title	Credit	L-T-P
CS23001	Introduction to Artificial Intelligence and Machine Learning	4	3-1-0

Course Objective:

Develop a foundational understanding of AI and ML concepts, algorithms, and applications to improve decision-making and problem-solving in a business context.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of Artificial Intelligence (AI), Machine Learning (ML), business analytics, intelligent systems, and the applications of AI and ML in management.

- **CO2 (Understanding):** Explain and interpret the principles of supervised and unsupervised learning, predictive analytics, decision support systems, ethical AI, algorithmic bias, and responsible AI practices in business environments.
- **CO3 (Application):** Apply AI and ML algorithms, business analytics tools, and digital technologies to solve real-world problems in marketing, finance, human resource management, operations, and strategic decision-making.
- **CO4 (Analysis):** Analyze and compare AI and ML models, business use cases, ethical considerations, performance metrics, and implementation strategies to identify appropriate solutions for management challenges.
- **CO5 (Synthesis/Evaluation):** Design, evaluate, and present AI- and ML-based business solutions by integrating analytical techniques, ethical principles, emerging technologies, and research findings to support innovation, sustainable business practices, and informed decision-making.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	2	3	-	3
CO2	-	-	-	3	3	-	-	-	-	-	-	-	2	3	3	-
CO3	-	-	-	3	3	-	-	3	-	-	-	-	2	3	3	2
CO4	-	-	3	-	-	-	3	-	-	-	-	-	2	-	3	-
CO5	-	-	-	-	-	-	-	3	-	-	-	-	2	2	-	3

Course Duration: 45 Hours

Course Syllabus:

Unit 1: Introduction to Artificial Intelligence [9 Classroom Contact Hours]

What is AI? History and philosophical foundations, Intelligent agents and problem-solving approaches in AI, Applications of AI in various industries. (Case studies relevant to Management)

Readings:

- [Article] A. McAfee & E. Brynjolfsson (2017). Machine, Platform, Crowd: Harnessing the Power of a Digital Future. W. W. Norton & Company. (Ch. 2)

Unit 2: Introduction to Machine Learning [9 Classroom Contact Hours]

Supervised learning: Regression and Classification algorithms (Linear Regression, Decision Trees), Unsupervised learning: Techniques for data exploration and clustering (K-Means clustering, Principal Component Analysis), Model evaluation metrics for supervised and unsupervised learning.

Readings:

- [Online Resource] Machine Learning Crash Course by Google: https://developers.google.com/machine-learning/crash-course

Unit 3: Applications of Machine Learning in Management [9 Classroom Contact Hours]

Machine Learning in Marketing: Customer segmentation, targeted advertising, and recommendation systems, Machine Learning in Finance: Fraud detection, credit risk assessment, and algorithmic trading, Machine Learning in Operations: Supply chain management, demand forecasting, and resource optimization.

Readings:

- [Research Paper] Example research paper on a specific application of ML in Management (chosen by instructor).

Unit 4: Ethical Considerations and Societal Impact of AI and ML [9 Classroom Contact Hours]

Algorithmic bias and fairness in AI and ML systems, Explain ability and transparency of AI and ML models, The future of work and job displacement due to AI and ML.

Readings:

- [Article] E. Brynjolfsson & A. McAfee (2021). The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. W. W. Norton & Company. (Ch. 10)
- [Report] The Ethics of Artificial Intelligence by The European Commission's High-Level Expert Group on Artificial Intelligence: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM%3A2021%3A205%3AFIN

Unit 5: Future Trends and Business Opportunities in AI and ML [9 Classroom Contact Hours]

Emerging areas in AI and ML: Deep Learning, Natural Language Processing, Computer Vision, The role of AI and ML in business strategy and innovation.

Readings:

- Articles on recent advancements and business applications of AI and ML (chosen by instructor).

- **Reference Books:**

1. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig. [Pearson Education]
2. Machine Learning for Dummies by John Paul Mueller & Luca Massaron. [Wiley]
3. Hands-On Machine Learning with Scikit-Learn,

SDG Mapping for this Course

SDG	Title	Contribution
4	Quality Education	AI awareness for non-CS students
8	Decent Work and Economic Growth	Future skill orientation
9	Industry, Innovation and Infra	Intelligent systems overview
10	Reduced Inequalities	Using / critiquing AI for inclusion
13	Climate Action	Examples: precision agri, climate models

Course Title: Communicative English

Code	Course Title	Credit	L-T-P
AE24001	Communicative English	2	2-0-0

NB: Refer to English Department

Course Title: Prompt Engineering and AI Tools

Code	Course Title	Credit	L-T-P
CS25001	Prompt Engineering and AI Tools	3	2-0-1

Course Objectives:

1. To equip students with the skills to design, develop, and optimize prompts for AI tools, enabling them to solve complex problems and apply critical thinking.
2. The course will enhance analytical reasoning, research-related skills, and digital literacy, while promoting cooperative teamwork, leadership readiness, multicultural competence, and effective communication skills.
3. It also aims to instil environmental awareness, sustainability, and the principles of autonomy, responsibility, accountability, and self-directed lifelong learning.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of prompt engineering, generative artificial intelligence, large language models (LLMs), prompt structures, and AI-assisted content generation.
- **CO2 (Understanding):** Explain and interpret the principles of prompt design techniques, prompt optimization, context engineering, AI model behavior, and ethical considerations in generative AI.
- **CO3 (Application):** Apply prompt engineering techniques and AI tools to design, refine, and optimize prompts for tasks such as content generation, code generation, data analysis, summarization, translation, and problem-solving.
- **CO4 (Analysis):** Analyze and compare different prompting strategies, AI model responses, evaluation metrics, and optimization methods to improve the accuracy, reliability, and efficiency of AI-generated outputs.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate effective, ethical, inclusive, and sustainable AI-driven solutions by integrating advanced prompt engineering techniques, responsible AI practices, and domain-specific knowledge to address real-world challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	3	-	-	-	-	-	-	-	-	-	2	-	2	2
CO2	-	3	-	3	2	-	-	-	-	-	-	-	-	2	-	-

CO3	-	-	-	3	-	-	3	-	-	-	-	-	2	2	-	2
CO4	-	-	3	-	-	-	-	-	-	-	-	-	-	2	2	-
CO5	-	-	3	-	-	-	-	-	-	-	-	3	2	2	-	2

Course Duration: 34 hours

Course Syllabus:

Unit 1: Introduction to Prompt Engineering [6 Classroom Contact Hours]

Fundamentals of AI and machine learning, The role of prompts in AI interactions, Basic techniques for prompt engineering

Unit 2: Advanced Prompt Design [8 Classroom Contact Hours]

Designing prompts for complex tasks, Optimization strategies for prompt effectiveness, Case studies of successful prompt engineering

Unit 3: AI Tools and Technologies [7 Classroom Contact Hours]

Overview of current AI tools and platforms, Integration of AI tools with prompt engineering, Ethical considerations in AI tool deployment

Unit 4: Prompt Engineering for Language Models [8 Classroom Contact Hours]

Techniques for natural language processing (NLP), Crafting prompts for language generation and understanding, Evaluating language model responses

Unit 5: Capstone Projects and Future Directions [6 Classroom Contact Hours]

Hands-on projects with real-world AI applications, Emerging trends in prompt engineering and AI tools, Future challenges and opportunities in the field

Total Practical / Lab Experiments: [22 Lab Contact Hours]

1. Create a basic prompt for a chatbot interaction
2. Optimize a prompt for better user engagement
3. Analyze the effectiveness of prompts in a given scenario
4. Design a prompt for a language translation task
5. Evaluate the response quality of different AI models
6. Develop a prompt for an image recognition task
7. Integrate an AI tool with a custom prompt system
8. Craft prompts for sentiment analysis

9. Implement a prompt-based recommendation system
10. Create a series of prompts for a storytelling AI
11. Optimize prompts for diverse cultural contexts
12. Design a user study to test prompt clarity
13. Develop a prompt for an environmental sustainability app
14. Analyze the bias in AI responses to prompts
15. Create a prompt for a self-learning AI application
16. Develop a prompt for a problem-solving AI
17. Craft a prompt for a creative writing AI tool
18. Evaluate the ethical implications of prompt engineering
19. Design a prompt for an AI-based educational tool
20. Create a capstone project proposal for a novel AI application

- **Textbook:**
  1. "Prompt Engineering for Generative AI" by James Phoenix, Mike Taylor O'Reilly Media, Inc.
- **Reference Books:**
  1. Kore, Akshay. Designing Human-Centric AI Experiences. Jan. 2022, https://doi.org/10.1007/978-1-4842-8088-1.
  2. "Natural Language Processing in Action" by Lane, Howard, and Hapke

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	AI-supported learning and content creation
SDG 8	Decent Work and Economic Growth	Future-ready skills in AI-augmented workplaces
SDG 9	Industry, Innovation and Infrastructure	Applied generative AI for innovation
SDG 12	Responsible Consumption and Production	Responsible, ethical AI tool usage
SDG 16	Peace, Justice and Strong Institutions	Critical literacy around AI, misinformation

Course Title: Digital Storytelling

Code	Course Title	Credit	L-T-P
CS25003	Digital Storytelling	3	2-0-1

Course Objectives:

1. To develop the ability to craft and convey compelling digital narratives that integrates computer science concepts.
2. Fostering enhanced problem-solving, critical thinking, and digital literacy.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of digital storytelling, multimedia communication, narrative structures, digital content creation, and storytelling principles.
- **CO2 (Understanding):** Explain and interpret the principles of storyboarding, multimedia design, visual communication, audio-visual editing, audience engagement, and digital storytelling techniques.
- **CO3 (Application):** Apply digital storytelling tools, multimedia technologies, research techniques, and communication strategies to design and develop engaging digital stories for educational, technical, and societal applications.
- **CO4 (Analysis):** Analyze and compare storytelling frameworks, multimedia elements, digital platforms, and communication strategies to create effective, inclusive, and impactful digital narratives.
- **CO5 (Synthesis/Evaluation):** Design, produce, and evaluate creative digital storytelling projects by integrating multimedia content, research findings, ethical communication practices, and digital technologies to effectively communicate complex ideas to diverse audiences.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	-	-	-	3	-	-	-	-	-	-	-	-	2	2	1	2
CO2	-	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3	-	-	-	-	-	3	-	-	-	-	-	-	2	-	2	3
CO4	-	-	-	-	-	-	3	-	-	3	-	-	2	-	2	-
CO5	-	-	3	-	-	-	-	3	-	-	-	-	1	2	-	2

Course Duration: 34 hours

Course Syllabus:

UNIT 1: Foundations of Digital Storytelling [6 Classroom Contact Hours]

Topics: Introduction to digital storytelling, narrative theory, storyboarding for digital media.

UNIT 2: Storytelling with Data [7 Classroom Contact Hours]

Topics: Data visualization, interactive narratives, storytelling with code.

UNIT 3: Interactive Storytelling [7 Classroom Contact Hours]

Topics: Interactive fiction, game design principles, branching narratives.

UNIT 4: Multimedia Narratives [7 Classroom Contact Hours]

Topics: Audio-visual storytelling, animation, digital audio and video editing.

UNIT 5: Digital Publishing and Sharing [7 Classroom Contact Hours]

Topics: Web publishing, social media storytelling, digital rights management.

Total Practical / Lab Experiments: [22 Lab Contact Hours]

1. Explore multimedia authoring tools such as Canva, Adobe Express, Powtoon, or Microsoft Sway.
2. Develop a storyboard and script for a digital story on a chosen theme.
3. Create and edit images, illustrations, and infographics using image editing software.
4. Record narration and background audio using Audacity or similar software and apply noise reduction and audio enhancement techniques.
5. Create a short video by combining images, video clips, narration, background music, and transitions using OpenShot, Shotcut, Filmora, or Adobe Premiere Rush.

6. Design simple animated scenes using Powtoon, Animaker, Canva, or Adobe Express.
7. Apply titles, captions, subtitles, typography, and visual effects to enhance storytelling.
8. Develop an interactive digital story with branching narratives using Twine, Genially, or similar platforms.
9. Create visual stories using charts, maps, or infographics to effectively communicate data.
10. Design short digital stories optimized for social media platforms such as Instagram, YouTube Shorts, or Facebook.
11. Produce a 3–5 minute audio story or podcast incorporating narration, music, and sound effects.
12. Create a digital story using copyright-free media, proper citations, captions, and accessibility features.
13. Collaboratively develop a multimedia digital story using online collaboration tools.
14. Publish the completed digital story on a web platform or Learning Management System (LMS) and present it to the audience.
15. Design and develop a comprehensive digital storytelling project integrating text, graphics, audio, video, animation, and interactive elements on a socially relevant, educational, or technical theme.

- **Textbook:**
  1. "Digital Storytelling in the Classroom: New Media Pathways to Literacy, Learning, and Creativity" by Jason Ohler

- **Reference Books:**
  1. "Digital Storytelling: Capturing Lives, Creating Community" by Joe Lambert
  2. "The New Digital Storytelling: Creating Narratives with New Media" by Bryan Alexander

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Develops digital literacy, creativity, communication, critical thinking, and multimedia content creation skills to enhance technology-enabled learning.

SDG 9	Industry, Innovation and Infrastructure	Encourages innovation through the use of digital media, multimedia authoring tools, animation, and interactive storytelling technologies.
SDG 11	Sustainable Cities and Communities	Promotes the preservation and dissemination of cultural heritage, local traditions, and community awareness through digital storytelling.
SDG 16	Peace, Justice and Strong Institutions	Fosters ethical digital communication, media literacy, responsible digital citizenship, and awareness of social issues through impactful storytelling.
SDG 17	Partnerships for the Goals	Supports collaborative learning and teamwork by enabling students to create digital stories through group projects and community engagement.

Design Thinking

Code	Course Title	Credit	L-T-P
CS25005	Design Thinking	3	2-0-1

Course Objectives:

1. To develop a deep understanding of design thinking principles and their application in computer science to foster innovation.
2. Problem-solving, and user-centered design.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of design thinking, innovation, user-centered design, problem identification, ideation, and the design thinking process.
- **CO2 (Understanding):** Explain and interpret the principles of empathy, problem definition, brainstorming, prototyping, testing, and iterative design for developing innovative solutions.

- **CO3 (Application):** Apply design thinking methodologies, creative problem-solving techniques, user research methods, and digital tools to develop innovative and user-centric solutions for real-world problems.
- **CO4 (Analysis):** Analyze and compare user needs, design alternatives, prototypes, and feedback to evaluate and refine design solutions using analytical reasoning and collaborative approaches.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate innovative solutions by integrating design thinking principles, sustainability considerations, digital technologies, ethical practices, and effective communication to address societal and technological challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO1	-	-	-	3	-	-	-	-	-	-	-	-	2	-	-	-
CO2	-	-	-	3	2	-	-	-	-	-	-	-	-	3	-	2
CO3	-	-	-	-	-	3	-	-	-	-	-	-	2	3	-	-
CO4	-	-	-	-	-	-	3	-	-	3	-	-	-	-	2	-
CO5	-	-	3	-	-	-	-	3	-	-	-	-	2	-	-	2

Course Duration: 34 hours

Course Syllabus:

Unit 1: Introduction to Design Thinking [8 Classroom Contact Hours]

Topics: History of design thinking, principles, empathy in design.

Unit 2: Ideation and Prototyping [7 Classroom Contact Hours]

Topics: Brainstorming techniques, rapid prototyping, user feedback loops.

Unit 3: User-Centered Design [7 Classroom Contact Hours]

Topics: User research methods, persona creation, user journey mapping.

Unit 4: Iterative Design and Testing [7 Classroom Contact Hours]

Topics: Iterative development, usability testing, A/B testing.

Unit 5: Implementing Design Solutions [5 Classroom Contact Hours]

Topics: Integration of design solutions, project management, sustainability in design.

Total Practical / Lab Experiments: [22 Lab Contact Hours]

1. Create a persona for a new software application.
2. Map the user journey for an existing computer science tool.
3. Develop a prototype for a user interface based on user research.
4. Conduct usability testing on a computer science application.
5. Iterate on a design solution based on user feedback.
6. Identify and define a real-world problem through user observation and need identification.
7. Conduct empathy interviews and create user personas to understand user needs and challenges.
8. Develop an empathy map and customer journey map for the selected problem.
9. Formulate a clear problem statement using the "How Might We" (HMW) technique.
10. Generate multiple innovative solutions using brainstorming, mind mapping, and SCAMPER techniques.

- **Textbook:**
  1. "Design Thinking: Integrating Innovation, Customer Experience, and Brand Value" by Thomas Lockwood

- **Reference Books:**
  1. "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation" by Tim Brown
  2. "The Design of Everyday Things" by Don Norman

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution

SDG 4	Quality Education	Develops creative problem-solving, critical thinking, and innovation skills through human-centered design.
SDG 8	Decent Work and Economic Growth	Promotes entrepreneurship and employability by fostering innovative solution development.
SDG 9	Industry, Innovation and Infrastructure	Encourages the design of innovative and technology-driven solutions for real-world challenges.
SDG 11	Sustainable Cities and Communities	Supports the creation of inclusive and sustainable solutions for community development.
SDG 12	Responsible Consumption and Production	Promotes sustainable product and service design with efficient use of resources.

Course Title: Social Media Analytics

Code	Course Title	Credit	L-T-P
CS25007	Social Media Analytics	3	2-0-1

Course Objectives:

1. To equip students with the ability to analyze and interpret social media data, enabling them to synthesize insights for strategic decision-making.
2. This course aims to enhance critical thinking, analytical reasoning, and research-related skills, while fostering cooperative teamwork, leadership readiness, and digital literacy.
3. It also encourages multicultural competence, effective communication, environmental awareness, and the principles of autonomy, responsibility, accountability, and self-directed lifelong learning.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of social media analytics, social media platforms, digital marketing metrics, user engagement, and data collection techniques.
- **CO2 (Understanding):** Explain and interpret the principles of social media monitoring, sentiment analysis, audience segmentation, campaign analytics, key performance indicators (KPIs), and social media analytics tools.

