ACADEMIC CURRICULA 2022 - 2023

BACHELOR'S DEGREE PROGRAMME

B. Tech (Hons. /Res.) In

Computer Engineering

Curricula & Syllabi

Kalinga Institute of Industrial Technology (KIIT)
Deemed to be University U/S 3 of UGC Act, 1956
Bhubaneswar, Odisha, India

ACADEMIC CURRICULA
2022 - 2023

B. Tech (Hon. / Res.) in
Computer Engineering

Course Structure and Detailed Syllabi
for students admitted in
2022 - 2023
Academic Session

Kalinga Institute of Industrial Technology (KIIT)
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CONTENTS

Vision

To produce quality engineering graduates by imparting quality education and research in the field of computer science and information technology in order to respond swiftly the challenges of 21st century.

Mission

- To provide quality professional education in science and technology in fields relating to computer science and information technology that enable students to effectively apply this education to solve real-world problems.
- To provide a platform for students that helps students to inculcate event management skills and entrepreneurial skills.
- To create an ambience that helps students realizing social responsibilities and values of professional ethics.
- To conduct research in advanced and application-oriented arena relating to computer and information science involving students with promote on continuous learning.
- To establish strong bonding with globally leading industries.

The School of Computer Engineering offers the following Programmes:

- Computer Science and Engineering
- Information Technology
- Computer Science and Communication Engineering
- Computer Science and Systems Engineering

Programme Educational Objectives (PEO)

The Program Educational Objectives (PEO) expects professional accomplishments from our graduates.

PEO1- The graduates shall provide solutions to Computer Science & Engineering problems involving design, simulation, and analysis of algorithms for theory and applications of computing.

PEO2-The graduates shall perceive the limitations and impact of engineering solutions in social, legal, ethical, environmental, economical, and multidisciplinary contexts.

PEO3-The graduates shall demonstrate professional responsibility and thrive to reinforce their knowledge being a part of formal or informal educational programs.

Programme Outcomes (PO)

1. **Engineering knowledge:** Ability to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Ability to identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/Development of solutions:** Ability to 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.
4. **Conduct investigations on complex problems:** Ability to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Ability to 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.
6. **The engineer and society:** Ability to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Ability to understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Ability to apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team**: Ability to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Ability to 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.
11. **Project management and finance:** Ability to demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Ability to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcome (PSO)

1. Ability to design and develop hardware and software in emerging technology environments like cloud computing, embedded products and real-time systems.
2. Ability to work in multidisciplinary teams in small and large scale projects by utilizing modern software engineering tools and emerging technologies.
3. Ability to develop complex products for the societal and engineering needs with skills to communicate effectively in group discussions and report writing.

CURRICULUM

The total minimum credits required for completing the B. Tech. programme in Computer Science and Engineering is **162**

Guidelines for UG Engineering Curriculum – 2022

The curricula for B.Tech. courses have been designed following the general principles of curricular design and developing certain guiding strategies in order to build in the engineering graduate attributes in the courses.

Principles in Designing the Curricula

The overriding principles in designing the new curricula are that the curricula must (1) Impart specialized and interdisciplinary knowledge and creative problem-solving skills; (2) Reflect aspirations of the society to turn out technology-ready and socially conscious graduates to anticipate and avoid future problems; (3) Leverage the strengths and help making up the weaknesses of the university; (4) Inform the students about new technologies and the emerging social, environmental, and global forces, and (5) Give students the confidence to work in teams and in multi-cultural settings.

Key Graduate Attributes

Engineers are agents of social change. They interact with the common man to know and define the current and the looming future problems, develop sustainable design solutions using their science and engineering skills, and implement sustainable solutions. Thus, the graduating students must (1) Acquire knowledge and skills—both technical and soft skills such as communication, leadership, and skills of working in multi-cultural, interdisciplinary teams; (2) Develop the mental disposition to understand, conceptualize, and define complex, real-world problems; (3) Be independent, critical thinkers to inquire into the root causes of the problems; (4) Analyse the relevant data and social, economic, and political forces influencing these problems; (5) Synthesize knowledge and diverse perspectives and approaches to find technically and financially viable, sustainable, creative, ethical solutions by evaluating novel alternatives; (6) Use project planning and scheduling methods, establish institutional mechanisms, and communicate the plans and schedules and inspire the concerned individuals to implement the solutions; (7) Imbibe professional values and ethics, and (8) Be life-long learners with empathy for others.

Strategies for Curriculum Design

Strategies to design the curricula include (1) Understanding the dominant technological and social changes in the world, (2) Incorporating recommendations of the National Education Policy 2020 with respect to design of curricula, (3) Adding the novel features and best curricular practices of leading universities and institutes in India and abroad, (4) Recognizing the UGC and AICTE guidelines and ABET recommendations; (5) Using the opportunities that KIIT offers for multi- and inter-disciplinarity education, and (6) Delivering the key attributes and skills which the graduating students should be equipped with.

The Structure of the Curricula

The undergraduate engineering curricula are designed to inculcate in the students the graduate attributes indicated above. The curricula include (1) foundational subjects in the fields of humanities, social sciences, science, engineering science, and vocational courses, (2) depth subjects—both core and electives related to the respective disciplines, (3) open electives in diverse fields of humanities, arts, science, engineering, social science, management, law, public policy, media studies, etc., and (4) practice-based subjects. These subjects reflect a mix of theory, hands-on laboratory practice, short- and long-duration projects, field visits, internship, and extra- and co-curricular activities. The Institute has created many avenues for students to organize, lead, and actively participate in social, cultural, and techno-management functions to develop soft social and behavioural skills.

UG Programmes Offered by the Schools of Technology

The B. Tech. (Hons.) and B. Tech. (Res.) programmes offered by various Schools of Technology are tabulated below.

Name of the School	B. Tech. (Hons.) and B. Tech. (Res.) Programmes Offered
School of Civil Engineering	Civil Engineering
School of Computer Engineering	Computer Science and Engineering Information Technology Computer Science and Communication Engineering Computer Science and Systems Engineering
School of Electrical Engineering	Electrical Engineering
School of Electronics Engineering	Electronics and Telecommunication Engineering Electronics and Computer Science Engineering Electronics and Electrical Engineering
School of Mechanical Engineering	Mechanical Engineering Mechanical (Automobile Engineering) Mechatronics Engineering Aerospace Engineering

Highlights of the Curricula

1. The curricula allow the students to opt for either a B. Tech. (Hon.) degree or a B. Tech. (Res.) degree.
2. All the B. Tech. curricula have total of 160 – 165 credits.
3. The curricula provide for a Minor in selected areas if students fulfil additional credit requirements.
4. With the inclusion of many Humanities, Arts, and Social Science (HASS) subjects, the curricula are HASS-rich.

5. The curricula provide flexibility in many forms. The students can choose subjects from a large number science, HASS, and engineering electives. They can also choose subjects from lists of professional electives and open electives. The professional electives allow the students to concentrate in selected areas, whereas the open electives allow the students to opt for minors.
6. To ensure an all-round development of students, the curricula have included subjects like Yoga, Universal Human Values, a Community/Environment-based Project, a Vocational Elective, Industry 4.0 Technologies, and K-Explore that consider students' co- and extra-curricular activities for evaluation.
7. The curricula have included subjects like Scientific and Technical Writing and Research Methods and Ethics to instill research and research communication skills in the students.
8. The curricula have also provided for independent projects in the last three semesters to train the students in the art and science of identifying pressing problems and finding their sustainable solutions.

Notes and Guidelines

Science Core

Science forms the foundation of engineering. Subjects related to physical, chemical, biological, environmental, and mathematical sciences are covered in the first four semesters in the form core and elective subjects. The core subjects in science are the following:

Semester I/II: Physics, Chemistry, Science of Living Systems, Environmental Science, Differential Equations and Linear Algebra, Transform Calculus and Numerical Analysis, Physics Lab, and Chemistry Lab.

Semester III: Probability & Statistics

Semester IV: Selected Topics in Mathematics (Syllabi to be different for different Schools)

Engineering Science Core

Engineering science subjects provide a bridge between science and engineering. The related subjects are included as both core and electives. The semester-wise distribution of the core engineering science subjects is given below.

Semester I/II: Basic Electronics, Programming & Data Structures or Programming Lab, Engineering Drawing & Graphics, Workshop Practice, and Engineering Lab

Half the number of experiments in Engineering Lab will relate to Basic Electronics and the other half to the subject the student picks from the list of Engineering Elective I subjects.

Semester III: Industry 4.0 Technologies

HASS Core

The curricula include HASS subjects as both core and electives. The HASS subjects that improve the written and rhetoric skills, life skills and research skills of students are included as core subjects. Semester-wise distribution of these subjects are given below:

The semester-wise distribution of language- and human values-related subjects is given below:

Semester I/II: English (to develop language skills and skills for making critical analysis of English literature)
Semester I/II: Communication Lab (to develop skills of Listening, Speaking, and Writing)
Semester I/II: Yoga (to bring about unity of mind and body)
Semester III: Scientific and Technical Writing (to develop skills of writing varieties of scientific and technical documents)
Semester VI: Universal Human Values (to develop and respect human values) and Engineering Professional Practice (to understand roles and responsibilities of engineers and the ethical and selected legal issues)

Semester VIII: Research Methods and Ethics (for B. Tech. (Res.) students)

Professional Core

Professional core subjects form the backbone of an engineering discipline. Every School of Technology decides the list of core subjects that its students must credit. These can be theory and laboratory subjects. These subjects are diffused in Semester III through Semester VI.

Engineering Professional Practice, a professional core subject, is included as a HASS Elective but will be taught by engineering faculty.

Research Core

Students pursuing B. Tech. (Res.) programme have to go through a course on Research Methods and Ethics, which is offered in Semester VII.

Science, Engineering Science, and HASS Electives

Options are available to the students to choose subjects from lists of science, engineering science, and HASS electives. Their distributions in the curricula are as under:

Semester I/II: Science Electives, Engineering Electives I and II, and HASS Electives I.
Semester IV: HASS Electives II
Semester V: HASS Electives III
Semester VI: HASS Electives IV

HASS Elective I includes Community/Environment-based project as one of the subjects. Done as a group work, the subject gives the students an opportunity to connect with the community and the environment, learn and prioritize their problems, and define them in ways that make them amenable to scientific analysis and pragmatic solution.

The lists of Science, Engineering Science, and HASS electives will be available in the ERP. Before a semester begins the Institute will announce the subjects that will be offered in that semester and the students will have to give their choice of electives out of the offered subjects.

Vocational Elective

Vocational Elective courses provide engineering students a deeper appreciation of the practical aspects of engineering and allow them to relate their theoretical knowledge with practical skills. This subject is included in Semester III. A student must opt for one of the vocational electives which will be announced at the beginning of a semester.

Open Electives

Open electives allow students to choose subjects from lists of subjects offered by all the Schools. It is through these subjects that a student can pursue his or her latent interests in specific areas and work towards earning a Minor in an area which is outside his (or her) major engineering branch (if the subjects are selected in specific designated areas). These subjects are offered in Semester V through Semester VIII:

Semester V: K-Explore—Practice-based Open Elective I
Semester VI – VIII: Open Electives II, III, and IV

K-Explore is a 1-Credit Practice-based Open Elective that allows the students to use the scope that the Clubs and the Societies of KIIT University provides to learn the skills of Dance, Music, Photography, etc. and of conducting seminars and conferences through training, practice, and direct involvement.

Minor

The curricula allow a student to earn a Minor in an area outside the core discipline in which he (or she) has registered. For example, a student doing B. Tech in Mechanical Engineering (his/her parent branch) can choose to have a Minor in Computer Science Engineering. To get a Minor, a student must

(i) Get the fourth semester CGPA of 7.0 or more,

(ii) Successfully fulfill the coursework requirement for at least six theory subjects and two credit Lab/project subjects in an area or discipline other than the one for which he (or she) is registered, and

(iii) Complete at least 20 Credits of coursework in that area.

Thus, if a student has taken three Open Electives in one area other than his (or her) own then he (or she) must choose three theory subjects and two Lab/project subjects in that area in the Fourth year.

