THE ASSAM
ROYAL GLOBAL UNIVERSITY
GUWAHATI

Royal School of Engineering and Technology (RSET)

Department of Computer Science and Engineering (CSE)

Course Structure & Syllabus

(Based on National Education Policy 2020)

For

Bachelor of Technology

In

Artificial Intelligence

W.E.F

AY: 2024-2025

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Preamble

The National Education Policy (NEP) 2020 conceives a new vision for India's higher education system. It recognizes that higher education plays an extremely important role in promoting equity, human as well as societal well-being and in developing India as envisioned in its Constitution. It is desired that higher education will significantly contribute towards sustainable livelihoods and economic development of the nation as India moves towards becoming a knowledge economy and society.

Towards the attainment of holistic and multidisciplinary education, the flexible curricula of the University will include credit-based courses, projects in the areas of community engagement and service, environmental education, and value-based education. As part of holistic education, students will also be provided with opportunities for internships with local industries, businesses, artists, crafts persons, and so on, as well as research internships with faculty and researchers at the University, so that students may actively engage with the practical aspects of their learning and thereby improve their employability.

At The Assam RGU, we are committed that at the societal level, higher education will enable each student to develop themselves to be an enlightened, socially conscious, knowledgeable, and skilled citizen who can find and implement robust solutions to its own problems. For the students at the University, Higher education is expected to form the basis for knowledge creation and innovation thereby contributing to a more vibrant, socially engaged, cooperative community leading towards a happier, cohesive, cultured, productive, innovative, progressive, and prosperous nation."

The curriculum of B.Tech. in Artificial Intelligence program offered by the Department of Computer Science and Engineering under the Royal School of Engineering and Technology, RGU, is prepared in accordance with model curriculum framework of AICTE, 2022 along with the basic guidelines of National Education Policy (NEP) 2020, enabling the learners to gain professional competency with multi-disciplinary approach catering the minimum requirement (Program Specific Criteria) of Lead Societies like ACM and other Professional Bodies as per the Engineering Accreditation Commission (EAC) of ABET and NBA. In addition, the curriculum and syllabi are designed in a structured approach by deploying Feedback Mechanism on Curriculum from various stakeholders viz. Industry, Potential Employers, Alumni, Academia, Professional Bodies, Research Organizations and Parents to capture their voice of the respective stakeholders. The Curriculum design, delivery, and assessment, the three major pillars of academic system are completely aligned in line with Outcome Based Education (OBE) to assess and evaluate the learning outcomes to facilitate the learners to achieve their Professional and Career Accomplishments.

Section 1:

Overview

1. 1. Introduction:

1.1.1 About NEP 2020

The National Education Policy (NEP) 2020 clearly indicates that higher education plays an extremely important role in promoting human as well as societal well-being in India. As envisioned in the 21st-century requirements, quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals. According to the new education policy, assessments of educational approaches in undergraduate education will integrate the humanities and arts with Science, Technology, Engineering and Mathematics (STEM) that will lead to positive learning outcomes. This will lead to develop creativity and innovation, critical thinking and higher-order thinking capacities, problem-solving abilities, teamwork, communication skills, more in-depth learning, and mastery of curricula across fields, increases in social and moral awareness, etc., besides general engagement and enjoyment of learning. and more in-depth learning.

The NEP highlights that the following fundamental principles that have a direct bearing on the curricula would guide the education system at large, viz.

i. Recognizing, identifying, and fostering the unique capabilities of each student to promote her/his holistic development.
ii. Flexibility, so that learners can select their learning trajectories and programmes, and thereby choose their own paths in life according to their talents and interests.
iii. Emphasis on conceptual understanding rather than rote learning, critical thinking to encourage logical decision-making and innovation; ethics and human & constitutional values, and life skills such as communication, teamwork, leadership, and resilience.
iv. Extensive use of technology in teaching and learning, removing language barriers, increasing access for Divyang students, and educational planning and management.
v. Respect for diversity and respect for the local context in all curricula, pedagogy, and policy.

vi. Equity and inclusion as the cornerstone of all educational decisions to ensure that all students can thrive in the education system and the institutional environment are responsive to differences to ensure that high-quality education is available for all.

1.1.2 About the B. Tech (AI) Course:

The Bachelor of Technology (B. Tech.) in Artificial Intelligence (AI) is meticulously crafted in accordance with the AICTE 2021 policy and the National Education Policy (NEP) 2020, aiming to develop highly skilled and adaptable engineers equipped for the rapidly evolving tech landscape. The curriculum blends core technical competencies in computer science including programming, data structures, algorithms, networks, and security with interdisciplinary learning from areas such as artificial intelligence, robotics, and cloud computing. Emphasis on practical experience is ensured through labs, project-based learning, and industry internships.

Aligned with NEP 2020, the B. Tech. in AI incorporates a flexible academic structure that supports interdisciplinary education and provides students with choices in courses and projects. This flexibility allows students to tailor their education to their interests and career goals. Additionally, the program includes courses in ethics, communication, and management, preparing graduates to be socially responsible and effective in diverse workplace environments. This degree program encourages lifelong learning and includes provisions for credit-based recognition of MOOCs, online learning, and hands-on workshop experiences, fostering an environment where students are prepared to continuously adapt and thrive in a dynamic world.

1.1.3 Vision

To offer globally integrated opportunities in the domain of computer science and engineering, fostering the development of students as global citizens with the skills and perspectives needed to thrive in an interconnected world.

1.1.4 Mission

- To achieve academic excellence in computer science education through dynamic curriculum, research-driven initiatives, and industry-aligned programs.
- To instil ethical values and a spirit of community service
- To give back responsible leaders equipped to drive positive change and innovation in the global technological landscape.

1.2. Credits in Indian Context:

1.2.1. Choice Based Credit System (CBCS)

Under the CBCS system, the requirement for awarding a degree or diploma or certificate is prescribed in terms of the number of credits to be earned by the students. This framework is being implemented in several universities across States in India. The main highlights of CBCS are as below:

- The CBCS provides flexibility in designing curriculum and assigning credits based on the course content and learning hours.
- The CBCS provides for a system wherein students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning.
- CBCS also provides opportunity for vertical mobility to students from a bachelor's degree programme to masters and research degree programmes.

1.3. Definitions

1.3.1. Academic Credit:

An academic credit is a unit by which a course is weighted. It is fixed by the number of hours of instructions offered per week. As per the National Credit Framework:

1 Credit = 30 NOTIONAL CREDIT HOURS (NCH)

Yearly Learning Hours = 1200 Notional Hours (@40 Credits x 30 NCH)

30 Notional Credit Hours		
Lecture/Tutorial	**Practicum**	**Experiential Learning**
1 Credit = 15 -22 Lecture Hours	10-15 Practicum Hours	0-8 Experiential Learning Hours

1 Hr. Lecture (L) per week 1 credit	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credits
2 Hours Practical (Lab) per week	1 credit

1.3.2. Course of Study:

Couse of study indicate pursuance of study in a particular discipline/programme. Discipline/Programmes shall offer Professional Core Courses, Basic Science Courses, Engineering Courses including workshop, drawing, basics of electrical/mechanical/computer etc., Professional Elective Courses Relevant to chosen specialization, Humanities and Social Sciences including Management Courses, Indian Knowledge System, Multidisciplinary Open Elective Courses, Project Work, Seminar and Internship in Industry, Mandatory Audit Courses.

1.3.3. Disciplinary Major/ Professional Core Courses:

Professional core courses in B.Tech. programs are those that directly relate to the specific field of engineering in which a student is majoring. These courses are typically taken in the latter years of the program and delve deep into the foundational principles, theories, and practical applications of the chosen engineering discipline. Here's a breakdown of what professional core courses might entail:

i. **Core Engineering Concepts**: These courses lay the groundwork for understanding the fundamental principles of the chosen engineering discipline. They may cover topics such as mechanics, dynamics, thermodynamics, fluid mechanics, and electromagnetism. These courses provide students with a solid foundation in the basic principles that underpin all branches of engineering.

ii. **Specialized Technical Courses**: These courses focus on the specific areas of specialization within the chosen engineering discipline. For example, civil engineering students may take courses in structural analysis and design, transportation engineering, geotechnical engineering, or environmental engineering. Similarly, electrical engineering students may study courses in power systems, electronics, control systems, or telecommunications.

iii. **Laboratory Work and Design Projects**: Many professional core courses include laboratory work and design projects to provide students with hands-on experience and practical skills. In laboratory sessions, students may conduct experiments to reinforce theoretical concepts and develop their technical skills. Design projects challenge students to apply their knowledge to solve real-world engineering problems and to work collaboratively in teams.

iv. **Professional Practice and Ethics**: Courses in professional practice and ethics prepare students for the realities of working as professional engineers. Topics may include engineering ethics, codes of conduct, professional responsibility, safety standards, and legal issues in engineering practice. These courses emphasize the importance of ethical behavior, effective communication, and lifelong learning in the engineering profession.

1.3.4. Multidisciplinary Open Electives:

Students will have the option to choose courses from disciplinary/interdisciplinary skill-based elective courses

1.3.5. Basic Science Courses

These include a range of basic science courses that provide students with a strong foundation in fundamental scientific principles. These courses are designed to equip students with essential knowledge and skills that are necessary for understanding advanced engineering concepts and for solving real-world problems. Here are some common basic science courses offered in B.Tech. programs:

i. **Physics:** Physics courses cover topics such as classical mechanics, electromagnetism, thermodynamics, and quantum mechanics. These courses help students understand the fundamental principles governing the behavior of matter and energy.

ii. **Chemistry:** Chemistry courses introduce students to the structure, properties, and reactions of various chemical substances. Topics covered may include organic chemistry, inorganic chemistry, physical chemistry, and analytical chemistry.

iii. **Mathematics:** Mathematics courses form the backbone of engineering education. Topics typically covered include calculus, differential equations, linear algebra, probability theory, and numerical methods. These mathematical tools are essential for analyzing and solving engineering problems.

iv. **Biology:** Some B.Tech. programs may include basic biology courses to provide students with an understanding of living organisms and their biological processes. Topics covered may include cell biology, genetics, evolution, and ecology.

These basic science courses are typically spread across the first two years of the B.Tech program, after which students delve into more specialized courses related to their chosen engineering discipline. The knowledge gained from these basic science courses forms the basis for advanced engineering coursework and prepares students for careers in various technical field.

1.3.6. Engineering Science Course:

The Engineering Science course within the B.Tech. program is designed to provide a broad-based foundation in the fundamental principles that underpin engineering. This interdisciplinary course integrates key concepts from multiple engineering disciplines, including mechanical, electrical, civil, and computer engineering, offering students a holistic view of how these fields converge and interact. It will equip students with foundational knowledge across various engineering disciplines to promote versatility in problem-solving. Some of the Courses are

i. **Basic Electronics:** Basic electronics courses cover topics such as circuit theory, semiconductor devices, digital electronics, and electronic circuits. These courses provide

students with a foundation in electronics principles, which are essential for many engineering disciplines

ii. **Engineering Mechanics:** Engineering mechanics courses bridge the gap between physics and engineering, applying principles of mechanics to solve engineering problems. Topics may include statics, dynamics, solid mechanics, and fluid mechanics.

iii. **Computational Science:** Programming is essential in engineering education across all disciplines because it enhances problem-solving skills, which are central to engineering tasks. Learning to program equips engineers with the ability to think logically and analytically, breaking down complex problems into simpler, manageable components that can be tackled systematically. In essence, integrating programming into engineering curricula prepares students to tackle real-world engineering challenges with creativity and precision, making it an indispensable skill in their professional toolkit.

iv. **Engineering Graphics and Design:** Engineering graphics is applicable across various engineering disciplines, including mechanical, civil, electrical, and aerospace engineering. Regardless of their specialization, all engineers need to understand basic drawing principles and graphical representation techniques. Engineering graphics provides a common foundation that prepares students for interdisciplinary collaboration and communication in multidisciplinary engineering projects.

1.3.7. Humanities and Social Sciences:

Humanities courses offered in B.Tech. programs serve a crucial role in providing students with a well-rounded education that goes beyond technical skills. These courses are designed to develop students' critical thinking, communication, and problem-solving abilities, as well as to foster an understanding of social, cultural, and ethical issues. Here are some common humanities courses offered in B.Tech. programs:

i. **Communication Skills:** Communication skills courses focus on improving students' written and oral communication abilities. They cover topics such as technical writing, presentation skills, and effective communication in professional settings. These courses are essential for engineers who need to convey complex technical information to diverse audiences.

ii. **Ethics and Professional Responsibility:** Ethics courses explore ethical issues related to engineering practice, such as professional responsibility, safety, sustainability, and social justice. Students learn about ethical frameworks and develop the skills to identify and address ethical dilemmas that may arise in their careers.

1.3.8. Professional Elective Courses

These subjects are offered to offer students the opportunity to tailor their education to align with their interests, career goals, and emerging industry trends within their chosen engineering discipline.

These courses allow students to delve deeper into specific areas of specialization or to explore interdisciplinary topics that complement their core engineering curriculum. Here's an overview of professional elective courses:

i. **Specialized Technical Electives:** These courses focus on advanced topics within a specific area of specialization within the chosen engineering discipline. For example, civil engineering students might choose electives in earthquake engineering, structural dynamics, or advanced materials.

ii. **Professional Development Electives:** These courses focus on developing students' professional skills and preparing them for success in their engineering careers. Topics may include project management, leadership, entrepreneurship, communication skills, technical writing, and professional networking. Professional development electives help students cultivate essential skills that are highly valued by employers and contribute to their overall career readiness.

By offering a range of professional elective courses, students are empowered to customize their education according to their individual interests and career aspirations. These elective courses complement the core engineering curriculum and enable students to develop specialized expertise, practical skills, and professional competencies that enhance their competitiveness in the job market and prepare them for future leadership roles in their field.

1.3.9. Mandatory Audit/ Skill Enhancement Courses:

These courses are aimed at imparting practical skills, hands-on training, soft skills, etc., to enhance the employability of students and should be related to Major Discipline. They will aim at providing hands-on training, competencies, proficiency, and skill to students. These courses will be a basket course to provide skill-based instruction

1.3.10. Summer Internship

Students need to undergo six months of mandatory internship during their course of study which is a total of 10 credits and will be evaluated towards the end of 7th semester. The students can undergo 1 month internship during their semester breaks starting from 2nd semester onwards. The intention is induction into actual work situations. All students must undergo internships / Apprenticeships in a firm, industry, or organization or Training in labs with faculty and researchers in their own or other HEIs/research institutions during the summer/winter term. Students should take up opportunities for internships with local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations, artists, crafts persons, and a wide variety of organizations so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability. Students

who wish to exit after the first two semesters will undergo a 4-credit work-based learning/internship during the summer term to get a UG Certificate.

- *Community engagement and service:* The curricular component of 'community engagement and service' seeks to expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems. This can be part of summer term activity or part of a major or minor course depending upon the major discipline.
- *Field-based learning/minor project:* The field-based learning/minor project will attempt to provide opportunities for students to understand the different socio-economic contexts. It will aim at giving students exposure to development-related issues in rural and urban settings. It will provide opportunities for students to observe situations in rural and urban contexts, and to observe and study actual field situations regarding issues related to socioeconomic development. Students will be given opportunities to gain a first-hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process. They would have the opportunity to gain an understanding of the complex socio-economic problems in the community, and innovative practices required to generate solutions to the identified problems. This may be a summer term project or part of a major or minor course depending on the subject of study.

1.3.11. Indian Knowledge System:

In view of the importance accorded in the NEP 2020 to rooting our curricula and pedagogy in the Indian context all the students who are enrolled in the four-year UG programmes should be encouraged to take two courses in IKS in 3rd and 4th semester. The students are mandated to take these courses, preferably *during the first two semesters of the UG programme*.

1.3.12. Experiential Learning:

One of the most unique, practical & beneficial features of the National Credit Framework is assignment of credits/credit points/ weightage to the experiential learning including relevant experience and professional levels acquired/ proficiency/ professional levels of a learner/student. Experiential learning is of two types:

a. Experiential learning as part of the curricular structure of academic or vocational program. E.g., projects/OJT/internship/industrial attachments etc. This could be either within the Program- internship/ summer project undertaken relevant to the program being studied or as a part time employment (not relevant to the program being studied- up to certain NSQF level only). In case where experiential learning is a part of the curricular structure the credits would be calculated and assigned as per basic principles of NCrF i.e., 40 credits for 1200 hours of notional learning.

b. Experiential learning as active employment (both wage and self) post completion of an academic or vocational program. This means that the experience attained by a person after undergoing a particular educational program shall be considered for assignment of credits. This could be either Full or Part time employment after undertaking an academic/ Vocation program.

In case where experiential learning is as a part of employment the learner would earn credits as weightage. The maximum credit points earned in this case shall be double of the credit points earned with respect to the qualification/ course completed. The credit earned and assigned by virtue of relevant experience would enable learners to progress in their career through the work hours put in during a job/employment.

1.3.13. Minor/Honors (Optional)

A total of 18-20 credits has to be earned/ acquired by the students through MOOCS from 3rd semester onwards as a part of their Honors or Minor Track. The track has to be of a specific domain of the interest of the students. A student can acquire even more than 20 credits. However, a minimum of 3 credit must be acquired per semester. For successfully completing a 12-week course, a student will earn 3 credits and for a 16-week course, he/she will earn 4 credits.

Section 2

Award of Degree

The structure and duration of undergraduate programmes of study offered by the University as per NEP 2020 include:

2.1. Undergraduate programmes of either 3 or 4-year duration with Single Major, with multiple entry and exit options, with appropriate certifications:

2.1.1. UG Certificate: Students who opt to exit after completion of the first year and have secured 40 credits will be awarded a UG certificate if, in addition, they complete one vocational course of 6-8 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.

2.1.2. UG Diploma: Students who opt to exit after completion of the second year and have secured 84 credits will be awarded the UG diploma if, in addition, they will have to achieve an additional credit of 6-8 through vocational courses during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.

2.1.3. BE/B.Tech Vocational: Students who will undergo a 3-year UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 128 credits and additional 6-8 credits and satisfying the minimum credit requirement.

2.1.4. B.E/B.Tech. : A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree programme with 168 credits and have satisfied the credit requirements.

2.1.5. B.E/B.Tech. - Minor/ Honor's/Research: A student will be eligible to get Undergraduate degree with Honours or additional Minor Engineering, if he/she completes an additional 18-20 credits through MOOCs.

Table: 1: Award of Degree and Credit Structure with ME-ME

Level	Semester	Exit Option	Credits	Additional Credits for exit students	List of exit courses
4.5	Sem I &II	U.G Certificate	40	6-8	Industrial Training/ Internship/ Apprenticeship/ Minor Projects/ Courses like Office Automation, Computer Fundamentals, Computer Hardware and Networking etc
5.0	Sem III &IV	U.G Diploma	44	6-8	Industrial Training/ Internship/ Apprenticeship/ Minor Projects/ Courses like System Administration, Introduction to UI/UX, Animation and Design
5.5	Sem V &VI	B.E Vocational	44	6-8	Industrial Training/ Internship/ Apprenticeship/ Minor Projects/ Courses like Web Development, Data Analytics, Cybersecurity, Artificial Intelligence, Cloud Computing
6.0	Sem VII &VIII	B.E/B.Tech.	40	--	
		B.E/B.Tech. - Minor/ Honor's/Research	18	--	

Section 3

Credit, Credit Points & Credit hours for different types of courses

3.1. Introduction:

'Credit' is recognition that a learner has completed a prior course of learning, corresponding to a qualification at a given level. For each such prior qualification, the student would have put in a certain volume of institutional or workplace learning, and the more complex a qualification, the greater the volume of learning that would have gone into it. Credits quantify learning outcomes that are subject achieving the prescribed learning outcomes to valid, reliable methods of assessment.

The ***credit points*** will give the learners, employers, and institutions a mechanism for describing and comparing the learning outcomes achieved. The credit points can be calculated as credits attained multiplied with the credit level.

The workload relating to a course is measured in terms of credit hours. A credit is a unit by which the coursework is measured. It determines the number of hours of instruction required per week over the duration of a semester (minimum 15 weeks).

Each course may have only a lecture component or a lecture and tutorial component or a lecture and practicum component or a lecture, tutorial, and practicum component, or only practicum component.

A course can have a combination of ***lecture credits, tutorial credits, practicum credits and experiential learning credits.*** The following types of courses/activities constitute the programmes of study. Each of them will require a specific number of hours of teaching/guidance and laboratory/studio/workshop activities, field-based learning/projects, internships, and community engagement and service.

- **Lecture courses:** Courses involving lectures relating to a field or discipline by an expert or qualified personnel in a field of learning, work/vocation, or professional practice.
- **Tutorial courses:** Courses involving problem-solving and discussions relating to a field or discipline under the guidance of qualified personnel in a field of learning, work/vocation, or professional practice. Should also refer to the Remedial Classes, flip classrooms and focus on both Slow and Fast Learners of the class according to their merit.

- **Practicum or Laboratory work:** A course requiring students to participate in a project or practical or lab activity that applies previously learned/studied principles/theory related to the chosen field of learning, work/vocation, or professional practice under the supervision of an expert or qualified individual in the field of learning, work/vocation or professional practice.
- **Seminar:** A course requiring students to participate in structured discussion/conversation or debate focused on assigned tasks/readings, current or historical events, or shared experiences guided or led by an expert or qualified personnel in a field of learning, work/vocation, or professional practice.
- **Internship:** A course requiring students to participate in a professional activity or work experience, or cooperative education activity with an entity external to the education institution, normally under the supervision of an expert of the given external entity. A key aspect of the internship is induction into actual work situations. Internships involve working with local industry, government or private organizations, business organizations, artists, crafts persons, and similar entities to provide opportunities for students to actively engage in on-site experiential learning.
- **Field practice/projects:** Courses requiring students to participate in field-based learning/projects generally under the supervision of an expert of the given external entity.