- **CO3 (Application):** Apply social media analytics tools, data visualization techniques, statistical methods, and digital marketing strategies to analyze user behavior and develop effective social media campaigns.
- **CO4 (Analysis):** Analyze and compare social media datasets, engagement metrics, campaign performance, sentiment analysis results, and audience insights to support data-driven decision-making and optimize digital strategies.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate sustainable and inclusive social media strategies by integrating analytics, visualization, ethical practices, multicultural perspectives, and emerging digital technologies to achieve organizational objectives**.**

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	3	-	-	-	-	-	-	-	-	2	-	-	-
CO2	-	-	-	2	-	3	-	3	-	-	-	-	-	2	-	-
CO3	-	-	-	-	-	-	3	-	-	3	-	-	-	-	-	2
CO4	-	-	3	-	-	-	-	-	-	-	-	-	-	1	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	2

Course Duration: 34 hours

Course Syllabus:

Unit 1: Foundations of Social Media Analytics

Introduction to social media platforms, Overview of social media metrics and KPIs, Basics of data collection and privacy considerations

Unit 2: Data Analysis and Visualization

Techniques for analyzing social media data, Tools for data visualization, Interpreting and reporting data findings

Unit 3: Social Media Research Methods

Qualitative and quantitative research in social media, Sentiment analysis and opinion mining, Ethical considerations in social media research

Unit 4: Social Media Strategy and Campaigns

Developing a social media strategy, Planning and executing social media campaigns, Measuring campaign effectiveness

Unit 5: Advanced Topics in Social Media Analytics

Predictive analytics in social media, Machine learning applications, Emerging trends and future directions

Total Practical / Lab Experiments: [22 Lab Contact Hours]

1. Analyze the audience demographics of a social media platform
2. Create visualizations of social media engagement metrics
3. Conduct sentiment analysis on a set of social media posts
4. Develop a social media campaign for a product launch
5. Measure the ROI of a social media marketing strategy
6. Perform competitor analysis using social media data
7. Design a dashboard for real-time social media monitoring
8. Implement A/B testing for social media content
9. Explore the use of chatbots in customer service on social media
10. Research the impact of social media on brand reputation
11. Study the effect of influencers on consumer behavior
12. Analyze the spread of information on social networks
13. Evaluate the ethical implications of social media data mining
14. Propose a strategy for crisis management on social media
15. Investigate the role of social media in political campaigns
16. Explore the use of artificial intelligence in social media analytics
17. Assess the sustainability practices of companies on social media
18. Develop a plan for personal branding on social media
19. Conduct a multilingual analysis of social media content
20. Create a predictive model for social media trends

- **Textbook:**
    1. “Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media” by Matthew Ganis & Avinash Kohirkar

- **Reference Books:**
  1. "Social Media Mining: An Introduction" by Reza Zafarani, Mohammad Ali Abbasi, & Huan Liu
  2. "Analyzing Social Media Networks with NodeXL: Insights from a Connected World" by Derek Hansen, Ben Shneiderman, & Marc A. Smith

SWAYAM Courses

1. Social Networks - https://onlinecourses.nptel.ac.in/noc24_cs120/preview
2. Social Network Analysis - https://onlinecourses.nptel.ac.in/noc24_cs90/preview

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Develops data analytics, digital literacy, and critical thinking skills through the analysis of social media data.
SDG 9	Industry, Innovation and Infrastructure	Promotes the use of data analytics, AI, and machine learning for extracting insights from social media platforms.
SDG 10	Reduced Inequalities	Enables the analysis of online discourse to identify trends related to inclusion, diversity, and social equity.
SDG 17	Partnerships for the Goals	Facilitates collaborative research and data sharing to address societal challenges using social media analytics.

SEMESTER – IV

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS20002	Computer Systems and Architecture	3	1	0	4
	CS20004	Operating Systems	3	0	1	4
	CS20006	Database Management Systems	3	0	1	4
	CS20008	Cyber Security	2	0	0	2
Minor (Opted by students from other departments)	CS22002	Database Systems	3	0	1	4
Ability Enhancement Course (AEC)	AE24002	Professional Communication	2	0	0	2

		Total				**20**

Course Title: Computer Systems and Architecture

Code	Course Title	Credit	L-T-P
CS20002	Computer Systems and Architecture	4	3-1-0

Course Objectives:

1. To provide students with foundational knowledge and skills in computer systems and architecture, aligning with UGC NET and GATE standards,
2. To enable them to design, analyze, and optimize computer systems for a variety of applications.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of computer organization, computer architecture, instruction sets, processor organization, and system components.
- **CO2 (Understanding):** Explain and interpret the principles of data path, control unit design, instruction execution, arithmetic and logic operations, and processor performance.
- **CO3 (Application):** Apply concepts of memory hierarchy, cache memory, virtual memory, input/output organization, and processor architecture to design and implement efficient computer systems.
- **CO4 (Analysis):** Analyze and compare different processor architectures, memory management techniques, pipelining, input/output systems, and parallel processing architectures to determine suitable solutions for performance optimization.
- **CO5 (Synthesis/Evaluation):** Design, evaluate, and optimize computer architectures by integrating advanced processor organization, memory hierarchy, pipelining, parallelism, and input/output mechanisms to improve system performance and efficiency.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO2	-	-	3	3	-	-	-	-	-	-	-	-	2	2	-	-
CO3	-	-	-	-	-	-	-	2	-	-	-	-	2	2	-	-
CO4	-	-	3	-	-	-	3	-	-	-	-	-	-	-	2	2
CO5	-	-	3	-	-	-	-	-	-	-	-	3	2	-	-	2

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Computer Systems [9 Classroom Contact Hours]

Basics of computer architecture, Data representation and arithmetic, Introduction to assembly language

Unit 2: Data Path and Control [9 Classroom Contact Hours]

CPU organization and design, Instruction set architecture, Data path design and control signals

Unit 3: Memory Hierarchy [9 Classroom Contact Hours]

Cache memory and performance, Virtual memory and paging, Secondary storage

Unit 4: Input/Output Systems [9 Classroom Contact Hours]

I/O interfaces and buses, Interrupts and direct memory access, Performance issues in I/O

Unit 5: Parallelism and Advanced Architectures [9 Classroom Contact Hours]

Instruction-level parallelism, Multiprocessor systems and interconnects, Emerging trends in computer architecture

- **Textbook**:
  1. “Computer Organization and Architecture” by William Stallings

- **Reference Books**:
  1. "Digital Design and Computer Architecture" by Sarah Harris and David Harris
  2. "Structured Computer Organization" by Andrew S. Tanenbaum

SWAYAM Course

Computer Architecture - https://onlinecourses.nptel.ac.in/noc24_cs83/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Core CS systems literacy
SDG 7	Affordable and Clean Energy	Efficient architectures, low-power systems
SDG 9	Industry, Innovation and Infrastructure	Robust, scalable digital infra
SDG 12	Responsible Consumption and Production	Hardware efficiency, lifecycle awareness

Course Title: Operating Systems

Code	Course Title	Credit	L-T-P
CS20004	Operating Systems	4	3-0-1

Course Objectives:

1. To provide students with a comprehensive understanding of operating system concepts, design, and implementation.
2. Enabling them to apply this knowledge to complex problem-solving, critical thinking, and analytical reasoning in line with UGC NET and GATE standards.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of operating systems, system architecture, processes, threads, process scheduling, and operating system services.

- **CO2 (Understanding):** Explain and interpret the principles of process synchronization, deadlock handling, CPU scheduling, inter-process communication, and resource management.
- **CO3 (Application):** Apply memory management techniques, file systems, storage management, and process management concepts to design and implement efficient operating system solutions.
- **CO4 (Analysis):** Analyze and compare process scheduling algorithms, synchronization mechanisms, memory allocation strategies, storage management techniques, and operating system security models to optimize system performance.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate efficient, secure, and reliable operating system solutions by integrating process management, memory management, file systems, storage organization, and security mechanisms to address real-world computing challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

SDG Mapping for this Course

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO2	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-	-
CO3	-	-	-	3	-	-	-	2	-	-	-	-	-	2	-	2
CO4	-	-	-	-	-	-	3	-	-	-	-	-	2	-	2	-
CO5	-	-	3	-	-	-	-	-	-	-	-	2	-	2	-	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Operating Systems [8 Classroom Contact Hours]

Overview of operating systems, System structures and operations, Process and thread management

Unit 2: Process Synchronization and Communication [9 Classroom Contact Hours]

Critical sections and synchronization mechanisms, Deadlocks: prevention, avoidance, and recovery, Inter-process communication techniques

Unit 3: Memory Management [9 Classroom Contact Hours]

Memory hierarchy and partitioning, Paging, segmentation, and virtual memory concepts, Memory allocation and garbage collection

Unit 4: Storage Management [10 Classroom Contact Hours]

File systems and directory structures, Disk scheduling and management, RAID levels and data reliability

Unit 5: Security and Protection [9 Classroom Contact Hours]

Principles of secure operating system design, Access control, authentication, and security policies, Case studies on operating system vulnerabilities and defenses

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Simulate process scheduling using round-robin algorithm.
2. Implement deadlock detection and recovery algorithm.
3. Write a program for producer-consumer problem using semaphores.
4. Develop a page replacement algorithm simulation.
5. Create a file system simulation with basic operations.
6. Simulate disk scheduling using the SCAN algorithm.
7. Implement a simple shell with process creation and management.
8. Write a program for memory allocation using best-fit strategy.
9. Develop a program for inter-process communication using pipes.
10. Create a user authentication system using password hashing.
11. Simulate a RAID configuration for data redundancy.
12. Implement a program for bank's banker algorithm for deadlock avoidance.
13. Write a program for virtual memory management using paging.
14. Develop a program to simulate access control mechanisms in an OS.
15. Create a simulation of a memory garbage collection algorithm.
16. Implement a program to demonstrate the use of mutex locks.
17. Write a program for file compression and decompression.
18. Develop a program to simulate a secure login protocol.
19. Create a simulation of CPU scheduling using priority queues.

20. Implement a program to demonstrate the concept of thread synchronization.

- **Textbook**:

1. "Operating System Concepts" by Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne

- **Reference Books**:

1. "Modern Operating Systems" by Andrew S. Tanenbaum
2. "Linux Kernel Development" by Robert Love

SWAYM Course

Operating System Fundamentals - https://onlinecourses.nptel.ac.in/noc24_cs108/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Fundamental systems knowledge
SDG 8	Decent Work and Economic Growth	Employability in systems/software roles
SDG 9	Industry, Innovation and Infrastructure	Reliable, secure multi-user systems
SDG 16	Peace, Justice and Strong Institutions	Security, integrity, auditability of data

Course Title: Database Management Systems

Code	Course Title	Credit	L-T-P
CS20006	Database Management Systems	4	3-0-1

Course Objectives:

1. To provide students with a comprehensive understanding of database management systems, encompassing theoretical foundations, practical skills, and advanced topics in line with UGC NET and GATE requirements.
2. The course aims to equip students with the ability to design, implement, and manage databases effectively, while also fostering critical thinking, problem-solving, and research skills.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of database systems, data models, database architecture, entity-relationship modeling, and relational databases.
- **CO2 (Understanding):** Explain and interpret the principles of relational algebra, relational calculus, normalization, indexing, SQL, and transaction management.
- **CO3 (Application):** Apply database design principles, SQL queries, normalization techniques, indexing methods, and transaction processing to develop and manage efficient database systems.
- **CO4 (Analysis):** Analyze and compare database schemas, normalization techniques, indexing strategies, query optimization methods, concurrency control, and recovery mechanisms to improve database performance and reliability.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate secure, scalable, and efficient database systems by integrating data modeling, SQL programming, transaction management, concurrency control, and database security techniques for real-world applications.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	2	3
CO2	-	3	3	-	-	-	-	-	-	-	-	-	-	2	-	2
CO3	-	-	-	3	-	2	-	2	-	-	-	-	2	-	2	2
CO4	-	-	-	-	-	-	3	-	-	3	-	-	-	2	-	2
CO5	-	-	3	-	-	-	-	-	-	-	-	-	2	-	2	3

Course Duration: 45 Hours

Course Syllabus:

Unit 1: Database Design and ER-Model [9 Classroom Contact Hours]

Introduction to databases and their applications, ER-model: entities, relationships, and constraints, Enhanced ER-model features

Unit 2: Relational Model and SQL [9 Classroom Contact Hours]

Relational model concepts, SQL: queries, updates, and database design, Integrity constraints and normalization

Unit 3: Storage and Indexing [10 Classroom Contact Hours]
Disk storage, file structures, and hashing, Indexing: B-trees and B+ trees, Query processing and optimization

Unit 4: Transaction Management [9 Classroom Contact Hours]
Transaction concepts and ACID properties, Concurrency control and recovery techniques, SQL transaction management

Unit 5: Advanced Database Topics [8 Classroom Contact Hours]
NoSQL databases and Big Data, Data warehousing and data mining, Database security and authorization

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Design an ER diagram for a library management system.
2. Implement SQL queries for a university database.
3. Write a program to simulate B+ tree indexing.
4. Develop a transaction management system with concurrency control.
5. Create a NoSQL database for a social media application.
6. Implement a data warehouse using star schema.
7. Write SQL scripts for database backup and recovery.
8. Develop a program for deadlock detection and resolution.
9. Simulate query optimization techniques.
10. Implement a hash-based indexing mechanism.
11. Create a distributed database system.
12. Write a program for implementing integrity constraints.
13. Develop a simple object-relational mapping system.
14. Simulate the ACID properties in a database transaction.
15. Implement a basic information retrieval system.
16. Write a program for normalization of database tables.
17. Develop a program to demonstrate the use of triggers and stored procedures.

18. Create a data mining application for customer segmentation.
19. Implement a file organization technique for efficient data access.
20. Write a program to simulate the operations of a Big Data platform.

- **Textbook**:
  1. "Database System Concepts" by Abraham Silberschatz, Henry F. Korth, and S. Sudarshan

- **Reference Books**:
  1. "Fundamentals of Database Systems" by Ramez Elmasri and Shamkant B. Navathe
  2. "Database Management Systems" by Raghu Ramakrishnan and Johannes Gehrke

SWAYAM Course

Data Base Management System - https://onlinecourses.nptel.ac.in/noc24_cs75/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Data literacy and information management
SDG 9	Industry, Innovation and Infrastructure	Core for information systems
SDG 10	Reduced Inequalities	Designing inclusive socio-economic databases
SDG 16	Peace, Justice and Strong Institutions	Evidence-based governance, record-keeping

Course Title: Cyber Security

Code	Course Title	Credit	L-T-P
CS20008	Cyber Security	2	2-0-0

Course Objectives:

1. Understand the cyber security threat landscape.
2. Develop a deeper understanding and familiarity with various types of cyberattacks, cybercrimes, vulnerabilities and remedies thereto.
3. Analyse and evaluate existing legal framework and laws on cyber security.
4. Analyse and evaluate the digital payment system security and remedial measures against digital payment frauds.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of cyber security, cyber threats, cyber-attacks, information security principles, and the cyber threat landscape.
- **CO2 (Understanding):** Explain and interpret the principles of common cyber-attacks, cybercrimes, network vulnerabilities, malware, security mechanisms, and preventive measures to protect digital systems.
- **CO3 (Application):** Apply cyber security principles, legal frameworks, security tools, and best practices to identify, mitigate, and respond to cyber threats, cybercrimes, and digital security incidents.
- **CO4 (Analysis):** Analyze and compare cyber security laws, digital payment security mechanisms, cyber risk management strategies, and fraud prevention techniques to evaluate their effectiveness in securing digital transactions and information systems.
- **CO5 (Synthesis/Evaluation):** Design, evaluate, and recommend comprehensive cyber security strategies by integrating legal, ethical, technical, and organizational measures to protect information assets, digital payment systems, and critical infrastructure from emerging cyber threats.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-
CO2	-	3	2	2	-	-	-	-	-	-	-	-	2	-	2	2
CO3	-	-	-	3	-	2	-	-	-	-	-	-	3	2	-	-
CO4	-	-	-	-	-	-	3	-	-	-	-	-	2	-	3	2
CO5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Course Duration: 30 Hours

Course Syllabus:

Unit I: Introduction to Cyber security [6 Classroom Contact Hours]

Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security

Unit II: Cyber-crime and Cyber law [6 Classroom Contact Hours]

Classification of cyber-crimes, Common cyber-crimes- cyber-crime targeting computers and mobiles, cyber-crime against women and children, financial frauds, social engineering attacks, malware and ransom-ware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber-crimes.

Unit III: Social Media Overview and Security [6 Classroom Contact Hours]

Introduction to Social networks: Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media.

Unit IV: E-Commerce and Digital Payments [6 Classroom Contact Hours]

Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures.

Unit V: Digital Devices Security, Tools and Technologies for Cyber Security [6 Classroom Contact Hours]

End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy,

Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security.

- **Text Books:**

1. Cyber security For Dummies Steinberg, J. (2019). *Cyber security For Dummies*. Wiley Publishing.
2. Cryptography and Network Security: Principles and Practice Stallings, W. (2022). *Cryptography and Network Security: Principles and Practice* (8th ed.). Pearson.
3. Network Security Essentials Stallings, W. (2017). *Network Security Essentials: Applications and Standards* (6th ed.). Pearson.
4. The Complete Ethical Hacking Book *The Complete Ethical Hacking Book*. BPB Publications.

- **Reference Books:**

1. Cyber security Essentials Brooks, C. J., Grow, C., Craig, P., & Short, D. (2018). *Cyber security Essentials*. Wiley.
2. CompTIA Security+ Study Guide Chapple, M., & Seidl, D. (2021). *CompTIA Security+ Study Guide: Exam SY0-601* (8th ed.). Wiley.
3. Gray Hat Hacking: The Ethical Hacker's Handbook Harper, A., Harris, S., Ness, J., Eagle, C., Lenkey, G., & Williams, T. (2022). *Gray Hat Hacking: The Ethical Hacker's Handbook* (7th ed.). McGraw-Hill.
4. Introduction to Cyber Security Shinde, A. (2021). *Introduction to Cyber Security: Guide to the World of Cyber Security*. Notion Press.