If no Lab subject is available in that Minor, then the student must choose an additional theory subject with at least 2 Credits. Students having no backlogs till the end of Semester 4 and a minimum CGPA of 7.0 will only be allowed to opt for the Minor scheme. Students opting for Minor have to mandatorily attend a minimum of 75% Theory and Lab classes (as the case may be) failing which the Minor option will be withdrawn.

Professional Electives

Professional elective subjects provide the students the opportunity to concentrate in certain specific areas of their interest. These subjects are offered in Semester V through Semester VIII for B. Tech. (Hons.) students (total 15 credits) and in Semester V through Semester VI for B. Tech. (Res.) students (total 9 credits). The distribution of these subjects is given below:

Semester V: Professional Electives (6),

Semester VI: Professional Electives (3),

Semester VII: Professional Electives Theory (3 Credits) for only B. Tech (Hons.) students

Semester VIII: Professional Core Theory (3 Credits) for only B. Tech (Hons.) students

Research Electives

The students pursuing B. Tech. (Res.) degree may need specialized knowledge in the areas of their theses. For this reason, the curriculum provides for two research electives to be selected in Semester VII and Semester VIII. Every

School prepares a list of Research Electives and announces, at the beginning of every semester, the subject which will be offered in that semester. The student is required to select the electives from out of these offered lists.

Summer Internship

Internship exposes the students to the realities of engineering systems. Every student must go through at least 60 days of internship. It can be taken in an industrial organization or at an institute of higher learning in the summer breaks after the second year and/or after the third year. Internship carries 2 Credits. And the grade secured by a student appears in the Semester VII Grade Sheet of the student.

Projects

Projects allow the students to work under the supervision of a faculty advisor and apply their acquired knowledge to solve the real-world problems. They define problems, mine information from past works, conceptualize forces and factors that impact the problems, develop design solutions, and demonstrate the effectiveness of the solutions. Semester-wise distribution of this subject is given below:

Semester VI: Mini Project (2 Credits)
Semester VII: Project I (5 Credits)
Semester VIII: Project II (9 Credits for B. Tech. (Hons.) and 12 Credits for B. Tech. (Res.))

Semester-away Provision for Project II

The Institute sometimes allows a student to carry out the fourth-year project (Project II) away from the University campus if the following conditions are satisfied:

- This provision applies to Project II.
- That means a student can avail of this provision in Semester VIII.
- The project must be done either in an industrial unit or in an academic institution.

- The organization in which the student wishes to carry out the project must give in writing that it will provide all facilities (office space, equipment, instrument, data, and travel and stay facilities, if possible) for the student to do the project. In addition, it will also identify a senior and competent employee of the organization to whom the student will report.
- The faculty supervisor must recommend the student's application for availing the semester-away provision.
- A co-supervisor from the organization may be appointed for the project.
- The intending student gives an undertaking that he (or she) will
  - Remain in constant touch with the faculty supervisor,
  - Send monthly progress reports to the supervisor,
  - Give seminar presentations, whenever required.
  - Collect class notes, read books, and prepare for and appear at the examinations (online, if necessary). The student must also do and submit all home assignments given by the teachers and give seminar presentation (online) if necessary.

Since Semester VIII curricula have one theory subject (B. Tech. (Res.)) and two theory subjects (B. Tech. (Hons.)) students, a student applying for this provision will be exempted from attending the lectures on these subjects. But the student must give an undertaking that it will be his (or her) responsibility to collect class notes, read books and other reading materials, submit all home assignments, give seminar presentations (online if required) and prepare for and appear at the examinations.

SCHEME I
FIRST SEMESTER

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	PH10001	Physics	3	0	0	3	3
2	MA11001	Differential Equations and Linear Algebra	3	1	0	4	4
3		Science Elective	2	0	0	2	2
4		Engineering Elective II	2	0	0	2	2
5	LS10001	Science of Living Systems	2	0	0	2	2
6	CH10003	Environmental Science	2	0	0	2	2
Total Credit (Theory Subjects)						**15**	**15**
Practical							
1	PH19001	Physics Lab	0	0	2	2	1
2	CS13001	Programming Lab	0	2	4	6	4
Sessional							
1	CE18001	Engineering Drawing & Graphics	0	0	2	2	1
Total Credit (Practical & Sessional subject)						**10**	**6**
Total Credit (Semester)						**25**	**21**

SCHEME I
SECOND SEMESTER

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CH10001	Chemistry	3	0	0	3	3
2	MA11002	Transform Calculus and Numerical Analysis	3	1	0	4	4
3	HS10001	English	2	0	0	2	2
4	EC10001	Basic Electronics	2	0	0	2	2
5		Engineering Elective I	2	0	0	2	2
6		HASS Elective I	2	0	0	2	2
Total Credit (Theory Subjects)						**15**	**15**
Practical							
1	CH19001	Chemistry Lab	0	0	2	2	1
2	EX19001	Engineering Lab	0	0	2	2	1
Sessional							
1	ME18001	Workshop	0	0	2	2	1
2	YG18001	Yoga	0	0	2	2	1
3	HS18001	Communication Lab	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**10**	**5**
Total Credit (Semester)						**25**	**20**

SCHEME II
FIRST SEMESTER

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CH10001	Chemistry	3	0	0	3	3
2	MA11001	Differential Equations and Linear Algebra	3	1	0	4	4
3	HS10001	English	2	0	0	2	2
4	EC10001	Basic Electronics	2	0	0	2	2
5		Engineering Elective I	2	0	0	2	2
6		HASS Elective I	2	0	0	2	2
Total Credit (Theory Subjects)						**15**	**15**
Practical							
1	CH19001	Chemistry Lab	0	0	2	2	1
2	EX19001	Engineering Lab	0	0	2	2	1
Sessional							
1	YG18001	Yoga	0	0	2	2	1
2	ME18001	Workshop	0	0	2	2	1
3	HS18001	Communication Lab	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**10**	**5**
Total Credit (Semester)						**25**	**20**

SCHEME II
SECOND SEMESTER

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	PH10001	Physics	3	0	0	3	3
2	MA11001	Differential Equations and Linear Algebra	3	1	0	4	4
3		Science Elective	2	0	0	2	2
4		Engineering Elective II	2	0	0	2	2
5	LS10001	Science of Living Systems	2	0	0	2	2
6	CH10003	Environmental Science	2	0	0	2	2
Total Credit (Theory Subjects)						**15**	**15**
Practical							
1	PH19001	Physics Lab	0	0	2	2	1
2	CS13001	Programming Lab	0	2	4	6	4
Sessional							
1	CE18001	Engineering Drawing & Graphics	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**10**	**6**
Total Credit (Semester)						**25**	**21**

LIST OF ELECTIVES

Engineering Elective I							
Sl. No.	**Course Code**	**Subjects**	L	T	P	Total	Credit
1	CE10001	Basic Civil Engineering	2	0	0	2	2
2	ME10003	Basic Mechanical Engineering	2	0	0	2	2
3	EE10002	Basic Electrical Engineering	2	0	0	2	2

Engineering Elective II							
Sl. No.	**Course Code**	**Subjects**	L	T	P	Total	Credit
1	EE10001	Elements of Machine Learning*	2	0	0	2	2
2	ME10001	Engineering Mechanics	2	0	0	2	2
3	EC10003	Biomedical Engineering	2	0	0	2	2
4	EE10003	Basic Instrumentation	2	0	0	2	2

*Not for students of Computer Engineering

Science Elective							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CH10005	Nanoscience	2	0	0	2	2
2	PH10003	Smart Materials	2	0	0	2	2
3	LS10003	Molecular Diagnostics	2	0	0	2	2
4	PE10002	Science of Public Health	2	0	0	2	2
5	MA10003	Optimization Techniques	2	0	0	2	2
HASS Elective I							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	HS10013	Society, Science, and Technology	2	0	0	2	2
2	HS10202	Essential of Management	2	0	0	2	2
3	HS10121	Shades of Economics	2	0	0	2	2
4	HS10123	India Economy Post Liberalisation	2	0	0	2	2
5	SO10043	Socio-Political Environment	2	0	0	2	2
6	PS10043	Thinking Perspectives	2	0	0	2	2
7	PS10045	Creativity, Innovation and Entrepreneurship	2	0	0	2	2
8	EX17001	Community/Environment-based Project	0	0	4	2	2

Detailed Syllabus

Course Title	Physics
Course Code (Credit)	PH10001 (L-T-P-Cr: 3-0-0-3)

Course Objective:

This subject is designed to enrich the basic knowledge of engineering students in the field of physics and to support the engineering and research programs. The subject will also help the students to develop mathematical models to understand the behavior of physical systems and phenomena.

Course Contents:

UNIT I

Oscillation:

Damped Harmonic Oscillation (under damped, over damped and critically damped), Energy decay, Relaxation time, Quality factor, Forced oscillation, Resonance, Coupled oscillations, Applications.

UNIT II

Waves and Interference:

Wave equation, Superposition of waves, Interference of light, Types of interference: Division of wave front and division of amplitude.

UNIT III

Interference in thin films:

Wedge shaped thin film, Newton's rings and their applications, Michelson interferometer, Applications.

UNIT IV

Diffraction:

Diffraction and its applications, Types of diffraction, Fraunhofer diffraction by a single slit, Plane diffraction grating (condition of maxima, minima), Maximum order of observable spectra, Absent spectra, and Dispersive power, Applications.

UNIT V

Quantum Mechanics:

Dual nature of radiation and matter, de Broglie hypothesis for matter waves, Phase velocity and Group velocity, Heisenberg's uncertainty principle and applications, Wave function and its interpretation, Concepts of operators, Schrodinger's time-dependent and time-independent equations, Postulates of Quantum mechanics, Particle in one-dimensional box and applications, Quantum tunnelling and applications.

UNIT VI

Electromagnetic Theory:

Vector calculus: scalar and vector field, Gradient, divergence and curl, Line, surface and volume integrals, Gauss divergence and Stoke’s theorem, Maxwell's equations in differential and integral form with necessary derivations. Electromagnetic wave equations, Transverse nature of electromagnetic waves.

UNIT VII

Laser and Fiber Optics:

LASER: Properties and applications, Spontaneous and stimulated emission, Meta-stable state, Population inversion, Pumping, Three and four-level Laser, Ruby Laser.

UNIT VIII

Optical fiber

Principle, Construction, Types of optical fiber, Acceptance angle, Numerical aperture, Applications.

Course Outcomes:

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

CO1 : Learn the basic concepts of oscillation, waves, wave function and fields.

CO2 : Understand the principles of wave phenomena in light and matter, and the quantum mechanics.

CO3 : Apply the principles of oscillation, superposition of waves, electromagnetic theory, and quantum mechanics in different fields.

CO4 : Analyze different types of particle motion in different media.

CO5 : Evaluate the problem-solving skills for the topics learnt.

CO6 : Develop critical thinking ability supported by the learned concepts of Physics.

Textbook

1. B. K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Publication, New Delhi, 2nd Edition 2022, ISBN-13: 978-81-953536-7-5.

Reference Books

1. D J Griffiths, Introduction to Electrodynamics, Pearson Education, 4th Edition, 2015.
2. L. I. Schiff and J. Bandhyopadhyay, Quantum Mechanics, Tata McGraw-Hill Publications, 4th Edition, 2014, ISBN- 9781259062865.
3. A K Ghatak, Optics, Tata McGraw-Hill Publications, 4th Edition, 2008, ISBN: 9780070262157.
4. A. Beiser, Concepts of Modern Physics ,Tata McGraw-Hill Publications, 6th Edition, 2002, ISBN 10: 0071234608.

5. R K Gaur and S. L. Gupta, Engineering Physics, Dhanpat Rai Publications, New Delhi, 2nd Edition, 2012, ISBN-10: 8189928228.

Course Title	**Chemistry**
Course Code (Credit)	**CH10001 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

This course is designed to enrich the students with the basic concepts in Chemistry and to strengthen their fundamentals which will support them to pursue education and research in engineering. The course will help the students to conceptualize alternative sources of energy by electrochemical means and use the instrumental techniques to explore chemical products.