Table:2: Course wise Distribution of Credits

Sl. No	*Category*	*Abbreviation*	*Credit Breakup*
1	Humanities and Social Sciences including Management courses	HSMC	06
2	Basic Science courses	BSC	20
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	ESC	24
4	Professional core courses	PCC	60
5	Professional Elective courses relevant to chosen specialization/branch	PEC	20
6	Indian Knowledge System	IKS	04
7	Open subjects – Electives from other technical and /or emerging subjects	OEC	12
8	Project work, seminar and internship in industry or elsewhere	PROJ	18
9	Mandatory Audit/ Skill Enhancement Courses	MC	04
		Total	**168**

Section 4

Level of Courses

4.1 NHEQF levels:

The NHEQF levels represent a series of sequential stages expressed in terms of a range of learning outcomes against which typical qualifications are positioned/located. NHEQF level 4.5 represents learning outcomes appropriate to the first year (first two semesters) of the undergraduate programme of study, while Level 8 represents learning outcomes appropriate to the doctoral-level programme of study.

Table: 3: NHEQF Levels

NHEQF level	Examples of higher education qualifications located within each level	Credit Requirements
Level 4.5	Undergraduate Certificate. Programme duration: First year (first two semesters) of the undergraduate programme, followed by an exit 4-credit skills-enhancement course(s).	40
Level 5	Undergraduate Diploma. Programme duration: First two years (first four semesters) of the undergraduate programme, followed by an exit 4-credit skills-enhancement course(s) lasting two months.	80
Level 5.5	Bachelor's Degree. Programme duration: First three years (Six semesters) of the four-year undergraduate programme.	120
Level 6	Bachelor's Degree (Honours/ Honours with Research). Programme duration: Four years (eight semesters).	160
Level 6	Post-Graduate Diploma. Programme duration: One year (two semesters) for those who exit after successful completion of the first year (two semesters) of the 2-year master's programme	160
Level 6.5	Master's degree. Programme duration: Two years (four semesters) after obtaining a 3- year Bachelor's degree (e.g. B.A., B.Sc., B.Com. etc.).	80
Level 6.5	Master's degree. Programme duration: One year (two semesters) after obtaining a 4 -year Bachelor's degree (Honours/ Honours with Research) (e.g. B.A., B.Sc., B.Com. etc.).	40
Level 7	Master's degree. (e.g., M.E./M.Tech. etc.) Programme duration: Two years (four semesters) after obtaining a 4-year Bachelor's degree. (e.g., B.E./B.Tech. etc.)	80
Level 8	Doctoral Degree	Credits for course work, Thesis, and published work

Section 5

Graduate Attributes & Learning Outcomes

5.1 Introduction

As per the NHEQF, each student on completion of a programme of study must possess and demonstrate the expected ***Graduate Attributes*** acquired through one or more modes of learning, including direct in-person or face-to-face instruction, online learning, and hybrid/blended modes. The graduate attributes indicate the quality and features or characteristics of the graduate of a programme of study, including learning outcomes relating to the disciplinary area(s) relating to the chosen field(s) of learning and generic learning outcomes that are expected to be acquired by a graduate on completion of the programme(s) of study.

The graduate profile/attributes must include,

- capabilities that help widen the current knowledge base and skills,
- gain and apply new knowledge and skills,
- undertake future studies independently, perform well in a chosen career, and
- play a constructive role as a responsible citizen in society.

The graduate profile/attributes are acquired incrementally through development of cognitive levels and describe a set of competencies that are transferable beyond the study of a particular subject/disciplinary area and programme contexts in which they have been developed.

Graduate attributes include,

- ***learning outcomes that are specific to disciplinary areas*** relating to the chosen field(s) of learning within broad multidisciplinary/interdisciplinary/ transdisciplinary contexts.
- ***generic learning outcomes*** that graduate of all programmes of study should acquire and demonstrate.

5.2 Graduate Attributes:

Table: 4: The Learning Outcomes Descriptors and Graduate Attributes

Sl.no.	**Graduate Attribute**	**The Learning Outcomes Descriptors** ***(The graduates should be able to demonstrate the capability to:)***
GA1	Disciplinary Knowledge	acquire knowledge and coherent understanding of the chosen disciplinary/interdisciplinary areas of study.

Sl.no.	Graduate Attribute	The Learning Outcomes Descriptors *(The graduates should be able to demonstrate the capability to:)*
GA 2	Complex problem solving	solve different kinds of problems in familiar and non-familiar contexts and apply the learning to real-life situations.
GA 3	Analytical & Critical thinking	apply analytical thought including the analysis and evaluation of policies, and practices. Able to identify relevant assumptions or implications. Identify logical flaws and holes in the arguments of others. Analyse and synthesize data from a variety of sources and draw valid conclusions and support them with evidence and examples.
GA 4	Creativity	create, perform, or think in different and diverse ways about the same objects or scenarios and deal with problems and situations that do not have simple solutions. Think 'out of the box' and generate solutions to complex problems in unfamiliar contexts by adopting innovative, imaginative, lateral thinking, interpersonal skills, and emotional intelligence.
GA 5	Communication Skills	listen carefully, read texts and research papers analytically, and present complex information in a clear and concise manner to different groups/audiences. Express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media.
GA 6	Research-related skills	develop a keen sense of observation, inquiry, and capability for asking relevant/ appropriate questions. Should acquire the ability to problematize, synthesize and articulate issues and design research proposals, define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inferences based on the analysis and interpretation of data, and predict cause-and-effect relationships. Should develop the ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in personal research work.
GA 7	Collaboration	work effectively and respectfully with diverse teams in the interests of a common cause and work efficiently as a member of a team.
GA 8	Leadership readiness/qualities	plan the tasks of a team or an organization and setting direction by formulating an inspiring vision and building a team that can help achieve the vision.
GA 9	Digital and technological skills	use ICT in a variety of learning and work situations. Access, evaluate, and use a variety of relevant information sources and use appropriate software for analysis of data.

Sl.no.	Graduate Attribute	The Learning Outcomes Descriptors *(The graduates should be able to demonstrate the capability to:)*
GA 10	Autonomy, responsibility, and accountability:	apply knowledge, understanding, and/or skills with an appropriate degree of independence relevant to the level of the qualification,
GA 11	Environmental awareness and action	mitigate the effects of environmental degradation, climate change, and pollution. Should develop the technique of effective waste management, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development and living.
GA 12	Community engagement and service	demonstrate the capability to participate in community-engaged services/ activities for promoting the well-being of society

5.3 Programme Learning Outcomes (PLO)

The term 'programme' refers to the entire scheme of study followed by learners leading to a qualification. Individual programmes of study will have defined learning outcomes that must be attained for the award of a specific certificate/diploma/degree. Programme Learning Outcomes describe what students are expected to know or be able to do by the time of graduation. PLOs are statements about the knowledge, skills and attitudes (attributes) the graduate of a formal engineering program should have. PLOs deal with the general aspect of graduation for a particular program, and the competencies and expertise a graduate will possess after completion of the program. The identified PLOs are as follows:

- **PLO1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **PLO2: Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **PLO3: Conduct investigations of complex problems:** apply critical thinking skills to identify complex problems in the field of computer science, analyze these problems with a systematic and logical approach, evaluate various solutions considering multiple aspects, such as technical feasibility, ethical implications, sustainability, and practicality, and synthesize information to devise effective, efficient, and innovative solutions.

- **PLO4: Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **PLO5: Communication skills:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PLO6: Research-related skills:** Conduct original research in computer science and engineering, employing scientific methods to design experiments, analyze data, and interpret results.
- **PLO7: Collaboration:** Contribute constructively to collaborative environments, leveraging collective knowledge to achieve common goals, resolve conflicts, and enhance team productivity in both face-to-face and virtual settings.
- **PLO8: Leadership and readiness/qualities:** Exhibit readiness for professional success in the field of computer science and engineering, with the ability to adapt to emerging technologies, navigate ethical and societal issues, collaborate effectively with diverse teams, and demonstrate integrity and accountability in their work.
- **PLO9: Digital and technological skills:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
- **PLO10: Autonomy, responsibility, and accountability:** Take ownership of their work, setting goals, managing time effectively, and seeking out opportunities for continuous learning and improvement, exhibit accountability for their actions, acknowledging and learning from mistakes, and adhering to ethical and professional standards in all aspects of their work.
- **PLO11: Environmental awareness and action:** Integrate environmental considerations into their engineering projects, implementing strategies to minimize resource consumption, reduce carbon footprint, and promote environmental sustainability.
- **PLO12: Community engagement and service:** Actively collaborate with community stakeholders to identify needs and co-create technology-based solutions that address local, national, or global issues.

5.4 Programme Educational Objectives (PEOs)

The Programme Educational Objectives (PEOs) are defined and developed for each program with the consultation and involvement of various stakeholders such as management, students, industry, regulating authorities, alumni, faculty and parents. Their interests, social relevance and contributions are taken in to account in defining and developing the PEOs. The Program Educational Objectives (PEOs) of the Computer Science and Engineering are listed below:

- **PEO1**: To provide students with a strong foundation in the Mathematical, Scientific and Engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduate studies, R&D.
- **PEO2**: To provide exposure to emerging cutting-edge technologies, adequate training & opportunities to work as teams on multidisciplinary projects with effective communication skills and leadership qualities.
- **PEO3**: To prepare the students for a successful career for bridging the digital divide and meeting the requirements of Indian and multinational companies.
- **PEO4**: To promote student awareness on life-long learning and to introduce them to professional ethics and codes of professional practice.

5.5 Programme Specific Outcomes (PSOs)

- **PSO1:** Able to apply the knowledge of programming languages, data structures and Algorithms, network security, data science, networks and software engineering principles for software product development.
- **PSO2:** Able to analyze and formulate solutions to real world and socially relevant problems over multi-disciplinary domains by using latest technologies.
- **PSO3:** Able to be a technically competent employee, researcher, entrepreneur, excel in competitive exams and zest for higher studies.

5.4 Course Learning Outcomes (CLOs)

The programme learning outcomes are attained by learners through the essential learnings acquired on the completion of selected courses of study within a programme of study. The term 'course' is used to mean the individual courses of study that make up the scheme of study for a programme.

Course learning outcomes are specific to the learning for a given course of study related to a disciplinary or interdisciplinary/multi-disciplinary area of learning. Some courses of study are highly structured, with a closely laid down progression of compulsory/core courses to be taken at different phases/stages of learning.

5.5 The Qualification Specifications:

Table: 5: NHEQF Qualification specifications

Qualification type	**Purpose of the qualification**
Undergraduate Certificate	The students will be able to apply technical and theoretical concepts and specialized knowledge and skills in a broad range of contexts to undertake skilled or paraprofessional work and/or to pursue further study/learning at higher levels.
Undergraduate Diploma	The students will be able to apply specialized knowledge in a range of contexts to undertake advanced skilled or paraprofessional work and/or to pursue further learning/study at higher levels.
Bachelor's degree	The students will be able to apply a broad and coherent body of knowledge and skills in a range of contexts to undertake professional work and/or for further learning.
Bachelor's degree (Honours/ Honours with Research)	The students will be able to apply the knowledge in a specific context to undertake professional work and for research and further learning.
	The students will be able to apply an advanced body of knowledge in a range of contexts to undertake professional work and apply specialized knowledge and skills for research and scholarship, and/or for further learning relating to the chosen field(s) of learning, work/vocation, or professional practice.

Section 6

Course Structure and Syllabus of the Framework

6.1 Course Structure of B. Tech (AI)

1st Semester							
S. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Basic Science Course (BSC)							
1	PHY022C101	Physics	3	0	2	4	5
2	MAT022C102	Mathematics – I	3	1	0	4	4
Engineering Science Course (ESC)							
3	CSE022C103	Basic Electrical Engineering	3	0	2	4	5
4	CEE022C104	Engineering Graphics & Design	2	0	4	4	6
Humanities/Social Science including Management Course (HSMC)							
5	BHS022A101	Universal Human Values: Understanding Harmony and Ethical Human Conduct	2	0	0	2	2
Mandatory Courses (MC)/ Skill Enhancement Courses							
6	COD022S116	Design Thinking	0	0	2	1	2
7	CSE022S117	Ideation Lab	0	0	2	1	2
		TOTAL	**13**	**1**	**12**	**20**	**26**
8		**Honors/Minor (Optional) [To be obtained through MOOCS/ SWAYAM]**	**0**	**0**	**0**	**3**	**0**
2nd Semester							
S. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Basic Science Course (BSC)							
1	CHY022C201	Chemistry	3	0	2	4	5
2	MAT022C202	Mathematics – II	3	1	0	4	4
3	CSE022C203	Biology for Engineers	3	0	0	3	3
Engineering Science Course (ESC)							
4	CSE022C204	Programming for Problem Solving	3	0	2	4	5
5	MEE022C215	Manufacturing Practices Workshop	0	0	4	2	4
Humanities/Social Science including Management Course (HSMC)							
6	CEN022A201	English for Technical Writing	2	0	0	2	2
Mandatory Courses (MC)/ Skill Enhancement Courses							
7	CSE022S217	Sports and Yoga	0	0	2	1	2

		TOTAL	**14**	**1**	**10**	**20**	**25**
8		**Honors/Minor (Optional) [To be obtained through MOOCS/ SWAYAM]**	**0**	**0**	**0**	**3**	**0**
3rd Semester							
S. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Professional Core Course (PCC)							
1	MAT022C301	Discrete Mathematics	3	1	0	4	4
2	ARI022C302	Data Structures and Algorithms	3	0	2	4	5
3	ARI022C303	Computer Organisation and Architecture	3	0	0	3	3
Engineering Science Course (ESC)							
4	ARI022C304	Digital Logic and Design	3	0	2	4	5
IKS							
5	ARI022K305	Indian Knowledge System-I	2	0	0	2	2
Open Elective							
6	ARI022G306	Open Elective-I	3	0	0	3	3
Internship							
7	ARI022C327	Internship-I	0	0	0	2	0
		TOTAL	**17**	**1**	**4**	**22**	**22**
8		**Honors/Minor (Optional) [To be obtained through MOOCS/ SWAYAM]**	**0**	**0**	**0**	**3**	**0**
4th Semester							
S. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Professional Core Course (PCC)							
1	ARI022C401	OOP using C++	3	0	2	4	5
2	ARI022C402	Database Management Systems	3	0	2	4	5
3	ARI022C403	Formal Language and Automata Theory	3	1	0	4	4
4	ARI022C405	Mathematical Foundations for AI	3	0	0	3	3
IKS							
5	ARI022K405	Indian Knowledge System-II	2	0	0	2	2
Open Elective							
6	ARI022G406	Open Elective-II	3	0	0	3	3
Internship							
7	ARI022C427	Internship-II	0	0	0	2	0
		TOTAL	**17**	**1**	**4**	**22**	**22**
8		**Honors/Minor (Optional) [To be obtained through MOOCS/ SWAYAM]**	**0**	**0**	**0**	**3**	**0**
5th Semester							
S. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Professional Core Course (PCC)							
1	ARI022C501	Operating Systems	3	0	2	4	5
2	ARI022C504	Data Communication	3	0	2	4	5
3	ARI022C503	Design and Analysis of Algorithms	3	0	0	3	3
4	ARI022C505	Introduction to AI and ML	3	0	0	3	3

Humanities/Social Science including Management Course (HSMC)							
5	BSA022C505	Principles of Management & Organisational Behaviour	3	0	0	3	3
Open Elective							
6	ARI022G506	Open Elective-III	3	0	0	3	3
Internship							
7	ARI022C527	Internship-III	0	0	0	2	0
		TOTAL	**17**	**0**	**6**	**22**	**23**
8		**Honors/Minor (Optional) [To be obtained through MOOCS/ SWAYAM]**	**0**	**0**	**0**	**3**	**0**
6th Semester							
S. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Professional Core Course (PCC)							
1	ARI022C601	Computer Networks	3	0	2	4	5
2	ARI022C604	Introduction to Deep Learning	3	0	2	4	5
3	ARI022C603	Software Engineering	3	0	0	3	3
Professional Elective Course (PEC)							
4	ARI022D60X	Professional Elective Course-I	4	0	0	4	4
5	ARI022D60X	Professional Elective Course-II	4	0	0	4	4
Open Elective							
6	ARI022G606	OEC-II	3	0	0	3	3
Internship							
7	ARI022C627	Internship-IV	0	0	0	2	0
		TOTAL	**20**	**0**	**4**	**24**	**24**
8		**Honors/Minor (Optional) [To be obtained through MOOCS/ SWAYAM]**	**0**	**0**	**0**	**3**	**0**
7th Semester							
S. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Professional Core Course (PCC)							
1	ARI022C703	Data and Visual Analytics in AI	4	0	0	4	4
2	ARI022C702	Web Technology	3	0	2	4	5
Professional Elective Course (PEC)							
3	ARI022D70X	Professional Elective Course-III	4	0	0	4	4
4	ARI022D70X	Professional Elective Course-IV	4	0	0	4	4
Internship							
5	ARI022C725	Internship-V	0	0	0	2	0
Project/ Dissertation							
6	ARI022C726	Project-I	0	0	6	2	8
		TOTAL	**13**	**0**	**2**	**20**	**25**
7		**Honors/Minor (Optional) [To be obtained through MOOCS/ SWAYAM]**	**0**	**0**	**0**	**3**	**0**
8th Semester							
S. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Professional Core Course (PCC)							
1	ARI022C803	Predictive Modelling & Optimization Techniques	3	0	2	4	5
2	ARI022C802	Cryptography and Network Security	4	0	0	4	4

Professional Elective Course (PEC)							
3	ARI022D80X	PEC-V	4	0	0	4	4
Project/ Dissertation							
4	ARI022C824	Project-II	0	0	12	6	8
		TOTAL	**11**	**0**	**14**	**18**	**21**
5		**Honors/Minor (Optional) [To be obtained through MOOCS/ SWAYAM]**	**0**	**0**	**0**	**3**	**0**

PEC Tracks	Subjects
Artificial Intelligence	PEC 1: Advanced Deep Learning (ARI022D601)
	PEC 2: Natural Language Processing (ARI022D601)
	PEC 3: Computer Vision (ARI022D701)
	PEC 4: Reinforcement Learning (ARI022D702)
	PEC 5: AI for Robotics (ARI022D801)

List of Open Electives to be offered by Department of CSE	
Open Elective-I	Programming with Python (ARI022G306)
Open Elective-II	Fundamentals of Web Design (ARI022G406)
Open Elective-III	Introduction to AI (ARI022G506)
Open Elective-IV	Fundamentals of IOT (ARI022G606)

6.2 Detailed Syllabus of 1st Semester

Paper I/Subject Name: Physics		Subject Code: PHY022C101
L-T-P-C – 3-0-2-4	Credit Units: 04	Scheme of Evaluation: TP

Objective:

The objectives of the course are to make the students enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology

Prerequisites: Concepts of Physics of +2 level

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** the basic terminologies of physics	**BT 1**
CO 2	**Understand** the basic concepts of Physics	**BT 2**
CO 3	**Solve** problems in wave mechanics.	**BT 3**
CO 4	**Analyze** knowledge in calculating red and blue shift and also in acoustics.	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Electromagnetic Theory**	Electrostatics in vacuum, Electrostatics in a linear dielectric medium, Magneto statics, Magneto statics in a linear magnetic medium, Faraday's law, Displacement current, Magnetic field due to time-dependent electric field and Maxwell's equations, Electromagnetic waves	**13**
II.	**Introduction to Mechanics**	Transformation of scalars and vectors under Rotation transformation; Potential energy function; Non-inertial frames of reference; Harmonic oscillator; Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum, Introduction to three-dimensional rigid body motion	**25**
III.	**Quantum Mechanics for Engineers**	Wave nature of particles and the Schrodinger equation, Mathematical Preliminaries for quantum mechanics, Applying the Schrodinger equation, molecular bonding, Solids	**10**
IV	**Oscillations, Waves and Optics**	Simple harmonic motion, damped and forced simple harmonic oscillator, Non-dispersive transverse and longitudinal waves in one dimension and introduction to dispersion, The propagation of light and geometric optics, Wave optics, Lasers	**18**
		TOTAL	**66**

Physics Lab Syllabus

Detailed Syllabus:

Experiment	Experiment Title	Lab Hours
I	Determination of Moment of Inertia of a given solid about its own axis by using M.I.Table	2
II	Determination of Young's Modulus using Searle's Apparatus	2
III	Determination of Rigidity of Modulus of the material of the given rod by Statiscal method	2
IV	Determination of Powers of Given lenses using an Optical Bench i. Concave Lens, ii Convex Lens	2
V	Determination of Resistance of a Galvanometer using Post Office Box.	2
VI	To determine the mechanical equivalent of heat by Joule's calorimeter	2
VII	Determination of ratio of E.M.F of two cells using Potentiometer.	2
VIII	To determination of the focal length of a convex mirror with the help of an auxiliary lens.	2
IX	Determination of Horizontal Components of Earth's Magnetic field using Magnetometer	2
X	Determination of coefficient of Viscosity of water by Capillary Flow Method	2

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 22 NCH = 66 NCH	2 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Elements of properties of matter,* Mathur D.S., 7th Edition, Revised Edition, 2005, S. Chand publication, New Delhi.
2. *Electricity and Magnetism,* Tayal D.C, Publisher, 4th Edition, 2017, Himalaya Publishing House,New Delhi.
3. *Geometrical and Physical Optics,* Chakraborty P.K., 3rd Edition, 2005, New Central Book agency (P) Ltd.

Reference Books:

1. Singh A.K. and Malik Hitendra *Engineering Physics,* 2nd Edition, 2016, McGraw Hill Education Private Limited. New Delhi.
2. Gaur R.K and Gupta S.L, *Engineering Physics*, 2015, Dhanpat Rai publication, New Delhi.
3. Arthur Beiser, Shobhit Mahajan, S. Rai. Choudhury, *Concept of Modern physics,* 6th Edition, 2009, McGraw-Hill education Private limited. New Delhi.
4. M Ghosh & D Bhattacharya, *A Textbook of Oscillations, Waves and Acoustics,* 5th Edition, 2016, S. Chand publication.