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Digital/cyber literacy
SDG 5	Gender Equality	Safer digital spaces for women and girls
SDG 9	Industry, Innovation and Infrastructure	Secure digital infrastructure
SDG 16	Peace, Justice and Strong Institutions	Cyber law, digital rights, secure governance

Course Title: Database Systems

Code	Course Title	Credit	L-T-P
CS22002	Database Systems	4	3-0-1

Course Objectives:

This course introduces students to the fundamental concepts of database systems, data modeling, and database design. It develops skills in designing relational databases, writing SQL queries, ensuring data integrity, and understanding database management concepts. The course prepares students to develop efficient database applications for diverse real-world and interdisciplinary domains.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of database systems, data models, database architecture, relational databases, entities, attributes, relationships, keys, and normalization.
- **CO2 (Understanding):** Explain and interpret the principles of relational database design, entity-relationship (ER) modeling, normalization, Structured Query Language (SQL), transaction management, and database security.
- **CO3 (Application):** Apply database design principles and SQL commands to create, retrieve, update, delete, and manage data in relational database systems for real-world applications.
- **CO4 (Analysis):** Analyze database requirements, design normalized database schemas, formulate complex SQL queries, and evaluate database performance, integrity, and consistency.
- **CO5 (Evaluation/Create):** Design, implement, and manage relational database applications by applying appropriate database concepts, query optimization techniques, and security measures while following standard database design practices.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	-	-	-	-	-	-	-	-	-	-	-	2	-	2	2
CO2	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO3	-	-	-	3	-	2	-	2	-	-	-	-	2	-	2	2
CO4	-	-	-	-	-	-	3	-	-	3	-	-	-	2	-	2
CO5	-	-	3	-	-	-	1	-	-	-	-	-	2	-	2	2

Course Duration: 45 Hours

Course Syllabus:

Unit 1: Introduction to Database Systems [8 Classroom Contact Hours]

Introduction to database systems, characteristics of databases, database users, advantages of DBMS over file processing systems, database architecture (three-schema architecture), data models, database management system (DBMS).

Unit 2: Database Design and Data Modeling [10 Classroom Contact Hours]

Entity-Relationship (ER) model, entities, attributes, relationships, constraints, ER diagrams, mapping ER diagrams to relational schemas, keys (primary, foreign, candidate, and composite keys), relational model, integrity constraints, functional dependencies, normalization (1NF, 2NF, 3NF, and BCNF), and database design principles.

Unit 3: Structured Query Language (SQL) [10 Classroom Contact Hours]

Introduction to SQL, data definition language (DDL), data manipulation language (DML), data control language (DCL), and transaction control language (TCL). SQL commands including **CREATE, ALTER, DROP, INSERT, UPDATE, DELETE, SELECT**, filtering, sorting, aggregate functions, grouping, joins.

Unit 4: Transaction Management and Database Security [9 Classroom Contact Hours]

Introduction to transaction processing, ACID properties, transaction states, concurrency control concepts, locking mechanisms, deadlocks (basic concepts).

Unit 5: Advanced Database Concepts and Applications [8 Classroom Contact Hours]

Introduction to distributed databases, cloud databases, NoSQL databases, data warehousing, data mining concepts, database administration, database performance tuning, database

applications in healthcare, banking, e-commerce, education, business, and emerging trends in database technologies.

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Installation and configuration of MySQL/PostgreSQL.
2. Creating databases and tables using SQL.
3. Implementing constraints and keys.
4. SQL queries using SELECT, WHERE, ORDER BY, GROUP BY, and HAVING.
5. SQL joins and subqueries.
6. Aggregate functions and views.
7. Database normalization exercises.
8. Transaction and security commands.
9. Mini database application development.
10. Database performance and backup exercises.

- **Textbook**:
  1. "Database System Concepts" by Abraham Silberschatz, Henry F. Korth, and S. Sudarshan

- **Reference Books**:
  3. "Fundamentals of Database Systems" by Ramez Elmasri and Shamkant B. Navathe
  4. "Database Management Systems" by Raghu Ramakrishnan and Johannes Gehrke

SWAYAM Course

Data Base Management System - https://onlinecourses.nptel.ac.in/noc24_cs75/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Data literacy and information management
SDG 9	Industry, Innovation and Infrastructure	Core for information systems
SDG 10	Reduced Inequalities	Designing inclusive socio-economic databases
SDG 16	Peace, Justice and Strong Institutions	Evidence-based governance, record-keeping

Course Title: Professional Communication

Code	Course Title	Credit	L-T-P
AE24002	Professional Communication	2	2-0-0

NB: Refer to English Department

SEMESTER – V (Single Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS30001	Object Oriented Programming in Java	3	0	1	4
	CS30003	Software Engineering	3	1	0	4
	CS30005	Computer Networks	3	1	0	4
Minor (Opted by students from	CS32001	Computer Networks	3	1	0	4

other departments)		Fundamentals				
Electives (Choose ONE)	CS30051	Artificial Intelligence	3	0	1	4
	CS30053	Data Science	3	0	1	4
Internship	IP37081	Internship	0	0	2	2
		Total				**22**

Course Title: Object Oriented Programming in Java

Code	Course Title	Credit	L-T-P
CS30001	Object Oriented Programming in Java	4	3-0-1

Course Objectives:

1. To provide students with an in-depth understanding of object-oriented programming principles using Java.
2. Enabling them to develop robust, secure, and maintainable software solutions that address complex problems.
3. Enhance digital literacy in line with UGC NET and GATE standards.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of object-oriented programming, Java syntax, data types, classes, objects, inheritance, polymorphism, encapsulation, and abstraction.
- **CO2 (Understanding):** Explain and interpret the principles of exception handling, multithreading, file handling, packages, interfaces, collections, and input/output streams in Java.
- **CO3 (Application):** Apply object-oriented programming concepts and Java libraries to design and implement robust applications with graphical user interfaces, file processing, and database connectivity.

- **CO4 (Analysis):** Analyze and compare object-oriented design principles, exception handling mechanisms, multithreading techniques, GUI frameworks, and Java collections to develop efficient, secure, and maintainable software solutions.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate object-oriented Java applications by integrating advanced Java features, GUI development, exception handling, multithreading, database connectivity, and software engineering principles to solve real-world problems.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	2	3	-	3
CO2	-	-	3	3	-	-	-	-	-	-	-	-	2	-	2	-
CO3	-	-	-	-	-	2	2	-	-	-	-	-	2	-	2	3
CO4	-	-	-	-	-	-	-	3	-	3	-	-	2	-	2	-
CO5	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Java Fundamentals [8 Classroom Contact Hours]

Java history and features, Data types, variables, and operators, Control flow statements, Methods and arrays

Unit 2: Object-Oriented Concepts [10 Classroom Contact Hours]

Classes and objects, Inheritance and polymorphism, Interfaces and abstract classes, Encapsulation and access modifiers

Unit 3: Exception Handling and I/O [9 Classroom Contact Hours]

Exception types and handling, Try-catch blocks and resource management, File I/O using streams, Serialization and deserialization

Unit 4: GUI and Event Handling [9 Classroom Contact Hours]

AWT and Swing basics, Event-driven programming, Building GUI applications, Layout managers and components

Unit 5: Advanced Java Features [9 Classroom Contact Hours]

Generics and collections, Multithreading and concurrency, Networking with sockets, Java Database Connectivity (JDBC)

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Create a Java class and implement method overloading.
2. Develop a Java application using inheritance and interfaces.
3. Write a program to handle multiple exceptions in Java.
4. Build a simple calculator using Swing components.
5. Implement a multithreaded producer-consumer problem.
6. Create a file management system using Java I/O.
7. Design a network chat application using sockets.
8. Develop a JDBC application to connect and query a database.
9. Write a program using Java collections framework.
10. Implement a generic class and its methods.
11. Create a Java applet with event handling for form submission.
12. Develop a serialization mechanism for a Java object.
13. Write a program to sort a list of objects using a comparator.
14. Build a multithreaded server that handles multiple clients.
15. Create a GUI-based application to display a user profile.
16. Implement exception handling in file I/O operations.
17. Write a program to demonstrate the use of lambda expressions.
18. Develop a Java program to manage a list of students using a hashmap.
19. Create a multithreaded program to simulate a bank transaction.
20. Write a Java program that uses JDBC to insert, update, and delete records in a database.

- **Textbook**:
  1. “Java: The Complete Reference” by Herbert Schildt.

- **Reference Books**:
  1. "Effective Java" by Joshua Bloch
  2. "Head First Java" by Kathy Sierra and Bert Bates

SWAYAM Course

Programming in Java - https://onlinecourses.nptel.ac.in/noc24_cs105/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Core software development competence
SDG 8	Decent Work and Economic Growth	Employability in Java-based ecosystems
SDG 9	Industry, Innovation and Infra	Foundation for enterprise applications

Course Title: Software Engineering

Code	Course Title	Credit	L-T-P
CS30003	Software Engineering	4	3-1-0

Course Objectives:

1. To provide students with a deep understanding of software engineering principles, methodologies, and practices.
2. Enabling them to design, develop, and maintain high-quality software systems that meet complex requirements and are sustainable, secure, and efficient.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of software engineering, software development life cycle (SDLC), software process models, requirements engineering, and software design principles.
- **CO2 (Understanding):** Explain and interpret the principles of software project planning, software architecture, design methodologies, software testing, quality assurance, and software maintenance.
- **CO3 (Application):** Apply software engineering principles, development methodologies, project management techniques, and software development tools to design, develop, test, and deploy software systems.
- **CO4 (Analysis):** Analyze and compare software development models, project management strategies, testing techniques, quality assurance methods, and risk management practices to develop reliable and maintainable software solutions.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate high-quality software systems by integrating software engineering principles, project management, testing strategies, quality assurance practices, and modern software development tools to address real-world computing challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-	-
CO2	-	-	3	3	-	-	-	-	-	-	-	-	2	-	2	-
CO3	-	-	-	-	-	-	2	-	-	2	-	-	-	2	-	2
CO4	-	-	-	-	-	3	-	3	-	-	-	-	2	-	-	-
CO5	-	-	3	-	-	-	-	-	-	-	-	2	-	-	2	2

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Software Engineering [9 Classroom Contact Hours]

Software processes and lifecycle models, Requirements engineering and specification, Software design principles and patterns

Unit 2: Software Quality Assurance [9 Classroom Contact Hours]

Software testing strategies and techniques, Verification and validation, Software metrics and quality management

Unit 3: Software Project Management [9 Classroom Contact Hours]

Project planning and scheduling, Risk management, Software cost estimation and control

Unit 4: Advanced Software Development [9 Classroom Contact Hours]

Agile methodologies, DevOps practices, Software maintenance and evolution

Unit 5: Emerging Trends in Software Engineering [9 Classroom Contact Hours]

Software globalization and localization, Cloud computing and service-oriented architecture, AI and machine learning in software development

- **Textbook**:
  1. "Software Engineering" by Ian Sommerville

- **Reference Books**:
  1. "Design Patterns: Elements of Reusable Object-Oriented Software" by Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides
  2. "The Mythical Man-Month: Essays on Software Engineering" by Frederick P. Brooks Jr.

SWAYAM Course

Software Engineering - https://onlinecourses.nptel.ac.in/noc24_cs119/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Process and project literacy
SDG 8	Decent Work and Economic Growth	Team-based, industry-aligned skills
SDG 9	Industry, Innovation and Infra	Structured development of robust systems
SDG 12	Responsible Consumption/Production	Sustainable software processes

Course Title: Computer Networks

Code	Course Title	Credit	L-T-P
CS30005	Computer Networks	4	3-1-0

Course Objectives:

1. To provide students with a robust understanding of computer networking principles, protocols, and technologies.
2. Enabling them to design, analyze, and implement network systems that are efficient, secure, and scalable, in accordance with UGC NET and GATE standards.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of computer networks, network architectures, OSI and TCP/IP models, transmission media, and network devices.
- **CO2 (Understanding):** Explain and interpret the principles of data link, network, transport, and application layer protocols, routing algorithms, switching techniques, congestion control, and network communication.
- **CO3 (Application):** Apply networking protocols, IP addressing, subnetting, routing, switching, and network security concepts to design, configure, and manage computer networks.
- **CO4 (Analysis):** Analyze and compare network architectures, routing protocols, transport protocols, network performance, congestion control mechanisms, and security techniques to optimize network efficiency and reliability.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate secure, scalable, and reliable computer networks by integrating network protocols, routing strategies, performance optimization, and security mechanisms to address real-world communication requirements.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	3	-	-	-	-	-	-	-	-	2	2	-	2
CO2	-	-	3	2	-	-	-	-	-	-	-	-	-	2	-	3
CO3	-	-	-	-	-	2	-	2	-	-	-	-	3	2	2	-
CO4	-	-	-	-	-	-	3	-	-	3	-	-	2	-	-	-
CO5	-	-	3	-	-	-	-	-	-	-	2	-	-	2	2	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Computer Networks [9 Classroom Contact Hours]

Overview of network topologies, types, and models, OSI and TCP/IP layers, Introduction to network protocols and standards

Unit 2: Data Link Layer and Medium Access Control [9 Classroom Contact Hours]

Framing, error detection, and correction techniques, Medium Access Control (MAC) protocols, Ethernet standards and bridging

Unit 3: Network Layer [9 Classroom Contact Hours]

IP addressing and subnetting, Routing algorithms and protocols, IPv4 and IPv6 transition

Unit 4: Transport Layer [9 Classroom Contact Hours]

Transport protocols: TCP and UDP, Congestion control and Quality of Service (QoS), Socket programming basics

Unit 5: Application Layer and Security [9 Classroom Contact Hours]

DNS, HTTP, SMTP, and other application layer protocols, Network security fundamentals, Cryptography and network security protocols

- **Textbook**:
  1. “Computer Networking: A Top-Down Approach” by James Kurose and Keith Ross

- **Reference Books**:
  1. “Data Communications and Networking” by Behrouz A. Forouzan

2. “Computer Networks” by Andrew S. Tanenbaum and David J. Wetherall

SWAYAM Course

Computer Networks And Internet Protocol -

https://onlinecourses.nptel.ac.in/noc24_cs19/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Understanding Internet-scale infrastructure
SDG 9	Industry, Innovation and Infrastructure	Networking backbone
SDG 10	Reduced Inequalities	Access and digital inclusion
SDG 11	Sustainable Cities and Communities	Smart-city and communication systems

Course Title: Computer Networks Fundamentals

Code	Course Title	Credit	L-T-P
CS32001	Computer Networks Fundamentals	4	3-1-0

Course Objectives:

This course introduces students to the fundamental concepts of computer networks, network architectures, communication protocols, and data transmission. It develops skills in understanding network devices, addressing, routing, and network security while enabling learners to analyze and troubleshoot basic networking problems, providing a foundation for advanced networking and communication technologies.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of computer networks, network architectures, communication models, transmission media, network devices, and communication protocols.

- **CO2 (Understanding):** Explain and interpret the principles of the OSI and TCP/IP reference models, data transmission, switching techniques, IP addressing, subnetting, routing, and transport layer protocols.
- **CO3 (Application):** Apply networking concepts, IP addressing, subnetting techniques, and network protocols to configure, manage, and troubleshoot basic computer networks.
- **CO4 (Analysis):** Analyze network performance, routing mechanisms, congestion control, error detection techniques, and security challenges to evaluate efficient communication in computer networks.
- **CO5 (Evaluation/Create):** Design and implement basic computer network solutions by selecting appropriate network devices, protocols, and security mechanisms while following standard networking practices for real-world applications.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	3	-	-	-	-	-	-	-	-	2	2	-	2
CO2	-	-	3	2	-	-	-	-	-	-	-	-	-	2	-	3
CO3	-	-	-	-	-	2	-	2	-	-	-	-	3	2	2	-
CO4	-	-	-	-	-	-	3	-	-	3	-	-	2	-	-	-
CO5	-	-	3	-	-	-	-	-	-	-	2	-	-	2	2	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Computer Networks [8 Classroom Contact Hours]

Introduction to computer networks, network applications, types of computer networks (LAN, MAN, WAN, PAN), network topologies, network components and devices (hub, switch, router, gateway, modem, access point), transmission media (guided and unguided).

Unit 2: Network Models and Data Communication [10 Classroom Contact Hours]
Fundamentals of data communication, communication modes, transmission techniques, multiplexing concepts, switching techniques (circuit, message, and packet switching), OSI reference model, TCP/IP protocol suite, functions of each layer.

Unit 3: Internet Protocols and Routing [10 Classroom Contact Hours]
IPv4 addressing, IPv6 overview, subnetting concepts, network address translation (NAT), Address Resolution Protocol (ARP), Internet Control Message Protocol (ICMP), Dynamic Host Configuration Protocol (DHCP), Domain Name System (DNS).

Unit 4: Transport, Application Layer Protocols, and Network Security [10 Classroom Contact Hours]
Transport layer services, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), flow control, error control, congestion control (basic concepts), application layer protocols including HTTP, HTTPS, FTP, SMTP, POP3, IMAP, Telnet.

Unit 5: Wireless Networks and Emerging Trends [8 Classroom Contact Hours]
Wireless communication fundamentals, Wi-Fi standards, Bluetooth, mobile networks (3G, 4G, 5G), Internet of Things (IoT) networking concepts, cloud networking.