Course Contents:

UNIT I
Chemical Equilibrium and Thermodynamics:
Introduction, Internal energy, Enthalpy, Entropy and free energy, Dependence of free energy on temperature and pressure, Gibbs-Helmholtz equation, Free energy change and equilibrium constants, Van't Hoff isotherm and isochore, Clapeyron- Clausius equation, Partial molar properties, Chemical potential, and Gibbs-Duhem equation.

UNIT II
Chemical Kinetics:

Rate of reaction and rate laws of multiple reactions (steady-state approximation), and of parallel, opposing and consecutive reactions; Theories of reaction rate: Collision theory, Lindemann modification, Absolute reaction rate; Catalysis: Types, theories, and kinetics of enzyme catalysis (Michaelis-Menten mechanism).

UNIT III
Spectroscopy:

UV-Vis spectroscopy: Beer-Lamberts law, Types of transition, Concept of auxochrome and chromophores, Factors affecting λ_{max} and, Woodward-Fieser rules for calculation of λ_{max} in diene systems; IR spectroscopy: Types of vibration, Hooks law, detection of functional groups like C=C, -OH, $-NH_2$ and -C=O**;**

UNIT IV
NMR Spectroscopy:
Basics of NMR Spectroscopy: Theory, Chemical shift, Shilding-deshilding effect, Structural elucidation of simple compounds**.**

UNIT V
Electrochemical Energy Systems:
Types of electrodes, electrode/cell potential; Nernst equation and application to: find electrode and cell potential, equilibrium constant, solubility product and pH; Modern batteries: Fuel cells (AFCs, PEMFs, SOFCs, MCFCs), Zn-air battery, Li-ion battery, Na-ion battery, Ni-MH battery.

UNIT VI
Smart and Intelligent Materials:
Introduction to smart materials, Properties and types of smart materials, Structures, System intelligence- components and classification of smart structures, Common smart materials and associated stimulus-response, Application areas of smart systems.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1 : Rationalize bulk properties and processes using thermodynamic consideration and apply the knowledge to decide the feasibility of a given process,
CO2 : Analyze the kinetics of multistep reactions as well as the theories of reaction rates,
CO3 : Understand the importance of catalysis and their mechanism of action and applications,
CO4 : Apply the principles of electrochemistry to evaluate properties, such as pH, solubility Product, etc. and understand the working principle of modern batteries,
CO5 : Apply different spectroscopic techniques, such as UV-Vis, IR and NMR, for structural Elucidation, and
CO6 : Differentiate between smart and intelligent materials.

Textbooks:
1. S Chawala, Engineering Chemistry, Dhanpat Rai and Co, 4th Edition, ISBN: 9788177001938.

Reference Books:
1. S Agarwal, Engineering Chemistry: Fundamentals and Applications, Cambridge University Press, ISBN: 9781107476417.
2. S. Chakroborty, S. Sen, and S. Mittal, Engineering Chemistry, Cengage Learning India Pvt. Ltd., ISBN: 9386668645.
3. B.R. Puri, L.R Sharma, and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 47th Edition, ISBN: 978-9382956013.

4. R M. Silverstein, Fransis X, Webster, D J Kiemle, Spectrometric Identification of Organic compounds, -Jhon Wiley& Sons, INC, 7th Edition.
5. S Glasstone, Elements of Physical chemistry-, Macmillan publishers, 2nd Edition ISBN: 978-0333038437.
6. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007, 1st Edition ISBN: 978-0471684770.

Course Title	**Environmental Science**
Course Code (Credit)	**CH10003 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

This course is designed to create awareness in the students on monitoring, assessment, and management of environmental pollutants. The subject will also make the students aware of more benign chemistry, i.e., green chemistry, and help them to understand the implementation of Environmental Impact Assessment (EIA).

Course Contents:

UNIT I
Overview of the Environment:

Overview of the environment, terminologies, Components of Earth: Lithosphere, atmosphere, hydrosphere and biosphere, Concept of black body radiation and albedo, eZro-dimensional energy balance model.

UNIT II
Air Pollution and Control:

Primary and secondary air pollutants, CFC, Smog (oxidizing and reducing), Important environmental issues: Depletion of the ozone layer, Acid Rain, Greenhouse effect and global warming, Control measures: Baghouse filter, Cyclone separator, Electrostatic precipitator, Catalytic converter, and Scrubber.

UNIT III
Water Pollution and Control:

Types and sources of water pollutants, wastewater treatment techniques: Ultrafiltration, aerobic and anaerobic treatment, Reverse osmosis, Electrodialysis, Ddisinfection by chlorination, Ozonization, Modern water purification system, Water quality parameters like hardness, Water softening process (permutit), WHO guidelines for drinking water.

UNIT IV
Soil Pollution and Solid Waste Management:

Soil pollution: Sources of pollutants and mitigation measures. Types of solid wastes: Heavy metal, bio-medical and radioactive wastes, Toxic and biochemical effects of solid wastes, Solid waste management (landfilling, incineration, and composting).

UNIT V
Green Chemistry and EIA:
Basic principles of green chemistry with examples, Matrices to explain greenness, R^4M^4 model, life cycle analysis. Importance, scope and principles of EIA with a case study.

Course Outcomes:

Upon completion of this course, the students will be able to

CO1 : Understand the components and composition of the environment along with the radiation balance model,
CO2 : Rationalize the different types of pollutants, their sources, effects, and control measures,
CO3 : Develop the idea of water purification strategies,
CO4 : Identify toxic wastes and conceptualize the principles of solid waste management,
CO5 : Conceptualize the principles of green chemistry and implement them in the synthesis of advanced material, to reduce pollution, and
CO6 :Provide for Environmental Impact Assessment (EIA) requirements before planning a project.

Textbooks:

1. A. K. De, Environmental Chemistry, New Age International Publishers, 9th Edition.

Reference Books:

1. S. Chakroborty, D. Dave, and S. S. Katewa, Environmental Chemistry-, Cengage Learning India Pvt. Ltd., 1st Edition.
2. Aloka Debi, Environment Science and Engineering, Universities Press,2nd Edition.
3. Erach Bharucha, Textbooks: of Environment studies for undergraduate courses, Universities Press, 2nd Edition.
4. D. De and D. De, Fundamentals of Environment and Ecology, S. Chand &Co, 2013.
5. Jain and Jain, Engineering Chemistry, Dhanpat Rai,Publishing Company.
6. S.C. Santra, Environmental Science,New Central Book Agency, ISBN: 9788173814044.

Course Title	Physics Laboratory
Course Code (Credit)	**CH19001 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

This lab course covers different measurement techniques of various parameters using the instruments i.e. interferometer, spectrometer, spherometer, screw gauge, vernier calliper, microscope, and telescope. It includes the application of photoelectric effect and photovoltaic effect in photo cell and solar cell respectively. Evaluation of the mechanical strength of materials by calculating elastic constants such as Young's modulus, rigidity modulus and Poisson's ratio are also included. This course provides hands on training for the usage of electrical, optical and mechanical systems for various measurements with precision and analysis of the experimental data by graphical interpretation and error calculation.

Course Contents:

Measurement by vernier callipers, screw gauge, spherometer: A review

- Determination of wavelength (λ) of a monochromatic light by Newton's ring experiment.
- Determination of wavelength (λ) and difference (dλ) between wavelengths of sodium D-lines by Michelson's interferometer.
- Determination of grating element (e+d) of a plane diffraction grating.
- Determination of Planck's constant using photocell.
- Study of the characteristics of a photo cell.
- Study of the characteristics of a solar cell.
- Determination of Young's modulus (Y) of a material by bending of beam method.
- Determination of Poisson's ratio (σ) of rubber.
- Determination of rigidity modulus (η) of a material by dynamic method.
- Determination of refractive index (μ) of a transparent liquid by Boy's method.
- Determination of numerical aperture of optical fibre.
- Determination of acceleration due to gravity (g) by bar pendulum.
- Determination of damping coefficient, relaxation time and quality factor of damped harmonic oscillation by simple pendulum.
- Measurement of velocity of sound in air using resonance column method.
- Studies on dielectric/multi-ferroic materials (Open ended)
- Diffraction studies using Laser sources (Open ended)

Course Outcomes:

Upon completion of this course, the students will be able to

CO1 : Understand the wave nature of light through experiments based on interference and diffraction Phenomena.

CO2 : Apply the laws of quantum physics to understand the photoelectric emission using the particle nature of light.

CO3 : Characterize photovoltaic cells to find out efficiency in terms of power output.

CO4 : Evaluate mechanical properties of materials using their elastic properties.

CO5 : Apply the principles of optics such as refraction, total internal reflection to calculate refractive index and related parameters.

CO6 : Use the principles of oscillation to understand phenomena such as damping, resonance and todetermine the factors (such as gravity, elasticity etc) affecting the time period of various oscillators.

Reference Materials:

1. Physics laboratory instruction manual, School of Applied Sciences, Department of Physics, KIIT Deemed to be University, Bhubaneswar.
2. S. L. Gupta and V. Kumar, 2018, Practical Physics, Pragati Prakashan, 33rd Edition, ISBN: 978-93-87151-58-1.

Course Title	**Chemistry Laboratory**
Course Code (Credit)	**CH19001 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

This lab course covers different types of chemical experiments ranging from volumetric analysis to spectroscopic techniques. This course provides the students with hands-on training in many of the advanced spectroscopic and analytical techniques in chemistry. The experiments in the course span over diverse applications in chemistry. It contains experiments dealing with environmental chemistry, volumetric analysis, organic and inorganic synthesis, electrochemistry, and spectroscopy**.**

Course Contents:

- Estimation of total hardness in a given water sample in terms of calcium and magnesium hardness by EDTA method.
- Estimation of the amount of NaOH and Na_2CO_3 present in a given mixture solution
- (a) Determination of the strength of $KMnO_4$ solution by using standard sodium oxalate solution. (b) Determination of the amount of Ferrous (Fe^{2+}) ions present in the Mohr's salt solution by using standard $KMnO_4$ solution.

- Determination of the amount of dissolved oxygen present in a given water sample by Winkler's method.
- Finding the strength of Fe^{2+} present in the supplied Mohr's salt solution by potentiometric titration.
- Determination of the rate constant of acid-catalyzed hydrolysis of ethyl acetate.
- Determination of the chloride ion (Cl^-) present in a given water sample by the argentometric method.
- Finding the strength of supplied acid by pH-metric titration against a standard alkali.
- Finding the strength of a given hydrochloric acid solution by titrating it against standard sodium hydroxide solution conducto-metrically.
- Verification of Beer Lambert's Law and application of this law to determine the unknown concentration of a given solution.
- Determination of the concentration of ferric ions (Fe^{3+}) in a given water sample by a spectrometric method using KCNS as color developing agent.
- Determination of the Isoelectric point (pI) of glycine amino acid.
- Synthesis of transition metal complexes and characterization by using IR and ^1H-NMR. (Open ended)
- Determination of the concentration of different ions (cations and anions) in a given water sample by colorimetry. (Open ended).
- Application of potentiometric titrations (Open ended).

Course outcomes:

Upon completion of this course, the students will be able to

CO 1 : Handle different chemicals with proper safety protocols in an advanced Chemistry laboratory.

CO 2 : Learn and apply basic techniques used in Chemistry laboratory for preparation, purification and identification.

CO 3 : Analyze the kinetics of 1^{st} order reactions and estimate the rate constant.

CO 4 : Use different instrumental techniques such as Conductometry, pH-metry, Potentiometry and Colorimetry.

CO 5 : Analyse basic water quality parameters like hardness, dissolved oxygen, alkalinity, chloride ferrous iron contents etc.

CO 6 : Rationalize and learn the spectroscopic and synthesis techniques in chemistry.

Reference Materials:

1. Chemistry laboratory Instruction manual, School of Applied Sciences, KIIT Deemed to be University
2. Vogel's Quantitative Chemical Analysis, J. Mendham, R.C. Denney J. D. Barnes, M.J.K. Thomas, 6^{th} Edition, Longman

3. Standard methods for examination of water and wastewater, 23rd Edition, APHA.

Course Title	Differential Equations And Linear Algebra
Course Code (Credit)	MA11001 (L-T-P-Cr: 3-1-0-4)

Course Objective:

The objective of this course is to familiarize the prospective engineers with techniques in ordinary differential equations and linear algebra. It aims to equip the students to tackle advanced level of mathematics and applications that they would find useful in their disciplines.