Additional Readings

1. https://www.griet.ac.in/nodes/Engineering%20Physics%20Notes.pdf
2. https://mrcet.com/downloads/digital_notes/HS/R20/Engineering%20Physics.pdf
3. NPTEL Course on Introduction To Electromagnetic Theory by Prof. Manoj Harbola, IIT Kanpur

Paper II/Subject Name: Mathematics-I		**Subject Code: MAT022C102**
L-T-P-C – 3-0-2-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective:

The objectives of the course are to enable students to achieve conceptual understanding and to retain the best traditions of traditional calculus

Prerequisites: Concepts of Mathematics of +2 level

Course Outcomes

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** basic terminologies of calculus	**BT 1**
CO 2	**Understand** the applications of differential and integral calculus in different fields of Engineering.	**BT 2**
CO 3	**Apply** the single and multivariable differential and Integral calculus in engineering problems.	**BT 3**
CO 4	**Analyze** and **assess** the patterns in series	**BT 4 & 5**

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I.	**Basic & Single Variable Calculus**	Curvature, evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Rolle's Theorem, Mean value theorems and applications; Extreme values of functions; Linear approximation; Indeterminate forms and L' Hospital's rule.	**15**
II.	**Multi Variable Calculus I**	Limit, continuity and partial derivatives, directional derivatives, gradient, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.	**15**
III.	**Multi Variable Calculus II**	Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar	**15**

		surface integrals, vector surface integrals, Gradient, curl and divergence, Theorems of Green, Gauss and Stokes.	
IV	**Sequence and Series**	Limits of sequence of numbers, Calculation of limits, Infinite series; Tests for convergence; Power series, Taylor and Maclaurin series; Taylor theorem, convergence of Taylor series, error estimates.	**15**
		TOTAL	**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4*15 NCH = 60 NCH	1*30 NCH = 30 NCH	30 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Books:

1. *A text book of Engineering Mathematics*, Bali N. P. and Narayan Iyenger N., 9th Edition, 2016, Laxmi Publication.
2. *Mathematical Methods for Physics and Engineering: A Comprehensive Guide,* K. F. Riley, M. P. Hobson, 3rd Edition, 2006, Cambridge University Press

Reference Books:

1. Grewal B. S., *Higher Engineering Mathematics*, 43rd Edition, 2014, Khanna Publishers.
2. Das B. C. & Mukherjee B. N., *Differential Calculus*, 55th Edition, U. N. Dhur & Sons Pvt. Ltd.
3. Das B. C. & Mukherjee B. N, *Integral Calculus*, 57th Edition, U. N. Dhur & Sons Pvt. Ltd

Additional Readings:

1. https://mrcet.com/downloads/digital_notes/HS/Mathematics-I.
2. https://www.vidyalankar.org/gate/assets/docs/notes/maths.pdf

Paper III/Subject Basic Electrical Engineering		**Subject Code: CSE022C103**
L-T-P-C – 3-0-2-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective:

The objectives of the course are to make students understand the basic electrical terminologies and familiarize them with the basic concepts of D.C., single-phase and three-phase A.C. networks.

Prerequisites: Basic concepts of D.C. networks of Class XII, Electromagnetic Induction and A.C. Fundamentals etc.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Recall** the basic concepts of electrical engineering	**BT 1**
CO 2	**Understand** the concept behind basic electric and magnetic circuits.	**BT 2**
CO 3	**Apply** the working principles of electrical machines in real-life.	**BT 3**
CO 4	**Analyze** DC & AC circuits using different laws and theorems.	**BT 4**

Detailed Syllabus:

Modules	Topic	Course Content	Hours
I.	**DC Circuits**	Electrical Circuit Elements – The resistance element, the inductance element, the capacitance element. Voltage & Current source, practical & ideal voltage and current sources, source transformation. Kirchhoff's Laws, Analysis of simple circuits with DC excitation – series circuit, parallel circuit, voltage and current divider rule, star -delta conversion, Maxwells mesh current method, nodal voltage analysis , Network Theorems – Thevenin's Theorem, Nortons Theorem, Superposition theorem	**12**
II.	**AC Circuits**	AC fundamentals – generation of alternating voltage, representation of sinusoidal waveform, concept of frequency, cycle, time period, instantaneous value, average value, peak value, RMS value, phasor representation. Single phase AC Circuits – analysis of single-phase AC circuits consisting of R-L-C parameters, apparent power, real power, reactive power, power factor and its significance. Analysis of R-C series circuit, R-L-C series circuit, analysis of AC parallel circuits.	**20**
III.	**Electrical Machines:**	Principle of operation and construction of single-phase transformers. EMF equation, losses, efficiency and voltage regulation. DC Machines – Constructional details of a DC Machine; EMF Equation of a DC machine, Types of DC Machines, Applications of DC Generators, operation of a DC machine as a motor, Torque equation, importance of back emf, speed equation, speed regulation, starting a DC motor, types of DC Motor, applications of DC motors	**20**

IV.	**Electrical Installations:**	Electrical Power Supply System. Three phase four wire distribution system. Protection of electrical installations against overload, short circuit and earth fault. Protective devices for overload, short circuit, earth fault and electric shock – SFU, MCB, ELCB. Earthing – difference between neutral wire & earth wire, methods of earthing of domestic fittings and appliances. Types of wires, cables and wiring used in electrical installations.	**14**
		TOTAL	**66**

Basic Electrical Engineering Lab Syllabus

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 10 Laboratory experiments based on the following-

Lab	Experiments	Hours
I	To verify Thevenin's Theorem for DC network	**2**
II	To verify Maximum Power Transfer Theorem for DC network	**2**
III	Study of R-L-C Series circuit and determine R,L,C, cos Φ,P and Q and draw the phasor diagram	**2**
IV	Study of R-L-C Parallel circuit and determine R,L,C,cos Φ,P and Q and draw the phasor diagram	**2**
V	Calibration of a milli-ammeter as a voltmeter.	**2**
VI	To determine the ohmic and effective resistance (armature winding)	**2**
VII	To study the characteristics of a filament lamp	**2**
VIII	To measure the power in a single-phase load using one wattmeter	**2**
IX	To measure the insulation resistance using Megger	**2**
X	Demonstration of house wiring	**2**
	TOTAL	**20**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 22 NCH = 66 NCH	2 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *A Text Book of Electrical Technology*, Thereja, B.L., 1st Edition revised, 2008, S Chand & Company Ltd. Ram Nagar; New Delhi.
2. *Basic Electrical Engineering*, D. P. Kothari, I. J.Nagrath, 3rd Edition, 2009, Tata McGraw-Hill

Reference Books:

1. D. C. Kulshreshtha, *Basic Electrical Engineering*, 1st Edition, 2009, McGraw-Hill
2. E. Hughes, *Electrical and Electronics Technology,* 10th Edition, 2011, Pearson Publication

Additional Readings:

1. https://mrcet.com/downloads/digital_notes/HS/Basic%20Electrical%20Engineering%20R-20.pdf
2. https://www.cet.edu.in/noticefiles/231_BASIC_ELECTRICAL_ENGG-min.pdf
3. NPTEL Course on Basic Electrical Circuits by Prof. Nagendra Krishnapura, IITM
4. NPTEL Course on Fundamentals of Electrical Engineering by Prof. Debapriya Das, IIT, Kharagpur

Paper IV/Subject Name: Engineering Graphics & Design		**Subject Code: CEE022C104**
L-T-P-C – 3-0-2-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective:

The objectives of the course are to make students understand the process of drawing projections and sections and basic engineering drawing formats and to convert sketches to engineered drawings.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Relate** with the concepts of drawings and projections	**BT 1**
CO 2	**Understand** the dimension and figures using the drawing instruments and acquire visualization skills, projection of points, etc.	**BT 2**
CO 3	**Utilize** engineering curves in tracing the paths of simple machine components.	**BT 3**
CO 4	**Analyze** and assess sketches to convert them to engineered drawings.	**BT 4**

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I.	**Introduction and Projections**	Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales; Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;	**11**

		Covering those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc	
II.	**Angular Solids and Isometric Projections**	Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only). Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;	**11**
III.	**Overview of Computer Graphics**	Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids]. Consisting of set up of the drawing page and the printer, including scale settings, setting up of Modules and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;	**11**
IV	**Customisation and CAD drawing**	Covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computeraided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;	**11**
		TOTAL	**44**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
2 * 22 NCH = 44 NCH	4 * 15 NCH = 60 NCH	8 * 2 NCH = 16 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Engineering Drawing;* Bhatt, N.D, 53rd Edition, 2016, Charotar Publishing House

Reference Books:

1. Jolhe Dhananjay A; *Engineering drawing*, 5th Edition, 2010, Tata McGraw-Hill Education Pvt. Ltd., New Delhi

Additional Readings:

1. https://mrcet.com/downloads/digital_notes/HS/Engineering%20Graphics%20Manual%20final.pdf
2. https://www.pvpsiddhartha.ac.in/autonomus14/1-1/it/IT1L3.pdf
3. NPTEL Course on Engineering Drawing and Computer Graphics by Prof. Rajaram Lakkaraju, IIT, Kharagpur
4. NPTEL Course on Engineering Graphics by Prof. Nihar Ranjan Patra, IIT, Kanpur

Paper V/Subject Name: Universal Human Values		**Subject Code: BHS022A101**
L-T-P-C – 2-0-0-2	**Credit Units: 02**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** the basic need of human values in real life	**BT 1**
CO 2	**Understand** the importance of following the basic universal human values	**BT 2**
CO 3	**Apply** the holistic understanding in one's day-today life so as to keep oneself happy and to socialize with nature, society, etc	**BT 3**
CO 4	**Analyze** the harmony within human beings by distinguishing the needs of the self and the body.	**BT 4**

Detailed Syllabus:

Modules	**Topics**	**Course content**	**Periods**
I	**Value Education**	Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Sharing about Oneself, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Exploring Human Consciousness, Happiness and Prosperity – Current Scenario, Lectured, Method to	**11**

		fulfil the Basic Human Aspirations, Exploring Natural Acceptance	
II	**Harmony in Human Being**	Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, Exploring the difference of Needs of Self and Body, The Body as an Instrument of the Self Understanding Harmony in the Self, Exploring Sources of Imagination in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health, Exploring Harmony of Self with the Body	**11**
III	**Harmony in the Family & Society**	Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship", Exploring the Feeling of Trust, 'Respect' – as the Right Evaluation, Exploring the Feeling of Respect, Other Feelings, Justice in Human-to-Human Relationship Understanding Harmony in the Society, Vision for the Universal Human Order, Exploring Systems to fulfil Human Goal	**11**
IV	**Harmony in Nature & Implications of Holistic Understanding**	Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Exploring the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence, Exploring Co-existence in Existence Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, Exploring Ethical Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Exploring Humanistic Models in Education, Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession Exploring Steps of Transition towards Universal Human Order	**11**
TOTAL			**44**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
2 * 22 NCH = 44 NCH	-	8 * 2 NCH = 16 NCH (Seminar, Case Study, Discussion, Internship)

Text Books:

1. *A Foundation Course in Human Values and Professional Ethics,* R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi

Reference Books:

1. *Human Values*, A.N. Tripathi, 3rd Edition, 2019, New Age Intl. Publishers, New Delhi,

Additional Readings:

1. https://uhv.org.in/uhv2notes
2. https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php

Paper VI/Subject Name: Design Thinking		**Subject Code: COD022S116**
L-T-P-C – 0-0-2-1	**Credit Units: 01**	**Scheme of Evaluation: P**

Objective:

The objectives of the course are to provide the students with new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing innovative products which useful for a student in preparing for an engineering career.

Prerequisites: None

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Tell** the utility of design thinking	**BT 1**
CO 2	**Compare** and **classify** the various learning styles and memory techniques	**BT 2**
CO 3	**Develop** new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing innovative products	**BT 3**
CO 4	**Analyze** emotional experience and inspect emotional expressions to better understand users while designing innovative products	**BT 4**
CO 5	**Perceive** individual differences and its impact on everyday decisions and further Create a better customer experience	**BT 5**

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I.	**Insight to Learning, Remembering Memory and Emotions**	Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting. Understanding the Memory process, Problems in retention, Memory enhancement techniques. Understanding Emotions: Experience & Expression, Assessing Empathy, Application with Peers	**05**
II.	**Basis of Design Thinking**	Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test. Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving	**05**

III.	**Process of Prototype Design & Testing**	Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, Assignment – Engineering Product Design. What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing. Understanding Individual differences & Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences	**06**
IV	**Customer-Centric Design, Feedback, Re-Design & Re-Create**	Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design. Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – "Solving Practical Engineering Problem through Innovative Product Design & Creative Solution"	**06**
		TOTAL	**22**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
	1 * 22 NCH = 22 NCH	8 * 1 NCH = 8 NCH (Seminar, Case Study, Discussion, Internship)

Text Books:

1. *Developing Thinking Skills (The Way to Success)*, E. Balaguruswamy, 1st Edition, 2022, Khanna Publishing House
2. *Design Thinking for Engineering: A practical guide;* Iñigo Cuiñas, Manuel José Fernández Iglesias, 2023, Institution of Engineering and Technology
3. *Design Thinking For Strategic Innovation: What They Can't Teach You at Business or Design School,* Idris Mootee, 1st Edition, 2014, Adams Media

Reference Books:

1. Christian Müller-Roterberg; *Design Thinking For Dummies*, 1st Edition, 2020, For Dummies
2. *A Text Book of DESIGN THINKING For B.TECH. 4th Year, Semester-VII, Suitable For All The 4th Year B-Tech Students*

Additional Reading:

1. https://www.tutorialspoint.com/hi/design_thinking/design_thinking_tutorial.pdf

Paper VII/Subject Name: Ideation Lab		Subject Code: CSE022C117
L-T-P-C – 0-0-2-1	Credit Units: 01	Scheme of Evaluation: P

Objective:

The objectives of the course are to spread the culture of innovation among students, & other stakeholders, to motivate students to ideate and pursue creativity and to train students to become imaginative, creative, and capable of converting their ideas into prototypes.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Label** the basic technologies used for innovate	**BT 1**
CO 2	**Understand** and use tools for designing electronic systems, including schematic design, PCB layout, and documentation.	**BT 2**
CO 3	**Apply** advanced prototyping technologies, including Arduino and Raspberry Pi programming, power supply design, and 3D printing	**BT 3**
CO 4	**Analyze** the tools taught	**BT 4**

Detailed Syllabus:

The theory component will include the following:

- Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub.
- Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT.
- Introduction to basic hand tools - Tape measure, combination square, Vernier calliper, hammers, fasteners, wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives
- Introduction to Power tools: Power saws, band saw, jigsaw, angle grinder, belt sander, bench grinder, rotary tools. Various types of drill bits
- Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output)
- Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.
- Mechanical cutting processes - 3-axis CNC routing, basic turning, milling, drilling and grinding operations, Laser cutting, Laser engraving etc. Basic welding and brazing and other joining techniques for assembly. Concept of Lab aboard a Box.
- Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging.
- 3D printing and prototyping technology – 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverse engineering. Prototyping using subtractive

cutting processes. 2D and 3D Structures for prototype building using Laser cutter and CNC routers. Basics of IPR and patents; Accessing and utilizing patent information in IDEA Lab

Total Lab Hours for the semester = 22 (2 hours per week)

Minimum 08 Laboratory experiments based on the following-

1. Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2. Machining of 3D geometry on soft material such as soft wood or modelling wax.
3. 3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
4. 2D profile cutting of press fit box/casing in acrylic (3 or 6mm thickness)/cardboard, MDF (2 mm) board using laser cutter & engraver.
5. 2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6. Familiarity and use of welding equipment.
7. Familiarity and use of normal and wood lathe.
8. Embedded programming using Arduino and/or Raspberry Pi.
9. Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
-	1 * 22 NCH = 22 NCH	8 * 1 NCH = 8 NCH (Seminar, Case Study, Discussion, Internship)

Text/ Reference Books

1. Chris Hackett, *The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects,* Reprint Edition, 2018, Weldon Owen
2. Paul Horowitz, Winfield Hill, *The Art of Electronics,* 3rd Edition, 2015, Cambridge University Press
3. Simon Monk, *Programming Arduino: Getting Started with Sketches*, 2nd Edition, 2016, McGraw Hill TABH
4. Simon Monk, *Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards,* 2014, McGraw Hill Education
5. Scott Chacon, Ben Straub, *Pro Git*, 2nd Edition, 2014, A Press
6. Chapman W.A.J, *Workshop Technology*, 5th Edition, 2002, CBS Publishers and distributors

Additional Reading:

1. https://www.aicte-india.org/sites/default/files/IDC/idealab/AICTE%20-%20IDEA%20LAB%20User%20Manual.pdf
2. https://vignaniit.edu.in/ideaLab.php

6.3 Detailed Syllabus of 2nd Semester

Paper I/Subject Name: Chemistry		Subject Code: CHY022C201
L-T-P-C – 3-0-2-4	Credit Units: 04	Scheme of Evaluation: TP

Objective:

The objectives of the course are to s to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during course of their study in the industry and Engineering field and to understand the new developments and breakthroughs efficiently in engineering and technology

Prerequisites: Concepts of +2 level Chemistry

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** the basic properties of chemical reactions	**BT 1**
CO 2	**Interpret** periodic properties such as ionization potential, electronegativity, oxidation states, electronegativity and bulk	**BT 2**
CO 3	**Experiment with** major chemical reactions that are used in the synthesis of molecules.	**BT 3**
CO 4	**Analyze** microscopic chemistry in terms of atomic and molecular orbitals and intermolecular	**BT 4**

Detailed Syllabus:

Module	Topics	Course Content	Periods
I.	**Atomic and Molecular Structure**	Schrodinger equation. Particle in a box solution and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.	**16**
II.	**Spectroscopic Techniques and Applications, Intermolecular Forces and Potential Energy Surfaces**	Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering. Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.	**17**
III.	**Use of free**	Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and EMF. Cell potentials, the Nernst equation and applications. Acid base, oxidation	**16**

	Energy in Chemical Equilibria and Periodic Properties	reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams. Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries	
IV.	**Stereochemistry, Organic Reactions and Synthesis of a Drug Molecule**	Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule	**17**
TOTAL			**66**

Chemistry Lab Syllabus

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 10 Laboratory experiments based on the following-

1. Determination of surface tension and viscosity.
2. Thin layer chromatography.
3. Ion exchange column for removal of hardness of water.
4. Determination of chloride content of water.
5. Colligative properties using freezing point depression.
6. Determination of the rate constant of a reaction.
7. Determination of cell constant and conductance of solutions.
8. Potentiometry - determination of redox potentials and EMFs.
9. Synthesis of a polymer/drug.
10. Saponification/acid value of an oil.
11. Chemical analysis of a salt.
12. Lattice structures and packing of spheres.
13. Models of potential energy surfaces.
14. Chemical oscillations- Iodine clock reaction.
15. Determination of the partition coefficient of a substance between two immiscible liquids.
16. Adsorption of acetic acid by charcoal.
17. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 22 NCH = 66 NCH	2 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books

1. *A Textbook of Physical Chemistry*, Negi A.S. and Anand S.C., 2nd Edition, 2007, New Age International
2. *Concise Inorganic Chemistry,* Lee J.D., 5th Edition, 2008, John Wiley and Sons Ltd.

Reference Books:

1. Atkins, P.W. and Paula, J. De,*Physical Chemistry,* 10th Edition, 2014, Oxford University Press
2. Huheey, J.E. Keiter, E.A. Keiter, R.L Medhi, O.K.,*Inorganic Chemistry Principles of Structure and Reactivity*, 4th Edition, 2006, Pearson Education

Additional Readings:

1. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition, http://bcs.whfreeman.com/vollhardtschore5e/default.asp
2. NPTEL Course on Chemistry - I by Prof. Mangala Sunder Krishnan, IITM

Paper II/Subject Name: Mathematics-II		**Subject Code: MAT022C202**
L-T-P-C – 3-0-1-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective:

The objectives of the course are to teach the students Mathematics fundamentals necessary to formulate, solve and analyze engineering problems

Prerequisites: Concepts of Mathematics I

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**List** the methodologies used for solving various equations	**BT 1**
CO 2	**Understand** essential tool of matrices and linear algebra in a comprehensive manner	**BT 2**
CO 3	**Utilize** the essential tools in the field of applied sciences and related fields.	**BT 3**
CO 4	**Analyze** and **evaluate** the qualitative behavior of solutions of systems of differential equations and interpret in the context of an underlying model.	**BT 4 & 5**

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I	**Matrices** .	Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.	**15**

II	**Differential Equations**	Exact, linear and Bernoulli's equations. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type. Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.	**20**
III	**Complex Variable Differentiation**	Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.	**15**
IV	**Complex Variable Integration**	Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour	**16**
TOTAL			**16**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 22 NCH = 66 NCH	2 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *A text book of Engineering Mathematics*, Bali N. P. and Narayan Iyenger N., 9th Edition, 2016, Laxmi Publication.
2. *Mathematical Methods for Physics and Engineering: A Comprehensive Guide,* K. F. Riley, M. P. Hobson, 3rd Edition, 2006, Cambridge University Press

Reference Books:

1. Grewal B. S., *Higher Engineering Mathematics,* 43rd Edition, 2014, Khanna Publishers.
2. Raisinghania M.D., *Ordinary and Partial Differential Equations*, 17th Edition, 2014, S. Chand and Co., New Delhi.
3. Narayna S., *A Text Book of Vector Calculus,* Revised Edition, 2009, S. Chand & Co., New Delhi.