- **Textbook**:
  1. "Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross

- **Reference Books**:
  1. "Data Communications and Networking" by Behrouz A. Forouzan
  2. "Computer Networks" by Andrew S. Tanenbaum and David J. Wetherall

SWAYAM Course
Computer Networks And Internet Protocol -
https://onlinecourses.nptel.ac.in/noc24_cs19/preview

SDG Mapping for this Course

SDG	Title	Contribution

SDG 4	Quality Education	Understanding Internet-scale infrastructure
SDG 9	Industry, Innovation and Infrastructure	Networking backbone
SDG 10	Reduced Inequalities	Access and digital inclusion
SDG 11	Sustainable Cities and Communities	Smart-city and communication systems

Course Title: Artificial Intelligence

Code	Course Title	Credit	L-T-P
CS30051	Artificial Intelligence	4	3-0-1

Course Objectives:

1. To equip students with a comprehensive understanding of artificial intelligence concepts, techniques, and applications.
2. Enabling them to design intelligent systems that can solve complex problems.
3. Think critically, and adapt to new challenges.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of artificial intelligence, intelligent agents, problem-solving techniques, knowledge representation, search strategies, and reasoning methods.
- **CO2 (Understanding):** Explain and interpret the principles of knowledge representation, inference mechanisms, heuristic search, machine learning, expert systems, and reasoning under uncertainty.
- **CO3 (Application):** Apply artificial intelligence algorithms, machine learning techniques, and AI development tools to design and implement intelligent systems for solving real-world problems.
- **CO4 (Analysis):** Analyze and compare AI search strategies, knowledge representation methods, machine learning algorithms, reasoning techniques, and intelligent system architectures to identify effective AI solutions.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate intelligent systems by integrating AI algorithms, machine learning models, knowledge representation,

reasoning mechanisms, and ethical AI practices to address complex computational challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	-	-	-	-	-	-	-	-	-	3	3	2	2
CO2	-	-	-	3	3	-	-	-	-	-	-	-	2	3	2	1
CO3	-	-	-	2	3	2	-	-	-	-	-	-	2	3	1	2
CO4	-	-	-	-	-	-	3	-	-	3	-	-	2	3	2	1
CO5	-	-	3	-	-	-	-	3	-	-	2	-	2	2	1	3

Course Duration: 60 hours

Course Syllabus:

Unit 1: Introduction to AI and Intelligent Agents [9 Classroom Contact Hours]

History and foundations of AI, Intelligent agents and environments, Problem-solving and search strategies

Unit 2: Knowledge Representation and Reasoning [9 Classroom Contact Hours]

Propositional and predicate logic, Ontologies and semantic networks, Planning and decision-making in AI

Unit 3: Machine Learning and Neural Networks [9 Classroom Contact Hours]

Supervised, unsupervised, and reinforcement learning, Decision trees, SVMs, and ensemble methods, Basics of neural networks and deep learning

Unit 4: Natural Language Processing and Robotics [9 Classroom Contact Hours]

Language models and text processing, Speech recognition and generation, Robotics: perception, planning, and control

Unit 5: AI Ethics and Future Trends [9 Classroom Contact Hours]

Ethical considerations in AI, Impact of AI on society and jobs, Future trends and research frontiers in AI

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Implement a simple reflex agent in a simulated environment.
2. Design a propositional logic-based expert system.
3. Train a decision tree classifier on a given dataset.
4. Develop a chatbot using natural language processing techniques.
5. Program a neural network to recognize handwritten digits.
6. Create a reinforcement learning agent for a game.
7. Build a speech recognition system.
8. Design a robot's path planning algorithm.
9. Analyze the ethical implications of AI in a case study.
10. Research and present on an emerging AI technology.

- **Textbook**:

1. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig

- **Reference Books**:

1. "Artificial Intelligence: Structures and Strategies for Complex Problem Solving" by George F. Luger
2. "Machine Learning" by Tom M. Mitchell

SWAYAM Courses

1. Artificial Intelligence : Search Methods For Problem solving - https://onlinecourses.nptel.ac.in/noc24_cs88/preview
2. An Introduction to Artificial Intelligence - https://onlinecourses.nptel.ac.in/noc24_cs08/preview

SDG Mapping for this Course

SDG	Title	Contribution
4	Quality Education	Exposure to emerging AI paradigms
8	Decent Work and Economic Growth	AI-related job readiness
9	Industry, Innovation and Infra	Intelligent systems and automation
10	Reduced Inequalities	AI for inclusive services, but critical view
13	Climate Action	AI for prediction, optimisation

Course Title: Data Science

Code	Course Title	Credit	L-T-P
CS30053	Data Science	4	3-0-1

Course Objectives:

1. To equip students with the foundational knowledge and practical skills in data science, enabling them to perform complex problem-solving.
2. Exhibit critical thinking, and apply analytical reasoning in diverse contexts. The course aims to enhance research-related skills, promote cooperative teamwork.
3. Foster digital literacy in a multicultural and inclusive setting, while also developing communication skills, environmental awareness, and a commitment to sustainability.
4. Encourages autonomy, responsibility, and accountability, as well as self-directed learning and lifelong learning.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of data science, data analytics, data preprocessing, statistical analysis, machine learning, and data visualization.
- **CO2 (Understanding):** Explain and interpret the principles of data collection, data cleaning, exploratory data analysis, feature engineering, predictive modeling, and data visualization techniques.
- **CO3 (Application):** Apply data science methodologies, statistical techniques, machine learning algorithms, and programming tools to analyze datasets and develop solutions for real-world problems.
- **CO4 (Analysis):** Analyze and compare data mining techniques, machine learning models, visualization methods, and evaluation metrics to extract meaningful insights and support data-driven decision-making.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate end-to-end data science solutions by integrating data preprocessing, machine learning, visualization,

ethical data practices, and domain knowledge to address complex business and societal challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	-	-	-	-	-	-	-	-	-	3	3	-	-
CO2	-	-	-	3	3	3	-	-	-	-	-	-	2	3	2	-
CO3	-	-	-	2	-	-	2	-	-	-	-	-	2	3	-	2
CO4	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	2	-	2	3	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Data Science [9 Classroom Contact Hours]

Overview of data science and its impact on society, Basic statistics for data science, Introduction to programming for data analysis

Unit 2: Data Management and Visualization [9 Classroom Contact Hours]

Data cleaning and pre-processing, Data storage and retrieval, Data visualization techniques

Unit 3: Machine Learning and Predictive Analytics [9 Classroom Contact Hours]

Supervised and unsupervised learning, Model selection and evaluation, Predictive analytics in practice

Unit 4: Big Data Technologies [9 Classroom Contact Hours]

Introduction to big data and Hadoop ecosystem, Working with large datasets, Real-time data processing

Unit 5: Ethics and Future of Data Science [9 Classroom Contact Hours]

Ethical considerations in data science, Data privacy and security, Emerging trends and future directions

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Statistical analysis of a dataset
2. Data cleaning and pre-processing

3. Building a linear regression model
4. Clustering analysis
5. Text mining and sentiment analysis
6. Time-series forecasting
7. Network analysis
8. Data visualization project
9. Implementing a recommendation system
10. Analyzing big data with Hadoop
11. Real-time data processing simulation
12. Privacy and security case study
13. Ethical dilemma discussion
14. Data storytelling workshop
15. Building a neural network
16. Natural language processing task
17. Social media data analysis
18. Environmental data analysis
19. Autonomous learning project
20. Capstone project integrating multiple data science techniques

- **Textbook:**
  1. "Data Science for Business" by Foster Provost and Tom Fawcett

- **Reference Books:**
  1. "Python for Data Analysis" by Wes McKinney
  2. "The Elements of Statistical Learning" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman

SWAYAM Courses

1. Essentials Of Data Science With R Software - 1: Probability And Statistical Inference - https://onlinecourses.nptel.ac.in/noc24_ma18/preview
2. Essentials Of Data Science With R Software - 2: Sampling Theory And Linear Regression Analysis - https://onlinecourses.nptel.ac.in/noc24_ma19/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 3	Good Health and Well-being	Health, epidemiology datasets
SDG 4	Quality Education	Quantitative and analytical literacy
SDG 9	Industry, Innovation and Infra	Data-driven innovation
SDG 10	Reduced Inequalities	Analytics on inequality, tribal development
SDG 13	Climate Action	Climate/agri data analysis

Course Title: Internship

Code	Course Title	Credit	L-T-P
IP37081	Internship	2	0-0-2

Course Objectives:

The internship provides students with practical exposure to professional work environments by applying academic knowledge to real-world problems. It develops technical competence, problem-solving ability, communication, teamwork, ethical practices, and project management skills while fostering industry readiness, professional responsibility, lifelong learning, and experiential understanding of organizational practices.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the organizational structure, professional practices, workplace ethics, safety regulations, and operational procedures followed in the internship organization.
- **CO2 (Understanding):** Explain and interpret industry requirements, project workflows, organizational processes, professional responsibilities, and the application of theoretical concepts in real-world environments.
- **CO3 (Application):** Apply domain knowledge, technical skills, modern tools, and problem-solving techniques to complete assigned tasks and projects effectively in a professional setting.
- **CO4 (Analysis):** Analyze real-world problems, evaluate alternative solutions, interpret project outcomes, and recommend appropriate improvements based on technical and organizational requirements.

- **CO5 (Synthesis/Evaluation):** Demonstrate professional competence by planning, executing, documenting, and presenting internship work while exhibiting effective communication, teamwork, ethical conduct, project management, and lifelong learning skills.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, "_" - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	1	-	-	1	-	2	3	1	2	-	-	2	1	-	-
CO2	2	2	1	1	2	2	2	3	2	2	2	2	2	2	1	-
CO3	2	3	3	2	–	2	2	2	3	2	3	2	2	3	2	2
CO4	2	3	2	–	–	3	2	2	2	3	3	2	3	2	2	2
CO5	2	3	3	–	3	3	3	3	3	3	3	3	3	3	3	3

Course Duration: 38 hours

Total Practical / Lab Experiments: [38 Lab Contact Hours]

1. **Internship Orientation and Workplace Induction**
   - Introduction to the organization
   - Workplace policies, ethics, and safety guidelines
   - Understanding organizational structure and work culture
2. **Technical Skill Development**
   - Training on organization-specific software, tools, or technologies
   - Familiarization with development environments, databases, cloud platforms, or hardware (as applicable)
3. **Assignment and Task Execution**
   - Participation in project-related activities
   - Requirement analysis and task planning
   - Problem identification and solution implementation
   - Testing and validation of assigned work
4. **Documentation and Reporting**
   - Maintenance of daily work diary/logbook
   - Weekly progress reports
   - Preparation of technical documentation
5. **Professional Skills Development**

- Team collaboration
- Technical communication
- Time management
- Professional ethics and workplace responsibility

6. **Project Demonstration**
   - Presentation of completed work
   - Demonstration of developed solution or assigned tasks
   - Interaction with industry/faculty mentor
7. **Internship Report and Viva Voce**
   - Submission of internship report
   - Seminar presentation
   - Viva voce examination

Suggested Assessment Scheme

Component	**Weightage (%)**
Industry/Supervisor Evaluation	30
Faculty Mentor Evaluation	20
Daily Logbook and Attendance	15
Internship Report	20
Presentation and Viva Voce	15

SDG Mapping for this Course

SDG	**Title**	**Contribution**
SDG 4	Quality Education	Experiential learning
SDG 8	Decent Work and Economic Growth	Work-readiness, industry exposure
SDG 9	Industry, Innovation and Infra	Understanding real-world systems
SDG 10	Reduced Inequalities	Application in tribal/rural/NGO contexts

SEMESTER – V (Double Major)

Course Category	**Course Code**	**Course Title**	**Credits**			**Total Credit**
			L	**T**	**P**	
	CS30001	Object Oriented Programming in Java	3	0	1	4

Core Course (Major)	CS30003	Software Engineering	3	1	0	4
	CS30005	Computer Networks	3	1	0	4
Minor(Opted by students from other departments)	CS32001	Computer Networks Fundamentals	3	0	1	4
Electives (Choose ONE)	CS30051	Artificial Intelligence	3	0	1	4
	CS30053	Data Science	3	0	1	4
Double Major I (Opted by students from other departments)	CS30001	Object Oriented Programming in Java	3	0	1	4
Double Major II (Opted by students from other departments)	CS30003	Software Engineering	3	1	0	4
Double Major III (Opted by students from other departments)	CS30005	Computer Networks	3	1	0	4
Internship	IP37081	Internship	0	0	2	2
		Total				**34**

SEMESTER – VI (Single Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS30002	Web Technologies	3	0	1	4
	CS30004	Theory of Computation	3	1	0	4
Minor (Opted by students from other departments)	CS32002	Web Designing	3	0	1	4
	CS30052	Machine Learning	3	0	1	4

Electives (Choose ONE Set)	CS30054	Neural Networks	3	0	1	4
	OR					
	CS30056	Data Mining	3	0	1	4
	CS30057	Data Visualization	3	0	1	4
		Total				**20**

Course Title: Web Technologies

Code	Course Title	Credit	L-T-P
CS30002	Web Technologies	4	3-0-1

Course Objectives:

1. To provide students with a comprehensive understanding of web technologies,
2. Enabling them to design, develop, and deploy robust web applications that address complex problems,
3. Demonstrate critical thinking, and exhibit analytical reasoning in line with UGC NET and GATE standards.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of web technologies, including HTML, CSS, JavaScript, client-server architecture, web protocols, and web application development.
- **CO2 (Understanding):** Explain and interpret the principles of responsive web design, server-side scripting, DOM manipulation, web frameworks, form handling, and database connectivity in web applications.
- **CO3 (Application):** Apply HTML, CSS, JavaScript, server-side scripting languages, and web development frameworks to design and develop responsive, interactive, and database-driven web applications.

- **CO4 (Analysis):** Analyze and compare client-side and server-side technologies, web architectures, security mechanisms, performance optimization techniques, and web development frameworks to build efficient and secure web applications.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate scalable, secure, and user-friendly web applications by integrating front-end technologies, back-end programming, databases, APIs, and modern web development practices to address real-world computing challenges**.**

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-	2
CO2	-	-	-	3	-	-	-	-	-	-	-	-	2	-	2	-
CO3	-	-	-	3	-	3	-	2	-	-	-	-	-	2	-	2
CO4	-	-	-	-	-	-	3	-	-	3	-	-	2	2	-	-
CO5	-	-	3	-	-	-	-	-	-	-	-	-	1	-	2	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Web Technologies [9 Classroom Contact Hours]

Overview of the Internet and web applications, Web standards and protocols, Introduction to HTML5 and CSS3.

Unit 2: Client-Side Scripting [9 Classroom Contact Hours]

JavaScript fundamentals, Document Object Model (DOM) manipulation, Event handling and form validation

Unit 3: Server-Side Scripting [9 Classroom Contact Hours]

Introduction to server-side technologies, PHP and database integration, RESTful web services and APIs

Unit 4: Web Application Development [9 Classroom Contact Hours]

Frameworks and libraries (React, Angular, Node.js), Responsive web design and Bootstrap, Web security best practices

Unit 5: Advanced Topics and Trends [9 Classroom Contact Hours]

Single Page Applications (SPA), Progressive Web Apps (PWA), and Web performance optimization

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Create a multi-page website using HTML5 and CSS3.
2. Develop a JavaScript program for form validation.
3. Implement a PHP script to interact with a MySQL database.
4. Build a responsive web page using Bootstrap.
5. Create a RESTful API for a web service.
6. Develop a single-page application using React.
7. Implement user authentication and session management.
8. Optimize a website for performance and SEO.
9. Create a progressive web app with offline capabilities.
10. Write a JavaScript program using AJAX for dynamic content loading.
11. Develop a Node.js server application.
12. Implement a shopping cart feature using session storage.
13. Create an interactive data visualization using D3.js.
14. Build a web application using the MVC architecture.
15. Develop a chat application using Web-Sockets.
16. Implement a custom content management system.
17. Create a web application with real-time updates using Firebase.
18. Optimize a website's accessibility and user experience.
19. Develop a feature-rich blog platform.
20. Implement security measures to protect against common web vulnerabilities.

- **Textbook**:

1. "Web Development and Design Foundations with HTML5" by Terry Felke Morris

- **Reference Books**:

1. "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics" by Jennifer Niederst Robbins

2. “JavaScript and JQuery: Interactive Front-End Web Development” by Jon Duckett

SWAYAM Course

1. Web Technology - https://onlinecourses.swayam2.ac.in/nou24_cs18/preview

SDG Mapping for this Course

SDG	Title	Contribution
4	Quality Education	Practical digital creation skills
9	Industry, Innovation and Infra	Web as core infra
10	Reduced Inequalities	Accessible, inclusive e-services
11	Sustainable Cities/Communities	Smart-service front-ends

Course Title: Theory of Computation

Code	Course Title	Credit	L-T-P
CS30004	Theory of Computation	4	3-1-0

Course Objectives:

1. To equip students with the theoretical foundations of computation, enabling them to understand, design, and analyze computational processes.
2. Apply these concepts to complex problem-solving in computer science.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of formal languages, automata theory, grammars, finite automata, regular expressions, and Turing machines.
- **CO2 (Understanding):** Explain and interpret the principles of deterministic and non-deterministic finite automata, context-free grammars, pushdown automata, Turing machines, computability, and computational complexity.
- **CO3 (Application):** Apply automata, formal grammar, parsing techniques, and Turing machine models to solve computational problems and language recognition tasks.