Course Contents:

UNIT I

Ordinary Differential Equations of First Order:

Introduction and formation of differential equations, Overview: Variable separable, homogeneous, equations reducible to homogeneous form.Exact differential equations, equations reducible to exact form, linear differential equations, equations reducible to linear form (Bernoulli's equation). Applications of differential equations: Growth-Decay Problem, Newton's Law of Cooling, Mixing problem, Orthogonal trajectories.

UNIT II

Linear Differential Equations of second order:

Second order linear homogeneous equations with constant coefficients; differential operators; solutions of homogeneous equations; Euler-Cauchy equation; linear dependence and independence; Wronskian; Solutions of non-homogeneous equations: general solution, complementary function, particular integral; solution by variation of parameters; undetermined coefficients. Applications of 2nd order differential equations in Electric circuit.

UNIT III

Special Functions:

Improper Integrals for one variable, some test for convergence of improper integrals, Gamma function, Properties, Beta function, Relation between Gamma and Beta functions. Radius of convergence of power series, Legendre equation. Legendre polynomial. Recurrence relations and Orthogonality property of Legendre polynomial. Bessel's equation, Bessel's function, Recurrence relation.

UNIT IV

System of Linear Equations and Vector Space:
Linear system of equations; rank of matrix; consistency of linear systems; Solution of system of linear equations: Gauss elimination, inverse of a matrix by Gauss Jordan method, Vector Space, Sub-space, Basis and dimension, linear dependence and independence, Linear transformation.

UNIT V
Matrix-Eigen value problems:
1. Eigen values, Eigen vectors, Eigen basis, quadratic form; Hermitian, Skew-Hermitian forms; similar matrices; Diagonalization of matrices.

Course Outcomes:
Upon completion of this course, the students will be able to
CO1 :Understand the concept of modelling and formulation of Differential equation of physical problems,
CO2 :Apply different methods to solve ODE problems involving growth-decay, cooling effects and electrical circuits etc,
CO3 : Develop an ability to solve $2^{nd}$and higher order ODEs,
CO4 : Apply the knowledge of special function in engineering problems,
CO5 :Use the essential tool of matrices and linear algebra in a comprehensive manner, and
CO6 : Apply the knowledge of Eigen value and Eigen vector in the field of engineering and also get the concept of complex matrices.

Textbooks:
1. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley INC, 10^{th} Edition,2011.

Reference Books:
1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44^{th} Edition.
2. H.K. Das, Introduction to Engineering Mathematics, S.Chand & Co Ltd, 11^{th} Edition.
3. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publications 2007.
4. J. Sinha Roy and S. Padhy, A course on ordinary & partial differential Equation, Kalyani Publication, 3rd Edition.

Course Title	**Transform Calculus And Numerical Analysis**
Course Code (Credit)	**MA11002 (L-T-P-Cr: 3-1-0-4)**

Course Objective:

The objective of this course is to familiarize the students with the methods of Laplace and Fourier transformation and various numerical techniques to solve engineering problems.

Course Contents:

UNIT I
Laplace Transforms:
Laplace Transform, Inverse Laplace Transform, Linearity, Transform of derivatives and integrals, Unit Step function, Dirac delta function, Second shifting theorem, Differentiation and integration of transforms, Convolution, Solution of ODEs and integral equation by Laplace transform.

Fourier Series and Transform: Fourier series, Arbitrary periods, Even and odd functions, Half range expansions, Fourier integral, Cosine and sine transforms, Fourier Transform, Inverse Fourier Transform, Linearity, Fourier Transform of derivative, Convolution.

UNIT II
Approximations & Errors:
Approximation of numbers by truncation and rounding-off, Types of errors.

Numerical solution of Nonlinear equations: Solutions by Bisection Method, Fixed Point Iteration Method, Newton-Raphson Method, Regula-Falsi and Secant Method, Rate of Convergence of Secant & Newton-Raphson Method.

UNIT III
Interpolation & Approximation:

Finite Differences, Operators and Relation between them. Interpolation: Newton's forward and backward difference interpolation, Newton's divided difference interpolation and Lagrange interpolation.

Numerical Differentiation & Integration: Numerical differentiation of first- and second-order equations using difference table. Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules, Gauss-Legendre’s two-point and three -point formulae. Error in Numerical Integration.

UNIT IV
Numerical Solution to ODE:

Taylor’s (OK?) series Method, Euler's Method, Modified Euler's Method, Runge-Kutta Methods of order 2 and 4, Reduction of second-order ODE to system of first-order ODEs and its solution by R-K method of order four.

Solution of System of Linear Equations, Solutions by Gauss-Seidel and Gauss-Jacobi methods.

Course outcomes:

Upon completion of this course, the students will be able to

CO1 : Apply Laplace Transform to problems in the field of science and engineering,

CO2 : Use Fourier series and Transform as a tool to solve differential equations,

CO3 : Estimate the error in the results obtained in the numerical methods,

CO4 : Solve nonlinear equations that arise in engineering problems and interpolation,

CO5 : Know various numerical methods of differentiation and integration, and

CO6 : Apply numerical solution of differential equations and systems of linear equations.

Textbooks:

1. E Kreyszig, Advanced Engineering Mathematics by Wiley, INC, 10th Edition.
2. Jain, Iyenger and Jain, Numerical Methods for Scientific and Engineering Computation, New age International (P) Ltd., 6th Edition.

Reference Books:

1. B.S. Grewal, Khanna ,Higher Engineering Mathematics, Publishers, 44th Edition.
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publications, 2007.
3. A, Thangapandi and Somasundaram, Numerical Methods, Scitech Publishers, 2nd Edition.

Course Title	**Science Of Living Systems**
Course Code (Credit)	**LS10001 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

The objective of the course is to enrich the basic knowledge of students in the field of biology and use that knowledge to support the engineering and research programs. Besides, the course also helps to learn methodology to establish models for various biological phenomena and apply the aforementioned models to predict/analyse the functionality of various systems.

Course Contents:

UNIT I

Cellular Organization of a Living Organism:

Biology in engineering, The Living World: Biodiversity of living world, Microorganisms, Cell as the basic unit of life, Cell theory, Structure and function of Prokaryotic and Eukaryotic cells, Cell growth and reproduction, Homeostasis, Concept of gene, Basic structure and function of chromosomes.

UNIT II

Molecular and Biochemical Basis of an Organism:

Chemical Context of Life: Water, Carbon, Structure and Function, Types of bonding, Bio- macromolecules (Carbohydrates, Proteins, Amino acids, Lipids and Nucleic acids), Protein synthesis, Cell differentiation, Stem cells and their applications.

UNIT III

Enzymes, Photosynthesis, Metabolism and Bioenergetics:

Enzymes: Introduction, structure, properties, Classification, Mechanism of enzyme actions, Factors affecting enzyme action, Strategies utilized by enzymes to affect catalysis. Photosynthesis: Introduction, pigments, process of photosynthesis, Mechanism of photosynthesis (light reaction and dark reaction). Metabolism and Bioenergetics: Anabolism and catabolism.

UNIT IV

Nervous system, Immune system and Cell Signaling:

Nervous system: Introduction, History of neuroscience, Types of glial cells, Nerve cells - Neurons, Organization of the nervous system, Action potential, Diseases of the nervous system, Computer-based Neural Networks. Immune system: Introduction, Innate Immunity, Adaptive or acquired immunity, Diseases of the immune system, Immune engineering. Cell signaling: General principles of cell signaling.

UNIT V

Molecular Machines, Biosensor and Bioremediation:

Molecular Machines: Introduction, Molecular motors and Machines, F0F1-ATP synthase motors, Cytoskeleton associated motors. Biosensors: Concept of biosensor, Working principle, Types of biosensors, Glucose biosensors, Bio-detectors: DNA detection biosensor, Detection of pollutants, Biosensor in food industry. Bioremediation: Introduction, Role of microorganisms, Factors determining bioremediation, Types – *in situ/ex situ,* Advantages and disadvantages, Biofuel.

Course Outcomes:

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

CO1 :Learn the typical characteristics that distinguish life forms and analyze life process at cellular level,

CO2 :Apply concepts on structure and function of simple biomolecules in life processes

CO3 : Understand different process involved in life and analyse their effects,

CO4 : Analyse different biological phenomena and relate them to engineering applications, CO5 :Comprehend different physiological functions and relate them to computer-based techniques, and

CO6 : Implement concepts of biology and their relevance to engineering and technology.

Textbooks:

1. S. Thyagarajan, N. Selvamurugan, M.P Rajesh, R.A Nazeer, Richard W. Thilagarajan, S. Bharathi and M.K. Jaganathan, Biology for Engineers, McGraw Hill Education (India),7^{th} Edition, 2022.

Reference Books:

1. P. H. Raven and G.B. Johnson. Biology (Indian Edition), Tata McGraw Hill Education Publication,13^{th} Edition, 2023.
2. E D. Enger, Feederick C, Ross and David B. Bailey. Concepts of Biology,Tata McGraw-Hill Publication, 14^{th} Edition, 2011.
3. Neil A. Campbell and Jane B. Recee, Biology, Pearson Education, 8^{th} Edition , December 2007.
4. Cecie Starr, Biology Concepts and Application, Thomson Books, 6^{th} Edition, January 2006.

Course Title	**English**
Course Code (Credit)	**HS10001 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

The objective of the course is to develop and improve, in the students, the skills of active listening, speaking, reading, and writing in English, through lecture classes and practice sessions, and improve their professional communication abilities. The course will help the students to enhance their critical thinking and situational communicative skills through the study of contemporary social issues depicted in literature.

Course Contents:

UNIT I

Professional Communication:

Process of Communication: Definition, Explanation & Diagram, Difference Between General and Technical Communication; Methods of Communication (Verbal & Non-Verbal); Non-Verbal Communication (Kinesics, Proxemics, Chronemics, Oculesics, Olfactics, Gustorics, Haptics, and Iconics); Paralanguage; Flow of Communication (Formal & Informal); Levels of Communication; and Barriers of Communication (Intrapersonal, Interpersonal, and Organizational**).**

UNIT II
Basics of Grammar and Writing Skills:

Error Detection in Sentences: Articles, Prepositions, Tense, Subject-Verb Agreement, Active and Passive Voice; Use of Punctuation: Full Stop, Comma, Colon, Semi-colon, Single & Double Inverted Commas, Exclamation & Interrogation Marks, Hyphens and Dashes, and Ampersand;

Paragraph Writing – Components; Writing Bias-free English; Business Letters: Enquiry, Claim/Complaint, and Order; Technical Reports: Formats, Style & Referencing; and Reading Techniques: Skimming, Scanning, Intensive & Extensive Reading.

UNIT III
Basic Sounds of English:

Hearing & Listening: Types of Listening – Appreciative, Empathetic, Critical, Comprehensive, Superficial, Differences between Listening & Hearing; Introduction to Basic Sounds of IPA: Symbols of IPA, Types of Vowels & Consonants; and Problem Sounds & Mother Tongue Influence: Concept of MTI with Examples.

UNIT IV
English Literature:

Short Story – O. Henry: 'Gift of the Magi;'Short Story – Ismat Chughtai: 'Sacred Duty;'; Poem – Robert Frost: 'Stopping by Woods on a Snowy Evening;'Poem – Tennessee Williams: 'We Have Not Long to Love;' and Drama: William Shakespeare: Merchant of Venice.

Course Outcomes:

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

CO1 : Apply verbal and non-verbal modes of communication effectively in practical Situations,
CO2 : Retain a grammatically correct and logical flow while drafting reports and other technical pieces of writing,
CO3 : Develop competence in reading and comprehension,
CO4 : Implement active listening responses in professional practice,
CO5 : Utilize neutral accent in English pronunciation successfully, and
CO6 : Understand situational and conversational English used for different purposes and contents.