Additional Readings:

1. https://mrcet.com/downloads/digital_notes/HS/R-18%20Mathematics-II.pdf
2. http://www.bosecuttack.in/studentcorner/LECTURE_NOTE.MATH2.2ND_SEM__1_.pdf
3. https://www.srividyaengg.ac.in/coursematerial/Iyear/111223.pdf

Paper III/Subject Name: Biology for Engineers		Subject Code: CSE022C203
L-T-P-C – 3-0-0-3	Credit Units: 03	Scheme of Evaluation: T

Objective:

This course focuses on understanding various bio-potentials and their propagation, exploring different types of electrodes and their optimal placement for diverse recordings. It includes the design of bio-amplifiers for physiological recordings and examines measurement techniques for non-physiological parameters. Additionally, it aims to provide familiarity with biochemical measurement methods.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** the different physiological processes of human body.	**BT 1**
CO 2	**Explain** the different electrode placement for various physiological recording	**BT 2**
CO 3	**Apply** bio amplifier for various physiological recording	**BT 3**
CO 4	**Analyze** various technique nonelectrical, physiological & biochemical measurements	**BT 4**

Detailed Syllabus:

Modules	Topics	Course content	Hours
I	**Fundamentals of Human Physiology: Cellular, Blood, Cardiovascular, and Nervous Systems**	Structure and function of Cell & cellular components, Membrane Potential, Action Potential, Generation and Conduction. Blood Cell, Composition, Fluid and electrolytic balance, Blood Groups, Estimation of RBC, WBC and platelet. Cardiovascular system, Heart and vascular system, ECG, Blood Pressure, Homeostasis, Cardiac output, Coronary and Peripheral Circulation, Heart Sounds Nervous System, Structure and functions of Neurons, Synapse, Reflex action and Receptors, Velocity of Conduction of Nerve Impulses, Nervous control of Heart.	**15**
II	**Transducers**	Classification, selecting of transducers, circuit based on transduction. Temperature transducers, Displacement transducer, Pressure transducer, catheter tip transducers. Photoelectric transducers, Flow transducers, Piezoelectric transducers and their applications	**10**

Modules	Topics	Course content	Hours
III	**Biomedical Signal Acquisition: Principles and Applications of Bioelectrical Recordings**	Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes – Electrode-tissue interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes, Needle electrodes	**15**
IV	**Advances in Biosensing, Bioprinting, and Biomedical Innovations**	Biosensors Chemoreceptors, hot and cold receptors, baro receptors, sensors for smell, sound, vision, osmolality and taste. Transducers for the measurement of ions and dissolved gases. Ion exchange membrane electrodes, Measurement of pH, Glass pH electrodes, Measurement of pO2, Measurement of pCO2. ISFET for glucose, urea. Bioprinting techniques and materials, 3D printing of ear, bone and skin, Artificial intelligence for disease diagnosis, Biocomputing, Bioimaging.	**20**
TOTAL			**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3*20 NCH = 60 NCH	-	30 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Book:

1. *Biomedical Instrumentation and measurement,* Leslie Cromwell, 2nd Edition, 1990, Prentice Hall of India, New Delhi.
2. *Medical Instrumentation Application and Design,* John G. Webster, 4th Edition, 2009, John Wiley and sons, New York, (Units I, II & V)

Reference Books:

1. Myer Kutz, *Standard Handbook of Biomedical Engineering and Design*, 202, McGraw Hill Publisher
2. Khandpur R.S, *Handbook of Biomedical Instrumentation*, 3rd Edition, 2014, Tata McGraw-Hill, New Delhi, (Units II & IV)
3. Joseph J. Carr and John M. Brown, *Introduction to Biomedical Equipment Technology*, 4th Edition, 2004, Pearson Education.
4. R. Anandanatarajan, *Biomedical Instrumentation*, Kindle Edition, 2015, PHI Learning
5. M. Arumugam, *Biomedical Instrumentation*, 2003, Anuradha Agencies Publishers

Additional Readings:

1. https://www.studocu.com/in/document/aryabhatta-knowledge-university/btechit-btechcse/biology-notes-for-engineers/61016774
2. https://www.aminotes.com/2017/02/biology-for-engineers-module-1-cocepts.html
3. https://topperworld.in/b-tech-biology-notes/

Paper IV/Subject Name: Programming for Problem Solving		Subject Code: CSE022C204
L-T-P-C – 3-0-2-4	Credit Units: 04	Scheme of Evaluation: TP

Objective:

The objectives of the course are to make the students capable of using C programming to solve basic as well as advanced computing problems.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**List** the various constructs used in programming	**BT 1**
CO 2	**Demonstrate** the working of C programming language.	**BT 2**
CO 3	**Apply** the programming concepts to solve various problems.	**BT 3**
CO 4	**Analyze** and debug the errors while writing the programs.	**BT 4**
CO 5	**Assess** and design a new algorithm to solve a new real-life problem.	**BT 5**

Detailed Syllabus:

Modules	Topics	Course content	Hours
I	**Fundamentals of Programming**	Introduction to Programming; Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.	**15**
II	**Expressions, Conditional Operators and Loops**	Arithmetic expressions and precedence. Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops. Arrays, Arrays (1-D, 2-D), Character arrays and Strings	**15**
III	**Functions, Recursion, Sorting**	Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required). Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference. Recursion, Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort	**15**

Modules	Topics	Course content	Hours
IV	**Advanced Programming Concepts using C**	Structures, Defining structures and Array of Structures, Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), File handling.	**15**
TOTAL			**60**

Programming for Problem Solving Lab Syllabus

Detailed Syllabus:

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 20 Laboratory experiments based on the following-

1. Character set, Tokens, Keywords and Identifiers, Constants, variables, data types, statements, comments, declaration of storage class, assigning values to variables.
2. Managing I/O, reading and writing characters, formatted Input/output.
3. Arithmetic operators, relational operators, logical operators, assignment operators, increment & decrement operators, conditional operators, bitwise operators, special operators.
4. Importance of decision making, decision making with if statement, if-else statement, nested if-else statements, switch-case statement.
5. Importance of iterative statements, the while statement, do-while statement, for statement, nested for looping.
6. Significance of Arrays, creation and use of one & two-dimensional arrays
7. Declaration and use of string variables, reading and writing strings.
8. Benefits of user-defined functions, creation and use of user-defined functions, parameter passing, return types.
9. Use of Pointers, declaration & initialization of pointer variables, accessing a variable through its pointer.
10. Defining, opening & closing files in C.

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3*20 NCH = 60 NCH	1*30 NCH = 30 NCH	30 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Book:

1. *Computer Fundamentals and Programming in C,* Reema Thareja, 2nd Edition, 2016, Oxford University Press, Delhi.

Reference Books:

1. E Balaguruswamy, *Computing Fundamentals and C Programming*, 1st Edition, 2017, McGraw Hill.
2. Venugopal and Prasad, *Mastering C*, 2nd Edition, 2017, Tata McGraw Hill.
3. Yashawant Kanetkar,*Let us C,* 15th Edition, 2017, BPB.

Additional Readings:

1. https://mrcet.com/downloads/digital_notes/HS/Programming%20for%20Problem%20Solving.pdf
2. NPTEL course on Introduction to Programming in C by Prof. Satyadev Nandakumar, IIT, Kanpur

Paper V/Subject Name: Workshop Practices		Subject Code: MEE022C215
L-T-P-C – 0-0-4-2	Credit Units: 02	Scheme of Evaluation: P

Objective:

The objectives of the course are to provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Label** the various techniques used under mechanical engineering	**BT 1**
CO 2	**Understand** the different manufacturing processes which are commonly employed in the industry	**BT 2**
CO 3	**Utilize** tools, instruments and techniques learnt to perform basic household chores in terms of house wiring, carpentry etc.	**BT 3**
CO 4	**Experiment** using the tools and techniques learnt for various purposes and decide on the best prospect.	**BT 4**

Detailed Syllabus:

Total Lab Hours for the semester = 40 (4 hours per week)

Minimum 10 Laboratory experiments based on the following-

The lecture sessions will be on the following topics:

- Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.
- CNC machining, Additive manufacturing.
- Fitting operations & power tools.
- Electrical & Electronics.
- Carpentry.
- Plastic moulding, glass cutting.
- Metal casting.
- Welding (arc welding & gas welding), brazing g topics:

And the lab sessions will on the topics:

- Machine shop
- Fitting shop
- Carpentry
- Electrical & Electronics
- Welding shop (Arc welding + Gas welding)
- Casting
- Smithy
- Plastic moulding & Glass Cutting

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
-	2*20 NCH = 40 NCH	20 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Books:

1. *Elements of Workshop Technology,* Hajra Choudhury, S K, Hajra Choudhury, A K, 14th Edition, 2007, Mumbai Media Promoters
2. *Manufacturing Technology – I,* Gowri P. Hariharan and A. Suresh Babu, 2008, Pearson Education.

Reference Books:

1. Roy A. Lindberg, *Processes and Materials of Manufacture*", 4th Edition, 1998, Prentice Hall India,

Additional Readings:

1. http://mm-coep.vlabs.ac.in/LaserSpotWelding/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20Micromachining%20laboratory
2. http://fab-coep.vlabs.ac.in/exp7/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20FAB%20laboratory

Paper VI/Subject Name: English for Technical Writing		**Subject Code: CEN022A201**
L-T-P-C – 2-0-0-2	**Credit Units: 02**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to provide learning environment to practice listening, speaking, reading and writing skills, to assist the students to carry on the tasks and activities through guided instructions and materials and to effectively integrate English language learning with employability skills and training.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** the various forms of communication	**BT 1**
CO 2	**Understand** basic proficiency in English.	**BT 2**
CO 3	**Develop** reading and listening comprehension, writing and speaking skills.	**BT 3**
CO 4	**Analyze** the type of communication	**BT 4**

Detailed Syllabus:

Modules	Topics	Course content	Hours
I	**Vocabulary Building**	The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives, Synonyms, antonyms, and standard abbreviations.	**10**
II	**Basic Writing Skills**	Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, creating coherence, organizing principles of paragraphs in documents, Techniques for writing precisely, Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés	**10**
III	**Writing Practices**	Nature and Style of sensible Writing, Describing, Defining 1.3. Classifying, providing examples or evidence, Writing introduction and conclusion, Comprehension, Précis Writing, Essay Writing	**10**
IV	**Oral Communication**	Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues, Communication at Workplace, Interviews, Formal Presentations	**10**
		TOTAL	**40**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
2*20 NCH = 40 NCH	-	20 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Book:

1. *Effective Communication Skills.* Kul Bhushan Kumar, 2022, Khanna Book Publishing
2. *Practical English Usage,* Michael Swan. 1995, OUP

Reference Books:

1. F.T. Wood, *Remedial English Grammar.,* 2007, Macmillan.
2. William Zinsser, *On Writing Well*, 2001, Harper Resource Book.
3. Liz Hamp-Lyons and Ben Heasly, *Study Writing*, 2006,
4. Sanjay Kumar and PushpLata, *Communication Skills*, 2011, Oxford University Press.

Additional Readings:

1. AICTE's Prescribed Textbook: English (with Lab Manual), Khanna Book Publishing Co., https://khannabooks.com/index.php?route=product/product&path=99_105&product_id=480
2. NPTEL Course on English Language for Competitive Exams by Prof. by Aysha Iqbal, IIT, Madras
3. NPTEL Course on Technical English for Engineers by Prof. by Aysha Iqbal, IIT, Madras

Paper VII/Subject Name: Sports and Yoga		Subject Code: CSE022C217
L-T-P-C – 0-0-2-1	Credit Units: 01	Scheme of Evaluation: P

Objective:

The objectives of the course are to make the students understand the importance of sound health and fitness principles as they relate to better health, to expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness and to develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Choose** the best form of yoga/ exercise for them	**BT 1**
CO 2	**Understand** basic skills associated with yoga and physical activities including strength and flexibility, balance and coordination	**BT 2**
CO 3	**Experiment with** different forms of yoga to keep oneself physically fit and mentally strong	**BT 3**
CO 4	**Assess** current personal fitness levels	**BT 4**

Detailed Syllabus:

Modules	Topics	Course content	Periods
I	**Physical Education, Olympic Movement, Fitness, Wellness & Lifestyle**	Meaning & definition of Physical Education. Aims & Objectives of Physical Education. Changing trends in Physical Education, Ancient & Modern Olympics (Summer & Winter), Olympic Symbols, Ideals, Objectives & Values, Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc., Meaning & Importance of Physical Fitness & Wellness, Components of Physical fitness, o Components of Health-related fitness, Components of wellness, Preventing Health Threats through Lifestyle Change, Concept of Positive Lifestyle	**5**
II	**Anatomy & Physiology in Physical Education, Sports, Yoga & Postures**	Define Anatomy, Physiology & Its Importance, ffect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.), Meaning & Importance of Kinesiology & Biomechanics in Physical Edu. & Sports, o Newton's Law of Motion & its application in sports. o Friction and its effects in Sports, Meaning and Concept of Postures, Causes of Bad Posture. Advantages & disadvantages of weight training. Concept & advantages of Correct Posture. Common Postural Deformities – Knock Knee; Flat Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis. Corrective Measures for Postural Deformities	**5**

III	**Yoga & Lifestyle**	Meaning & Importance of Yoga, Elements of Yoga, Asanas, Pranayama, Meditation & Yogic Kriyas, yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana & Shashankasana) Relaxation Techniques for improving concentration - Yog-nidra, Asanas as preventive measures. Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana. Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana. Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana. Diabetes: Procedure, Benefits & contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana. Asthema: Procedure, Benefits & contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.	**5**
IV	**Training, Planning and Psychology in Sports**	Meaning of Training, Warming up and limbering down, Skill, Technique & Style, Meaning and Objectives of Planning. Tournament – Knock-Out, League/Round Robin & Combination. Definition & Importance of Psychology in Physical Edu. & Sports, Define & Differentiate Between Growth & Development, Adolescent Problems & Their Management, Emotion: Concept, Type & Controlling of emotions, Meaning, Concept & Types of Aggressions in Sports. Psychological benefits of exercise. Anxiety & Fear and its effects on Sports Performance. Motivation, its type & techniques. Understanding Stress & Coping Strategies	**5**
TOTAL			**20**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
	1*20 NCH = 20 NCH	10 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Books:

1. *Modern Trends and Physical Education*, Ajmer Singh, Gill J.S, Bains J, 4th Edition, 2012, Kalyani Publishers

Reference Books:

1. B.K.S. Iyengar, *Light on Yoga*, 2006, Thorsons

6.4 Detailed Syllabus of 3rd Semester

Paper I/Subject Name: Discrete Mathematics		Subject Code: MAT022C301
L-T-P-C – 3-1-0-4	Credit Units: 04	Scheme of Evaluation: T

Objective:

The objectives of the course are to make the students learn the concept of mathematical logic, sets, relations, and functions, generating functions and recurrence relations, Graph Theory for solving engineering related problems.

Prerequisites: Concepts of Mathematics I, II

Course Outcomes

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** the concept of logic, sets, relations and functions to solve problems.	**BT 2**
CO 2	**Apply** the concepts learnt to solve computer science related problems.	**BT 3**
CO 3	**Analyze** and evaluate the solutions.	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I	**Sets, Relations, Functions & Algebraic Structures**	Operations and Laws of Sets, Binary, Relation, Partial Ordering Relation, Equivalence Relation, Functions, Inverse and Composite Function, Finite and infinite Sets, Countable and uncountable Sets, Poset, Lattice. The Well-Ordering Principle, The Division algorithm: Prime numbers, The Greatest Common Divisor, The least common multiple, Euclidean Algorithm, The Fundamental Theorem of Arithmetic, Congruence, Euler's phi function. Algebraic Structures with one Binary Operation, Semi Groups, Monoids, Groups, Congruence Relation and Quotient Structures, Free and Cyclic Monoids and Groups, Permutation Groups, Normal Subgroups, Algebraic Structures with two Binary Operation, Rings, Integral Domain and Fields.	**13**
II	**Graph Theory and Combinatorics**	Graphs and their properties, Degree, subgraphs, walks, paths and circuits, connected and disconnected graphs, Isomorphism, Eulerian and Hamiltonian graphs, Complete graphs, Bipartite graph, Trees, Properties of trees, Pendant vertex, Distance and Centers, Binary tree, Spanning trees, Planar graphs, Matrix representation of graphs, Chromatic number, Chromatic polynomial, Five colours theorem. Pigeon-hole principle, permutation and combination, Recurrence relations, Generating functions.	**20**
III	**Propositional Logic**	Proposition, connectives, tautology, contradiction, logical equivalence, normal forms-DNF, CNF, argument, Validity of	**20**

		argument, fallacy, Rules of Inference, Quantifiers. Boolean Algebra and Boolean Ring, Identities of Boolean Algebra, Duality, Representation of Boolean Function.	
IV	**Probability**	Definition of Probability, Classical, Relative Frequency, and Axiomatic Approaches, Basic Terminologies: Sample Space, Events, Outcomes, Types of Events: Mutually Exclusive, Exhaustive, Independent, Dependent, Addition Theorem of Probability, Conditional Probability, Multiplication Theorem of Probability, Bayes' Theorem and Its Applications, Discrete and Continuous Random Variables, Probability Mass Function (PMF) and Probability Density Function (PDF), Expectation, Variance, and Standard Deviation, Common Discrete Distributions, Joint and Marginal Probability, Independent and Dependent Events, Conditional Independence	**13**
		TOTAL	**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 22 NCH = 66 NCH	2 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *A text book of Discrete Mathematics*, Sarkar S. K., Revised Edition, 2016, S Chand & Co Ltd.

Reference Books:

1. Deo N; *Graph Theory with applications to engineering and computer science*, New Edition, 2009, PHI Learning Private Limited.
2. Chandrasekaran N. and Umaparvathi, *Discrete Mathematics*, Eastern Economic Edition, 2013, PHI
3. *Discrete Mathematics and its Applications,* Rosen, K.H., 6th Edition, 2006, McGraw Hill.
4. Tremblay, J.P. and Manohar, R., *Discrete Mathematical Structures with Applications to Computer Science*, 35th Reprint, 2007, Tata McGraw Hill

Paper II/Subject Name: Data Structure & Algorithms		**Subject Code: ARI022C302**
L-T-P-C – 3-0-2-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective:

The objectives of the course are to make the students understand about the data structures, how to implement them in C, their advantages and drawbacks, & how they can be overcome.

Prerequisites: Concepts of Computer Programming

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy**

		Level
CO 1	**Define** various data structures used in programming.	**BT 1**
CO 2	**Understand** the basic constructs of data structure and its implementation.	**BT 2**
CO 3	**Utilise** the appropriate data structures to solve a given problem.	**BT 3**
CO 4	**Analyse** and **evaluate** the data structures used for problem solving	**BT 4 & 5**

Detailed Syllabus:

Modules	Topics	Course content	Hours
I	**Linear Data Structure-I**	a. Introduction: Why we need data structure? Concepts of data structures: Data and data structure, Abstract Data Type and Data Type. Algorithms and programs, basic idea of pseudo-code. Algorithm efficiency and analysis, time and space analysis of algorithms – order notations. b. Array : Different representations – row major, column major. Sparse matrix - its implementation and usage. Array representation of polynomials. c. Linked List: Singly linked list, circular linked list, doubly linked list, linked list representation of polynomial and applications.	**15**
II	**Linear Data Structure-I**	**a. Stack and Queue:** Stack and its implementations (using array, using linked list applications. Queue, circular queue, dequeuers. Implementation of queue- both linear and circular (using array, using linked list), applications. **b. Recursion:** Principles of recursion – use of stack, differences between recursion and iteration, tail recursion. Applications - The Tower of Hanoi, Eight Queens Puzzle.	**18**
III	**Non-Linear Data Structures**	**a. Trees:** Basic terminologies, forest, tree representation (using array, using linked list). Binary trees - binary tree traversal (pre-, in-, post- order), threaded binary tree (left, right, full) - non-recursive traversal algorithms using threaded binary tree, expression tree. Binary search tree- operations (creation, insertion, deletion, searching). Height balanced binary tree – AVL tree (insertion, deletion with examples only). **b. Graphs:** Graph definitions and concepts (directed/undirected graph, weighted/un-weighted edges, sub-graph, degree, cut-vertex/articulation point, pendant node, clique, complete graph, connected components – strongly connected component, weakly connected component, path, shortest path, isomorphism). Graph representations/storage implementations – adjacency matrix, adjacency list, adjacency multi-list. Graph traversal and connectivity – Depth-first search (DFS), Breadth-first search (BFS) – concepts of edges used in DFS and BFS (tree-edge, back-edge, cross-edge, and forward-edge), applications. Minimal spanning tree – Prim's algorithm	**18**

		(basic idea of greedy methods). B-Trees operation	
IV	**Searching and Sorting**	**a. Sorting Algorithms:** Bubble sort and its optimizations, insertion sort, shell sort, selection sort, merge sort, quick sort, heap sort (concept of max heap, application – priority queue), radix sort. **b. Searching Algorithms:** Sequential search, binary search, interpolation search.	**15**
TOTAL			**66**

Data Structures and Algorithms Lab Syllabus

Detailed Syllabus:

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 20 Laboratory experiments based on the following-

1. Some common programs of C as revision.
2. Programs on Arrays- Traversal, Insertion, Deletion, Polynomial Representation, etc.
3. Programs on Linked List- Creation Insertion, Deletion, Polynomial Representation, etc.
4. Programs on Stacks-Creation, Push Pop, Infix to Postfix Conversion, Evaluation.
5. Programs on Queues-Creation, Insertion, Deletion, etc.
6. Programs on Trees- Binary Tree Creation, Tree Traversal, BST
7. Programs on Searching- Linear Search, Binary Search
8. Programs on Sorting- Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Merge Sort, Heap Sort.

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 22 NCH = 66 NCH	1 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Data Structures Using C*, Reema Thareja, 2nd Edition, 2014, Oxford University Press.

Reference Books:

1. Seymour Lipschutz, *Data Structures*, 1st Edition (reprint) 2017, McGraw Hill Education.
2. Narasimha Karumanchi, *Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles*, 5th Edition, 2016, Careermonk Publications.
3. Horowitz, Sahni and Anderson-Freed, *Fundamentals of Data Structures in C*, 2nd Edition, 2008, Universities Press.
4. E. Balagurusamy, *Data Structures Using C*, 1st Edition, 2017, McGraw Hill Education.