- **CO4 (Analysis):** Analyze and compare computational models, formal languages, automata, computability, decidability, and complexity classes to determine the appropriate computational approach for solving theoretical problems.
- **CO5 (Synthesis/Evaluation):** Design, evaluate, and optimize computational models using automata, formal grammars, Turing machines, and complexity analysis to solve language processing and computational problems in computer science.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-	2
CO2	-	-	-	3	3	-	-	-	-	-	-	-	1	2	-	-
CO3	-	-	-	-	-	3	-	-	-	-	-	-	-	2	2	2
CO4	-	-	-	-	-	-	3	-	-	-	-	-	2	-	-	-
CO5	-	-	3	-	-	-	-	3	-	-	-	-	2	-	1	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Automata and Languages [9 Classroom Contact Hours]

Finite automata and regular expressions, Context-free grammars and push-down automata, Pumping lemma for regular and context-free languages

Unit 2: Computability Theory [9 Classroom Contact Hours]

Turing machines and their variants, Church-Turing thesis, Decidability and the halting problem

Unit 3: Complexity Theory [9 Classroom Contact Hours]

Time and space complexity classes, P vs NP problem, NP-complete and NP-hard problems

Unit 4: Advanced Automata Theory [9 Classroom Contact Hours]

Closure properties of language classes, Turing machine constructions, Undecidability in language theory

Unit 5: Applications of Theory of Computation [9 Classroom Contact Hours]

Applications to compiler design, Applications to algorithm analysis, Applications to artificial intelligence

- **Textbook**:
  1. "Introduction to the Theory of Computation" by Michael Sipser

- **Reference Books**:
  1. "Automata Theory, Languages, and Computation" by John E. Hopcroft, Rajeev Motwani, and Jeffrey D. Ullman
  2. "Elements of the Theory of Computation" by Harry R. Lewis and Christos H. Papadimitriou

SWAYAM course

1. Theory of Computation - https://onlinecourses.nptel.ac.in/noc24_cs49/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Deep conceptual CS foundations
SDG 9	Industry/Innovation	Basis for understanding limits of CS

Course Title: Web Designing

Code	Course Title	Credit	L-T-P
CS32002	Web Designing	4	3-0-1

Course Objective:

This course introduces students to the fundamentals of web designing, including HTML, CSS, JavaScript, and responsive web development. It develops skills in designing interactive, user-friendly, and visually appealing websites while emphasizing usability, accessibility, web standards, and best design practices, preparing learners for modern web application development.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of web designing, web technologies, HTML, CSS, JavaScript, web browsers, web standards, and website architecture.
- **CO2 (Understanding):** Explain and interpret the principles of web page design, responsive web design, Cascading Style Sheets (CSS), client-side scripting, user interface (UI), user experience (UX), and accessibility standards.
- **CO3 (Application):** Apply HTML, CSS, JavaScript, and web design principles to create interactive, responsive, and user-friendly web pages and websites.
- **CO4 (Analysis):** Analyze website requirements, evaluate design layouts, optimize web content, identify usability issues, and troubleshoot errors to improve website functionality and performance.
- **CO5 (Evaluation/Create):** Design, develop, test, and deploy responsive and visually appealing websites by integrating web technologies and following modern web standards, accessibility guidelines, and best design practices.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-	2
CO2	-	-	-	3	-	-	-	-	-	-	-	-	2	-	2	-
CO3	-	-	-	3	-	3	-	2	-	-	-	-	-	2	-	2
CO4	-	-	-	-	-	-	3	-	-	3	-	-	2	2	-	-
CO5	-	-	3	-	-	-	-	-	-	-	-	-	1	-	2	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Web Designing [8 Classroom Contact Hours]
Introduction to the World Wide Web (WWW), Internet and web technologies, website architecture, web browsers and web servers, client-server architecture, URL structure.

Unit 2: Cascading Style Sheets (CSS) [10 Classroom Contact Hours]
Introduction to CSS, types of CSS (inline, internal, and external), selectors, colors, backgrounds, fonts, text formatting, borders, margins, padding, box model, positioning, display properties.

Unit 3: Client-Side Scripting with JavaScript [10 Classroom Contact Hours]
Introduction to JavaScript, variables, data types, operators, control statements, loops, functions, arrays, objects, events, Document Object Model (DOM).

Unit 4: Responsive Web Design and User Experience [9 Classroom Contact Hours]
Principles of responsive web design, mobile-first design, user interface (UI) design, user experience (UX) principles, website navigation, multimedia integration (audio and video).

Unit 5: Web Development Tools and Deployment [8 Classroom Contact Hours]
Web development environments and editors, version control using Git (introduction), website testing and debugging, browser developer tools, website hosting and deployment.

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Creating basic HTML web pages.
2. Designing tables, forms, and hyperlinks.
3. Styling web pages using CSS.
4. Creating responsive layouts using Flexbox and Grid.
5. Developing interactive web pages using JavaScript.
6. Form validation using JavaScript.
7. DOM manipulation and event handling.
8. Responsive website design using Bootstrap.
9. Website testing and debugging.
10. Designing and deploying a personal or business website.

- **Textbook**:

2. “Web Development and Design Foundations with HTML5” by Terry Felke Morris

- **Reference Books**:

3. “Learning Web Design: A Beginner’s Guide to HTML, CSS, JavaScript, and Web Graphics” by Jennifer Niederst Robbins
4. “JavaScript and JQuery: Interactive Front-End Web Development” by Jon Duckett

SWAYAM Course

2. Web Technology - https://onlinecourses.swayam2.ac.in/nou24_cs18/preview

SDG Mapping for this Course

SDG	Title	Contribution
4	Quality Education	Practical digital creation skills
9	Industry, Innovation and Infra	Web as core infra
10	Reduced Inequalities	Accessible, inclusive e-services
11	Sustainable Cities/Communities	Smart-service front-ends

Course Title: Machine Learning

Code	Course Title	Credit	L-T-P
CS30052	Machine Learning	4	3-0-1

Course Objectives:

1. To provide students with a comprehensive understanding of machine learning principles and techniques as they apply to artificial intelligence.
2. Enabling them to develop and implement complex problem-solving strategies, enhance critical thinking and analytical reasoning.
3. Cultivate research-related skills. This course will also promote cooperative teamwork, foster leadership readiness, advance digital literacy, encourage multicultural competence and inclusive spirit, improve communication skills.
4. Instill environmental awareness and sustainability.
5. Support autonomy, responsibility, accountability, and self-directed lifelong learning.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of machine learning, data preprocessing, supervised learning, unsupervised learning, feature engineering, and model evaluation.
- **CO2 (Understanding):** Explain and interpret the principles of classification, regression, clustering, dimensionality reduction, model training, validation, and performance evaluation techniques.
- **CO3 (Application):** Apply machine learning algorithms, data preprocessing techniques, feature selection methods, and appropriate software tools to develop predictive models for real-world applications.
- **CO4 (Analysis):** Analyze and compare machine learning algorithms, model evaluation metrics, optimization techniques, and feature engineering methods to select appropriate models for solving complex computational problems.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate machine learning solutions by integrating appropriate algorithms, model optimization techniques, ethical AI principles, and responsible data practices to address real-world challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	3	-	-	-	-	-	-	-	-	3	3	2	2
CO2	-	-	-	3	3	3	-	3	-	-	-	-	2	3	2	2

CO3	-	-	-	-	-	-	3	-	-	3	-	-	2	2	2	2
CO4	-	-	3	-	-	-	-	-	-	-	-	-	2	3	2	2
CO5	-	-	-	-	-	-	-	-	-	-	-	3	2	3	2	2

Course Duration: 45 hours

Course Syllabus:

Unit 1: Foundations of Machine Learning [9 Classroom Contact Hours]

Introduction to Machine Learning and AI, Supervised vs. Unsupervised Learning, Evaluation Metrics and Data Pre-processing

Unit 2: Supervised Learning Algorithms [9 Classroom Contact Hours]

Linear Regression and Regularization Techniques, Classification Algorithms: Logistic Regression, SVMs, Decision Trees, Ensemble Methods: Bagging, Boosting, Random Forests

Unit 3: Unsupervised Learning and Dimensionality Reduction [9 Classroom Contact Hours]

Clustering Techniques: K-Means, Hierarchical Clustering, Dimensionality Reduction: PCA, t-SNE, Association Rule Mining

Unit 4: Neural Networks and Deep Learning [9 Classroom Contact Hours]

Fundamentals of Neural Networks, Deep Learning Architectures: CNNs, RNNs, LSTMs, Transfer Learning and Fine-tuning

Unit 5: Advanced Topics and Applications [9 Classroom Contact Hours]

Reinforcement Learning, Natural Language Processing (NLP), Ethical Implications and Future of Machine Learning

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Implement linear regression on a dataset
2. Perform logistic regression for binary classification
3. Use SVMs for non-linear data separation
4. Build a decision tree classifier
5. Create an ensemble model using boosting
6. Apply K-means clustering to group data
7. Reduce dataset dimensions with PCA

8. Mine association rules from transaction data
9. Construct a basic neural network
10. Train a CNN for image recognition
11. Develop an RNN for sequence prediction
12. Fine-tune a pre-trained deep learning model
13. Design a reinforcement learning agent
14. Perform sentiment analysis using NLP
15. Address overfitting using regularization techniques
16. Visualize high-dimensional data with t-SNE
17. Implement a chatbot using sequence models
18. Explore ethical considerations in AI
19. Predict stock prices using time-series analysis
20. Participate in a Kaggle competition

- **Textbook:**
  1. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy

- **Reference Books:**
  1. "Pattern Recognition and Machine Learning" by Christopher M. Bishop
  2. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
  3. "Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto

SWAYAM Courses

Introduction to Machine Learning - https://onlinecourses.nptel.ac.in/noc24_cs101/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 3	Good Health and Well-being	Predictive models in health
SDG 4	Quality Education	Advanced analytical skill-building
SDG 9	Industry, Innovation and Infra	Intelligent systems development
SDG 10	Reduced Inequalities	Models for inclusion, risk of bias focus
SDG 13	Climate Action	Climate/agri prediction models

Course Title: Neural Networks

Code	Course Title	Credit	L-T-P
CS30054	Neural Networks	4	3-0-1

Course Objectives:

1. To provide students with a comprehensive understanding of neural networks and deep learning.
2. Enabling them to develop solutions for complex problems, think critically about data.
3. Engage in research with a spirit of teamwork and inclusivity.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of deep learning, artificial neural networks, activation functions, learning algorithms, and deep neural network architectures.
- **CO2 (Understanding):** Explain and interpret the principles of feedforward neural networks, convolutional neural networks (CNNs), recurrent neural networks (RNNs), transformers, optimization techniques, and model evaluation methods.
- **CO3 (Application):** Apply deep learning algorithms, neural network frameworks, and optimization techniques to design, train, and implement intelligent models for computer vision, natural language processing, and other real-world applications.
- **CO4 (Analysis):** Analyze and compare different deep learning architectures, loss functions, optimization algorithms, regularization techniques, and performance metrics to develop efficient and accurate predictive models.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate advanced deep learning solutions by integrating appropriate neural network architectures, optimization strategies, transfer learning, and ethical AI practices to solve complex real-world problems.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	3	-	-	-	-	-	-	-	-	3	3	2	2
CO2	-	-	-	3	3	3	-	3	-	-	-	-	2	3	2	2
CO3	-	-	-	-	-	-	3	-	-	-	-	-	2	2	3	3
CO4	-	-	3	-	-	-	-	-	-	-	-	3	2	2	3	3
CO5	-	-	-	-	-	-	-	-	3	-	-	-	2	3	2	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Neural Networks [9 Classroom Contact Hours]

Fundamentals of neural networks, Activation functions and network architectures, Gradient descent and backpropagation, Overfitting and regularization

Unit 2: Deep Learning Architectures [9 Classroom Contact Hours]

Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM) networks, Autoencoders and Generative Adversarial Networks (GANs)

Unit 3: Optimization and Regularization Techniques [9 Classroom Contact Hours]

Advanced optimization algorithms, Regularization methods, Hyperparameter tuning, Model evaluation and validation

Unit 4: Applications of Neural Networks [9 Classroom Contact Hours]

Image and speech recognition, Natural language processing, Reinforcement learning, Neural networks in industry

Unit 5: Current Trends and Ethical Considerations [9 Classroom Contact Hours]

Transfer learning and few-shot learning, Interpretability and explainability of models, Ethical implications of AI, Future directions in neural networks and deep learning

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Implementing a perceptron from scratch
2. Training a CNN for image classification
3. Using RNNs for time series prediction
4. Building an LSTM for text generation

5. Creating a GAN for image generation
6. Applying transfer learning to a new dataset
7. Optimizing neural networks with advanced algorithms
8. Regularizing models to prevent overfitting
9. Tuning hyperparameters for better model performance
10. Validating models using cross-validation techniques
11. Developing a speech recognition system
12. Processing natural language for sentiment analysis
13. Designing a reinforcement learning agent
14. Analyzing the impact of AI in healthcare
15. Exploring the interpretability of neural networks
16. Discussing the ethical considerations of AI deployment
17. Investigating the role of AI in environmental sustainability
18. Engaging in self-directed learning to explore a new deep learning library
19. Collaborating on a team project to solve a real-world problem using neural networks
20. Presenting a research proposal on a novel application of deep learning

- **Textbook:**
  1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
- **Reference Books:**
  1. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal
  2. "Pattern Recognition and Machine Learning" by Christopher M. Bishop

SWAYAM Courses

Deep Learning - IIT Ropar - https://onlinecourses.nptel.ac.in/noc24_cs114/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Frontier AI literacy
SDG 8	Decent Work and Economic Growth	High-end AI skillset
SDG 9	Industry, Innovation and Infra	Advanced intelligent infra
SDG 10	Reduced Inequalities	Critical study of NN impacts on justice

SDG 13	Climate Action	DL for remote sensing, climate, disasters

Course Title: Data Mining

Code	Course Title	Credit	L-T-P
CS30056	Data Mining	4	3-0-1

Course Objectives:

1. To equip students with the skills to **analyze** and **synthesize** data mining concepts and techniques for **complex problem-solving**.
2. Enhance **critical thinking** and **analytical reasoning**, and apply these skills in a **multicultural** and **inclusive** environment.
3. Fostering **digital literacy**, **research-related skills**, and **environmental awareness**.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of data mining, knowledge discovery in databases (KDD), data preprocessing, data warehousing, and data mining techniques.
- **CO2 (Understanding):** Explain and interpret the principles of classification, clustering, association rule mining, anomaly detection, pattern discovery, and data mining evaluation techniques.
- **CO3 (Application):** Apply data mining algorithms, preprocessing techniques, and analytical tools to extract meaningful patterns and knowledge from large datasets for real-world applications.
- **CO4 (Analysis):** Analyze and compare different data mining techniques, algorithms, evaluation metrics, and visualization methods to identify appropriate approaches for solving data-driven problems.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate data mining solutions by integrating suitable algorithms, data preprocessing methods, visualization techniques, and ethical data practices to support informed decision-making and knowledge discovery.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	3	-	-	-	-	-	-	-	-	3	3	2	3
CO2	-	-	-	2	2	3	-	3	-	-	-	-	3	3	2	2
CO3	-	-	-	-	-	-	3	-	-	3	-	-	3	3	2	2
CO4	-	-	3	-	-	-	-	-	-	-	-	-	2	2	2	3
CO5	-	-	-	-	-	-	-	-	3	-	-	-	2	2	2	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Data Mining [8 Classroom Contact Hours]

Overview of data mining, Data preprocessing, Understanding data types and sources

Unit 2: Data Mining Algorithms [10 Classroom Contact Hours]

Classification and prediction, Clustering techniques, Association rule mining

Unit 3: Advanced Topics in Data Mining [9 Classroom Contact Hours]

Web mining, Text mining, Big data analytics

Unit 4: Data Mining Tools and Software [9 Classroom Contact Hours]

Introduction to data mining tools, Practical exercises with data mining software, Data visualization techniques

Unit 5: Ethical and Environmental Implications [9 Classroom Contact Hours]

Ethical considerations in data mining, Data privacy and security, Data mining for environmental sustainability

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Preprocessing a given dataset
2. Implementing a decision tree classifier
3. Performing k-means clustering
4. Mining association rules from transaction data
5. Analyzing web usage patterns

6. Conducting sentiment analysis on text data
7. Visualizing complex datasets
8. Using a data mining tool for predictive modeling
9. Evaluating the performance of a classifier
10. Exploring big data analytics with Hadoop
11. Privacy-preserving data mining
12. Mining social network data
13. Forecasting with time-series data
14. Detecting outliers and anomalies
15. Recommender systems design
16. Text classification with natural language processing
17. Analyzing environmental data for sustainability
18. Data mining project proposal development
19. Participating in a data mining competition
20. Reflective journaling on ethical data mining practices

- **Textbook:**
  1. "Introduction to Data Mining" by Pang-Ning Tan, Michael Steinbach, and Vipin Kumar

- **Reference Books:**
  1. "Data Mining: Concepts and Techniques" by Jiawei Han, Micheline Kamber, and Jian Pei
  2. "Mining of Massive Datasets" by Jure Leskovec, Anand Rajaraman, and Jeff Ullman

SWAYAM Courses

1. Data Mining - https://onlinecourses.swayam2.ac.in/cec24_cs12/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 3	Good Health and Well-being	Health surveillance data mining
SDG 4	Quality Education	Strong data-analytic competence
SDG 9	Industry, Innovation and Infra	Insight-driven innovation
SDG 10	Reduced Inequalities	Evidence on marginalisation, tribal issues

SDG 13	Climate Action	Pattern discovery in climate/agri data

Course Title: Data Visualization

Code	Course Title	Credit	L-T-P
CS30057	Data Visualization	4	3-0-1

Course Objectives:

1. To equip students with the skills to synthesize and apply data visualization techniques for complex problem-solving.
2. Enhance critical thinking and analytical reasoning, and apply these skills in a multicultural and inclusive environment.
3. Fostering digital literacy, research-related skills, and environmental awareness.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of data visualization, data representation, visualization principles, chart types, dashboards, and visual analytics.
- **CO2 (Understanding):** Explain and interpret the principles of data visualization techniques, exploratory data analysis, visual perception, storytelling with data, and visualization best practices.
- **CO3 (Application):** Apply data visualization tools, programming libraries, and dashboard technologies to design and develop effective visual representations for analyzing and communicating data.
- **CO4 (Analysis):** Analyze and compare different visualization techniques, dashboard designs, interactive visualizations, and evaluation methods to select appropriate approaches for presenting data-driven insights.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate interactive and informative data visualization solutions by integrating visualization principles, analytical tools, and ethical data communication practices to support effective decision-making.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	3	-	-	-	-	-	-	-	-	2	3	2	-
CO2	-	-	-	3	2	3	-	3	-	-	-	-	2	3	-	2
CO3	-	-	-	-	-	-	3	-	-	3	-	-	2	2	2	-
CO4	-	-	3	-	-	-	-	-	-	-	-	-	2	2	-	2
CO5	-	-	-	-	-	-	-	-	3	-	-	-	2	2	2	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Fundamentals of Data Visualization [9 Classroom Contact Hours]

Principles of visual perception, Data types and structures, Basic chart types and when to use them.