Textbooks:

1. M. Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill Education Publication, 2005.

Reference Books:

1. Sidney Greenbaum. The Oxford Grammar (English). Oxford University Press, 1st Edition. 2005.
2. S Verma,Technical Communication for Engineers, Vikas Publishing House,2015.
3. R Dove,The Penguin Anthology of 20th Century American Poetry,Penguin Books. 2013.
4. The Merchant of Venice (The New Cambridge Shakespeare). Mahood & Lockwood eds. CUP. 2018.

Course Title	**Communication Laboratory**
Course Code (Credit)	**HS18001 (L-T-P-Cr: 0-0-2-1)**

Course Objective:
This subject is designed to enrich the basic knowledge of engineering students in the field of communication and to support the engineering and research programs.

Course Contents:

UNIT I
Reading Comprehension:
Understanding meaning and sequence of ideas in written language

Activity based on matching, multiple choice questions, open close, appropriate headings.

UNIT II
Time & Tense + Subject-Verb Agreement:
Applying correct grammar in everyday writings.

UNIT III
Vocabulary Building (Mind Mapping/Phrasal Verbs):
Developing vocabulary through associating key ideas, and learning idioms and phrases.

UNIT IV
Listening Comprehension:
Interpreting meaning and syntax in spoken language.

UNIT V
E-mail Writing:
Formulating appropriate e-mails with relevant salutation, language & conclusion

UNIT VI
Resume Writing/ Video Resume
Creating suitable, job-oriented resume

UNIT V
Thematic Speaking:
Practising and implementing theme-based individual speaking skills.

UNIT VI
PowerPoint Presentation
Developing skills to design and deliver engaging, informative and impactful presentations

UNIT VII
Class Participation.

Course Outcomes:
Upon completion of this course, the students will be able to:
CO1 : Use English grammar correctly and unambiguously in technical writing,
CO2 : Apply verbal and non-verbal modes of communication effectively in practical situations,
CO3 : Have a basic understanding of the communication process and to know the practical implementations in the workplace,
CO4 : Retain a logical flow while drafting reports and other technical pieces of writing,
CO5 : Develop competence in reading and comprehension, and
CO6: Be familiar with English pronunciation and use neutral accent successfully.

Course Title	**Basic Electronics**
Course Code (Credit)	**EC10001(L- T- P-Cr: 2-0-0-2)**

Course Objective:
The subject is designed to familiarize students of all branches to the all-pervasive field of Electronics, enable them to carry out research in interdisciplinary fields involving semiconductor devices, and utilize the knowledge in solving practical problems in real life in today's age of electronics.

Course Contents:

UNIT I
Semiconductors, Diodes and Transistors:
Properties of semiconductor materials, Applications of semiconductors as p-n junction diode, Diode characteristics and breakdown mechanisms, Half-wave and full-wave rectifiers with filters, Zener diode, Transistor constructions, operations and their characteristics. Transistor biasing, amplifiers, and load line analysis, Concepts of JFET and MOSFET.

UNIT II

Operational Amplifier (Op-amp) and applications:

Introduction to Op-amp and its Characteristics. Application of Op-Amp as Inverting amplifier, Non-inverting Amplifier, Summing, Difference amplifier and comparator

UNIT III

Introduction to Digital Electronics:

Different number systems and its conversions, Logic gates and truth tables of OR, AND, NAND, EX-OR. Combinational circuit and Sequential circuit.

UNIT IV

Miscellaneous Electronic Devices

SCR, Opto-electronic devices and fiber techniques, Introduction and description of sensor performance, Fundamentals of analog communication techniques (AM and FM).

Course Outcomes:

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

CO1 : Understand the properties of semiconductor and current conduction mechanism,

CO2 : Comprehend the working of P-N junction diodes; identify different diode circuits and analyze them,

CO3 : Understand the working of different types of transistors,

CO4 : Know about OP-AMP and its applications,

CO5 : Analyze the working of op-amp using either inverting or non-inverting configurations, timing circuit, regulated power supply ICs, and their applications, and

CO6 : Realize the importance of various analog and digital electronic systems and electronic devices.

Textbooks:

1. J Millman, Christos C. Halkias & C D. Parikh, Integrated Electronics: Analog and digital circuits and Systems , 9th Edition, 2021.

Reference Book

1. R. L. Boylestad & L. Nashelsky, Electronic Devices & Circuits,PHI,7th Edition,2021

2. D. A. Bell. Electronic Devices and Circuits.(Oxford)5th Edition,2021.
3. D. Chattopadhyay and P. C. Rakshit. Fundamentals & Applications ,New Age International, 15th Edition 2021.

Course Title	Workshop
Course Code (Credit)	**ME18001(L-T-P-Cr: 0-0-2-1)**

Course Objective:

This workshop practice is designed to impart students the basic knowledge on manufacturing or developing a given object irrespective of their branch of engineering. While furnishing the given object, students will familiar with various mechanical operations and the respective tools or machines. This course involves four different sections namely Fitting, Welding, Turning and Sheet metal which cover both conventional and advanced tools to provide students the updated manufacturing experience. Students are also advised with various safety precautions to be followed during a specific manufacturing practice. At the end, students will also gain knowledge on different advanced machines such as CNC machine tools and 3D printing.

Course Contents:

- Turning operations
- Sheet metal operations
- Fitting
- Welding

Course Outcomes:

Upon completion of this course, the students will be able to

CO1 : Practice different operations related to fitting shop.

CO2 : Use different welding tools to prepare a given type of joint.

CO3 : Demonstrate various turning operations including taper turning and knurling using a conventional lathemachine.

CO4 : Design a tray and prepare it using sheet metal equipment involving soldering.

CO5 : Appraise different operations using a CNC machines.

CO6 : Interpret different advanced machines such as 3D printing/additive manufacturing.

Course Title	Engineering Drawing & Graphics
Course Code (Credit)	**CE18001 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

The objective of this course is to provide students with knowledge and abilities to design a 3D object on 2D paper by hand sketching method and by means of computer aided drafting software.

Course Contents:

- Introduction to Engineering graphics

- Lettering
- Projection of points & lines
- Line inclined to both the planes
- Projection of planes
- Introduction to Computer Aided Drafting
- Projection of solids
- Section of solids
- Development of surface

Course Outcomes:

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

CO1 : Use common drafting tools properly.

CO2 : Select, construct and interpret appropriate drawing scale as per the situation.

CO3 : Draw orthographic projections of points, lines and planes.

CO4 : Draw orthographic projection of solids like cylinders, cones, prisms and pyramids,

CO5 : Develop the section of solids for practical situations, and

CO6 : Communicate ideas effectively using Computer Aided Drafting.

Textbook:

1. K. Venugopal,Engineering Drawing + AutoCAD New Age Publishers, 1st Edition, 2011.

Reference Book

1. S. N. Lal Engineering Drawing with an Introduction to AutoCAD, Cengage India Private Limited, 1st Edition, 2017.

Course Title	**PROGRAMMING LABORATORY**
Course Code (Credit)	**CS13001 (L-T-P-Cr: 0-2-4-4)**

Course Objective:

The course aims to provide exposure to problem-solving through programming. It aims to train the student to the basic concepts of the C-programming language. This course involves lab component which is designed to give the student hands-on experience with the concepts.

Course Contents:

UNIT I

Introduction to Computer and Programming:

Basic concepts of computer organization, CPU, Memory. I/O devices, Number Systems , Evolution of programming languages, structured programming,

Compilation process, source code, object code, executable code, Operating systems, interpreters, linkers, loaders, Algorithms, flow charts, pseudo-code.
Program Constructs:

Character set, Identifiers, Keywords, Data Types, Constant and Variables, Operators: Precedence and associativity, Expressions, Statements, Input and Output functions, Control structures: Branching & Looping.

UNIT II
Arrays and Strings:
One dimensional Array, Multidimensional Array and their applications, String Manipulation.

UNIT III
Functions:
Library and User defined functions, Formal and Actual parameters, function prototypes, Parameter passing: Call

By-value, Call-by-reference, Recursion, Storage Classes.

UNIT IV
Pointers:
Pointer variable, Pointer Arithmetic, passing parameters by reference, pointer to pointer, pointers to functions,
Dynamic memory allocation.

UNIT V
Structures, Unions:

Structures, Unions, pointer to structure & pointer to union, linked list.

UNIT VI
File Handling:
Declaration of file pointer, opening and closing files, Working with text and binary files. Command line arguments, bit wise operators, enumerated data types, type casting, macros, Preprocessor directives.

Course Outcomes:
Upon completion of this course, the students will be able to:
CO1 : Have fundamental knowledge of computers hardware and number systems with commands in Linux,
CO2 : Write, compile and debug programs in C language.
CO3 : Design programs involving decision structures, loops, and functions.
CO4 : Construct arrays to store, manipulate, search and display data.
CO5 : Apply the dynamics of memory by the use of pointers.
CO6 : Use different data structures and create/update basic data files.

Text books:

T1: Programming in ANSI C (8th Edition) by E. Balagurusamy

Reference books:

R1: The C Programming Language by Brian Kernighan and Dennis Ritchie (Second Edition)

List of Experiments:

Sr	Details
1	Write All Linux commands in the LAB report
2	Practice and write programs on simple input and output operations
3	Practice and write programs on Operators and Expressions
4	Practice and write programs on branching statements
5	Practice and write programs on looping (control) statements
6	Practice and write programs on Arrays
7	Practice and write programs on Character Arrays
8	Practice and write programs on Functions
9	Practice and write programs on Pointers
10	Practice and write programs on Structures
11	Practice simple programs on file handling

SCIENCE ELECTIVE

Course Title	**Nanoscience**
Course Code (Credit)	**CH10005 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

This course is designed to educate, inspire, and motivate young students about nanoscience, nanotechnology, and their applications. The course provides information on the latest innovations in this field to get insights into the nanomaterials synthesis/fabrication and applications that can be achieved at a nanoscale.

Course Contents:

UNIT I

Introduction:

Concept and Classifications based on dimensions and compositions, Significance of nanosize: Surface area to volume changes; Properties changing with size (reactivity, melting point, catalytic, electrical, optical), Nanoscience in nature, and Quantum dots as data storage.

UNIT II

Synthesis of nanomaterials:

Top-down synthesis (Mechanical method-ball milling, Photolithography, Laser ablation, sputtering), Bottom up (pyrolysis, sol-gel, CVD, self-assembly), Green synthesis (metallic nanoparticles, metal oxides), Biosynthesis.

UNIT III

Characterization:

XRD-X-ray generation, Working principle (Bragg's law), Peak broadening in nanomaterials (Scherrer formula), Electron microscopy (SEM, TEM)—high energy electron generation, electron optics, Scanning Electron Microscopy (SEM)—secondary, back scattered, EDX, Transmission Electron Microscopy (TEM)—bright field imaging, dark field imaging, and Selected area diffraction pattern.

UNIT IV

Applications:

Cosmetics—ZnO, SiO_2, TiO_2 Nanoparticles in cosmetics, SiO_2 TiO_2 in toothpaste, silver, gold, copper nanoparticles in skin care product; ***Medical Fields*—**MRI, CT scan contrast enhancement agent, Drug and gene delivery system, Magnetic hyperthermia treatment; ***Agriculture*—**Nano-pesticides, herbicides, and fungicides, Food packaging**;** ***Aerospace and Aviation Industries*—**Carbon nanotubes (CNT)nanocomposites, Metal Nanoparticle-Polymer composites, SiC Nanoparticle reinforced alumina (high temperature strength, creep resistance); and ***Nanomaterials for Environmental Remediation*—**Degradation/removal of pollutants.

Course Outcomes:

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

CO1 : Learn fundamental aspects of nanoscience,

CO2 : Classify different types of nanomaterials based on their dimension and composition

CO3 : Understand different synthesis techniques to grow nanomaterials,

CO4 : Analyse nanomaterials using different characterisation techniques,

CO5 : Apply the acquired knowledge to design new materials, and

CO6 : Evaluate the importance of nanoscience in engineering applications.

Textbooks:

1. B S Murty, P Shankar, Baldev Raj, B B Rath and James Murday,Textbooks: of Nanoscience and Nanotechnology, 1st Edition, 2012, ISBN-13: 978-8173717383.