Paper III/Subject Name: Computer Organization and Architecture		Subject Code: ARI022C303
L-T-P-C – 3-0-0-3	Credit Units: 03	Scheme of Evaluation: T

Objective:

The objectives of the course are to explain about the machine instructions and basic computer organization and I/O subsystems and pipelining processing

Prerequisites: Fundamental concepts of Digital Logic

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** the different hardware and its working in a Computer Systems in architectural level	**BT 1**
CO 2	**Demonstrate** computer architecture concepts related to design of modern processors, memories, and I/O	**BT 2**
CO 3	**Solve** problems related to computer Organization and Architecture	**BT 3**
CO 4	**Analyse** the performance of commercially available computers in architectural level.	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Content	Hours
I	**Basic organization of computers and machine instructions**	Block level description of the functional units as related to the execution of a program; Fetch, decode and execute cycle. Instruction set architectures, Assembly language programming, addressing modes, instruction cycles, registers and storage, addressing modes; discussions about RISC versus CISC architectures; Inside a CPU.	**15**
II	**Information representation**	Floating point representation (IEEE 754), computer arithmetic and their implementation; Fixed-Point Arithmetic: Addition, Subtraction, Multiplication and Division, Arithmetic Logic Units control and data path, data path components, design of ALU and data path, controller design; Hardwired and Microprogrammed Control	**18**
III	**Memory Technology**	Static and dynamic memory, Random Access and Serial Access Memories, Cache memory and Memory Hierarchy, Address Mapping, Cache updation schemes, Virtual memory and memory management unit.	**18**
IV	**I/O subsystems & Pipeline Processing**	Input-Output devices such as Disk, CD-ROM, Printer etc.; Interfacing with IO devices, keyboard and display interfaces; Basic concepts Bus Control, Read Write operations, Programmed IO, Concept of handshaking, Polled and Interrupt-driven I/O, DMA data transfer. Instruction and Arithmetic Pipeline, Pipeline hazards and their resolution, Parallel Processing.	**15**

TOTAL	**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 22 NCH = 66 NCH	--	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Computer System and Architecture*, Moris Mano, 3rd Edition, 2007, PHI.
2. *Structured Computer Organization,* A. S. Tanenbaum, 5th Edition, 2009, Prentice Hall of India

Reference Books:

1. V. C. Hamacher, Z. G. Vranesic and S. G. Zaky, *Computer Organization,* 5th Edition, 20011, McGraw Hill.
2. J. L. Hennessy and D. A. Patterson, *Computer Architecture: A Quantitative Approach,* 5th Edition, 2011, Morgan Kaufmann.

Paper IV/Subject Name: Digital Logic and System Design		**Subject Code: ARI022C304**
L-T-P-C – 3-0-2-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective:

The objectives of the course are to make the students understand the simplification of Boolean expression and how to implement with various gates.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** the different types of circuits in system design	**BT 1**
CO 2	**Understand** the concepts of combinational and sequential circuit design	**BT 2**
CO 3	**Apply** the concepts learnt to design digital circuits.	**BT 3**
CO 4	**Analyze** the outputs produced and behaviour of the different circuits.	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Content	Hours
I	**Fundamental of Digital Electronics &Boolean algebra and its simplification**	Review of number system; Position number system – decimal, binary, octal and hexadecimal, number base conversion. Representation of negative binary numbers. Codes – BCD Gray, Excess -3 Digital signal, logic gates: AND, OR, NOT, NOR, EX-OR, EX-NOR Axioms and basic theorem of Boolean algebra. Truth table, logic function and their realization, standard representation (canonical forms) of logic gates-SOP and POS forms, MIN terms and MAX terms Simplification of logic function: K-map of 2, 3, 4 and 5 variables. Simplification of algebra and by map method. Don't care condition. Quine Mcluskey methods of simplification. Synthesis using AND, OR and INVERT and then to convert to NAND or NOR implementation	**18**
II	**Combinational logic circuit design**	Combinational logic circuit and buildings blocks. Binary adders and sub tractors. Carry look ahead adder. Encoders, Decoders, Multiplexers, Demultiplexers, Comparators, parity generators, etc. Realization of logic gates functions through decoders and multiplexers.	**15**
III	**Sequential circuits**	Flip flops: truth table and state table SR, JK, TD, race around condition, master slave conversion of flip-flops. Sequential shift register, sequence generator. Counter s: asynchronous and d Synchronous generators. Ring counter s and Johnson counter, up. Down counter modulo – N counter. Design of Synchronous sequential circuit.	**15**
IV	**Digital logic families and programmable logic devices**	Switching mode operation of PN junction, Bipolar and MOD device Bipolar families: RTL, DTL, DCTL, HTL, TTL, ECL, MOS, and CMOS logic families, Tristate logic. Gate properties fan in, fan out, propagation delay and power delay product. RAM and ROM their uses, SSI, MSI LSI and V LSI devices. Introduction to PLA, PAL TO FPGA and CPLDS, some commonly used digital ICs	**18**
TOTAL			**66**

Digital Logic and System Design Lab Syllabus

Detailed Syllabus:

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 08 Laboratory experiments based on the following-

- To realize a transistorized AND Gate
- To realize a transistorized OR Gate
- To realize a transistorized NOT Gate
- To realize a transistorized NAND Gate
- To realize a transistorized NOR Gate
- To verify the truth tables of logic gates using ICs
- Realization of half and full adder
- Realization of half and full subtractor
- Realization of 2:1 and 1:2 DEMUX

- Realization of Encoder and Decoder

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	1 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Digital Logic & Computer Design*, M. Morris Mano, 1st Edition, 2016, Prentice Hall of India.
2. *Digital Principles and Applications*, P. Malvino and D. K. Leach, 8th Edition, 2014, Tata McGraw Hill.

Reference Books:

1. S. Salivahanan and S. Pravin Kumar, *Digital Logic Circuits*, 1st Edition, 2010, Vikas Publishing House.
2. Stephen Brown and Zvonko Vranesic, *Fundamentals of Digital Logic with VHDL Design*, 3rd Edition, 2017, McGraw Hill.
3. Sanjay Sharma, *Digital Electronics: Digital Logic Design*, 1st Edition, 2013, S K Kataria & Sons.
4. Pratima Manhas and Shaveta Thakral, *Digital Logic & Design*, 1st Edition, 2013, S K Kataria & Sons.
5. A Potton, *An Introduction to Digital Logic*, Imort Edition, 2013, Palgrave.

Paper V/Subject Name: Programming with Python		**Subject Code: ARI022G306**
L-T-P-C – 3-0-0-3	**Credit Units: 03**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to teach the students about Programming with Python and use it to solve real world problems.

Prerequisites: Fundamentals of Computers

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** semantics and syntax of Typescripts.	**BT 1**
CO 2	**Understand** static types and know how to port untyped JavaScript	**BT 2**
CO 3	**Apply** the concepts learnt to create Single Page Web Applications (SPA) using React, Typescript and Tailwind CSS.	**BT 3**
CO 4	**Inspect** different elements of front-end development	**BT 4**

Detailed Syllabus:

Modules	Topics	Course content	Periods
I	**Introduction to Python**	Introduction to Python Programming: Python interpreter/shell, indentation; identifiers and keywords; literals, numbers, and strings; operators (arithmetic operator, relational operator, Boolean operator, assignment, operator, ternary operator and bitwise operator) and expressions	**18**
II	**Programming With Python**	Input and output statements, defining functions, control statements (conditional statements, loop control statements, break, continue and pass, exit function.), default arguments,	**18**
III	**Python Functions and Strings**	Python Functions, Python Lambda, Python Arrays, Python Classes/Object, Inheritance, Iterator, Polymorphism, Scope, Modules, Dates, Maths, JSON,RegEx, PIP, User Input , Strings	**15**
IV	**Python Modules**	Introduction to Numpy, Pandas,SciPy, Dijango	**15**
Total			**66**

Introduction to Python Programming Lab

Detailed Syllabus:

Total Lab Hours for the semester = 48 (4 hours per week)

Minimum 20 Laboratory experiments based on the following-

1. **Hello World Program:**
   - Write a simple Python program to print "Hello, World!" to the console.
2. **Variable Declaration and Printing:**
   - Practice declaring variables of different types (int, float, string) and printing their values.
3. **Basic Arithmetic Operations:**
   - Write Python scripts to perform basic arithmetic operations such as addition, subtraction, multiplication, and division.
4. **Conditional Statements:**
   - Create programs using if-else statements to perform tasks based on certain conditions.
5. **Loops (for and while):**
   - Practice writing for and while loops to iterate over sequences or execute code repeatedly.
6. **Lists and List Operations:**
   - Explore lists in Python and perform operations like appending, removing, and accessing elements.

   Level: Intermediate
7. **Functions:**
   - Define and call functions to encapsulate reusable code blocks. Practice passing arguments and returning values from functions.
8. **String Manipulation:**
   - Work on tasks involving string manipulation, such as concatenation, slicing, and searching.
9. **File Handling:**
   - Write Python scripts to read from and write to files. Practice handling exceptions during file operations.
10. **Dictionaries and Sets:**

- Experiment with dictionaries and sets in Python. Perform operations like adding, removing, and accessing elements in dictionaries and sets.

11. **Object-Oriented Programming (OOP) Concepts:**
    - Introduce students to OOP concepts like classes, objects, inheritance, and polymorphism. Have them implement simple classes and explore inheritance hierarchies.
12. **Exception Handling:**
    - Practice handling exceptions using try-except blocks to gracefully manage errors in Python programs.
13. **Data Structures and Algorithms:**
    - Implement common data structures (e.g., stacks, queues, linked lists) and algorithms (e.g., sorting, searching) using Python.
14. **Regular Expressions:**
    - Introduce regular expressions and their usage in Python for pattern matching and text processing tasks.
15. **Modules and Packages:**
    - Explore the concept of modules and packages in Python. Have students create their own modules and packages and import them into other scripts.
16. **GUI Programming with Tkinter:**
    - Introduce GUI programming using Tkinter. Have students create simple graphical user interfaces (GUIs) for basic applications.

National Credit Hours		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3*22 NCH = 66 NCH	--	3*8 = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Project)

Textbooks:

1. Guttag, J.V. (2016). Introduction to computation and programming using Python. 2nd edition. MIT Press.

Reference Books:

1. Kamthane, A. N., & Kamthane, A.A. (2017) Programming and Problem Solving with Python, McGraw Hill Education.
2. Liang, Y. D. (2013). Introduction to Programming using Python. Pearson Education.

6.5 Detailed Syllabus of 4th Semester

Paper I/Subject Name: OOP using C++		Subject Code: ARI022C401
L-T-P-C – 3-0-2-4	Credit Units: 04	Scheme of Evaluation: TP

Objective:

The objectives of the course are to make the students understand how C++ improves C with object-oriented features and to explain problem solving and programming skills in C++ with extensive programming projects.

Prerequisites: Fundamentals of Computer Programming

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** and **understand** the basic concepts of OOP.	**BT 1 & 2**
CO 2	**Apply** the concepts learnt to write efficient programs in C++.	**BT 3**
CO 3	**Analyze** a problem and construct a C++ program that solves it.	**BT 4**
CO 4	**Assess** a C++ program and describe ways to improve it.	**BT 5**

Detailed Syllabus:

Modules	Topics	Course content	Periods
I	**Introduction**	Introduction, Need, Characteristics, Difference between POP and OOP, Basic concepts of OOP, Features, Applications of OOP. Revision of topics like data types, keywords, identifiers, tokens, reference variables, different operators, conditional and loop control structures.	**15**
II	**Classes and Objects**	Definition of class, object, Difference between class and structure, class definitions, member functions, access specifiers. Objects Dynamic Creation and initialization, Passing and Returning objects, Object assignment and array of objects. Constructors Types, Destructors, Nesting member function, Private member function , Inline functions. Static class members, Function prototyping, Call by reference, Return by reference, Default Argument, Friend functions, this pointer.	**18**
III	**Inheritance and Polymorphism**	Types of Inheritance; Base and Derived classes, Syntax of derived classes, access to the base class; Types of Inheritance, Multiple inheritance, Virtual Base classes, Constructors and Destructors in Inheritance, Container classes, Abstract Classes. Polymorphism: Compile time(Early/Static binding), Overloading functions and operators,Overloading new and delete operators, Run time polymorphism(Late/Dynamic Binding), Virtual functions, Pure Virtual functions, Virtual	**18**

		Destructors, Review of Virtual base classes,	
IV	**Templates, Exception and File Handling**	Templates–Uses, Generic classes, Class templates, Function templates, Advance templates. Examples. Exception handling-Advantages, Try catch and throw clauses, Examples,Manipulators, different examples of manipulators. Pointer types-uses; Dynamic memory allocation techniques, garbagecollection, Linked list, generic pointers; FilesOpen, Close, Read and Write; File attributes, File management	**15**
		TOTAL	**66**

OOP using C++ Lab Syllabus

Detailed Syllabus:

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 20 Laboratory experiments based on the following-

1. Write a C++ program to display "HELLO WORLD".
2. Write a C++ program that will ask the temperature in Fahrenheit and display in Celsius
3. Write a C++ program to print the following output using forloop.

   1
   2 2
   3 3 3
   4 4 4 4
4. Write a C++ program to reverse a number using do-whileloop
5. Write a C++ program to find out the factorial of a number using while loop
6. Write a C++ program to read an integer array and display it.
7. Write a C++ program to read a character array and display it.
8. Write a C++ program to find out the maximum of three number using if-elsestatement
9. Write a C++ program to implement the concept of static data member in class.
10. Write a C++ program to implement the concept of static function in class.
11. Write a C++ program using function with default argument.
12. Write a C++ program to illustrate the use of objects as function arguments (which performs the addition of time in the hour and minutes format)
13. Write a C++ program to illustrate the use of friend function.
14. Write a C++ program to illustrate how an object can be created (within a function) and returned to another function
15. Write a C++ program to illustrate the use of constructors and destructors.
16. Write a C++ program to illustrate the use of copy constructor.
17. Write a C++ program to implement single inheritance (private/public)
18. Write a C++ program to implement multilevel inheritance
19. Write a C++ program to implement multiple inheritances.
20. Write a C++ program to illustrate the use of virtual base class.
21. Write a C++ program to overload unary minus operator
22. Write a C++ program to overload binary „+" operator
23. Write a C++ program to illustrate how an operator can be overloaded using friend function.
24. Write a C++ program to illustrate the use of run time polymorphism.
25. Write a C++ program to swap two variable using function template
26. Write a C++ program to implement try(), catch(), throw()function.
27. Write a C++ program to implement this pointer
28. Write a C++ program to illustrate the use of pointers to derived objects
29. Write a C++ program to illustrate the use of virtual function
30. Write a C++ program to open and close a file using open(), close() function
31. Write a C++ program to illustrate the use of read(), write() function

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	1 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Object Oriented Programming With C++,* E. Balaguruswamy, 4th Edition, 2011, Tata McGraw Hill.
2. C++, *The Complete Reference,* Herbert Schildt, 4th Edition, 2017, McGraw Hill Education.

Reference Books:

1. Deital And Deital, *C++ How To Program,* 9th Edition, 2016, Pearson Education India.
2. R. Lafore, *Object Oriented Programming In Turbo C++*, 4th Edition, 2013, Galgotia, New Delhi

Paper II/Subject Name: Database Management Systems		**Subject Code: ARI022C402**
L-T-P-C – 3-0-2-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective:

The objectives of the course are to make the students learn about databases and the process of designing and constructing data models.

Prerequisites: C/C++, Concepts of Data Structures.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** and **understand** the basic concepts and applications of database systems	**BT 1 & 2**
CO 2	**Apply** the basic concepts of MySql and write queries using it.	**BT 3**
CO3	**Analyze** the designed database for normalization.	**BT 4**
CO 4	**Evaluate** the process of transaction processing and concurrency control	**BT 5**

Detailed Syllabus:

Modules	Topics	Course content	Periods
I	**Basic Concepts**	Purpose of database systems-Components of DBMS –DBMS Architecture-Three Tier Architecture, and Data Independence-Data modelling -Entity Relationship Model and Diagram, Relational –Network-Hierarchical and object oriented models-Data Modelling using the Entity Relationship Model.	**9**
II	**Structure of**	Relational databases –relational algebra-relational calculus,	**9**

	Relational Databases	tuple and domain calculus. Data definition with SQL, insert, delete and update statements in SQL –views –data manipulation with SQL. assertions –triggers, Cursors	
III	**Database Design**	Design guidelines–Relational database design –Integrity Constraints –Domain Constraints-Referential integrity –Functional Dependency-Normalization using Functional Dependencies, Normal forms based on primary keys-general definitions of Second and Third Normal Forms. Boyce-Codd Normal Form–Multi-valued Dependencies and Forth Normal Form –Join Dependencies and Fifth Normal Form –Pitfalls in Relational Database Design, Properties of Relational Decomposition, Dependency Preserving Property, Lossless Non-Additive Join Property, Testing Relational Decompositions for non-additive and dependency preserving properties.	**9**
IV	**Introduction to Transaction and Query Processing**	Transaction and System Concepts-Desirable properties of Transactions-Schedules and Recoverability-Serializability of Schedules -Concurrency Control–Data Storage Indexing and Query processing and Optimization MySQL case study: The basic structure of the MySQL system database structure and its manipulation in MySQL -storage organization in MySQL -Programming in PL/SQL-Cursor in PL/SQL	**9**
		TOTAL	**36**

Database Management Systems Lab Syllabus

Detailed Syllabus:

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 10 Laboratory experiments based on the following-

1. Programs to understand the functionality and limitations of file system.
2. Consider the following relational schema
   Employee (Emp_no, Name, Salary, design, dept_id, DOJ)
   Department (Dept_id, DName, loc, DOE)
   a. Display the name of the employees working in marketing dept.
   b. Display the details of the employee joined in the month of July.
   c. Display the details of the employee who gets maximum salary.
   d. Count the no of employees in each department
3. Consider the following relational schema
   Student (Rollno, Name, Address, DOB, C_id)
   Course (C_id, Cname, Dur, Fees)
   a. Display rollno,name,cname,fees of each student
   b. Count the no of students in each course
4. Consider the following relational schema
   Books(book_id,b_name,author,purchase_date,cost)
   Members(member_id,m_name,address,phone,birthdate)
   Issue_return(book_id,member_id,issue_date,return_date)
   a. Find the author of the books that have not been issued.
   b. Display the member_id and no of books issued to that (Assume that if a book in Issue_Return relation does not have a return_date then it is issued)

c. Find the book that has been issued the minimum no of times.
d. Display the names and author of the books that have been issued at any time to a member whose name begins with "Ra".
e. Display the name and Cost of those books that have been issued to any member whose date of birth is less than 01-01-1989 but not been issued to any member having the birth date equal to or greater than 01-01-1989.

5. Consider the following relational schema
   Student(name,phone,dob,s_id)
   Course(c_id,cname,credit,teacher_id)
   Result(s_id,c_id,mark)
   a. Find the name of the students whose results are not declared in any course
   b. Find the teachers who are teaching more than one course
   c. Display the name and marks of those students who were born before 1-1-1989 and score more than 80 marks in any course
   d. Find the details of students securing pass marks in more than 3 course
   e. Find the total no of credits earned by a students whose id is 10.
   f. Find name of the students who got maximum overall marks.
   g. Display the name and marks of those students who scored more than 80 marks in any subject.
   h. Find the details of the students securing less than 30 marks in more than 3 subjects.
6. Consider the following relational schema
   Customer(C_id, Name , Address)
   Item(i_code , Name , Price)
   Purchase (P_id ,C_id , I_code, qty , pdate)
   a. Find the name of the customer who has done maximum purchase.
   b. Display the name of the item that has been purchased maximum no of times in the month of Feb.
   c. Display the name of the customer who didn't purchase any item.
7. Create three triggers (insert, delete and update) on emp table so that:
   a. Whenever a new record is inserted then the emp_id and date of insertion is stored in another table called new_rec.
   b. Whenever a record is deleted the emp_id and date of deletion is stored in another table called old_rec.
   c. Whenever employee's salary is updated the emp_id , old salary and updated salary is stored in another table called update_info.
8. Write a procedure to accept a emp_id and display the employee details.
9. Write a procedure to accept a emp_id and return the employee salary.
10. Given,
    Emp(emp_no,name,salary,supervisor_no,dept_code)
    Dept(dept_code, dept_name)
    a. employees who get more salary than their supervisor
    b. Department name and total number of employees in each Department.
    c. Name and department of employee(s) who earn maximum salary.
11. Programs on Views and Cursors

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	1 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Fundamentals of Database System,* Elmasri and Navathe, 7thEdition, 2016, Pearson Education Asia
2. *Database System Concepts*, Henry F Korth, Abraham Silberschatz, 6th Edition, 2013, Mc Graw Hill.
3. *DataBase Management System*, Paneerselvam, 2nd Edition, 2011, PHI Learning

Reference Books:

1. C. J. Date, *An Introduction to Database Systems,* 8th Edition, 2003, Pearson Education Asia
2. Bibin C. Desai, *An Introduction to Database Systems*, Revised Edition, 2012, Galgotia Publications

Paper III/Subject Name: Formal Language and Automata Theory		**Subject Code: ARI022C403**
L-T-P-C – 3-1-0-4	**Credit Units: 04**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to impart knowledge on regular grammars, regular expressions and to teach about the basics of parsing and ambiguity.

Prerequisites: Fundamentals of Set Theory

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**List** and **understand** the utility and importance of Automata Theory as the basis of all computer science languages design	**BT 1 & 2**
CO 2	**Construct** minimized sample automata and grammars of context free languages	**BT 3**
CO3	**Analyze** the power and limitation of a computer and solve the problems using formal language	**BT 4**

Detailed Syllabus:

Modules	**Topics**	**Course content**	**Periods**
I	**Introduction**	Basics of Strings and Alphabets, DFA, transition graphs, regular languages, non-deterministic FA, equivalence of DFA and NDFA	**15**
II	**Grammars**	Regular grammars, regular expressions, equivalence between regular languages, properties of regular languages, pumping lemma.	**18**
III	**Deterministic and Non-Deterministic PDA**	Leftmost and rightmost derivation, parsing and ambiguity, ambiguity in grammar and languages, normal forms. NDPDA, DPDA, context free languages and PDA, comparison of deterministic and non-deterministic versions, closure properties, pumping lemma for CFL	**18**
IV	**Turing Machine**	Turing Machines, variations, halting problem, PCP Chomsky Hierarchy Manipulators, different examples of manipulators; Pointer types- uses; Dynamic memory allocation techniques - garbage collection, Linked list, generic pointers; Files- Open, Close, Read and Write; File attributes, File	**15**

		management	
		TOTAL	**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum/ Tutorial**	**Experiential Learning**
3* 22 NCH = 66 NCH	1 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *An Introduction to Formal Languages and Automata*, Peter Linz, 3rd Edition, 2010, Narosa Publishers

Reference Books:

1. J. E. Hopercroft and J. D. Ullman,*Introduction to Automata Theory, Languages & Computation*, 3rd Edition, 2006, Narosa
2. J. C. Martin, *Introduction to Languages and The Theory of Computation,* 3rd Edition, 2009, McGraw Hill International Edition.

Paper IV/Subject Name: Mathematical Foundations of AI		**Subject Code: ARI022C405**
L-T-P-C – 3-0-0-3	**Credit Units: 03**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to develop a strong mathematical foundation for understanding AI and Machine Learning concepts.