Unit 2: Visual Encoding and Graphic Design [9 Classroom Contact Hours]

Visual encoding techniques, Design principles for data visualization, Color theory and its application

Unit 3: Interactive Data Visualization [9 Classroom Contact Hours]

Introduction to interactive visualization, Tools for creating interactive visualizations, User interaction and dynamic visualizations

Unit 4: Advanced Visualization Techniques [9 Classroom Contact Hours]

Geospatial data visualization, Network visualization, Advanced chart types and visualization tools

Unit 5: Data Storytelling and Ethics [9 Classroom Contact Hours]

Narrative techniques in data visualization, Ethical considerations in data presentation, Case studies of effective data storytelling

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Create a bar chart and a line chart
2. Design a dashboard for a given dataset
3. Develop an interactive map visualization
4. Visualize a network graph

5. Construct a data story around a social issue
6. Analyze the ethical implications of a visualization
7. Implement a treemap visualization
8. Create a scatter plot matrix
9. Develop a visualization using a novel dataset
10. Critique a set of visualizations for design principles
11. Build a choropleth map
12. Design an animated time-series visualization
13. Create a visualization portfolio
14. Implement advanced chart types in a given tool
15. Conduct a user study on an interactive visualization
16. Visualize multivariate data
17. Explore the use of color in data visualization
18. Create a visualization for mobile devices
19. Develop a visualization with real-time data
20. Write a reflective essay on the role of visualization in society

- **Textbook:**

1. "The Visual Display of Quantitative Information" by Edward R. Tufte

- **Reference Books:**

1. "Data Points: Visualization That Means Something" by Nathan Yau
2. "Storytelling with Data: A Data Visualization Guide for Business Professionals" by Cole Nussbaumer Knaflic

Online Course

1. Data Visualization - https://www.freecodecamp.org/learn/data-visualization/

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Communicating complex data clearly
SDG 9	Industry, Innovation and Infra	Dashboards for decision-making
SDG 10	Reduced Inequalities	Making inequities visible
SDG 13	Climate Action	Climate and risk visualisation

SEMESTER – VI (Double Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS30002	Web Technologies	3	0	1	4
	CS30004	Theory of Computation	3	1	0	4
Minor (Opted by students from other departments)	CS32002	Web Designing	3	0	1	4
Electives (Choose ONE Set)	CS30052	Machine Learning	3	0	1	4
	CS30054	Neural Networks	3	0	1	4
	OR					
	CS30056	Data Mining	3	0	1	4
	CS30057	Data Visualization	3	0	1	4
Double Major IV (Opted by students from other departments)	CS30002	Web Technologies	3	0	1	4
Double Major V (Opted by students from other departments)	CS30004	Theory of Computation	3	1	0	4
Double Major VI (Opted by students from other departments) **Choose ONE**	CS30052	Machine Learning	3	0	1	4
	CS30054	Neural Networks	3	0	1	4
		Total				**32**

SEMESTER – VII (Single Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	

Core Course (Major)	CS40001	Computer Graphics	3	1	0	4
	IK40051	Scientific Research Methods	3	0	1	4
Minor (Opted by students from other departments)	CS42001	Introduction to Computer Graphics	3	1	0	4
Electives (Choose ONE Set)	CS40051	Computer Vision and Image Processing	3	0	1	4
	CS40053	Natural Language Processing	3	0	1	4
	OR					
	CS40055	Big Data Analytics	3	0	1	4
	CS40057	Machine Learning and Deep Learning	3	0	1	4
		Total				**20**

Course Title: Computer Graphics

Code	Course Title	Credit	L-T-P
CS40001	Computer Graphics	4	3-1-0

Course Objectives:

1. To provide students with advanced knowledge and practical skills in computer graphics.
2. Enabling them to design and implement complex graphical applications.
3. Critically evaluate and optimize graphical systems.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of computer graphics, graphics systems, display devices, coordinate systems, graphical transformations, and rendering techniques.
- **CO2 (Understanding):** Explain and interpret the principles of line, circle, and polygon generation algorithms, clipping techniques, windowing, viewing transformations, shading models, lighting techniques, and graphical rendering.
- **CO3 (Application):** Apply computer graphics algorithms, transformation techniques, rendering methods, and graphics programming tools to design and develop interactive two-dimensional and three-dimensional graphical applications.
- **CO4 (Analysis):** Analyze and compare graphical transformations, rendering algorithms, shading techniques, lighting models, clipping methods, and visualization approaches to develop efficient and realistic graphics applications.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate advanced computer graphics systems by integrating transformation techniques, rendering algorithms, shading and lighting models, animation principles, and graphics APIs to solve real-world visualization problems.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	-	-	-	3	3	-	-	-	-	-	-	-	-	2	-	2
CO3	-	-	-	3	-	3	-	-	-	-	-	-	-	-	2	-
CO4	-	-	-	-	-	-	3	-	-	-	-	-	2	-	-	-
CO5	-	-	3	-	-	-	-	3	-	-	-	-	-	-	-	2

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Computer Graphics [8 Classroom Contact Hours]

Overview of computer graphics and applications, Graphics systems and models, Basic rendering techniques

Unit 2: 3D Modeling and Transformation [10 Classroom Contact Hours]

Geometric transformations, 3D modeling and viewing, Hierarchical modeling

Unit 3: Illumination and Shading [9 Classroom Contact Hours]

Light, color, and materials, Illumination models and shading techniques, Texture mapping and bump mapping

Unit 4: Advanced Rendering Techniques [8 Classroom Contact Hours]

Ray tracing and radiosity, Global illumination models, Real-time rendering techniques

Unit 5: Graphics Programming and GPU [10 Classroom Contact Hours]

Graphics programming with OpenGL and shaders, GPU architecture and parallel processing, Advanced topics in GPU-based rendering

- **Textbook**:

1. "Computer Graphics: Principles and Practice" by John F. Hughes, Andries van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner, and Kurt Akeley

- **Reference Books**:

1. "Real-Time Rendering" by Tomas Akenine-Möller, Eric Haines, and Naty Hoffman
2. "Fundamentals of Computer Graphics" by Steve Marschner and Peter Shirley

SWAYAM Course

1. Computer Graphics - https://onlinecourses.nptel.ac.in/noc24_cs82/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Visual computing literacy

SDG 9	Industry, Innovation and Infra	Basis for visualization, HCI, media

Course Title: Scientific Research Methods

Code	Course Title	Credit	L-T-P
IK40051	Scientific Research Methods	4	3-0-1

Course Objectives:

This course introduces students to the principles and methodologies of scientific research. It develops skills in research design, literature review, hypothesis formulation, data collection, statistical analysis, ethical research practices, scientific writing, and publication, enabling students to conduct independent, rigorous, and high-quality research in interdisciplinary scientific and technological domains.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of scientific research, research methodologies, research ethics, literature review, hypothesis formulation, research design, and data collection techniques.
- **CO2 (Understanding):** Explain and interpret the principles of qualitative and quantitative research methods, sampling techniques, statistical analysis, experimental design, research ethics, intellectual property rights, and scholarly communication.
- **CO3 (Application):** Apply appropriate research methodologies, statistical tools, and data analysis techniques to formulate research problems, conduct scientific investigations, and interpret research findings.
- **CO4 (Analysis):** Analyze research literature, evaluate experimental results, assess the validity and reliability of data, and critically examine scientific findings using appropriate analytical and statistical methods.
- **CO5 (Synthesis/Evaluation):** Design and conduct independent research by integrating scientific methodologies, ethical practices, statistical analysis, and academic writing skills to prepare research proposals, technical reports, dissertations, and research publications.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	2	–	2	2	3	1	–	2	2	3	2	1	–	2	2
CO2	–	2	–	3	–	3	–	3	2	–	2	–	3	–	3	1
CO3	1	3	2	3	1	3	1	2	2	–	2	–	2	1	3	2
CO4	–	2	3	2	–	2	1	3	2	–	2	–	2	–	2	2
CO5	3	2	2	2	2	3	–	1	2	2	3	1	1	–	2	2

Course Duration: 45 hours

Course Syllabus:

Unit 1: Scope of Research [5 Classroom Contact Hours]

Introduction, overview of research process: define research problem, review literature, formulate hypothesis, design research/experiment, collect and analyse data, interpret and report, scope and importance.

Unit 2: Literature Survey, Databases and Research metrics [15 Classroom Contact Hours]

Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, Digital: Databases and their responsible use: Google Scholar, Web of science, Scopus, UGC INFONET, SciFinder, PubMed, ResearchGate, E-consortium, e-books; Search techniques: Phrase, Field, Boolean, Proximity, Concept, Limiting/Refining Search Results. Research metrics: Impact factor of Journal, h-index, i10 index, Altmetrics, Citation index. Author identifiers/or profiles: ORCID, Publons, Google Scholar, ResearchGate, VIDWAN.

Unit 3: Communication in Science [13 Classroom Contact Hours]

Types of technical documents: Full length research paper, book chapters, reviews, short communication, project proposal, Letters to editor, and thesis. Thesis writing – different steps and software tools (Word processing, LaTeX, Chemdraw, Chemsketch etc) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, Illustrations and tables, bibliography, referencing: Styles (APA, Oxford etc), annotated bibliography, Citation management tools: Mendeley, Zotero and Endnote; footnotes. Oral presentation/posters – planning, software tools, creating and making effective presentation, use

of visual aids, importance of effective communication, electronic manuscript submission, effective oral scientific communication and presentation skills.

Unit 4: Ethical Practices in Research and Publication [12 Classroom Contact Hours]

Scientific Conduct: Ethics with respect to science and research, Scientific Misconducts: falsification, fabrication and plagiarism, similarity index, software tools for finding plagiarism (Turnitin, Urkund etc), redundant dublications Publication Ethics: Introduction, COPE (Committee on Publication Ethics) guidelines; conflicts of interest, publication misconduct: problems that lead to unethical behaviour and vice versa, types, violation of publication ethics, authorship and contributorship, predatory publishers and journals IPR - Intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS).

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Collection of journal articles on a particular topic using Google Scholar and creating a database.
2. Collection of journal articles on a particular topic using Science Direct and creating a database.
3. Collection of journal articles on a particular topic using Scopus and creating a database.
2. Drawing chemical structure, reactions and mechanisms using Chemsketch or ISIS draw or any other software.
3. Collection of chemical structure using ChemSpider and creating a database.
4. Curve fitting using freely available softwares/apps (any one)
5. Making of power point presentation
6. Technical writing on topics assigned.
7. Demonstration for checking of plagiarism using recommended software

- **Reference Book:**

1. Kothari, C. R. & Garg, G. (2019). *Research Methodology: Methods and Techniques* (4th Edition). New Age International Publishers, New Delhi.
2. Day, R. A. & Gastel, B. (2024). *How to Write and Publish a Scientific Paper* (9th Edition). Cambridge University Press..

3. Gopalakrishnan, S. (2019). *Patent Law and Intellectual Property*. Eastern Book Company, Lucknow.
4. Bird, A. (2020). *Understanding Scientific Method*. Routledge, London..
5. Wallwork, A. (2020). *English for Writing Research Papers* (2nd Edition). Springer Nature, Cham.
6. Resnik, D. B. (2020). *The Ethics of Research with Human Subjects: Protecting People, Advancing Science, Promoting Trust*. Springer Nature, Cham.

SWAYAM Course

Research Methodology - https://onlinecourses.nptel.ac.in/noc24_ge41/preview

SDG Mapping for this Course

SDG No.	SDG Title	Rationale
SDG 4	Quality Education	Strengthens research skills, ethical awareness and scientific communication for higher education
SDG 9	Industry, Innovation & Infrastructure	Supports innovation through responsible research, data analysis and publication practices
SDG 16	Peace, Justice & Strong Institutions	Encourages integrity, transparency, accountability and trust in scientific research

Course Title: Introduction to Computer Graphics

Code	Course Title	Credit	L-T-P
CS42001	Introduction to Computer Graphics	4	3-1-0

Course Objectives:

This course introduces students to the fundamental concepts of computer graphics, graphical transformations, and image generation techniques. It develops skills in creating, manipulating, and displaying two-dimensional and three-dimensional graphics using standard algorithms and graphics tools while providing a foundation for animation, visualization, multimedia, and interactive application development.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of computer graphics, graphics systems, display devices, coordinate systems, graphical primitives, and image representation.
- **CO2 (Understanding):** Explain and interpret the principles of raster graphics, line and circle generation algorithms, two-dimensional and three-dimensional transformations, viewing techniques, clipping algorithms, and graphical modelling.
- **CO3 (Application):** Apply computer graphics algorithms and transformation techniques to create, manipulate, and display two-dimensional and three-dimensional graphical objects using appropriate graphics programming tools.
- **CO4 (Analysis):** Analyze graphics algorithms, rendering techniques, clipping methods, and viewing transformations to evaluate their efficiency and suitability for different graphics applications.
- **CO5 (Evaluation/Create):** Design and develop basic computer graphics applications by integrating graphical transformations, visualization techniques, and rendering methods while following standard graphics programming practices.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	2	2	-	3	3	-	-	-	-	-	-	-	-	2	-	3
CO3	-	-	-	2	-	2	-	-	-	-	-	-	-	-	2	-
CO4	-	-	-	-	-	-	3	-	-	-	-	-	2	-	-	-
CO5	-	-	3	-	-	-	-	2	-	-	-	-	-	-	-	2

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Computer Graphics [8 Classroom Contact Hours]

Introduction to computer graphics, applications of computer graphics, graphics systems and components, graphics hardware and software, display devices (CRT, LCD, LED).

Unit 2: Graphics Primitives and Drawing Algorithms [10 Classroom Contact Hours]
Points, lines, circles, polygons, and curves, line drawing algorithms (DDA and Bresenham's algorithm), circle drawing algorithms (Midpoint Circle Algorithm), polygon filling techniques.

Unit 3: Two-Dimensional and Three-Dimensional Transformations [10 Classroom Contact Hours]
Two-dimensional transformations: translation, rotation, scaling, reflection, and shearing; homogeneous coordinates; composite transformations. Three-dimensional transformations: translation, rotation, scaling, viewing transformations, projection techniques (parallel and perspective projections).

Unit 4: Viewing, Clipping, and Windowing [9 Classroom Contact Hours]
Viewing pipeline, window-to-viewport transformation, clipping concepts, line clipping algorithms (Cohen–Sutherland and Liang–Barsky), polygon clipping (Sutherland–Hodgman algorithm).

Unit 5: Computer Graphics Applications and Emerging Trends [8 Classroom Contact Hours]
Computer animation fundamentals, multimedia and image processing basics, color models (RGB, CMY, HSV), graphical user interfaces, virtual reality (VR), augmented reality (AR).

- **Textbook**:

1. "Computer Graphics: Principles and Practice" by John F. Hughes, Andries van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner, and Kurt Akeley

- **Reference Books**:

1. "Real-Time Rendering" by Tomas Akenine-Möller, Eric Haines, and Naty Hoffman
2. "Fundamentals of Computer Graphics" by Steve Marschner and Peter Shirley

SWAYAM Course

2. Computer Graphics - https://onlinecourses.nptel.ac.in/noc24_cs82/preview

SDG Mapping for this Course

SDG	Title	Contribution

SDG 4	Quality Education	Visual computing literacy
SDG 9	Industry, Innovation and Infra	Basis for visualization, HCI, media

Course Title: Computer Vision and Image Processing

Code	Course Title	Credit	L-T-P
CS40051	Computer Vision and Image Processing	4	3-0-1

Course Objectives:

1. This subject emphasis on fundamentals of Image processing and Computer vision.
2. Gain the knowledge of Image Formation, Image Enhancement and Segmentation.
3. Learn various feature extraction techniques.
4. Emphasis on core vision tasks through Motion estimation and Object as well as pattern recognition.
5. Explore the areas where automation can be possible through Image processing and Computer Vision.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of digital image processing, computer vision, image formation, image representation, color models, and image acquisition techniques.
- **CO2 (Understanding):** Explain and interpret the principles of image enhancement, image restoration, filtering, histogram processing, image transformations, and image formation techniques.
- **CO3 (Application):** Apply image segmentation, feature extraction, feature matching, and computer vision algorithms using appropriate tools and libraries to solve real-world image analysis problems.
- **CO4 (Analysis):** Analyze and compare object detection, object recognition, motion estimation, image segmentation, and feature extraction techniques to develop efficient computer vision solutions.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate image processing and computer vision systems by integrating advanced algorithms, deep learning techniques,

and computer vision frameworks to solve real-world applications and support research and innovation.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	1	2	-
CO2	-	-	-	3	2	-	-	-	-	-	-	-	2	1	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	2	2	2	-
CO4	-	-	3	-	-	-	-	-	-	-	-	-	2	2	-	2
CO5	-	-	-	-	-	3	-	-	-	-	-	-	2	3	-	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Image Processing [8 Classroom Contact Hours]

Digital Image fundamentals, Image Sensing and acquisition, Sampling and Quantization, Image formation models, Overview of Computer Vision, Applications of Image processing and Computer Vision

Unit 2: Image enhancement [10 Classroom Contact Hours]

Image Enhancement: Image enhancement in spatial domain, Basic grey level Transformations, Histogram Processing Techniques , Spatial Filtering , Image smoothing and Image Sharpening, Image enhancement process in frequency domain, Low pass filtering, High pass filtering

Unit 3: Image Segmentation [9 Classroom Contact Hours]

Image Segmentation: point, line and edge detection, Thresholding, Regions Based segmentation, Edge linking and boundary detection

Unit 4: Feature Extraction [10 Classroom Contact Hours]

Feature Extraction: Importance of Features, Feature extraction techniques, Histogram of Oriented Gradient (HOG), Scale Invariant Feature Transform (SIFT), Background subtraction techniques, Image Matching

Unit 5: Application of Image Processing [8 Classroom Contact Hours]

Applications of Image Processing and Computer vision, Face Recognition, Facial Expression Recognition, Optical Character Recognition, Automated Video Surveillance

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Implement various grey level transformations for Image Enhancement.
2. Implement Histogram Equalization technique.
3. Write a Program to apply convolution processes on an input image for image smoothing.
4. Implement Histogram of Oriented Gradient (HOG) for Feature extraction.
5. Write a Program to apply Scale Invariant Feature Transform on input image.
6. Implement frame differencing technique for background subtraction from video.
7. Implement object detection algorithm YOLO.
8. Implement R-CNN algorithms for object detection.
9. Implement Object recognition.
10. Implement Facial Expression Recognition.