Reference Books:

1. Luisa Filipponi and Duncan Sutherland., Nanotechnologies: Principles, Applications, Implications and Hands-on Activities, Edited by the European Commission Directorate-General for Research and Innovation Industrial technologies (NMP) program, 2012, ISBN: 978-92-79-21437-0.
2. Charles P. Poole Jr., Frank J. Owens., Introduction to Nanoscience and Nanotechnology, An Indian Adaptation, 3rd Edition, 2020, ISBN-13: 978-9354240201.
3. P. I. Varghese, T. Pradeep. A Textbooks: of Nanoscience and Nanotechnology, Tata McGraw Hill Education, 2017, ISBN: 9781259007323.

Course Title	**Smart Materials**
Course Code (Credit)	**PH10003 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

This course is designed with the objective of enabling engineering students to get a flavour of advances in materials science. The knowledge of smart materials learnt by the students in the course will let them to realize the usefulness of various new-age materials for technological advances and allow them to explore further in their higher semesters. This course will help them bridge the gap between traditional Textbooks: science put into physics, chemistry, etc. and the state-of-the-art science of materials.

Course Contents:

UNIT I

Introduction to Smart Materials:

common smart materials and associated stimulus-response, Classification: active and passive, Piezoelectric, Shape-memory alloys, Photo-responsive polymers, Electroactive polymers, Magnetostriction and Electro-strictriction, Thermo-responsive polymers, Dielectric elastomers, Halochromic, Thermoelectric materials; Application areas of smart materials: Space, health care and biomedical sectors**.**

UNIT II

Piezoelectric Materials: Piezoelectric Effect:

Direct and Converse, Piezoelectric coefficients, Piezoceramics, Piezopolymers, Piezoelectric Materials as Sensors, Actuators etc.

UNIT III

Shape-memory Alloys:

Shape memory alloys (SMAs) and properties, Phase change in SMAs, Shape memory effect: One-way and two-way, binary, and ternary alloy systems, Applications.

UNIT-IV

Chromic Materials:

Photochromic, Thermochromic, Electrochromic, Magneto-chromic and Piezo-chromic Materials.

UNIT V

Multiferroic Materials:

Multiferroics definitions, Ferroic phases, Magnetoelectric coupling; Type-I and Type-II multiferroics, Mechanism: Charge ordering, lone pair, geometric effect, and spin driven mechanism; Multiferroic materials, Applications.

Course outcomes:

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

CO1 : Learn about smart materials, their properties and applications,

CO2 : Understand types of smart material based on their electrical and magnetic properties,

CO3 : Characterize piezoelectric, ferroelectric and multiferroic materials,

CO4 : Identify novel functions of smart materials,

CO5 : Apply the acquired knowledge of smart materials in different applications, and

CO6 : Evaluate the importance of smart materials in day-to-day life.

Textbooks:

1. B. K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Publication, New Delhi, 2nd Edition 2022, ISBN-13: 978-81-953536-7-5.

Reference Books:

1. Mohsen Shahinpoor, Fundamentals of Smart Materials, 2020, Royal Society of Chemistry, ISBN: 9781782626459.
2. M. Schwartz, Smart Materials, 1st Edition, 2008, CRC Press, ISBN 9781420043723.

Course Title	Molecular Diagnostics
Course Code (Credit)	LS10003 (L-T-P-Cr: 2-0-0-2)

Course Objective:

The objective of the course is to understand methods and techniques that are used to study biological processes in living beings. They include experimental and methodological approaches, protocols and tools for biological research.

Course Contents:
UNIT I
Bimolecular:
Overview of DNA, RNA, and Proteins, Chromosomal structure & mutations, DNA polymorphisms; and Gene and Genetic errors.

UNIT II
Molecular Basis of Diseases:
Infectious, non-infectious; Diagnosis- traditional, modern tools, Concepts of molecular diagnostics.

UNIT III
Molecular Diagnosis and Techniques:
DNA fingerprinting, Auto-antibody fingerprinting, Southern blotting, PCR, Real-time PCR and variations; Nucleic acid sequencing: New generations of automated sequencers, CRISPR technology and its use in diagnostics and gene editing.

UNIT IV
Protein Diagnostics Techniques
Antigen-antibody reactions, ELISA, variations of ELISA; Western blotting.

UNIT V:
Point-of-Care Devices
Biosensors and nano-biosensors for disease and metabollites detection.

Course Outcomes:

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

CO1 : Learn the basics of Genes, Chromosomes, DNA, RNA and proteins along with their Aberrations,

CO2 : Understand the principles and working mechanisms of various instruments used in the study of biological processes in living things, CO3 : Apply the knowledge of different diagnostics methods for quantitative estimation of xenobiotics (drugs and their metabolites) and biotics (proteins, DNA, metabolites) in biological systems,

CO4 : Analyze the recent developed techniques which are required for gene editing and their Applications,

CO5 : Evaluate the role of various bio-analytical techniques in environmental studies, biomedical sciences, life sciences, molecular biology, and biotechnological research, and

CO6 : Implement the knowledge of diagnostics in designing point-of-care instruments for different diseases.

Textbooks:

1. M K. Campbell, S O. Farrell, O M. McDougal, AE Biochemistry, Cengage Publisher,9th Edition 2017, ISBN-13: 9789814846448.

Reference Books:

1. N Rifai, Andrea Rita Horvath and Carl T. Wittwer, Principles and Applications of Molecular Diagnostics,2018, Elsevier Publisher, 1st Edition, 2018.
2. K G Ramawat & Shaily Goyal, Molecular Biology and Biotechnology, ISBN9788121935128 Publisher S Chand & Co., 2nd Edition, 2010.
3. H Lodish, Arnold Ber, Molecular Cell Biology, WH Freeman Publisher, 8th Edition, 2016, ISBN-10 9781464187445.

Course Title	**Science Of Public Health**
Course Code (Credit)	**PE10002 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

The objective of this course is to orient the students to core scientific disciplines in public health practice.

Course Contents:

UNIT I

Scientific Approaches to Public Health:

Health and public health concepts, Science and practice of applied public health: Scientific disciplines as part of interdisciplinary public health, Examples of use of behavioral model in changing the community perception of public health interventions

UNIT II

Social and Behavioral Sciences in Public Health:

Social and behavioral determinants of health and disease, WHO and CDC models of social determinants of health, Disease and social status, Disease and poverty, Social interventions for good health.

Health behavior change models for public health interventions, Health Belief Model, Transtheoretical Model. The theory of planned behavior, Health communication to improve the outcome of public health interventions

UNIT III

Environment Health Sciences in Public Health:

Environment & climate change, Ecosystem, Lifestyle and dietary effects on health, food safety and sanitation, Environmental pollution, waste disposal and treatment.

UNIT IV

Epidemiology and Data Science in Public Health:

Epidemiology and achievements in public health, Measurements in Epidemiology—Incidence and prevalence, Causation and association, and Measures of association.

Outline of study designs (including cross-sectional study design, case-control study design, cohort study design and randomized control trials); Introduction to confounding and bias; Screening tests- validity and reliability methods.

UNIT V

Management and Economic Sciences in Public Health:

Systems approach (input, process and outcome) in public health. Health management information system, Horizontal and vertical integration of public health interventions, Public-Private mix.

Understanding community, Community health related needs assessment, Community orientation and Community mobilization, Introduction to digital health.

Course Outcomes:

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

CO1 : Understand and enlist the scientific approaches in public health,

CO2 : Understand and apply the epidemiologic and biostatistical science in evidence synthesis,

CO3 : Understand and apply the environmental health science in public health practice,

CO4 : Understand and apply the social and behavioral science in public health practice,

CO5 : Understand and apply the health economic and health management principles in setting priority for resource allocation, and

CO6 : Understand and apply the health economic and health management principles in health system optimization.

Textbooks:

1. R Detal, Oxford Textbooks: of Global Public Health, Oxford, 7th Edition, 2021.

2. K Parks, Textbooks: of Preventive and Social Medicine, M/S Banarsidas Bhanot Publishers, . 26th Edition, 2021.

Reference Books:

1. Robert H. Friis,. Essentials of Environmental Health, Jones & Bartlett Publishers, 2018
2. Warrier S,. Information and Communication Technologies in Public Health A Sociological Study,CBS Publishers, 2020.
3. Baker JJ. Baker RW, Dworkin NR, Health Care Finance: Basic Tools for Non-financial Managers., Jones and Bartlett Publishers, Inc, 5th edition. 2017.
4. Ross TK, Practical Budgeting For Health Care: A Concise Guide, Jones and Bartlett Publishers, Inc, 2020.

Course Objective

The objective of this course is to orient the students to core scientific disciplines in public health practice.

Course Title	Optimization Techniques
Course Code (Credit)	**MA10003 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

To familiarise the students with a few rudimentary and popular optimization techniques to enable them to solve resource-constrained real world problems.

Course Contents:

UNIT I

Linear Programming:

Mathematical foundations and basic definitions, Linear optimization: Formulation and graphical solution of linear programming problems, Simplex method, Duality.

UNIT II

Transportation:

General structure of a transportation problem, Finding initial basic feasible solution by North-West corner rule, Least-Cost method and Vogel's Approximation Method, and Testing for optimality.

UNIT III

Assignment Problem:

Hungarian assignment method, Unbalanced assignment problems, Restrictions in assignment, Travelling Salesman model.

Course outcomes:

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

CO1 : Know the concept of Linear programming problem (LPP) and will able to formulate linear programming problem,

CO2 : Understand the basic terminology and concepts of solving LPP,
CO3 : Solve LPP by simplex method,
CO4 : Know the concept of duality in Optimization technique,
CO5 : Apply optimization technique to solve transportation problem, and
CO6 : Solve assignment problem.

Textbooks:

1. H.A. Taha, Operation Research, An Introduction, Pearson Education, 10^{th} Edition.

Reference Books:

1. K. Gupta, Kanti Swarup, and Man Mohan .,Operations Research, P., S.Chand &Co, 2004.
2. N. S. Kambo, Mathematical Programming Techniques.,East West Press, 1997.
3. R. Fletcher., Practical Methods of Optimization, 2^{nd} Ed., John Wiley, 1987.
4. Hanif D, Sherali, M. S. Bazarra. & J.J. Jarvis, Linear Programming and Network Flows, Wiley Publication. 2^{nd} Edition.

ENGINERING ELECTIVE I

Course Title	**Basic Civil Engineering**
Course Code (Credit)	**CE10001 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

The course is designed to provide an overview of different aspects of civil engineering profession, namely, surveying, materials, structural, and geotechnical engineering, hydraulics and water resources, environmental engineering, and transportation engineering and their roles in the societal development.

Course Contents:

UNIT I

Introduction:

Role of civil engineers in designing, building, and maintaining infrastructure and improving quality of life, Specializations in the civil engineering and their specific roles.

UNIT II

Surveying:

Plans, maps, scales, divisions of surveying, classification of surveying, leveling, and advanced methods of surveying.

UNIT III

Construction Materials & Structural Engineering:
Different construction materials and their uses**,** structural analysis and design philosophy.

UNIT IV
Geotechnical Engineering:
Overview on origin of soil, engineering properties and their classification; Soil exploration; Foundations: Their importance and purpose; Factors to consider in foundation design and stability of slopes; and Improving site soils for foundation use.

UNIT V
Hydraulics & Water Resources Engineering:
Overview of fluid properties, open channel flow, surface and groundwater hydrology, and irrigation infrastructures.

UNIT VI
Environmental Engineering:
Types of waste water, Principles of wastewater management, Types of solid waste, and Principles of solid waste management.

UNIT VII
Transportation Engineering:
Classification of highways, Typical construction methods of roads, traffic surveys and their applications in traffic planning, Railways, Ports and Harbours

Course Outcomes:
Upon completion of this course, the students will be able to:
CO1 : Understand the importance and practical applications of different types of surveying,
CO2 : Learn about the different construction materials and understand the philosophy of structural analysis and design,
CO3 : Understand engineering behaviour of soil and types of foundations,
CO4 :Understand different hydraulics, hydrological and water resources engineering applications,
CO5 :Learn about the management strategies of wastewater and solid waste, and
CO6 : Understand the basics of different types of highways, railways, ports and harbours.