Prerequisites: Basic knowledge of Linear Algebra, Probability, and Calculus

Course Outcomes

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** the basic mathematical foundations needed for dealing with AI systems	**BT 2**
CO 2	**Understand** probability and statistics to model uncertainty in AI systems.	**BT 3**
CO 3	**Apply** linear algebra concepts to AI applications like dimensionality reduction and embeddings.	**BT 3**
CO 4	**Apply** graph theory for solving AI-related problems such as network analysis and search algorithms.	**BT 3**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I	**Linear Algebra for AI**	Vector Spaces and Matrices: Basis, Span, Rank, Null Space, Orthogonality Matrix Operations: Transpose, Inverse, Determinants, Eigenvalues & Eigenvectors, Singular Value Decomposition (SVD) and Principal Component Analysis (PCA) Norms, Projections, and Distance Metrics Applications in AI: Feature transformation, Dimensionality Reduction, Word Embeddings	**15**
II	**Probability and Statistics for AI**	Probability Theory: Random Variables, Probability Distributions (Bernoulli, Binomial, Gaussian), Bayesian Inference: Bayes Theorem, Maximum Likelihood Estimation (MLE), Maximum A Posteriori (MAP) Expectation, Variance, Covariance, and Correlation, Markov Chains and Hidden Markov Models (HMM) Applications in AI: Naïve Bayes Classifier, Probabilistic Graphical Models, Decision Trees	**18**
III	**Optimization Techniques**	Convex Optimization: Gradient Descent, Stochastic Gradient Descent (SGD), Newton's Method, Lagrange Multipliers and Constrained Optimization, Linear and Quadratic Programming Backpropagation and Optimization in Neural Networks Applications in AI: Training Machine Learning Models, Regularization Techniques	**18**
IV	**Graph Theory and Advanced Topics**	Graph Basics: Graph Representation, Adjacency Matrices, Graph Traversal (BFS, DFS) Shortest Path Algorithms: Dijkstra's Algorithm, Bellman-Ford Algorithm Spectral Graph Theory and Laplacian Matrices Game Theory and Decision Making in AI Applications in AI: Social Network Analysis, Knowledge Graphs, Graph Neural Networks	**15**
TOTAL			**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	--	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Mathematics for Machine Learning,* Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, 2020, Cambridge University Press
2. *Pattern Recognition and Machine Learning,* Christopher M. Bishop, 1st Edition, 2009, Springer
3. *Probability, Statistics and Random Processes,* T. Veerarajan, 3rd Edition, 2017, McGraw Hill

Reference Books:

1. S. Kumaresan, *Linear Algebra and its Applications*, New Title Edition, 2000, Prentice Hall India

2. N. Deo, *Graph Theory and its Applications,* New Edition, 1979, PHI Learning
3. S. S. Rao, *Optimization Theory & Applications*, 1984, New Age International
4. J. N. Kapur, H. C. Saxena, *Mathematical Statistics*, 2010, S. Chand & Co.

Paper VI/Subject Name: Fundamentals of Web Design		**Subject Code: ARI022G306**
L-T-P-C – 3-0-0-3	**Credit Units: 03**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to enable the students to build a robust foundation for computational thinking and make them learn client-side web development.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define** basic building and design blocks of an website.	**BT 1**
CO 2	**Understand** the basic characteristics and concepts of web development.	**BT 2**
CO 3	**Build** static web pages and manipulate data using JavaScript and work with the HTML Canvas	**BT 3**
CO 4	**Analyse** and **evaluate** websites in terms of its design and basic processing at the client side.	**BT 4 & 5**

Detailed Syllabus:

Modules	**Topics**	**Course content**	**Periods**
I	**Introduction to Web and creating website**	The Internet: Client & Server, IP address and URL, The World Wide Web (WWW), Installing Visual Studio Code, Installing the Prettier VSCode extension, Install Ubuntu in Windows, using WSL, Install Ubuntu using virtual machine software, making and hosting website. Introduction to HTML tags, Looking inside websites using "Inspect Element"	**15**
II	**Styling and Working with Strings**	Working with modern HTML and CSS to produce an attractive, informative multi-page website based on the client's requirements, Creating a multipage website using HTML5, Control the look of a website using CSS, Formating a web page to display complex information, Adding graphical elements and maps to a website, Implement web forms to capture user input, Testing a website for compliance with standards and to ensure that it works with a range of browsers, Implementation of CSS using Bootstrap, Styling and Working with Strings: Introduction to strings, Joining strings together, Switching to the VSCode editor: Putting HTML and JS together, Adding comments to HTML and JS, Find the length of a string, Search for a string inside another string, String equality comparison, Sort a collection of strings, Split strings by a pattern,	**18**

III	**Functions**	Numbers, Booleans, Objects and Arrays, Number Data Type, Numbers Boolean Data Type, Boolean - comparisons and logical operations, Object Literals - create, read & update + nesting objects, Arrays - handling ordered values, Functions: Explicitly return a value from a function, Passing a function as an argument , introduction to Firebase.	**15**
IV	**Advanced Techniques of Javascript**	Iterating over Arrays: Iterating over an array using the for Eeach method, Generate an HTML list from an array, Using the index of the array value during iteration, Nested Array iteration, Transforming Arrays, Generate an HTML list from an array using the map function, Using index of array value with map, Transforming Nested Arrays, Filtering Arrays: Filter an array based on some criteria, A minimal UI for filtering flight search results, Use the index of the array value with filter, Building a game with Canvas,HTML canvas element, introduction to AJAX, JSON, RESTful API.	**18**
Total			**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3*22 NCH = 66 NCH	-	3*8 = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Project)

Text Book:

1. *Internet and World Wide Web How to program*, Deitel H.M. and Deitel P.J, 4th Edition, 2012, Pearson International, New Delhi
2. *Web Technology*, Gopalan N.P. and Akilandeswari J., 2nd Edition, 2014, Prentice Hall of India, New Delhi.
3. *Java How to Program*, Paul Dietel and Harvey Deitel, 8th Edition, 2014, Prentice Hall of India, New Delhi

Reference Books:

1. Uttam K. Roy, *Web Technologies*, 2010, Illustrated Oxford University Press.
2. Godbole A. S. & Kahate A., *Web Technologies*, 2nd Edition, 2006, TMH, New Delhi.

6.6 Detailed Syllabus of 5th Semester

Paper I/Subject Name: Operating Systems		Subject Code: ARI022C501
L-T-P-C – 3-0-2-4	Credit Units: 04	Scheme of Evaluation: TP

Objective:

The objectives of the course are to make the students understand the fundamental concepts and design of operating systems, apply principles of concurrency, synchronization, and deadlock in operating systems.

Prerequisites: Computer Programming, Computer Architecture & Organization

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Describe** and **illustrate** the role and responsibilities of an operating system, system calls, kernel vs. user mode, etc.	**BT 1 & 2**
CO 2	**Apply** process scheduling algorithms (FCFS, SJF, RR, etc.) to compute performance metrics.	**BT 3**
CO 3	**Analyze** synchronization problems and solutions like semaphores, monitors, and deadlock.	**BT 4**
CO 4	**Evaluate** different memory management strategies and their impact on performance.	**BT 5**

Detailed Syllabus:

Modules	Topics	Course content	Periods
I	**Operating Systems Overview**	Introduction and history of Operating systems, structure and operations; processes and files. **Computer System Overvie**w- Basic Elements, Instruction Execution, Interrupts Memory Hierarchy, Cache Memory, Direct Memory Access, Multiprocessor and Multicore Organization. **Operating system overview**-objectives and functions, Evolution of Operating System.- Computer System Organization- Operating System Structure and Operations- System Calls, System Programs, OS Generation and System Boot	**15**
II	**Process Management And Concurrency Control**	**Processes**-Process Concept, Process Scheduling, Operations on Processes, Interprocess Communication; Threads- Overview, Multicore Programming, Multithreading Models; Thread and SMP Management. **Process Synchronization** –	**18**

		Critical Section Problem, Mutex Locks, Semaphores, Monitors; CPU Scheduling and scheduling algorithms. **Deadlocks**- Shared resources, resource allocation and scheduling, resource graph models, deadlock detection, deadlock avoidance, deadlock prevention algorithms	
III	**Storage Management**	Memory Management requirements, Memory partitioning: Fixed and Variable Partitioning, Memory Allocation: Allocation Strategies (First Fit, Best Fit, and Worst Fit), Fragmentation, Swapping, and Paging. Segmentation, Demand paging, Virtual Memory: Concepts, management of VM, Page Replacement Policies (FIFO, LRU, Optimal, Other Strategies), Thrashing. 32 and 64 bit architecture Examples; Allocating Kernel Memory, OS Examples	**18**
IV	**I/O and File Systems**	I/O Devices, Organization of I/O functions, Operating System Design issues, I/O Buffering, Overview of mass storage structure- disks and tapes. Disk structure – accessing disks, Swap Space. Disk Scheduling (FCFS, SCAN, C-SCAN, SSTF), RAID, Disk Cache. Disk Protection– Goals, Principles, Domain. **File System Interface**: File Concepts – Attributes – operations – types – structure – access methods. File system mounting. Protection. File system implementation. Directory implementation – allocation methods. Free space Management.	**15**
		TOTAL	**66**

Operating Systems Lab Syllabus

Detailed Syllabus:

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 20 Laboratory experiments based on the following-

1. Basic Linux Commands and Overview.
2. Write Shell Script for followings
    - To find the global complete path for any file.
    - To broadcast a message to a specified user or a group of users logged on any terminal.
    - To copy the file system from two directories to a new directory in such a way that only the latest file is copied in case there are common files in both the directories.
    - To compare identically named files in two different directories and if they are same, copy one of them in a third directory
    - To delete zero sized files from a given directory (and all its sub- directories).
    - To display the name of those files (in the given directory) which are having multiple links.
    - To display the name of all executable files in the given directory.
    - Write a script to display the date, time and a welcome message (like Good Morning etc.). The time should be displayed with "a.m." or "p.m." and not in 24 hours notation.
    - Write a script to display the directory in the descending order of the size of each file.
3. Implementation of System Calls.
4. Implementation of FCFS (First Come First Serve) CPU Scheduling.
5. Implementation of SJF (Shortest Job First) CPU Scheduling.
6. Implementation of Round Robin (RR) CPU Scheduling.

7. Implementation of Priority CPU Scheduling Algorithm.
8. Implementation of FIFO Replacement Algorithm.
9. Implementation of Optimal Page Replacement Algorithm.
10. Implementation of LRU Page Replacement Algorithm by Stack method
11. Implement the producer-consumer problem using threads.

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	1 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Operating System Concepts,* Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, 9th Edition, 2012, John Wiley and Sons Inc.

Reference Books:

1. William Stallings, *Operating Systems – Internals and Design Principles*, 7th Edition, 2011, Prentice Hall.
2. Andrew S. Tanenbaum, *Modern Operating Systems*, 2nd Edition, 2001, Addison Wesley.
3. D M Dhamdhere, *Operating Systems: A Concept-Based Approach*, 2nd Edition, 2007, Tata McGraw-Hill Education.

Paper II/Subject Name: Data Communication		**Subject Code: ARI022C504**
L-T-P-C – 3-0-0-3	**Credit Units: 03**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to teach about the fundamental principles and models of data communication, apply knowledge of modulation, multiplexing, and switching techniques, etc.

Prerequisites: Concepts of Computer Fundamentals, Digital Logic and Design.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Describe** and **explain** the basic components and types of data communication systems and data transmission concepts.	**BT 1 & 2**
CO 2	**Apply** error detection and correction techniques such as CRC and Hamming code.	**BT 3**
CO 3	**Analyze** data link layer protocols such as HDLC, Stop-and-Wait, and Sliding Window	**BT 4**
CO 4	**Evaluate** performance issues in flow control, multiplexing, and switching techniques.	**BT 5**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I	**Introduction**	Introduction to Computer network, Networks: classification and components, Layered architecture of a network software, OSI and TCP/IP model. Data Transmission: Communication model- Simplex, half duplex and full duplex transmission - Periodic Analog signals: Sine wave, phase, wavelength, time and frequency domain, bandwidth – Digital Signals; Digital data Transmission:- Analog & Digital data, Analog & Digital signals, Analog &Digital transmission – Transmission Impairments: Attenuation, Delay distortion, Noise – Channel capacity:	**18**
II	**Signal Analysis**	Introduction to Signal and its Classification. System and its Basic Properties, Spectral Analysis of a Signal; Signal Bandwidth. Transmission media - Guided Transmission Media: Twisted pair, Coaxial cable, optical fiber, Wireless Transmission, Terrestrial microwave, Satellite microwave. Wireless Propagation: Ground wave propagation, Sky Wave propagation, LoS Propagation.	**15**
III	**Data Encoding and Multiplexing**	Baseband Communication: Data Encoding and Modulation, Analog Modulation: AM, FM and PM, Pulse Modulation System: PAM and PWM. Digital Modulation: ASK, FSK, PSK and QAM Multiplexing and its Application: Frequency Division Multiplexing, Wavelength Division Multiplexing, Time Division Multiplexing, Spread Spectrum.	**15**
IV	**Switching and Information Theory and Coding**	Switching: Switching and its Application, Circuit Switching and Packet Switching, Datagram Switching and Virtual Circuit SwitchingX.25, Frame Relay and ATM. Introduction to Information Theory and Average Information Source Coding: Huffman Coding, Error Detection and Correction Codes, Hamming Distance, Linear Block Coding, Cyclic Codes, CRC, Convolution Codes	**18**
TOTAL			**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	--	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Data Communications and Networking*, Forouzan B. A., 4th Edition, 2007, Tata McGraw Hill.

Reference Books:

1. Tanenbaum A. S. and D. Wetherall, *Computer Networks*, 5th Edition, 2013, Pearson Education.
2. William Stallings, *Data and Computer Communication,* 9th Edition, 2011, Pearson Education, Inc.

Paper III/Subject Name: Design and Analysis of Algorithms		Subject Code: ARI022C503
L-T-P-C – 3-0-0-3	Credit Units: 03	Scheme of Evaluation: T

Objective:

The objectives of the course are to enable the students analyze performance of algorithms and solve problems using algorithm design methods such as the greedy method, divide and conquer, dynamic programming, backtracking and branch and bound.

Prerequisites: Concepts of Data Structures and Basic Mathematics

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Examine** and **understand** the performance of algorithm.	**BT 1 & 2**
CO 2	**Apply** different designing methods for development of algorithms to realistic problems, such as divide and conquer, greedy and etc.	**BT 3**
CO 3	**Analyze** and **evaluate** algorithms to improve their efficiency.	**BT 4 & 5**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I	**Introduction and Divide and Conquer**	Algorithm, Psuedo code for expressing algorithms, Performance Analysis-Space complexity, Time complexity, Asymptotic Notation- Big oh notation, Omega notation, Theta notation and Little oh notation, Probabilistic analysis, Amortized analysis. Master's Theorem	**15**
II	**Searching and Traversal Techniques**	Efficient non - recursive binary tree traversal algorithm, Disjoint set operations, union and find algorithms, Spanning trees, Graph traversals - Breadth first search and Depth first search, AND / OR graphs, game trees, Connected Components, Bi - connected components. Disjoint Sets- disjoint set operations, union and find algorithms, spanning trees, connected components and bi-connected components.	**18**
III	**Types of Problem Solving Techniques**	Greedy Method: General method, applications - Job sequencing with dead lines, 0/1 knapsack problem, Minimum cost spanning trees, Single source shortest path problem. Dynamic Programming: General method, applications-Matrix chain multiplication, Optimal binary search trees, 0/1 Knapsack	**18**

		problem, All pairs shortest path problem,Travelling sales person problem, Reliability design. Backtracking: General method, applications-n-queen problem, sum of subsets problem, graph coloring, Hamiltonian cycles. Branch and Bound: General method, applications - Travelling sales person problem,0/1 knapsack problem- LC Branch and Bound solution, FIFO Branch and Bound solution	
IV	**NP-Hard and NP-Complete Problems**	NP-completeness – Polynomial time verification – Theory of reducibility – Circuit satisfiability - NP-completeness proofs – NP-complete problems: Vertex cover, Hamiltonian cycle and Traveling Salesman problems – Approximation Algorithms – Approximation algorithms to vertex-cover and traveling salesman problems.	**15**
TOTAL			**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum/ Tutorial**	**Experiential Learning**
3* 22 NCH = 66 NCH	-	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *An Introduction to Formal Languages and Automata*, Peter Linz, 3rd Edition, 2010, Narosa Publishers

Reference Books:

1. J. E. Hopercroft and J. D. Ullman,*Introduction to Automata Theory, Languages & Computation*, 3rd Edition, 2006, Narosa
2. J. C. Martin, *Introduction to Languages and The Theory of Computation,* 3rd Edition, 2009, McGraw Hill International Edition.

Paper IV/Subject Name: Introduction to AI and ML		**Subject Code: ARI022C505**
L-T-P-C – 3-0-0-3	**Credit Units: 03**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to teach about the foundational concepts and evolution of AI and ML, intelligent agents, search algorithms, and knowledge representation, machine learning types, models, and applications, etc.

Prerequisites: Data Structures and Algorithms, Discrete Mathematics, Programming in Python

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms**

		Taxonomy Level
CO 1	**Describe** and **explain** the basic principles, history, and goals of AI and ML.	**BT 1 & 2**
CO 2	**Apply** intelligent agents and implement basic search techniques.	**BT 3**
CO 3	**Analyze** supervised and unsupervised ML algorithms and their real-world applications.	**BT 4**
CO 4	**Evaluate** and compare model performance using standard metrics.	**BT 5**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I	**Introduction**	What is AI? – Definitions, History, Applications, Components of AI: Perception, Reasoning, Learning, Acting, Agents and Environments, Types of Agents: Simple, Reflex, Goal-based, Utility-based, Problem Solving: Problem formulation, state space, Uninformed Search: BFS, DFS, Uniform Cost Search, Informed Search: Greedy, A*, Heuristics	**18**
II	**Knowledge Representation and Reasoning**	Logic in AI: Propositional and Predicate Logic, Forward and Backward Chaining, Rule-Based Systems, Constraint Satisfaction Problems (CSP), Expert Systems and Inference Engines, Applications in NLP, Robotics, and Gaming	**15**
III	**ML Fundamentals**	What is Machine Learning? – ML vs AI, Types of ML: Supervised, Unsupervised, Reinforcement (intro only), Data preprocessing and visualization, Linear Regression, Logistic Regression, Decision Trees, Naïve Bayes, K-Nearest Neighbors (k-NN), Support Vector Machines (SVM), Clustering: K-Means, Hierarchical	**15**
IV	**Evaluation, Tools, Case Studies**	Model evaluation: Confusion matrix, accuracy, precision, recall, F1-score, Overfitting, Underfitting, Cross-validation, Introduction to tools: scikit-learn, pandas, NumPy, Use cases: spam detection, image classification, recommendation systems, Ethics in AI: bias, fairness, transparency, Recent trends in AI & ML: Generative AI, Explainable AI (XAI)	**18**
TOTAL			**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	--	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Artificial Intelligence: A Modern Approach,* Stuart Russell & Peter Norvig, 4th Edition, 2022, Pearson
2. *Machine Learning*, Tom M. Mitchell, 1st Edition, 2017, McGraw-Hill

Reference Books:

1. Elaine Rich, *Artificial Intelligence*, 1983, McGraw-Hill
2. Ethem Alpaydin, *Introduction to Machine Learning*, 3rd Edition, 2015, MIT Press

Paper V/Subject Name: Principles of Management and Organizational Behavior		**Subject Code: BSA022C505**
L-T-P-C – 3-0-0-3	**Credit Units: 03**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to make the students understand about the principles of management and their application to the functioning of an organization.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** the managerial functions like planning, and have same basic knowledge on international aspect of management	**BT 2**
CO 2	**Build** the ability to direct, leadership and communicate effectively	**BT 3**
CO3	**Analyze** the behavior of individuals and groups in organizations in terms of the key factors that influence organizational behavior.	**BT 4**
CO 4	**Assess** the potential effects of organizational-level factors (such as structure, culture and change) on organizational behavior	**BT 5**

Detailed Syllabus:

Modules	**Topics**	**Course content**	**Periods**
I	**Introduction To Management and Organizations**	Definition of Management – Science or Art, Manager vs. Entrepreneur, types of managers, managerial roles and skills. Evolution of Management-Scientific, human relations, system and contingency approaches, Types of Business organization, Sole proprietorship, partnership, company public and private sector enterprises, Organization culture and Environment, Current trends and issues in Management.	**18**
II	**Planning and Decision Making**	Nature and purpose of planning, planning process, types of planning, objectives, setting objectives, policies. Planning premises, Strategic Management, Planning Tools and	**15**

		Techniques, Decision making steps and process.	
III	**Organization and Human Resource Management**	Organizing- Nature and purpose, Formal and informal organization, organization chart, organization structure, types, Line and staff authority, departmentalization, delegation of authority, centralization and decentralization, Job Design. Human Resource Management- HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.	**15**
IV	**Direction and Control**	Directing-Foundations of individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment. Leadership- types and theories of leadership, communication, process of communication, barrier in communication, effective Communication, Communication and IT. Controlling- System and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in Management control, Productivity problems and management, control and performance, direct and preventive control, reporting.	**18**
		TOTAL	**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	--	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Management,* Stephen P. Robbins and Mary Coulter, 13th Edition, 2017, Prentice Hall India Pvt. Ltd.
2. *Fundamentals of Management,* Stephen A. Robbins, David A. Decenzo and Mary Coulter, 9th Edition, 2016, Pearson Education India.

Reference Books:

1. Robert Kreitner and Mamata Mohapatra,*Management*, 1st Edition, 2008, Dreamtech Press.
2. Harold Koontz and Heinz Weihrich, *Essentials of Management: An International, Innovation and Leadership Perspective,* 10th Edition, 2015, Tata McGraw Hill.
3. Tripathy P. C. & Reddy P. N., *Principles of Management*, 4th Edition, 2010, Tata McGraw Hill.
4. J. P. Pathak, *Fundamentals of Management,* 1st Edition, 2014, Vikas Publishing House.
5. Robert N. Lussier, *Management Fundamentals Concepts, Applications, Skill Development,* 5th Edition, 2012, Cengage Publications.