- **Textbook:**

1. **"**Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods

- **Reference Books:**

1. Digital Image Processing- Refael C. Gonzalez and Richard E. Woods, Wesley
2. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.
3. Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Publisher: Prentice Hall.
4. Computer Vision, D. H. Ballard, C. M. Brown, Prentice-Hall, Englewood Cliffs, 1982

SDG Mapping for this Course

SDG	Title	Contribution
SDG 3	Good Health and Well-being	Medical imaging use-cases
SDG 9	Industry, Innovation and Infra	Automation, quality control, robotics
SDG 10	Reduced Inequalities	Critical view of biased vision systems
SDG 13	Climate Action	Vision for climate/land-use monitoring

Natural Language Processing

Code	Course Title	Credit	L-T-P
CS40053	Natural Language Processing	4	3-0-1

Course Objectives:

1. To equip students with the ability to synthesize and apply advanced concepts in Natural Language Processing (NLP) for complex problem-solving.
2. Fostering critical thinking, analytical reasoning, and research-related skills in a multicultural and inclusive technological environment.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of natural language processing, text preprocessing, linguistic structures, language models, tokenization, and syntax and semantics.
- **CO2 (Understanding):** Explain and interpret the principles of text representation, feature extraction, sequence modeling, word embeddings, machine learning, and deep learning techniques used in natural language processing.
- **CO3 (Application):** Apply NLP techniques, machine learning algorithms, deep learning frameworks, and language processing tools to develop intelligent applications for text classification, sentiment analysis, machine translation, information retrieval, and question answering.

  CO4 (Analysis): Analyze and compare NLP models, language representation techniques, transformer architectures, evaluation metrics, and optimization methods to develop efficient and accurate language processing systems.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate advanced NLP solutions by integrating language models, deep learning techniques, transformer-based architectures, ethical AI principles, and multilingual processing to address real-world language understanding and generation tasks.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	3	-	-	-	-	-	-	-	-	3	3	2	2
CO2	-	-	-	-	2	3	-	3	-	-	-	-	3	3	2	2
CO3	-	-	-	-	2	-	3	-	-	-	-	-	2	3	-	2
CO4	-	-	3	-	-	-	-	-	-	-	-	3	2	3	2	-
CO5	-	-	-	-	-	-	-	-	3	-	-	-	2	2	-	2

Course Duration: 45 hours

Course Syllabus:

Unit 1: Foundations of NLP [9 Classroom Contact Hours]

Linguistic fundamentals, Text preprocessing and normalization, Language models and word embeddings, Syntax and parsing techniques

Unit 2: Machine Learning for NLP [9 Classroom Contact Hours]

Supervised and unsupervised learning in NLP, Sequence models: RNNs, LSTMs, and GRUs, Attention mechanisms and transformers, Pretrained language models (BERT, GPT)

Unit 3: Semantic Analysis [9 Classroom Contact Hours]

Word sense disambiguation, Semantic role labeling, Coreference resolution, Sentiment analysis and opinion mining

Unit 4: NLP Applications [9 Classroom Contact Hours]

Machine translation, Question answering systems, Information extraction and retrieval, Dialogue systems and chatbots

Unit 5: Emerging Trends and Ethical Considerations [9 Classroom Contact Hours]

Multilingual NLP and low-resource languages, NLP for social media analysis, Bias and fairness in NLP models, Privacy and ethical issues in NLP

Total Practical / Lab Experiments: [22 Lab Contact Hours]

1. Text pre-processing and tokenization
2. Building n-gram language models

3. Implementing a named entity recognition system
4. Creating a sentiment analysis model
5. Developing a chatbot with a sequence-to-sequence model
6. Fine-tuning BERT for text classification
7. Designing a machine translation system
8. Constructing a question answering model
9. Analyzing social media data for trend detection
10. Addressing bias in word embeddings
11. Coreference resolution in documents
12. Semantic role labeling of sentences
13. Information retrieval from a corpus
14. Summarization of news articles
15. Opinion mining from product reviews
16. Multilingual NLP for cross-lingual transfer
17. Privacy-preserving text generation
18. Ethical considerations in NLP applications
19. Implementing attention mechanisms in neural networks
20. Exploring the use of transformers in NLP tasks

- **Textbook:**
  1. "Speech and Language Processing" by Dan Jurafsky and James H. Martin

- **Reference Books:**
  1. "Foundations of Statistical Natural Language Processing" by Christopher D. Manning and Hinrich Schütze
  2. "Natural Language Processing with PyTorch" by Delip Rao and Brian McMahan

SWAYAM Courses

1. Natural Language Processing - https://onlinecourses.nptel.ac.in/noc24_cs39/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Access via translation, summarisation
SDG 5	Gender Equality	Tools to analyse gendered discourse
SDG 10	Reduced Inequalities	Language tech for minority/tribal tongues
SDG 16	Peace, Justice & Institutions	NLP for civic data, hate-speech detection

Big Data Analytics

Code	Course Title	Credit	L-T-P
CS40055	Big Data Analytics	4	3-0-1

Course Objectives:

1. To provide students with a comprehensive understanding of big data analytics, equipping them with the ability to perform complex problem-solving and critical thinking.
2. The course will develop analytical reasoning, research-related skills, and digital literacy, while fostering cooperative teamwork, leadership readiness, and a multicultural competence.
3. Students will enhance their communication skills, gain environmental awareness, and understand the importance of sustainability.
4. The course promotes autonomy, responsibility, accountability, and encourages self-directed learning and lifelong learning.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of big data, big data analytics, distributed computing, Hadoop ecosystem, data storage, and data processing frameworks.
- **CO2 (Understanding):** Explain and interpret the principles of distributed file systems, MapReduce, Apache Spark, NoSQL databases, data ingestion, and big data analytics techniques.

- **CO3 (Application):** Apply big data technologies, distributed computing frameworks, and analytical tools to process, manage, and analyze large-scale structured and unstructured datasets for real-world applications.
- **CO4 (Analysis):** Analyze and compare big data architectures, processing frameworks, storage technologies, analytics methods, and performance optimization techniques to develop efficient and scalable data-driven solutions.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate scalable big data analytics solutions by integrating distributed computing platforms, advanced analytics techniques, visualization tools, and ethical data management practices to support informed decision-making and sustainable development.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	3	-	-	-	-	-	-	-	-	2	3	-	3
CO2	-	-	-	-	2	3	-	3	-	-	-	-	-	3	2	2
CO3	-	-	-	-	-	-	3	-	-	3	-	-	-	1	-	-
CO4	-	-	3	-	-	-	-	-	-	-	-	-	2	-	2	3
CO5	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Foundations of Big Data [8 Classroom Contact Hours]

Introduction to Big Data: Concepts and Characteristics, Big Data Technologies: Hadoop, MapReduce, and Spark, Data Sources and Data Collection Techniques

Unit 2: Big Data Management [10 Classroom Contact Hours]

Data Storage and Processing Architectures, Distributed File Systems and Databases, Data Integration, Cleaning, and Transformation

Unit 3: Big Data Analytics and Mining [10 Classroom Contact Hours]

Descriptive, Predictive, and Prescriptive Analytics, Data Mining Techniques and Algorithms, Real-time Analytics and Stream Processing

Unit 4: Machine Learning for Big Data [8 Classroom Contact Hours]

Supervised and Unsupervised Learning, Scalable Machine Learning Algorithms, Deep Learning and Neural Networks for Big Data

Unit 5: Ethical and Legal Aspects of Big Data [9 Classroom Contact Hours]

Data Privacy and Security Challenges, Ethical Implications of Big Data, Regulatory Compliance and Data Governance

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Setting up a Hadoop cluster
2. Implementing MapReduce jobs
3. Building Spark applications
4. Data cleaning and preprocessing
5. Designing a NoSQL database schema
6. Integrating heterogeneous data sources
7. Conducting exploratory data analysis
8. Developing predictive models with machine learning
9. Real-time data stream processing
10. Neural network implementation for large datasets
11. Visualization of big data insights
12. Ethical case studies in big data
13. Security measures for big data storage
14. Compliance audit for data governance
15. Big data project management simulation
16. Collaborative data science project
17. Workshop on communication of data analytics
18. Environmental impact assessment of big data projects
19. Self-directed research on a big data topic
20. Capstone project integrating multiple aspects of big data analytics

- **Textbook:**
  1. "Big Data: Principles and Best Practices of Scalable Realtime Data Systems" by Nathan Marz and James Warren

- **Reference Books:**
  1. "Data-Intensive Text Processing with MapReduce" by Jimmy Lin and Chris Dyer
  2. "Learning Spark: Lightning-Fast Big Data Analysis" by Holden Karau, Andy Konwinski, Patrick Wendell, and Matei Zaharia
  3. "Hadoop: The Definitive Guide" by Tom White

SWAYAM Courses

1. Big Data Computing - https://onlinecourses.nptel.ac.in/noc24_cs130/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 3	Good Health and Well-being	Health and epidemic big-data
SDG 4	Quality Education	High-end analytics competence
SDG 9	Industry, Innovation and Infra	Data-driven innovation at scale
SDG 10	Reduced Inequalities	Macro-level inequality analysis
SDFG 13	Climate Action	Climate / energy large-scale analytics

Course Title: Machine Learning and Deep Learning

Code	Course Title	Credit	L-T-P
CS40057	Machine Learning and Deep Learning	4	3-0-1

Course Objectives:

1. To provide students with a comprehensive understanding of machine learning and deep learning.

2. Enabling them to develop solutions for complex problems, think critically about data.
3. Engage in research with a spirit of teamwork and inclusivity.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of deep learning, artificial neural networks, perceptrons, activation functions, learning algorithms, and deep neural network architectures.
- **CO2 (Understanding):** Explain and interpret the principles of feedforward neural networks, convolutional neural networks (CNNs), recurrent neural networks (RNNs), long short-term memory (LSTM) networks, transformers, optimization techniques, and model evaluation methods.
- **CO3 (Application):** Apply deep learning algorithms, neural network frameworks, and optimization techniques to design, train, and implement intelligent models for image processing, natural language processing, speech recognition, and other real-world applications.
- **CO4 (Analysis):** Analyze and compare deep learning architectures, optimization algorithms, loss functions, regularization methods, transfer learning techniques, and performance evaluation metrics to develop efficient and accurate predictive models.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate advanced deep learning solutions by integrating appropriate neural network architectures, optimization strategies, transfer learning, explainable AI, and ethical AI practices to address complex real-world problems across diverse domains.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	3	-	-	-	-	-	-	-	-	3	3	2	2
CO2	-	-	-	-	2	3	-	3	-	-	-	-	3	3	2	2
CO3	-	-	-	-	3	-	3	-	-	-	-	-	2	2	2	2
CO4	-	-	3	-	-	-	-	-	-	-	-	3	3	2	2	3

CO5	-	-	-	-	-	-	-	-	3	-	-	-	2	2	2	3

Course Duration: 60 hours

Course Syllabus:

Unit 1: Introduction to Machine learning [9 Classroom Contact Hours]

Fundamentals of machine learning, Machine learning process, Types of machine learning with example, Overview of data, collection of data

Unit 2: Deep Learning Architectures [12 Classroom Contact Hours]

Convolutional Neural Networks (CNNs),Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM) networks, Autoencoders and Generative Adversarial Networks (GANs)

Unit 3: Optimization and Regularization Techniques [6 Classroom Contact Hours]

Advanced optimization algorithms, Regularization methods, Hyperparameter tuning, Model evaluation and validation

Unit 4: Applications of Neural Networks [9 Classroom Contact Hours]

Image and speech recognition, Natural language processing, Reinforcement learning, Neural networks in industry

Unit 5: Current Trends and Ethical Considerations [9 Classroom Contact Hours]

Transfer learning and few-shot learning, Interpretability and explainability of models, Ethical implications of AI, Future directions in neural networks and deep learning

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Implementing a perceptron from scratch
2. Training a CNN for image classification
3. Using RNNs for time series prediction
4. Building an LSTM for text generation
5. Creating a GAN for image generation
6. Applying transfer learning to a new dataset

7. Optimizing neural networks with advanced algorithms
8. Regularizing models to prevent overfitting
9. Tuning hyperparameters for better model performance
10. Validating models using cross-validation techniques
11. Developing a speech recognition system
12. Processing natural language for sentiment analysis
13. Designing a reinforcement learning agent
14. Analyzing the impact of AI in healthcare
15. Exploring the interpretability of neural networks
16. Discussing the ethical considerations of AI deployment
17. Investigating the role of AI in environmental sustainability
18. Engaging in self-directed learning to explore a new deep learning library
19. Collaborating on a team project to solve a real-world problem using neural networks
20. Presenting a research proposal on a novel application of deep learning

- **Textbook:**
  1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

- **Reference Books:**
  1. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal
  2. "Pattern Recognition and Machine Learning" by Christopher M. Bishop

SWAYAM Courses

Deep Learning - IIT Ropar - https://onlinecourses.nptel.ac.in/noc24_cs114/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 3	Good Health and Well-being	Predictive models in health
SDG 4	Quality Education	Advanced analytical skill-building
SDG 9	Industry, Innovation and Infra	Intelligent systems development
SDG 10	Reduced Inequalities	Models for inclusion, risk of bias focus
SDG 13	Climate Action	Climate/agri prediction models

SEMESTER – VII (Double Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS40001	Computer Graphics	3	1	0	4
	IK40051	Scientific Research Methods	3	0	1	4
Minor (Opted by students from other departments)	CS42001	Introduction to Computer Graphics	3	1	0	4
Electives (Choose ONE set)	CS40051	Computer Vision and Image Processing	3	0	1	4
	CS40053	Natural Language Processing	3	0	1	4
	OR					
	CS40055	Big Data Analytics	3	0	1	4
	CS40057	Machine Learning and Deep Learning	3	0	1	4
Double Major VII (Opted by students from other departments)	CS40001	Computer Graphics	3	1	0	4
		Total				**24**

SEMESTER – VIII (Single Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS40002	Compiler Design	3	1	0	4
	RD40082	Research and Dissertation	0	0	12	12

Minor (Opted by students from other departments)	CS42002	Compiler Development	3	1	0	4
Without Dissertation	CS40004	Internet of Things	3	1	0	4
	CS40006	Blockchain Technologies	3	1	0	4
	CS40008	Cloud Computing	3	0	1	4
		Total				**20**

Course Title: Compiler Design

Code	Course Title	Credit	L-T-P
CS40002	Compiler Design	4	3-1-0

Course Objectives:

1. To provide students with an in-depth understanding of compiler construction.
2. Enabling them to design and analyze compilers that efficiently translate high-level programming languages into machine code.
3. Fostering complex problem-solving and critical thinking skills.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of compiler design, language processors, lexical analysis, syntax analysis, parsing techniques, and compiler phases.

- **CO2 (Understanding):** Explain and interpret the principles of lexical analysis, syntax-directed translation, semantic analysis, symbol table management, intermediate code generation, and error handling techniques.
- **CO3 (Application):** Apply compiler construction techniques, parsing algorithms, intermediate code generation, code optimization methods, and runtime environment concepts to develop compiler components for programming languages.
- **CO4 (Analysis):** Analyze and compare parsing methods, syntax analysis techniques, code optimization strategies, runtime environments, and compiler design approaches to improve the efficiency and performance of compilers.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate compiler components by integrating lexical analysis, parsing, semantic analysis, intermediate code generation, code optimization, runtime environments, and target code generation for efficient language processing.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-
CO2	-	-	-	3	2	3	-	-	-	-	-	-	2	3	-	3
CO3	-	-	-	3	-	-	-	3	-	-	-	3	2	3	-	-
CO4	-	-	-	-	-	-	3	-	-	3	-	-	-	-	3	3
CO5	-	-	3	-	-	-	-	-	-	-	-	-	1	-	-	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Compiler Design [9 Classroom Contact Hours]

Overview of compilation process, Lexical analysis and token generation, Syntax analysis and parsing techniques

Unit 2: Syntax-Directed Translation [9 Classroom Contact Hours]

Syntax-directed definitions and translations, Parsing and parse trees, Intermediate code generation

Unit 3: Type Checking and Runtime Environments [9 Classroom Contact Hours]
Semantic analysis and type checking, Symbol tables and scope management, Runtime environments and memory management

Unit 4: Code Optimization [9 Classroom Contact Hours]
Principles of code optimization, Optimization techniques and algorithms, Data-flow analysis and loop optimization

Unit 5: Code Generation and Linking [9 Classroom Contact Hours]
Target code generation and instruction selection, Register allocation and assignment, Linking and loading processes

- **Textbook**:
  1. "Compilers: Principles, Techniques, and Tools" by Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman

- **Reference Books**:
  1. "Engineering a Compiler" by Keith D. Cooper and Linda Torczon
  2. "Modern Compiler Implementation in C" by Andrew W. Appel

SWAYAM Courses

Compiler Design - https://onlinecourses.nptel.ac.in/noc24_cs18/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Advanced systems understanding
SDG 9	Industry/Infra	Toolchain foundations for software
SDG 12	Responsible Prod.	Efficient, optimised software output

Course Title: Research and Dissertation

Code	Course Title	Credit	L-T-P
RD40082	Research and Dissertation	12	0-0-12

Course Objectives:

1. To develop independent research and analytical skills
2. To apply computing knowledge to real-world or theoretical problems
3. To gain hands-on experience in designing and implementing solutions
4. To enhance scientific writing and communication skills