Textbooks:
1. Er. Shrikrishna A. Dhale and Er. Kiran M. Tajne, Basics of Civil Engineering, S. Chand & Co., 1st Edition, 2014.

Reference Books:

1. S. S. Bhavikati, “Basic Civil Engineering” by New Age International Publisher, 1st Edition, 2021.
2. M. S. Palanichamy “Basic Civil Engineering”, Tata McGraw-Hill Publication.

Course Title	**Basic Mechanical Engineering**
Course Code (Credit)	**ME10003 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

The course is designed to give an overview of the fundamental aspects of mechanical engineering so that a student pursuing any branch of engineering will realize the possibilities that the branch of mechanical engineering offers.

Course Contents:
UNIT I
Concepts of Thermodynamics:

Systems, properties, state, and cycle, Thermodynamic equilibrium and quasi-static process, First law of thermodynamics for closed system, First law of thermodynamics for open/flow systems, Second law of thermodynamics, Kelvin Plank statement, Clausius statement, and Basic concept of entropy

UNIT II
Fluid Mechanics and Hydraulic Machines:

Introduction to fluids, Properties of fluids, Pressure variation with depth, Bernoulli’s equation and its applications, and Introduction to hydraulic turbines and pumps.

UNIT III
Mechanics of Materials:

Stress, Strain, Stress-Strain diagrams for ductile and brittle materials, Elastic constants, Hooks Law, Factor of Safety, One-dDimensional loading of members of varying vross sections.

UNIT IV
Power Transmission:

Gear, Belt, and Chain Drives, Shaft under varying loading conditions, Introduction to robots, Applications of robotics, Basic robot motions, Sensors and Actuators

UNIT V

Manufacturing Processes:

Introduction to engineering materials, Types and classification of materials, Properties of materials, Introduction to casting, forming, forging, rolling, extrusion and welding, Introduction to machine tools, NC, CNC, and 3-D Printing.

Course Outcomes:

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

CO1 : Understand the basic principles of thermodynamics,

CO2 : Develop an understanding of fluid machines like turbine and pump,

CO3 : Determine stress and strains in a component subject to a load,

CO4 : Understand the working and design aspect of power drives,

CO5 : Recognize appropriate material for a particular engineering application, and

CO6 : Understand the fundamentals of manufacturing processes.

Textbooks:

1. P Kumar, Basic mechanical Engineering, Pearson Education, 2nd Edition, 2018

Reference Books:

1. J K Kittur and G D Gokak, Elements of Mechanical Engineering Willey, 1st Edition, 2015.
2. B Agrawal, C M Agrawal ,Basic Mechanical Engineering, Willey, 1st Edition, 2011.

Course Title	**Basic Electrical Engineering**
Course Code (Credit)	**EE10002 (L-T-P-Cr: 2-0-0-2)**

Course Objective

The course is designed to provide to the students a comprehensive overview of the basics of the electrical engineering discipline. In particular, the course includes fundamental aspects of DC, AC and magnetic circuit analysis, working principles and applications of machines, and safety measures used in various electrical apparatus and appliances.

Course Contents:

UNIT I

D. C. Circuits:

Kirchhoff's law, Source transformation, Star-delta transformation and equivalent resistance of the circuits, Mesh and Nodal analysis, Superposition theorem.

UNIT II

A.C. Circuits:

Peak, average, R.M.S. values of sinusoidal quantities, Peak factor, Form factor, Phase difference, Phasor representation, AC through R, L, C, AC Series Circuit (RL, RC, RLC), Three-phase AC circuits: Voltage, current and power in star and delta connections.

UNIT III

Electromagnetic Circuits:

Magnetizing Force, Reluctance, Permeance, Magnetic field, Magnetic permeability, Analogy between Electric Circuits and Magnetic Circuits. Series magnetic circuit, BH curve.

UNIT IV

Scope and Safety Measures:

Electrical Energy Scenario in India, Application of Transformer, Three-phase and single-phase induction Motors, Power ratings of air conditioners, PCs, laptops, printers, refrigerator, washing machine, different lamps, electricity tariff, calculation of electricity bill for domestic consumer**.**

UNIT V

Personal Safety Measures:

Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

UNIT VI

Equipment Safety Measures:

Working principles of fuse and miniature circuit breaker (MCB), Residual Current Circuit Breaker (RCCB).

Course Outcomes

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

CO1 : Analyze the concept of DC circuit,
CO2 : Understand the concepts of AC circuits,
CO3 : Analyze the three phase circuit,
CO4 : Interpret the behavior of magnetic circuits,
CO5 : Remember the principles and operation of electrical machines, and
CO6 : Know the concepts of electrical safety and protection systems.

Textbooks:

1. V K Mehta, Rohit Mehta, Principles of Electrical Engineering and Electronics S Chand and Company, New Delhi ,Revised Edition 2013.
2. D.C. Kulshreshtha, Basic Electrical Engineering Tata Mcgraw publication, 1st Edition 2011.
3. T.K. Nagasarkar and M.S. Sukhija Basic Electrical Engineering, Oxford University press, 3rd Edition 2017.

Reference Book:

1. Sanjeev Sharma, Basics Electrical Engineering I.K.International, New Delhi ,Third Reprint 2010.

ENGINERING ELECTIVE II

Course Title	Elements Of Machine Learning
Course Code (Credit)	EE10001 (L-T-P-Cr: 2-0-0-2)

Course Objective:

Today, we have access to massive data which get generated through information and computer technology in our connected world. Most of these data lie unused and often overwhelm us due to their size and variety. The objective of this course is to introduce to the students to the field of learning from data, discovering data patterns, converting them into knowledge, and applying it to solve real-world problems.

Course Contents:
UNIT I
Introduction:
Importance and Applications of Machine Learning, Supervised, Unsupervised, Reinforcement Learning and Evolutionary Learning.

UNIT II
Data Analysis:
Measurement Scales and Data Types; Visualization, Pre-processing and Transformation of Data; Dimensionality Reduction; and Data (Dis)Similarity.

UNIT III
Unsupervised Learning:
K-means and Density-based, Clustering Methods.

UNIT IV
Supervised Learning:
K-Nearest Neighbour, Decision Tree by Qualitative and Quantitative(information Gain method); Evaluation by Confusion Matrix of Supervised Learning Methods.

UNIT V
Learning with Neural Networks:
Perceptron, Multi-layer Perceptron and, Error Backpropagation Learning.

Course Outcomes:

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

CO1 : Demonstrate fundamentals of machine learning,
CO2 : Identify data types, apply suitable processing and visualize using suitable methods,
CO3 : Describe Unsupervised Learning and apply clustering techniques,
CO4 : Describe Supervised Learning and apply classification techniques,
CO5 : Demonstrate perceptron and Multi-layer Perceptron models, and
CO6 :Apply machine learning techniques for real world requirement**.**

Textbooks:

1. Gopal, M., Applied Machine Learning, McGraw Hill Education, 2018
2. Pradhan, M. and U. D. Kumar,Machine Learning Using Python,Wiley India Pvt.Ltd, 2019.

Reference Books:

1. Alpaydin, E., Introduction to Machine Learning, 3rd Edition, The MIT Press, 2014.
2. Bishop. C M, Pattern Recognition and Machine Learning, Springer, 2006.
3. Jain, V. K., Big Data Science Analytics and Machine Learning, Khanna Publishers, 2021
4. Mitchell, T. M.,Machine Learning, McGraw Hill, 1997.
5. Müller, A. C.,Introduction to Machine Learning with Python, O'Reilly Media, Inc, 2016
6. Raschka, S. and V. Mirjalili, Python Machine Learning, 3rd Edition, Packt Publishing, 2019.
7. Shalev-Shwartz, S. and S. Ben-David ,Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014.

Course Title	**Engineering Mechanics**
Course Code (Credit)	**ME10001 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

Engineering Mechanics is a specialized need-based extension of Applied Physics and uses the principles of Statics and Dynamics. The objective of this course is to build the foundational knowledge of the students which is required for the design of mechanical systems. In particular, the course will cover aspects of analysis of rigid body, frame and machine under the action of force system, and analysis of free body diagram of a system whether at rest or in motion

Course Contents:

UNIT I

Concurrent Forces in a Plane:

Introduction to Engineering Mechanics, Free-body diagrams, Composition and resolution of forces, Methods of moments. Friction: Concept of friction, Wedge friction.

UNIT II

Force Analysis of Plane Trusses:

Methods of joints, Method of Sections,Centroid: Parallel forces in a plane, Centroid of plane figures, Theorem of Pappus, and Centroid of composite plane figures.

UNIT III

Moment of Inertia:

Moment of Inertia of plane figures, Parallel axis theorem, Perpendicular axis theorem, and Moment of Intertia of composite figures.

UNIT IV

Principle of Virtual Work:

Equilibrium of Ideal Systems, Virtual work.

UNIT V

Dynamics of Particles:

Differential equations of rectilinear motion, Free vibration, D'Alembert's Principle, Momentum and Impulse, Work & Energy, Conservation of energy, Impact.

UNIT VI

Curvilinear Motion:

Normal and tangential acceleration, Motion of a projectile, Work and Energy in curvilinear motion.

UNIT VII

Rotation of a Rigid Body:

Kinematics of rotation, Rotation under the action of a constant moment.

Course outcomes:

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

CO1 :Draw complete and correct free-body diagrams and write the appropriate equations from the free-body diagram,

CO2 : Use scalar analytical techniques for analyzing forces and moments in mechanical systems,

CO3 : Analyze forces in statically determinate structures such as trusses, frames and problems related to friction,

CO4 : Determine the centroid and second moment of area,

CO5 : Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple and practical problems, and

CO6 : Solve real life problems by using mathematics, physical laws and theorems.

Textbooks:

1. 1.S Timoshenko, D. H Young & J.V. Rao, Engineering Mechanics, Tata McGraw-Hill Publication 5th Edition, 2017.

Reference Books:

1. IH Shames .,Engineering Mechanics (Statics and Dynamics) , Prentice Hall, 4th Edition, 2005.
2. S.S. Bhavikatti, Engineering Mechanics –New Age International,8th Edition, 2021.
3. S. Rajasekaran and G. Sankarasubramanian Engineering Mechanics (Statics and Dynamics),Vikas publishing House, 3rd Edition, 2017

Course Title	**Biomedical Engineering**
Course Code (Credit)	**EC10003 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

Biomedical Engineering is a multidisciplinary field that combines knowledge available in a wide range of disciplines such as engineering, medicine, and societal science. The course focuses on innovating newer equipment and technologies to improve human health and enhance health care facilities in a holistic manner.

Course Contents:

UNIT I

Introduction and Overview:

Introduction to biomedical engineering, Applications of biomedical engineering.

UNIT II

The Human Body:

cCll-structure and function, Tissue & organs, Bio-potentials, Action potential, Major human systems (musculoskeletal, circulatory, nervous, and respiratory system)

UNIT II

Bio-instrumentation:

Instruments in medical practice, Man-instrumentation system, Basic components, Linear network analysis, Bioelectric amplifier (OpAmp, isolation amplifier, instrumentation amplifier), Bio-instrumentation design, and Intelligent medical instrumentation.

UNIT III

Biomedical Electrodes and Sensors:

Ssignal acquisition, Bio-potential measurements, Active and passive sensors, and Electrodes for biophysical sensing (Ag-AgCl, surface electrodes, microelectrodes), transducers, sensors.

UNIT III
Biomedical Signals, Imaging and Informatics:
Bioelectric phenomena, Sources of biomedical signals, Origin of biopotentials, Basics of bio-signal processing, noise, Interference, Electrical safety issues, Principle of medical imaging techniques, such as X-ray, US, MRI, CT scan, and nuclear imaging, and Fundamentals of bio-informatics.

Course Outcomes:
Upon completion of this course, the students will be able to:
CO1 : Apply knowledge of basic engineering and biology to solve the problems,
CO2 : Knowledge of human body about cell, potential and organs of body,
CO3 : Develop a thorough understanding on principles of bio-instrumentation,
CO4 : Explain the role of bio-potential electrodes, and design of sensors,
CO5 : Differentiate and analyse the biomedical signal sources, and
CO6 : Knowledge about imaging techniques used in hospital.