Paper VI/Subject Name: Introduction to AI		**Subject Code: ARI022G506**
L-T-P-C – 3-0-0-3	**Credit Units: 03**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to provide the most fundamental knowledge to the students so that they can understand what the AI is and to impart knowledge on the importance of AI.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Demonstrate understanding of fundamental AI principles, including search algorithms and knowledge representation	**BT 1 & 2**
CO 2	Implement AI search techniques, constraint satisfaction problems, and optimization techniques	**BT 3**
CO 3	Design and analyze AI models for reasoning, learning, and decision-making	**BT 4**

Detailed Syllabus:

Modules	**Topics**	**Course content**	**Hours**
I	**Introduction to AI**	Definition and history of AI, AI applications, Turing Test, Rational Agents, Search strategies (uninformed: BFS, DFS; informed: A*, Iterative Deepening, Hill Climbing), Constraint Satisfaction Problems (CSP)	**15**
II	**Knowledge Representation and Reasoning**	Logic-based AI (Propositional & First-Order Logic), Rule-based systems, Bayesian Networks, Markov Decision Processes (MDP), Game Theory (Minimax, Alpha-Beta Pruning)	**18**
III	**Machine Learning and Neural Networks**	Supervised vs. Unsupervised Learning, Classification and Regression, Decision Trees, Naïve Bayes, SVMs, Neural Networks (Backpropagation, CNNs, RNNs), Introduction to Reinforcement Learning	**18**
IV	**AI Applications & Advanced Topics**	Natural Language Processing (NLP), Computer Vision, AI in robotics and autonomous systems, Deep Reinforcement Learning, Ethical considerations and bias in AI, Security in AI (adversarial attacks, fairness, explainability)	**15**
Total			**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	--	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Artificial Intelligence- A Modern Approach,* Russel & Norvig, 3rd Edition, 2009, Pearson

Reference Books:

1. Blaby Whitby, *Artificial Intelligence – A Beginner's Guide,* 2nd Edition, 2008, One World

6.7 Detailed Syllabus of 6th Semester

Paper I/Subject Name: Computer Networks		Subject Code: ARI022C601
L-T-P-C – 3-0-2-4	Credit Units: 04	Scheme of Evaluation: TP

Objective:

The objectives of the course are to make the students understand the fundamental concepts and reference models of computer networks, apply error detection, flow control, and congestion control techniques in network protocols, etc.

Prerequisites: Concepts of Data Communication

Course Outcomes

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Describe** and **explain** the layered architecture of computer networks and functions of each layer.	**BT 1 & 2**
CO 2	**Apply** subnetting, IP addressing, and routing algorithms in network design.	**BT 3**
CO 3	**Analyze** the operation of error control, flow control, and congestion control mechanisms.	**BT 4**
CO 4	**Evaluate** performance and reliability of network protocols and simulate them using tools.	**BT 5**

Detailed Syllabus:

Modules	Topics	Course content	Periods
I	**Data Link Layer and Medium Access Sub-layer**	Design issues, Framing, Error detection and correction codes: checksum, CRC, hamming code, Data link protocols for noisy and noiseless channels, Sliding Window Protocols: Stop & Wait ARQ, Go-back-N ARQ, Selective repeat ARQ, Data link protocols: HDLC and PPP Static and dynamic channel allocation, Random Access: ALOHA, CSMA protocols, Controlled Access: Polling, Token Passing, IEEE 802.3 frame format, Ethernet cabling, Manchester encoding, collision detection in 802.3, Binary exponential back off algorithm	**15**
II	**Network Layer**	Design issues, IPv4 classful and classless addressing, subnetting, Routing algorithms: distance vector and link state routing, Congestion control: Principles of Congestion Control, Congestion prevention policies, Leaky bucket and	**18**

		token bucket algorithms	
III	**Transport Layer**	Elements of transport protocols: addressing, connection establishment and release, flow control and buffering, multiplexing and de-multiplexing, crash recovery, introduction to TCP/UDP protocols and their comparison	**18**
IV	**Application Layer**	World Wide Web (WWW), Domain Name System (DNS), E-mail, File Transfer Protocol (FTP), SMTP, HTTP, Introduction to Network security	**15**
		TOTAL	**66**

Computer Networks Lab Syllabus

Detailed Syllabus:

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 20 Laboratory experiments based on the following-

1. To study various topologies for establishing computer networks.
2. To learn the usage of various basic tools (crimping, krone etc.) used in establishing a LAN.
3. To familiarize with switch and hub used in networks.
4. To learn the usage of connecters and cables (cabling standards) used in networks
5. To make certain copper and fiber patch cords using different standards.
6. To familiarize with routers & bridges
7. Use commands like ping, ipconfig for trouble shooting network related problems.
8. NIC Installation & Configuration (Windows/Linux)
9. TCP/UDP Socket Programming
10. Multicast & Broadcast Sockets
11. Develop a program to compute the Hamming Distance between any two code words.
12. Develop a program to compute checksum for an _m' bit frame using a generator polynomial.
13. IPC (Message queue)
14. Implementation of a Prototype Multithreaded Server
    a. Implementation of o Data Link Layer Flow Control Mechanism (Stop & Wait, Sliding Window)
    b. Data Link Layer Error Detection Mechanism (Cyclic Redundancy Check)
    c. Data Link Layer Error Control Mechanism (Selective Repeat, Go Back N)

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	1 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Data and Computer Communication*, William Stallings, 10th Edition, 2013, PHI.
2. *Data Communications and Networking*, Behrouz A Forouzan, 4th Edition, 2017, Tata McGraw Hill
3. *Computer Networks*, Tannenbaum, 3rd Edition, 1996, Pearson Education.

Reference Books:

1. L.L. Peterson & B.S. Davie, *Computer Networks: A Systems Approach*, 5th Edition, 2011, Morgan Kaufmann

2. Anuranjan Misra, *Computer Networks*, 2006, Acme Learning, Morgan Kaufman Publication, New Delhi

Paper II/Subject Name: Introduction to Deep Learning		**Subject Code: ARI022C604**
L-T-P-C – 3-0-2-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective

The objectives of the course are to provide the basic concept of neural networks and deep learning architectures, forward and backward propagation, loss functions, and optimization, evaluate CNNs, RNNs, and advanced deep learning models etc.

Prerequisites: Linear Algebra and Calculus, Probability and Statistics, Programming in Python, Basics of Machine Learning

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Explain** the architecture and learning process of neural networks.	**BT 1 & 2**
CO 2	**Apply** deep learning models using backpropagation and optimization techniques.	**BT 3**
CO 3	**Analyze** convolutional and recurrent neural networks.	**BT 4**
CO 4	**Assess** the performance of deep learning models on various datasets.	**BT 5**

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I	**Introduction**	Introduction to deep learning and applications, Perceptron model and limitations, Feedforward Neural Networks (FNN), Activation functions: ReLU, Sigmoid, Tanh, Softmax, Loss functions: MSE, Cross-Entropy, Forward and Backward Propagation, Gradient Descent and variants (SGD, Adam, RMSprop)	**15**
II	**Deep Neural Networks and Regularization**	Deep Feedforward Networks and Vanishing Gradients, Batch normalization and Dropout, Weight initialization techniques, Hyperparameter tuning: learning rate, batch size, epochs, Model evaluation: accuracy, precision, recall, F1, confusion matrix, Overfitting and underfitting	**18**
III	**CNNs and RNNs**	Convolutional Neural Networks (CNN): Convolution, pooling, padding, Architecture: LeNet, AlexNet, VGG, ResNet, Applications in image classification and object detection	**18**

		Recurrent Neural Networks (RNN): Basics, vanishing gradients, LSTM and GRU, Applications in time-series and NLP	
IV	**Advanced Topics**	Transfer learning and pretrained models (e.g., VGG, ResNet, BERT), Generative Adversarial Networks (GANs): Architecture, training challenges, Attention mechanism and Transformers (introductory level), Applications in computer vision, NLP, speech, healthcare, Model deployment using Flask/TensorFlow Lite, Ethical issues in deep learning (bias, fairness, explainability)	**15**
TOTAL			**66**

Introduction to Deep learning Lab Syllabus

Detailed Syllabus:

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 10 Laboratory experiments based on the following-

1. Introduction to NumPy, Pandas, and Matplotlib: Basics of Python for deep learning, Loading and preprocessing data
2. Implement a Perceptron and Feedforward Neural Network: Manual implementation using NumPy, XOR classification using MLP
3. Build an ANN using Keras or PyTorch, MNIST digit classification, Visualize loss and accuracy curves
4. Experiment with Different Activation and Loss Functions, Use ReLU, Sigmoid, Softmax, Compare MSE vs CrossEntropy
5. Optimization Techniques and Regularization, SGD, Adam optimizers, Dropout and Batch Normalization
6. Convolutional Neural Networks (CNNs), Build a CNN for CIFAR-10 or Fashion MNIST, Visualize feature maps
7. Transfer Learning with Pretrained Models, Use VGG16 or ResNet for classification, Fine-tune the final layers
8. Recurrent Neural Networks (RNNs): Character-level text generation, Basic RNN vs LSTM comparison
9. LSTM for Sentiment Analysis, IMDB or Twitter sentiment dataset, Embedding and sequence padding
10. Hyperparameter Tuning, Grid search or random search, Effect of learning rate and batch size
11. Evaluate Model Performance, Confusion matrix, precision, recall, F1-score, ROC-AUC curve
12. Mini Project: Students select a dataset and apply end-to-end deep learning, Example: plant disease detection, emotion recognition, etc.

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	1 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Deep Learning,* Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016, MIT Press
2. *Deep Learning: A Practitioner's Approach,* Josh Patterson, Adam Gibson, 1st Edition, 2017, O'Reilly

Reference Books:

1. Charu C. Aggarwal, *Neural Networks and Deep Learning*, 1st Edition, 2018, Springer

Paper III/Subject Name: Software Engineering		**Subject Code: ARI022C603**
L-T-P-C – 3-0-0-3	**Credit Units: 03**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to explain the fundaments of software engineering principles and practices, including project management, configurations management, requirements definition, system analysis, design, testing, and deployment.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Describe** and **demonstrate** the fundamental concepts of software engineering, software process models, and development life cycles.	**BT 1 & 2**
CO 2	**Identify** software requirements and develop software specifications using functional and non-functional requirements.	**BT 3**
CO 3	**Analyze** risk factors, cost estimation, and scheduling using various estimation and modeling techniques.	**BT 4**
CO 4	**Evaluate** and select appropriate software testing strategies, maintenance models, and quality assurance standards.	**BT 5**

Detailed Syllabus:

Modules	**Topics**	**Course content**	**Hours**
I	**Introduction to Process Models and Software Requirement Specification**	Importance of Software Project Management, Activities Methodologies, Categorization of Software Projects, Setting objectives, Software life cycle models: Waterfall, prototyping, Evolutionary, Spiral models and Agile Model. Software Requirements: Functional and non-functional requirements, user requirements, system requirements, interface specification, the software requirements document. Requirements engineering process: Feasibility studies, requirements elicitation and analysis, requirements validation, requirements management.	**18**
II	**Software Process Management,**	Project planning and control, Effort and Cost estimation techniques-LOC, Function Point, COCOMO, project	**15**

	Activity Planning and Agile Development	scheduling using PERT and GANTT charts, Critical path (CRM) method, cost-time relations: Rayleigh-Norden results, Staffing Pattern,S oftware configuration management, Introduction to Agility- Agile methods – Extreme Programming – SCRUM – Managing interactive processes.	
III	**Software Design and Risk Estimation**	Basics of Software Design, Procedural Design Methodology, Modularity, Cohesion, Coupling, DFD and Structure Chart, Object-Oriented concepts, Introduction to UML: Class and interaction Diagrams, Object-Oriented Analysis and Design, Object-oriented Software Modelling. Risk Management-Risk Identification, Risk Assessment, Risk Containment	**15**
IV	**Software Testing, Maintenance and Reuse**	Software testing fundamentals-Internal and external views of Testing-white box testing – basis path testing-control structure testing-black box testing-Regression Testing – Unit Testing – Integration Testing – Validation Testing – System Testing And Debugging –Software Implementation Techniques: Coding practices-Refactoring-Maintenance and Reengineering-BPR model-Reengineering process model-Reverse and Forward Engineering. Characteristics of Software Maintenance, Software Reverse Engineering, Software Maintenance Process Models, Estimation of maintenance cost, Software Reuse.	**18**
Total			**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum/ Tutorial**	**Experiential Learning**
3* 22 NCH = 66 NCH	-	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Book:

1. *Software Project Management,* Bob Hughes, Mike Cotterell and Rajib Mall, 5th Edition, 2012, Tata McGraw Hill, New Delhi

Reference Books:

1. Kieron Conway, *Software Project Management: From Concept to Deployment,* 1st Edition, 2000, Dreamtech Press.
2. S. A. Kelkar, *Software Project Management: A Concise Study,* 3rd Edition, 2012, PHI Publication.

Paper IV/Subject Name: Advanced Deep Learning (PEC-I)		**Subject Code: ARI022D607**
L-T-P-C – 4-0-0-4	**Credit Units: 04**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to teach the concept advanced neural network architectures and deep generative models, attention, transformers, and large-scale pretraining, application of deep learning in specialized domains like vision, language, and multimodal systems, etc.

Prerequisites: AI/ML Fundamentals

Course Outcomes

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Describe** and **demonstrate** generative models like GANs and VAEs.	**BT 1 & 2**
CO 2	**Utilize** advanced architectures like ResNet, DenseNet, and Inception.	**BT 3**
CO 3	**Analyze** and present recent advances and research trends in deep learning.	**BT 4**
CO 4	**Evaluate** and optimize models for interpretability, robustness, and deployment	**BT 5**

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I	**Advanced NN Architectures**	Deep CNN Architectures: ResNet, DenseNet, InceptionNet, MobileNet, EfficientNet for edge AI, Network engineering: skip connections, depthwise convolutions, residual learning, Neural architecture search (NAS) – basics, Attention Mechanisms (intro) in CNNs	**22**
II	**Generative Models**	Autoencoders and Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs): Vanilla GAN, DCGAN, CycleGAN, Training challenges: mode collapse, stability, Self-supervised learning basics, Contrastive learning and SimCLR	**22**
III	**Transformers**	Sequence modeling limitations of RNNs, Attention Mechanism and Self-Attention, Transformers: Encoder, Decoder, Positional Encoding, BERT, GPT, and their variants, Transfer learning and fine-tuning in NLP & vision (e.g., ViT), Vision-Language models: CLIP, BLIP (overview)	**22**
IV	**Deployment and Interpretability**	Model interpretability: SHAP, LIME, Grad-CAM, Adversarial attacks and defenses, Fairness, bias, and ethics in deep learning, Model compression: pruning, quantization, distillation, Real-time deployment using TensorFlow Lite, ONNX, Trends: diffusion models, foundation models, multimodal AI	**22**
TOTAL			**88**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**

4* 22 NCH = 88 NCH	--	8 * 4 NCH = 32 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Deep Learning,* Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016, MIT Press
2. *Deep Learning: A Practitioner's Approach,* Josh Patterson, Adam Gibson, 1st Edition, 2017, O'Reilly

Reference Books:

1. Charu C. Aggarwal, *Neural Networks and Deep Learning*, 1st Edition, 2018, Springer

Paper V/Subject Name: Natural Language Processing (PEC-II)		**Subject Code: ARI022D608**
L-T-P-C – 4-0-0-4	**Credit Units: 04**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to provide the student with knowledge of various levels of analysis, language modelling involved in NLP.

Prerequisites: Concepts of Automata Theory

Course Outcomes

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Demonstrate** the fundamental concepts of Natural Language Processing.	**BT 2**
CO 2	**Solve** the NLP tasks using various categories of algorithms.	**BT 3**
CO 3	**Analyze** the algorithms applied	**BT 4**
CO 4	**Evaluate** the algorithms applied	**BT 5**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I	**Overview and Language Modeling**	Overview: Origins and challenges of NLP-Language and Grammar-Processing Indian Languages-NLP Applications-Information Retrieval. Language Modeling: Introduction-Various Grammar-based Language Models-Statistical Language Model	**22**

II	**Word Level, Syntactic and Semantic Analysis**	Word Level Analysis: Introduction- Regular Expressions-Finite-State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. Syntactic Analysis: Introduction-Context-free Grammar-Constituency Parsing-Probabilistic Parsing Semantic Analysis: Introduction- Meaning Representation-Lexical Semantics Ambiguity-Word Sense Disambiguation. Discourse Processing: Introduction- cohesion-Reference Resolution Discourse Coherence and Structure	**22**
III	**Natural Language Generation and Machine Translation**	Natural Language Generation: Introduction-Architecture of NLG Systems Generation Tasks and Representations-Application of NLG. Machine Translation: Introduction-Problems in Machine Translation Characteristics of Indian Languages- Machine Translation Approaches-Translation involving Indian Languages	**22**
IV	**Information Retrieval and Lexical Resources**	Information Retrieval: Introduction-Design features of Information Retrieval Systems-Classical, Non-classical, Alternative Models of Information Retrieval - Evaluation Lexical Resources: Introduction-WordNet-FrameNet-Stemmers-POS Tagger Research Corpora	**22**
TOTAL			**88**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4* 22 NCH = 88 NCH	--	8 * 4 NCH = 32 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Natural Language Processing and Information Retrieval*, Tanveer Siddiqui, U.S. Tiwary, 1st Edition, 2008, Oxford University Press

Reference Books:

1. Daniel Jurafsky and James H Martin, *Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition*, 2nd Edition, 2008, Prentice Hall.
2. James Allen, Bejamin Cummings, *Natural Language Understanding*, 2nd Edition, 1995, Pearson.

Paper VI/Subject Name: Fundamentals of IOT		**Subject Code: ARI022G606**
L-T-P-C – 3-0-0-3	**Credit Units: 03**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to teach the vision and basic concepts of IoT, make the students understand IoT Market perspective, impart knowledge on Data and Knowledge Management and use of Devices in IoT Technology.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Explain** and **understand** the basic concepts, architecture, and enabling technologies of the Internet of Things.	**BT 1 & 2**
CO 2	**Identify** the use of microcontrollers (e.g., Arduino/Raspberry Pi) in designing simple IoT applications.	**BT 3**
CO 3	**Analyze** data acquisition and processing techniques in IoT-based systems.	**BT 4**
CO 4	**Assess** the performance, security, and scalability of different IoT applications across domains.	**BT 5**

Detailed Syllabus:

Modules	**Topics**	**Course content**	**Periods**
I	**Introduction**	Definition and Evolution of IoT, IoT Ecosystem: Components and Architecture, Characteristics and Design Principles of IoT, Embedded Systems vs. IoT, IoT Levels: Perception, Network, Middleware, Application, Physical and Logical Design of IoT, IoT Enabling Technologies: Cloud Computing, Big Data, AI, Edge Computing	**15**
II	**IOT Hardware and Sensors**	Microcontrollers and Microprocessors (Arduino, Raspberry Pi, ESP32), Digital and Analog Sensors: Working and Interfacing, Actuators and their Types, GPIO, PWM, ADC, I2C, SPI basics, Sensor Data Acquisition and Conditioning, Power Sources and Management for IoT Devices, Interfacing Sensors with Microcontrollers (Hands-on with Arduino or Pi)	**18**
III	**Networking and Communication Protocols**	Network Layer & Communication Models, OSI Layer & Role in IoT, Protocols: HTTP, MQTT, CoAP, LoRa, Zigbee, BLE, NFC, IP Addressing in IoT (IPv6, 6LoWPAN), Cloud Integration for IoT Data (ThingSpeak, Blynk, Firebase, AWS IoT), Security Concerns: Encryption, Authentication, Privacy, Hands-on: Sending data to cloud via MQTT/HTTP	**18**
IV	**IOT Applications and Challenges**	Domain Applications: Smart Agriculture, Smart Home / Smart Cities, Healthcare IoT, Industrial IoT (IIoT) Case Studies: Google Nest, Amazon Echo, Smart Irrigation Challenges in IoT: Scalability, Interoperability, Security, Ethics Final Project Design and Development, Documentation and Presentation of IoT Prototype	**15**
Total			**66**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**

3* 22 NCH = 66 NCH	--	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Internet of Things: A Hands-On Approach,* Vijay Madisetti, Arshdeep Bahga, 1st Edition, 2015, Orient Black Swan

Reference Books:

1. Waltenegus Dargie, Christian Poellabauer, *Fundamentals of Wireless Sensor Networks: Theory and Practice*, 1st Edition, 2015, Wiley india Pvt. Ltd
2. Raj Kamal, *Internet of Things - Architecture and Design Principles*, 1st Edition, 2017, McGraw Hill

6.8 Detailed Syllabus of 7th Semester

Paper I/Subject Name: Introduction to Artificial Intelligence		**Subject Code: ARI022C701**
L-T-P-C – 4-0-0-4	**Credit Units: 04**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to make the students learn data analytics concepts and visualization techniques, integrate AI/ML methods for extracting insights from structured and unstructured data, learn effective data storytelling and dashboarding for decision-making, etc.