Course Outcomes

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the principles of research problem identification, research objectives, hypothesis formulation, and literature review to establish a clear and relevant research problem.
- **CO2 (Understanding):** Explain and interpret research methodologies, experimental design, data collection techniques, and ethical research practices for conducting systematic scientific investigations.
- **CO3 (Application):** Apply appropriate research methodologies, computational tools, and domain knowledge to design, develop, and implement a working solution, model, or prototype for the identified research problem.
- **CO4 (Analysis):** Analyze experimental results using statistical, computational, and scientific methods to validate findings, evaluate performance, and draw meaningful conclusions.
- **CO5 (Synthesis/Evaluation):** Design, prepare, and evaluate a comprehensive dissertation report by integrating research findings, technical contributions, scientific writing, and professional presentation skills to effectively communicate the outcomes of the research.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	2	3	3	2	–	–	2	–	–	2	-	2	2	-
CO2	3	3	2	3	3	3	2	–	2	2	2	2	-	1	-	2
CO3	2	3	3	3	3	3	3	2	2	3	3	3	2	3	2	-
CO4	2	2	3	2	2	3	3	2	2	3	3	3	-	2	-	-
CO5	2	2	3	2	2	3	3	3	2	3	3	3	-	-	2	2

Course Duration: 270 hours

Course Syllabus:

UNIT 1: Research Foundations & Problem Identification [50 Lab Contact Hours]

Introduction to research in Computer Science, Types of research: basic, applied, experimental, Identification of research areas (AI, Data Science, IoT, etc.), Problem formulation, objectives, and scope, Feasibility study and planning

UNIT 2: Literature Review & Research Methodology [58 Lab Contact Hours]

Sources of literature: journals, conferences, digital libraries, Review techniques and gap identification, Citation and referencing styles (IEEE/APA), Research methodology: qualitative and quantitative approaches, Experimental design and hypothesis formulation

UNIT 3: System Design & Implementation [60 Lab Contact Hours]

System architecture design, Algorithm/model selection, Dataset identification and preprocessing, Tools and technologies selection, Coding, testing, and debugging

UNIT 4: Experimentation, Analysis & Validation [30 Lab Contact Hours]

Performance metrics (Accuracy, Precision, Recall, F1-score), Statistical and comparative analysis, Result visualization (graphs, charts), Interpretation and validation of results

UNIT 5: Dissertation Writing, Ethics & Defense [72 Lab Contact Hours]

Structure of dissertation: (Abstract, Introduction, Literature Review, Methodology, Implementation, Results & Discussion, Conclusion & Future Work), Research ethics, plagiarism, and IPR, Report formatting (IEEE/APA), Presentation, demonstration, and viva voce

- **Reference Books**

1. C. R. Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, 4th Edition, New Age International Publishers, 2019.
2. Roger S. Pressman and Bruce R. Maxim, Software Engineering: A Practitioner's Approach, 9th Edition, McGraw-Hill Education, 2019.
3. Ian Sommerville, Software Engineering, 10th Edition, Pearson Education, 2016.
4. Robert C. Martin, Clean Code: A Handbook of Agile Software Craftsmanship, Pearson Education, 2008.
5. Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup, and William T. FitzGerald, The Craft of Research, 4th Edition, University of Chicago Press, 2016.
6. Turabian, Kate L., A Manual for Writers of Research Papers, Theses, and Dissertations, 9th Edition, University of Chicago Press, 2018.
7. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, Introduction to Algorithms, 4th Edition, MIT Press, 2022.
8. Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, Design Patterns: Elements of Reusable Object-Oriented Software, Addison-Wesley, 1994.

- **Online Resources**

1. IEEE Xplore Digital Library (https://ieeexplore.ieee.org)
2. ACM Digital Library (https://dl.acm.org)
3. SpringerLink (https://link.springer.com)
4. ScienceDirect (https://www.sciencedirect.com)
5. Google Scholar (https://scholar.google.com)

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Research capacity building
SDG 9	Industry, Innovation and Infra	Innovating solutions/research prototypes
SDG 10	Reduced Inequalities	Work on tribal/indigenous issues
SDG 13	Climate Action	Topics on environment, resilience
SDG 16	Peace, Justice & Institutions	Governance, rights, ICT4D research

Course Title: Compiler Development

Code	Course Title	Credit	L-T-P
CS42002	Compiler Development	4	3-1-0

Course Objectives:

This course introduces students to the fundamental concepts of compiler development, language translation, lexical analysis, syntax analysis, semantic analysis, code generation, and optimization. It develops problem-solving and analytical skills while providing a foundation for understanding programming language implementation, software development tools, and modern computing systems.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of compiler development, language translators, phases of a compiler, lexical analysis, syntax analysis, semantic analysis, and symbol table management.
- **CO2 (Understanding):** Explain and interpret the principles of lexical analysis, parsing techniques, syntax-directed translation, intermediate code generation, error handling, and runtime environment concepts.
- **CO3 (Application):** Apply compiler design techniques and appropriate tools to construct lexical analyzers, parsers, intermediate code representations, and simple language processing applications.
- **CO4 (Analysis):** Analyze programming language constructs, parsing methods, intermediate code generation techniques, and code optimization strategies to evaluate the efficiency and correctness of compiler components.
- **CO5 (Evaluation/Create):** Design and develop basic compiler components by integrating lexical analysis, syntax analysis, semantic processing, intermediate code generation, and optimization techniques while following standard compiler design practices.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-
CO2	-	-	-	3	2	3	-	-	-	-	-	-	2	3	-	3
CO3	-	-	-	3	-	-	-	3	-	-	-	3	2	3	-	-
CO4	-	-	-	-	-	-	3	-	-	3	-	-	-	-	3	3
CO5	-	-	3	-	-	-	-	-	-	-	-	-	1	-	-	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Compiler Development [8 Classroom Contact Hours]

Introduction to language processors, compiler, interpreter and assembler, phases of a compiler, compiler architecture, overview of programming languages, applications of compiler technology.

Unit 2: Lexical Analysis and Syntax Analysis [10 Classroom Contact Hours]

Role of lexical analysis, tokens, lexemes, patterns, regular expressions, finite automata, lexical analyzer generation, introduction to parsing, context-free grammars (CFG), parse trees, introduction to LR parsing.

Unit 3: Semantic Analysis and Intermediate Code Generation [10 Classroom Contact Hours]

Syntax-directed definitions, syntax-directed translation, attributed grammars, semantic analysis, type checking, symbol table implementation, intermediate code generation, three-address code, quadruples, triples.

Unit 4: Code Optimization and Code Generation [9 Classroom Contact Hours]

Introduction to code optimization, basic blocks, flow graphs, local optimization techniques, common sub expression elimination, constant folding, dead code elimination.

Unit 5: Modern Compiler Techniques and Applications [8 Classroom Contact Hours]

Introduction to compiler construction tools (Lex/Flex and Yacc/Bison), just-in-time (JIT) compilation, virtual machines, bytecode, interpreters, compiler support for modern programming languages.

- **Textbook**:
  1. "Compilers: Principles, Techniques, and Tools" by Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman

- **Reference Books**:
  1. "Engineering a Compiler" by Keith D. Cooper and Linda Torczon
  2. "Modern Compiler Implementation in C" by Andrew W. Appel

SWAYAM Courses

Compiler Design - https://onlinecourses.nptel.ac.in/noc24_cs18/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Advanced systems understanding
SDG 9	Industry/Infra	Toolchain foundations for software
SDG 12	Responsible Prod.	Efficient, optimised software output

Course Title: Internet of Things

Code	Course Title	Credit	L-T-P
CS40004	Internet of Things	4	3-1-0

Course Objectives:

1. To provide students with a comprehensive understanding of the Internet of Things (IoT) ecosystem, including its architecture, technologies, and applications.
2. Enabling them to design and implement IoT solutions that address complex problems and contribute to sustainable development.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of the Internet of Things (IoT), IoT architecture, sensors, actuators, embedded systems, communication protocols, and IoT applications.
- **CO2 (Understanding):** Explain and interpret the principles of IoT communication protocols, networking technologies, cloud computing, edge computing, data acquisition, and IoT data management techniques.
- **CO3 (Application):** Apply IoT hardware platforms, communication protocols, cloud services, and programming tools to design, develop, and deploy secure IoT-based solutions for real-world applications.
- **CO4 (Analysis):** Analyze and compare IoT architectures, communication protocols, security mechanisms, data management strategies, and IoT platforms to develop efficient, scalable, and sustainable IoT systems.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate innovative IoT solutions by integrating sensing technologies, embedded systems, cloud platforms, security mechanisms, and data analytics to address industrial, environmental, healthcare, and smart city challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-	2
CO2	-	-	-	3	-	-	-	3	-	-	-	-	-	3	2	-
CO3	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO4	-	-	-	-	-	-	3	-	-	3	-	-	3	-	2	-
CO5	-	-	3	-	-	-	-	-	3	-	-	-	-	2	-	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to IoT [9 Classroom Contact Hours]

Overview of IoT and its significance, IoT architecture and design principles, Sensors, actuators, and smart objects

Unit 2: IoT Communication Technologies [9 Classroom Contact Hours]

Wired and wireless communication protocols, Networking for IoT: LAN, PAN, and mesh networks, IoT standards and ecosystems

Unit 3: IoT Data Management and Analytics [9 Classroom Contact Hours]
Data acquisition, preprocessing, and storage, Big data analytics in IoT, Cloud computing and IoT integration

Unit 4: IoT Security and Privacy [9 Classroom Contact Hours]
Security challenges in IoT, Privacy concerns and data protection, Secure IoT design and best practices

Unit 5: IoT Applications and Future Trends [9 Classroom Contact Hours]
Smart cities, homes, and grids, Industrial IoT and automation, Future trends and challenges in IoT

- **Textbook**:
  1. "Internet of Things: Principles and Paradigms" edited by Rajkumar Buyya and Amir Vahid Dastjerdi
- **Reference Books**:
  1. "Internet of Things: A Hands-On Approach" by Arshdeep Bahga and Vijay Madisetti
  2. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases" by Pethuru Raj

SWAYAM Course

1. Introduction to Internet of Things - https://onlinecourses.nptel.ac.in/noc24_cs115/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 3	Good Health and Well-being	Health and assistive IoT
SDG 7	Affordable and Clean Energy	Smart metering, energy monitoring
SDG 9	Industry, Innovation and Infra	Connected infrastructure
SDG 11	Sustainable Cities/Communities	Smart city / village applications
SDG 13	Climate Action	Environmental sensing networks

Blockchain Technologies

Code	Course Title	Credit	L-T-P
CS40006	Com Blockchain Technologies	4	3-1-0

Course Objectives:

1. To provide students with a comprehensive understanding of blockchain technology, its underlying principles, and its applications.
2. Enabling them to design and implement blockchain solutions that address complex problems and contribute to technological innovation.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of blockchain technology, distributed ledger systems, cryptographic techniques, consensus mechanisms, blockchain architecture, and decentralized networks.
- **CO2 (Understanding):** Explain and interpret the principles of blockchain architectures, consensus algorithms, cryptocurrency, distributed transactions, smart contracts, decentralized applications (DApps), and blockchain security.
- **CO3 (Application):** Apply blockchain platforms, smart contract programming, decentralized application development, and cryptographic techniques to design and implement secure blockchain-based solutions for real-world applications.
- **CO4 (Analysis):** Analyze and compare blockchain platforms, consensus protocols, smart contract frameworks, security mechanisms, and enterprise blockchain solutions to identify appropriate technologies for diverse application domains.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate blockchain-based systems by integrating distributed ledger technologies, smart contracts, decentralized applications, security mechanisms, and governance models to address business, industrial, and societal challenges.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	3	-	-	-	-	-	-	-	-	3	3	-	-
CO2	-	3	-	3	2	3	-	-	-	-	-	-	2	3	2	2
CO3	-	-	-	-	-	-	3	-	-	3	-	-	-	3	-	2
CO4	-	-	-	-	-	-	-	3	-	-	-	-	2	-	2	-
CO5	-	-	3	-	-	-	-	-	-	-	-	3	-	-	2	3

Course Duration: 48 hours

Course Syllabus:

Unit 1: Introduction to Blockchain [9 Classroom Contact Hours]

Fundamentals of blockchain technology, History and evolution of blockchain, Cryptography and security principles

Unit 2: Blockchain Architecture [9 Classroom Contact Hours]

Distributed ledger technology, Consensus algorithms, Smart contracts and decentralized applications

Unit 3: Blockchain Development [9 Classroom Contact Hours]

Blockchain platforms: Ethereum, Hyperledger, etc., Development tools and environments, Building and deploying smart contracts

Unit 4: Blockchain for Business [9 Classroom Contact Hours]

Use cases in finance, supply chain, and other industries, Tokenization and digital assets, Regulatory environment and compliance

Unit 5: Advanced Topics in Blockchain [9 Classroom Contact Hours]

Scalability solutions and layer-two protocols, Privacy-preserving technologies, Future trends and challenges in blockchain

- **Textbook**:

1. "Mastering Blockchain" by Imran Bashir

- **Reference Books**:

1. "Blockchain: Blueprint for a New Economy" by Melanie Swan
2. "Blockchain Revolution" by Don Tapscott and Alex Tapscott

SWAYAM Courses

1. Blockchain and its Applications - https://onlinecourses.nptel.ac.in/noc24_cs15/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 8	Decent Work and Economic Growth	New fintech/traceability models
SDDG 9	Industry, Innovation and Infra	Secure, transparent digital infra
SDG 10	Reduced Inequalities	Inclusive finance, land and IP records
SDG 16	Peace, Justice & Institutions	Tamper-evident records, governance systems

Course Title: Cloud Computing

Code	Course Title	Credit	L-T-P
CS40008	Cloud Computing	4	3-0-1

Course Objectives:

1. To provide students with a thorough understanding of cloud computing concepts, architectures, and services.
2. Enabling them to design, implement, and manage cloud-based solutions that address complex problems and demonstrate critical thinking and analytical reasoning.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of cloud computing, cloud architecture, virtualization, service models (IaaS, PaaS, SaaS), deployment models, and cloud infrastructure.
- **CO2 (Understanding):** Explain and interpret the principles of cloud resource management, virtualization, containerization, cloud storage, cloud networking, scalability, elasticity, and security mechanisms.
- **CO3 (Application):** Apply cloud computing platforms, virtualization technologies, container orchestration tools, and cloud services to design, develop, deploy, and manage cloud-based applications and solutions.
- **CO4 (Analysis):** Analyze and compare cloud architectures, service models, deployment strategies, resource allocation techniques, security frameworks, and performance optimization methods to develop efficient and scalable cloud solutions.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate secure, scalable, and cost-effective cloud computing solutions by integrating cloud platforms, virtualization, distributed computing, security practices, and cloud management tools for real-world applications.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	3	-	-	-	-	-	-	-	-	2	-	-	-
CO2	-	3	-	2	-	-	-	-	-	-	-	-	-	2	1	-
CO3	-	-	-	-	-	3	-	3	-	-	-	-	-	3	-	2
CO4	-	-	-	-	-	-	3	-	-	3	-	-	2	-	3	-
CO5	-	-	3	-	-	-	-	-	-	-	-	3	2	-	1	3

Course Duration: 45 hours

Course Syllabus:

Unit 1: Introduction to Cloud Computing [9 Classroom Contact Hours]

Fundamentals of cloud computing, Cloud service models (IaaS, PaaS, SaaS), Deployment models (public, private, hybrid, community)

Unit 2: Cloud Infrastructure and Virtualization [9 Classroom Contact Hours]

Data center technologies, Virtualization concepts and techniques, Cloud storage and computing resources

Unit 3: Cloud Services and Platforms [9 Classroom Contact Hours]
Web services and APIs, Cloud platforms (AWS, Azure, Google Cloud), Developing and deploying cloud applications

Unit 4: Cloud Security and Compliance [9 Classroom Contact Hours]
Security challenges in the cloud, Identity and access management, Legal, compliance, and privacy issues

Unit 5: Emerging Trends and Future of Cloud Computing [9 Classroom Contact Hours]
Serverless computing and microservices architecture, Cloud analytics and machine learning services, Future trends in cloud computing

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Set up a virtual private cloud environment.
2. Implement a virtual machine and manage its lifecycle.
3. Deploy a web application on a PaaS platform.
4. Configure cloud storage and database services.
5. Develop a cloud security plan for an organization.
6. Create a compliance checklist for cloud deployment.
7. Analyze performance metrics of cloud services.
8. Implement a server less function and trigger it via an event.
9. Integrate machine learning APIs into an application.
10. Research and present on a current trend in cloud computing.

- **Textbook**:
  1. “Coud Computing: Concepts, Technology & Architecture” by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood
- **Reference Books**:
  1. “Cloud Computing: Principles and Paradigms” edited by Rajkumar Buyya, James Broberg, and Andrzej M. Goscinski
  2. “Cloud Computing: From Beginning to End” by Ray J. Rafaels

SWAYAM Course

Cloud Computing - https://onlinecourses.nptel.ac.in/noc24_cs118/preview

SDG Mapping for this Course

SDG	Title	Contribution
SDG 4	Quality Education	Low-cost infra for learning/research
SDG 8	Decent Work and Economic Growth	Cloud-ready job skills
SDG 9	Industry, Innovation and Infra	Scalable digital backbone
SDG 12	Responsible Consumption/Prod.	Efficient resource pooling
SDG 13	Climate Action	Cloud for environmental analytics, but also energy focus

SEMESTER – VIII (Double Major)

Course Category	Course Code	Course Title	Credits			Total Credit
			L	T	P	
Core Course (Major)	CS40002	Compiler Design	3	1	0	4
	RD40082	Research and Dissertation	0	0	12	12
Minor (Opted by students from other departments)	CS42002	Compiler Development	3	1	0	4
	CS40004	Internet of	3	1	0	4

Without Dissertation		Things				
	CS40006	Blockchain Technologies	3	1	0	4
	CS40008	Cloud Computing	3	0	1	4
Double Major VIII (Opted by students from other departments)	CS40002	Compiler Design	3	1	0	4
		Total				**24**



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