Prerequisites: Basics of Python programming, Data Structures and Algorithms, Probability, Statistics, and Linear Algebra, Fundamentals of Machine Learning

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** the role of data analytics and visualization in AI-based systems.	**BT 1 & 2**
CO 2	**Apply** preprocessing, transformation, and dimensionality reduction techniques on real-world data.	**BT 3**
CO 3	**Analyze** AI models and visualize their results.	**BT 4**
CO 4	**Evaluate** and communicate insights using interactive dashboards and visual tools.	**BT 5**

Detailed Syllabus

Modules	**Topics**	**Course Contents**	**Hours**

I	**Introduction**	Introduction to data analytics in AI, Data types, scales, and distributions, Data wrangling and preprocessing (missing data, outliers, normalization), Exploratory Data Analysis (EDA): histograms, boxplots, scatter plots, Introduction to data visualization principles (Tufte's theory, Gestalt principles), Tools: Python (Matplotlib, Seaborn, Plotly), Tableau/Power BI (overview)	**22**
II	**Dimensionality Reduction and Feature Engineering**	Correlation and Covariance matrices, Principal Component Analysis (PCA) and t-SNE, Linear Discriminant Analysis (LDA), Feature selection vs feature extraction, Feature importance visualization in ML models (e.g., SHAP, permutation importance), Case study: reducing dimensionality in image or text datasets	**22**
III	**Machine Learning and Visual Analytics**	Supervised learning recap: regression and classification, Unsupervised learning recap: clustering and association rules, Visualizing ML performance: ROC, confusion matrix, lift charts, Interactive visualizations for ML insights (using Dash, Streamlit), AI explanations: SHAP values, partial dependence plots, decision plots, Real-world AI use cases: fraud detection, healthcare analytics, customer segmentation	**22**
IV	**Storytelling, Dashboards and Ethics**	Data storytelling concepts: audience, message framing, design, Creating interactive dashboards using Tableau, Power BI, or Dash, Real-time data visualization (live APIs, IoT, log data), Visualizing NLP and time-series data, Ethical visualization: avoiding misrepresentation, bias, overfitting, Capstone mini-project: end-to-end analytics pipeline with visuals	**22**
TOTAL			**88**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4* 22 NCH = 88 NCH	--	8 * 4 NCH = 32 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Book:

1. *Visualizing Data,* Ben Fry, 1st Edition, 2016, O'Reilly
2. *Data Points: Visualization That Means Something,* Nathan Yau, Illustrated Edition, 2013, Wiley
3. *Data Science from Scratch,* Joel Grus, 1st Edition, 2015, O'Reilly

Reference Books:

1. Kaufman & Rousseeuw, *Finding Groups in Data: An Introduction to Cluster Analysis*, 1st Edition, 2005, Wiley
2. Anil Maheshwari, *Data Analytics Made Accessible*, Kindle Edition, 2025, Amazon/KDP

Paper II/Subject Name: Web Technology **Subject Code: ARI022C702**

L-T-P-C – 3-0-2-4 **Credit Units: 04** **Scheme of Evaluation: TP**

Objective:

The objectives of the course are to provide knowledge on the basic web concepts, scripting languages and Internet protocols.

Prerequisites: Concepts of Databases and Object-Oriented Programming

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Describe** and **understand** the basic concept of web development	**BT 1 & 2**
CO 2	**Apply** the concepts learnt to develop simple web applications	**BT 3**
CO 3	**Assess** two web applications based on various design factors.	**BT 4**
CO 4	**Evaluate** the working of various web applications.	**BT 5**

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I	**Introduction, To Web Technology**	World Wide Web: Introduction to TCP/IP and WAP, DNS, Email, TelNet, HTTP and FTP. Introduction to Browser and search engines, Working of the search engines, Miscellaneous Web Browser details, Introduction to Web Servers: Features of web servers, caching, case study-IIS, Apache, Configuring web servers.Internet Principles – Basic Web Concepts – Client/Server model – retrieving data from Internet – HTM and Scripting Languages – Standard Generalized Mark –up languages – Next Generation – Internet –Protocols and Applications.	**18**
II	**HTML,CSS, Java Script**	Web Pages - types and issues, tiers; comparisons of Microsoft and java technologies, WWW-Basic concepts, web client and web server, http protocol (frame format), universal resource locator (URL), HTML different Tags, sections, image & pictures, listings, tables, frame, frameset, form. The need of dynamic web pages; an overview of DHTML, cascading style sheet (CSS), comparative studies of different technologies of dynamic page creation.Java Script : Data types, variables, operators, conditional statements, array object, date object, string object, Dynamic Positioning and front end validation, creating rollovers, building smarter forms, Event Handling, working with cookies, DOM, node and objects, creating sliding menu, pop-up menu, slideshow with caption	**18**
III	**XML and AJAX**	XML – Server side includes – communication – DTD – Vocabularies – DOMmethods – Introduction of XML, Validation of XML documents, DTD, Ways to use XML, XML for data files, HTML Vs XML, Embedding XML into HTML documents, Converting XML to HTML for Display, Rewriting HTML as XML, Firewalls– Proxy	**15**

		Servers.AJAX technologies, Action, XML HttpRequest database operations, security, issues	
IV	**J2SE, J2EE, Servlet and JSP**	Data Types, Arrays, Type Casting, Classes and Objects, Inheritance, Interfaces, Exception Handling, Multithreading,J2EE as a framework, Client Server Traditional model, Comparison amongst 2-tier, 3-tier and N-tier Architectures, Thin and Thick Clients. J2EE Servlet 2.x Specification, Writing small Servlet Programs, Deployment Descriptor, Inter Servlet Collaboration, Session: Definition, State on web, Different ways to track sessions.JSP Technology Introduction-JSP and Servlets- Running JSP Applications Basic JSP- JavaBeans Classes - Support for the Model-View- Controller Paradigm- Case Study- Related Technologies.	**15**
TOTAL			**66**

Web Technology Lab Syllabus

Detailed Syllabus:

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 10 Laboratory experiments based on the following-

1. Web page design: Designing web pages with HTML- use of tags, hyperlinks, URLs, tables, text formatting, graphics & multimedia, imagemap, frames and forms in web pages.
2. Use of Cascading Style Sheet in web pages.
3. Creating interactive and dynamic web pages with JavaScript: JavaScript overview; constants, variables, operators, expressions & statements; user-defined & built-in functions; client-side form validation; using properties and methods of built-in objects.
4. Extensible Markup Language (XML): Introduction- using user-defined tags in web pages; displaying XML contents; XML DTDs; use of XSL.
5. Server-side scripting: overview of CGI, ASP, and JSP.
6. Server side scripting using PHP; PHP basics, HTML form data handling, Web database connectivity- introduction to ODBC; PHP with database connectivity.
   Exposure to Advanced Web Technologies (as far as possible; not to be made compulsory): Distributed Object based models- DCOM, CORBA, EJB; Web services and Related Technologies- ISAPI, SOAP, UDDI, WSDL; Other Advanced Web Technologies- AJAX, ISAPI, .NET. Web Security

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	1 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Book:

4. *Internet and World Wide Web How to program*,Deitel H.M. and Deitel P.J, 4th Edition, 2012, Pearson International, New Delhi.
5. *Web Technology,* Gopalan N.P. and Akilandeswari J., 2nd Edition, 2014. Prentice Hall of India.
6. *Java How to Program*, Paul Dietel and Harvey Deitel, 8th Edition, 2014, Prentice Hall of India.

Reference Books:

3. Uttam K. Roy, *Web Technologies*, 2011, Oxford University Press.
4. Godbole A. S. & Kahate A., TMH, *Web Technologies*, 2nd Edition, 2006, TMH

Paper III/Subject Name: Computer Vision (PEC-III)		**Subject Code: ARI022D701**
L-T-P-C – 4-0-0-4	**Credit Units: 04**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to make the students understand the fundamentals of digital image processing and vision systems, explore image transformation, filtering, edge detection, and feature extraction techniques, implement machine learning and deep learning approaches for object recognition, etc.

Prerequisites: Linear Algebra, Probability & Statistics, Python Programming, Basics of Machine Learning and Deep Learning

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Describe** and **explain** core concepts of image formation, transformation, and processing.	**BT 1 & 2**
CO 2	**Apply** techniques for image filtering, edge detection, and feature extraction.	**BT 3**
CO 3	**Analyze** image classification and object detection pipelines.	**BT 4**
CO 4	**Evaluate** and compare vision models using performance metrics.	**BT 5**

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I	**Image Processing Fundamentals**	Introduction to computer vision and its applications, Image formation, pixel operations, Color spaces: RGB, HSV, Grayscale, Image thresholding, histogram equalization, Smoothing and filtering: Gaussian, median, bilateral, Edge detection: Sobel, Canny, Laplacian, Geometric transformations: translation, scaling, rotation, affine	**22**
II	**Feature Detection and Matching**	Interest point detection: Harris, FAST, Local descriptors: SIFT, SURF, ORB, Feature matching using distance metrics, Homography and image stitching, Motion estimation, optical flow basics, Object tracking: Kalman filter, Mean shift, Camshift	**22**
III	**ML and DL in Vision**	Classical classification: KNN, SVM for image data, Introduction to CNNs: architecture, layers, filters, Popular CNN models: LeNet, AlexNet, VGG, ResNet, Object	**22**

		detection models: R-CNN, Fast R-CNN, YOLO, SSD, Image segmentation: semantic and instance segmentation (Mask R-CNN)	
IV	**Application, Ethics and Deployment**	Applications: facial recognition, OCR, autonomous driving, healthcare, Real-time video analysis and gesture recognition, Vision in robotics and AR/VR, Explainable AI in computer vision (Grad-CAM), Ethical issues: bias, surveillance, privacy, Deploying models using OpenCV, TensorFlow Lite, ONNX	**22**
TOTAL			**88**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4* 22 NCH = 88 NCH	--	8 * 4 NCH = 32 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Book:

1. *Computer Vision: Algorithms and Application,* Richard Szeliski, 1st Edition, 2010, Springer

Reference Books:

1. Dana H. Ballard and Christopher M. Brown, *Computer Vision*, 1st Edition, 1982, Prentice Hall.
2. Theo Pavlidis, *Algorithms for Graphics and Image Processing*, 1st Edition, 1982, Springer-Verlag Berlin Heidelberg

Paper IV/Subject Name: Reinforcement Learning (PEC-IV)		**Subject Code: ARI022D702**
L-T-P-C – 4-0-0-4	**Credit Units: 04**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to introduce studentsto the fundamental concepts and mathematical formulation of reinforcement learning, explore dynamic programming, Monte Carlo, and temporal-difference learning methods, implement RL algorithms and apply them to games and control problems, etc.

Prerequisites: Linear Algebra and Probability, Python Programming, Basics of Machine Learning & Neural Networks (for advanced topics)

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Explain** and **understand** the core concepts of agents, environments, and rewards in reinforcement learning.	**BT 1 & 2**
CO 2	**Apply** value-based and policy-based methods to sequential decision-making problems.	**BT 3**

CO 3	**Analyze** RL algorithms using Bellman equations and convergence properties.	**BT 4**
CO 4	**Evaluate** and implement deep RL algorithms for complex environments.	**BT 5**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I	**Introduction**	Agent-Environment Interaction, Markov Decision Processes (MDP), Rewards, Policies, Returns, Value Functions (State-value, Action-value), Bellman Expectation Equations, Exploration vs Exploitation, Gridworld examples	**22**
II	**Dynamic Programming & TD Learning**	Policy Evaluation and Iteration, Value Iteration, Monte Carlo Methods: First-visit, Every-visit, Temporal-Difference (TD) Learning, SARSA and Q-Learning, ε-Greedy and Softmax policies	**22**
III	**Policy Gradient and Actor-Critic Methods**	Policy Gradient Theorem, REINFORCE Algorithm, Actor-Critic Architecture, Advantage Estimation, Trust Region Policy Optimization (TRPO), Proximal Policy Optimization (PPO), Applications in control and robotics	**22**
IV	**Deep Reinforcement Learning & Applications**	Deep Q-Networks (DQN), Target networks and experience replay, Double DQN, Dueling DQN, Deep Deterministic Policy Gradient (DDPG), Multi-Agent RL (basics), Applications in games (Atari, Chess, Go), robotics, recommendation systems, Ethics and safety in RL	**22**
TOTAL			**88**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4* 22 NCH = 88 NCH	--	8 * 4 NCH = 32 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Reinforcement Learning: An Introduction,* Richard S. Sutton and Andrew G. Barto, 2nd Edition, 2018, MIT Press
2. *Reinforcement Learning: Industrial Applications of Intelligent Agents,* Phil Winder, 2020, O'Reilly

Reference Books:

1. Laura Graesser & Wah Loon Keng, *Foundations of Deep Reinforcement Learning*, 1st Edition, 2020, Pearson
2. Alexander L. Strehl, *Reinforcement Learning: Theory and Algorithms*, 2011, Springer

6.9 Detailed Syllabus of 8th Semester

Paper I/Subject Name: Predictive Modelling & Optimization Techniques		**Subject Code: ARI022C801**
L-T-P-C – 3-0-2-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective:

The objectives of the course are to make the students learn various predictive modelling techniques and their real-world applications, equip students with optimization techniques for enhancing the performance of predictive models, impart practical skills in building, evaluating, and tuning models using tools like Python, R, or MATLAB, etc.

Prerequisites: Probability and Statistics, Linear Algebra and Calculus, Programming with Python/R, Basic understanding of Machine Learning

Course Outcomes

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Explain** and **interpret** fundamental predictive modelling concepts and statistical learning techniques.	**BT 1 & 2**
CO 2	**Apply** regression, classification, and ensemble methods to predictive tasks.	**BT 3**
CO 3	**Analyze** and compare model performance using relevant evaluation metrics.	**BT 4**
CO 4	**Evaluate** optimization techniques to improve model accuracy and efficiency.	**BT 5**

Detailed Syllabus

Modules	Topics	Course Contents	Hours
I	**Introduction**	Overview of predictive analytics and its applications, Statistical learning and data preparation, Types of predictive models: regression, classification, time-series, Linear and logistic regression, Bias-variance trade-off, Model validation: hold-out, cross-validation	**18**
II	**Advanced Predictive Modelling Techniques**	Decision Trees, Random Forests, Gradient Boosting (XGBoost, LightGBM), k-NN, SVM, Naïve Bayes, Model evaluation: Accuracy, Precision, Recall, F1, ROC-AUC, Model interpretability (LIME, SHAP), Handling imbalanced data and missing values, Feature engineering and selection techniques	**18**
III	**Optimization Techniques**	Introduction to optimization: objective function, constraints, Gradient Descent and its variants (SGD, Adam, RMSprop), Linear Programming and Integer Programming, Metaheuristic optimization: Genetic Algorithms, Particle Swarm Optimization, Hyperparameter tuning: Grid Search, Random Search, Bayesian Optimization	**15**
IV	**Applications and Case Studies**	Predictive analytics in finance, healthcare, marketing, and supply chain, Time series forecasting using ARIMA, Prophet, LSTM, AutoML tools and pipelines (e.g., TPOT, H2O AutoML, Scikit-learn pipelines), Deploying predictive models using Flask/Streamlit, Capstone project: End-to-end predictive modelling with optimization	**15**
TOTAL			**66**

Introduction to Machine Learning Lab Syllabus

Detailed Syllabus:

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 10 Laboratory experiments based on the following-

1. Data Exploration and Preprocessing: Load and clean a real-world dataset, handle missing, values, outliers, and encode categorical variables, Normalize/standardize features
2. Linear and Logistic Regression Models: Apply linear regression for prediction (e.g., house prices), Apply logistic regression on a binary classification problem, plot decision boundaries and residual errors
3. Decision Tree and Random Forest Classifiers: Build and visualize decision trees, Evaluate Random Forest using accuracy, F1-score, and feature importance, Compare overfitting/underfitting using training vs testing performance
4. Gradient Boosting with XGBoost and LightGBM: Implement XGBoost and LightGBM, Visualize learning curves and confusion matrix, Analyze feature importance and SHAP values
5. K-Nearest Neighbors and SVM Models: Apply k-NN and SVM to multi-class classification problems, Tune hyperparameters (K, kernel type), Visualize the effect of different kernels on decision boundaries
6. Hyperparameter Tuning using Grid Search and Random Search: Use GridSearchCV and RandomizedSearchCV, Compare performance metrics with default vs tuned models,Plot tuning curves
7. Metaheuristic Optimization – Genetic Algorithms: use DEAP/PyGAD or custom implementation, Optimize hyperparameters of a model using GA, Compare with Grid Search,
8. Linear and Integer Programming with PuLP/Excel Solver: Formulate and solve LP/IP problems for resource allocation, Use Python's PuLP or Excel Solver to find optimal solutions, Apply LP in model selection or feature reduction scenarios

9. Time Series Forecasting: Use ARIMA/Prophet/LSTM on stock or weather data, Plot predictions vs actual, Evaluate using MAE, RMSE
10. Model Explainability: Use SHAP, LIME for explaining Random Forest/XGBoost models, Visualize and interpret SHAP summary plots, Generate insights for stakeholders
11. Deployment of Predictive Model: Build a Streamlit/Flask app for a predictive task, Allow user input and display predictions and charts, Export and import trained model using joblib/pickle
12. Mini Project: Implement end-to-end predictive pipeline, Sample projects: churn prediction, energy forecasting, fraud detection, Documentation and demonstration

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3* 22 NCH = 66 NCH	1 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Book:

1. *The Elements of Statistical Learning,* Trevor Hastie, Robert Tibshirani, Jerome Friedman, 9th Edition, 2017, Springer
2. *Applied Predictive Modeling,* Max Kuhn & Kjell Johnson, 1st Edition, 2018, Springer

Reference Books:

1. S. Rajasekaran, *Optimization: Theory and Practice*, 4th Edition, 2009, PHI Learning
2. Amit Kumar Tyagi, *Data Analytics and Predictive Modeling*, 1st Edition, 2024, Wiley

Paper II/Subject Name: Cryptography and Network Security		**Subject Code: ARI022C802**
L-T-P-C – 4-0-0-3	**Credit Units: 04**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to explain the basics of cryptography, kinds of security threats in networks and to learn to find the vulnerabilities in programs and to overcome them and to teach about the models and standards for security.

Prerequisites: Concepts of Number Theory and Networking

Course Outcomes

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** and **illustrate** basic cryptographic algorithms, message and web authentication and security issues.	**BT 2**
CO 2	**Demonstrate** the current legal and ethical issues towards information.	**BT 2**
CO 3	**Identify** the applications of different protocol like SSL, TLS etc.	**BT 3**

CO 4	**Analyze** and **assess** the security services and mechanisms	**BT 4**

Detailed Syllabus

Modules	Topics	Course Contents	Hours
I	**Introduction**	Need for Security, Security Approaches, Principles of Security, Types of Attacks, Brute Force Attack, Encryption, Decryption, Crptosystem, Cryptographic Techniques: Substitution Ciphers, Transposition Ciphers, Product Ciphers, Stegenography, Block Cipher, Stream Cipher.	**22**
II	**Symmetric and Asymmetric Key Cryptography**	Overview, Algorithm Modes and Types, Data Encryption Standard: Simplified DES, The Strength of DES, Differential and Linear Cryptanalysis. Triple DES, Blowfish. Confidentiality using Conventional Encryption: Placement of Encryption Function, Traffic Confidentiality, Key Distribution, Random Number Generation. Modular Arithmetic, Public Key Cryptography and RSA: Principles of Public Key Cryptosystems, Difference with Symmetric Key Cryptography, The RSA Algorithms, Key Management, Diffie Hellman Key Exchange.	**22**
III	**Authentication Protocols**	Message Authentication: Authentication Requirements, Authentication Functions, Message Authentication Codes, MD5 Message Digest Algorithms, Digital Signatures and Authentication Protocols: Digital Signatures, Authentication Protocols, Digital Signature Standards.	**22**
IV	**Security Protocols**	Security Applications and Protocols- Authentication Applications: Secure HTTP, HTTPS, ERT, SSH, Kerberos. Email Security: PGP, S/MIME. IP Security: Overview, IPSec architecture.	**22**
TOTAL			**88**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4* 22 NCH = 88 NCH	--	8 * 4 NCH = 32 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Cryptography and Network Security*, Atul Kahate, 2nd Edition. 2003, Tata McGraw Hill.
2. *Cryptography and Network security,* Fourozan, 3rd Edition, 2007, McGraw Hill

Reference Books:

1. William Stallings, *Cryptography and Network Security*: *Principles and Practices*", 5th Edition, 2010, Prentice Hall.

2. Michael Howard, David LeBlanc, John Viega, *24 Deadly Sins of Software Security: Programming Flaws and How to Fix Them*, 1st Edition, 2009, Mc Graw Hill Osborne Media.

Paper III/Subject Name: AI for Robotics (PEC-V)		**Subject Code: ARI022D801**
L-T-P-C – 4-0-0-4	**Credit Units: 04**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to make the students understand the integration of AI techniques in robotic systems, path planning, localization, and mapping algorithms, apply machine learning and computer vision for robotic perception and control, etc.

Prerequisites: Basic Programming (Python/C++), Linear Algebra, Probability, and Calculus, Fundamentals of AI / Machine Learning

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Explain** and **understand** the foundations of robotic systems integrated with AI algorithms.	**BT 1 & 2**
CO 2	**Apply** probabilistic reasoning and search techniques to robot planning and navigation.	**BT 3**
CO 3	**Analyze** perception, localization, and mapping algorithms.	**BT 4**
CO 4	**Assess** machine learning and computer vision-based models for robotic perception and control.	**BT 5**

Detailed Syllabus:

Modules	**Topics**	**Course content**	**Periods**
I	**Introduction**	Overview of robotics: components (sensors, actuators, controllers), Role of AI in robotics: perception, cognition, control, Agent-based models and environments, Search algorithms: BFS, DFS, A*, D*, Configuration space and motion planning, Robot Operating System (ROS) introduction	**22**
II	**Localisation, Mapping an Navigation**	Probabilistic robotics basics, Markov localization and particle filters, Kalman and Extended Kalman Filters (EKF), Simultaneous Localization and Mapping (SLAM), Path planning: RRT, PRM, Obstacle avoidance: potential fields, dynamic window approach	**22**
III	**Perception and Computer Vision**	Camera models and calibration, Feature detection and matching (SIFT, ORB), Depth estimation and stereo vision, Visual odometry and 3D reconstruction, Object detection: YOLO, SSD, Sensor fusion (LIDAR + vision)	**22**

IV	**Learning & Autonomous Decision Making**	Supervised and Reinforcement Learning for robotics, Q-Learning, SARSA, Deep Q Networks (DQN), Policy gradient and actor-critic methods, Behavior trees and task-level planning, Human-robot interaction (HRI), Ethics and safety in AI-driven robots	**22**
Total			**88**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4* 22 NCH = 88 NCH	--	8 * 4 NCH = 32 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. *Probabilistic Robotics,* Sebastian Thrun, Wolfram Burgard, Dieter Fox, 2005, MIT Press
2. *Robotics, Vision and Control*, Peter Corke, 2nd Edition, 2017, Springer

Reference Books:

1. M. J. Mataric, *The Robotics Primer*, 2007, MIT Press
2. Sudeep Das, *AI and Machine Learning for Robotics*, BPB Publications
3. Francis X. Govers, *Artificial Intelligence for Robotics: Build intelligent robots that perform human tasks using AI techniques,* 2018, Packt Publishers