Textbooks:
1. John D. Enderle & Joseph D. Bronzino Introduction to Biomedical Engineering, Academic press, 3rd Edition, 2012.

Reference Books:
1. Joseph D. Bronzino, Donald R. Peterson,The Biomedical Engineering Handbook, CRC press, 4th Edition 2015.
2. G.S. Sawhney, Fundamentals of Biomedical Engineering, New Age International (P) Ltd, 2011.

Course Title	**Basic Instrumentation**
Course Code (Credit)	**EE10003 (L-T-P-Cr: 2-0-0-2)**

Course Objective:
The course is designed to impart, to the students, the principles of analog and digital measuring instruments which include the working mechanisms of sensors and transducers and their applications in industrial and biomedical systems.

Course Contents:
UNIT I

Analog and Digital Instruments:
Basics of measuring instruments, Types of analog instruments, Measurement of voltage, current, power and energy in single and three phase circuits; Digital Instruments: Digital voltmeter, Digital multimeter, Timer/counter, and Time, phase and frequency measurements in oscilloscope.

UNIT II
Sensors and Transducers:
Optical sources and detectors: LED, photo-diode, light dependent resistor; Basics of fiber optic sensing, IR Sensors. Resistive, capacitive, inductive, piezoelectric, and Hall effect sensors, Temperature transducers: Thermocouple, RTD , and thermistor.

UNIT III
Transducers in Industrial Applications:
Measurement of displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure, flow, liquid level, pH, conductivity and viscosity.

UNIT IV:
Instruments in biomedical applications:
ECG, Blood Pressure measurement, CT Scan, and Sonography

Course Outcome:
Upon completion of this course, the students will be able to:
CO1 : Know the basics of measuring instruments,
CO2 : Measure different electrical quantities,
CO3 :Understand the working principles of optical and electrical transducers and sensors,
CO4 : Understand the working of electrical transducers and sensors,
CO5 : Apply the transducers in industrial applications, and
CO6 : Use instruments in biomedical applications.

Textbooks:

1. R. K. Rajput ,Electrical and Electronic Measurements and Instruments,S Chand Publication, 4th Edition, 2015,William David Cooper,Electronic Instrumentation and Measurement Techniques, by PHI, 2010.

Reference Books:

1. Er. R.K. Jain, Mechanical and Industrial Measurements (Process Instrumentation and Control), Khanna Publishers, 1995.
2. A.K Sawhney, A course in Electrical and Electronics Measurements and Instrumentation Dhanpat Rai Publication, 10th Edition, 2012.

3. D Patranabis, Sensors And Tranducers, PHI Publication, 2ndEedition, 2017.

HASS ELECTIVE I

Course Title	**Society, Science And Technology**
Course Code (Credit)	**HS10013 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

There is a circular relationship between society, science, and technology. Society creates a need and an ambience to develop science and technology, and science and technology create means to meet societal needs and new opportunities to make human life better. Studying this relationship is the objective of this subject. The subject will expose, before the students, the past developments of science and technology and the social forces that played a dominant role in making these developments possible and the way these were used in the society. The subject will also present the ethical principles that underlie the development and use of science and technology in the society.

Course Contents:

UNIT I

Introduction:

Human Curiosity to Know the Truth of Nature, Need to Improve Quality of Life, Emergence of Science and Technology, Characteristics of Society, Science, and Technology, and Impact of Science and Technology on the Society.

UNIT II

Scientific Discoveries:

Milestone Scientific Discoveries of the Past and the Ways They Impacted Human Thought Process and Culture; Scientific Method, Developing a Theory, and Making of a Discovery; Discoveries in the Physical, Biological, and Mathematical Sciences; Normal Science, Paradigms, Anomalies, Crisis and Emergence of Scientific Theories, and Scientific Revolutions.

UNIT III

Technological Developments:

Milestone Developments of Technologies and the Ways They Transformed the Society. Stories of Technological Developments such as Steam Engines, Electricity, Semiconductors, and IoT.

UNIT IV

Science and Technology in the Service of the Society

Contributions of Science and Technology to Solving Societal, Environmental, and Global Problems. Successes and Limitations, and Abuses and Control of Science and Technology; Ethical Considerations.

Course Outcomes:

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

CO1 :Understand the forces that shape the development of science and technology,

CO2 :Understand the major milestones of scientific discoveries have impacted human thought processes,

CO3 :Understand the effect of technological developments in societal transformation,

CO4 : Analyse the contribution of Science and Technology in solving societal and Environmental problems,

CO5 : Evaluate the ethical issues related to abuse of science and technology, and

CO6 : Apply the skills learned to suggest solutions to global problems linked to science and Technology.

Textbooks:

1. Bucchi, M., Science In Society: An Introduction to Social Studies of Science, Routledge Publication, 1st Edition, 2004.

Reference Books:

1. Collins, H. and T. Pinch, The Golem: What You Should Know about Science, 2nd Edition, New York: Cambridge University Press,1998.
2. Collins, H. and T. Pinch,The Golem: What You Should Know about Technology, 2nd Edition. New York: Cambridge University Press, 2014.
3. Kuhn, T. S.,The Structure of Scientific Revolutions, 4th Edition, Chicago University Press, 2012.
4. Hatton, J. and P. B. Plouffe, Eds., Science and Its Ways of Knowing, New Jersey: Prentice Hall,1997.
5. Moskovites, M., Ed., Science and Society, Ontario: House of Anansi Press Limited,1997
6. Sismondo, S. An Introduction to Science and Technology Studies, 2nd Edition. Maldon, MA: Blackwell Publishing, 2009.
7. Sarukkai, S. What Is Science?, New Delhi: National Book Trust, India, 2012.
8. USSR Academy of Sciences Science and Society, Moscow: Nauka Publishers, 1989.

Course Title	**Essentials Of Management**

Course Code (Credit)	HS10202 (L-T-P-Cr: 2-0-0-2)

Course Objective:

This course explores the basic concepts and processes of management. Students will learn the importance of management in their professional life from the stories on the evolution and practices of management. Students will examine the fundamental roles and processes of planning, organizing, staffing, directing and controlling that comprise the managers' role. This course also examines the fundamentals of marketing and financial management for the success of the organization. This course will make an attempt to introduce students to the business environment and strategic management process to understand the nuances of business. Students will develop skills related to the manager’s function as required in today’s competitive environment.

Course Contents:

UNIT I

Evolution of Management Thoughts:

Concept, Scope and Significance of Management; Classical Approach; Scientific, Bureaucratic & Administrative theory of Management; Neo-classical and Modern Approach; Contribution of Management Practitioners

UNIT II

Functions of Management (Part I):

Nature, scope and significance of Planning; Types of Planning; Process of Planning; Barriers to effective planning; Decision making: concept, types and process; Organizing: concept and significance; Delegation of authority; Authority vs.Responsibility; Structure of Organization: departmentalization, Centralization vs. Decentralization

UNIT III

Functions of Management (Part II):

Concept of Staffing, Manpower planning and Job design; Recruitment and selection; Training and development; Performance Appraisal; Directing: Concept, Direction and Supervision; Controlling: Concept, Importance and levels; Process and types of controlling

UNIT IV

Marketing and Financial Management:

Marketing Mix (Product, place, price, Promotion); Market Segmentation; Introduction, scope, importance and functions of Financial management; Introduction to Financial statements: Profit and loss account; balance sheet

UNIT V

Business Environment and Strategic Management:
Business environment: concept, importance, elements; Types of business environment; Strategic Management: Concept, Importance and levels of strategy; Process of Strategic Management

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1 :Learn different approaches, theories and stories of various practitioners of management and know how such knowledge could be applied to achieve goals of Organizations within the changing environment,

CO2 : Understand the core functions of management in order to facilitate efficient and effective decision making both at individual and organizational level,

CO3 : Identify the human resource requirement of the organization for achieving its objective effectively,

CO4 : Synthesize various marketing and financial skills and techniques in order to be successful in corporate world,

CO5 : Assess the business environment and understand the importance of various types of business environment for better decision making, and

CO6 : Acquire the lesson learnt in strategic management process for strategic decision making by leveraging the core competencies of the organization.

Textbooks:
1. S.A. Sherlekar & V.S. Sherlekar, Modern Business Organization & Management (Systems Approach) by Himalya Publishing House, 2018.
2. Harold Koontz and Heinz Weihrich ,Essentials of Management: an International Perspective by, McGraw Hills, 2020

Reference Books:
1. K. Ashwathappa, Essentials of Business Environment, Himalaya Publishing House, 2017.
2. Joseph L. Massie, Essentials of Management Pearson Education India, Fourth edition, 2015.
3. Azhar Kazmi & Adela Kazmi, Strategic Management, McGrawHill, 5^{th} edition 2020.

Course Title	**Shades Of Economics**
Course Code (Credit)	**HS10121 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

This course will provide technical students with knowledge in concepts of environmental economics, resource economics, and circular economy, allowing prosperity for present and future generations. The course will equip future engineers with skill to handle resources efficiently and effectively. Acquaint them with the contemporary trends in business settings and thereby innovate novel solutions to existing problems.

Course Contents:

UNIT I

Purple Economy: Economics of Glocalization:

Introduction to colours and world of economics (including White, Blue, Black, Green, Purple, Grey, Red, Pink, Silver); Concept and definition of purple economy; Cultural footprint; Local and global cultural economy; Culture and well being; Rethinking employment and training in the purple economy; Vocal for Local; Make in India.

UNIT II

Grey Economy: Economics of Informal Sector:

Concept and definition of grey economy; Introduction to formal and informal Sector; Formal and informal sector linkage; Labour absorption and dualism in economy; Theoretical and policy issues; Migration in informal sector.

UNIT III

Green Economy: Economics of Reduce, Reuse, and Recycle:

Concept and definition of green economy; Green investment and green bond; Green technology and renewable resources; Carbon footprint; Waste management.

UNIT IV

Blue Economy: Economics of Ocean Resources:

Concept and definition of blue economy; The marine environment; Fisheries and aquaculture; Tourism; Ocean-based renewable sources of energy; Transportation and the blue economy; Pollution of water resources; Water resource management.

UNIT V

Black Economy: Economics of Unsanctioned Sector:

Concept and definition of black money; Causes and consequences of black economy; Global black income generation; Extent of black money in India. Government measures to curb black money.

Course Outcomes:

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

CO1 : Understand the economic drivers that shape the future of India,

CO2 : Understand sustainability issues related to usage of factor endowment,
CO3 : Ability to create linkage between Economics, Science and Technology,
CO4 : Apply knowledge, reasons and the need for regulating circular economy,
CO5 : Assess and analyses scope for global market opportunities, and
CO6 : Explore yet to be unearthed employment opportunities.

Textbooks:

1. S.K Mishra and V. K. Puri, Indian Economy. Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6

Reference Books:

1. Uma Kapila. Indian Economy:Economic Development and Policy. Academic Foundation ISBN-10 : 9332705550 and ISBN-13 : 978-9332705555,2022.
2. Taneja and Myer :Economics of development and Planning, Vishal Publishing Co. ISBN-13 978-9382956068 : .
3. Datt Gaurav & Mahajan Ashwani , Indian Economy, S Chand & Company Limited. 2017.
4. Adrian C. Newton, Elena Cantarello, An Introduction to the Green Economy. Science, Systems and Sustainability,2014
5. Circular Economy- (Re) Emerging Movement. (2020). Shalini Goyal Bhalla.
4. Shalini Goyal Bhalla. Circular Economy- (Re) Emerging Movement.,2020.
5. Somnath Hazra & Anindya Bhukta,The Blue Economy. An Asian Perspective.
6. The Informal Economy: an Employer's Approach. The Informal Economy: an Employer's Approach. 2021.
7. The Purple Economy: An Objective, An Opportunity, 2013.
8. Tom Tietenberg, Lynne Lewis, Environmental and Natural Resource Economics. 2018.

Course Title	**Indian Economy Post Liberalisation**
Course Code (Credit)	**HS10123 (L- T- P-Cr: 2-0-0-2)**

Course Objective:

Study of this course provides an extensive understanding of changing structure of Indian economy over time. This course targets to put emphasis on inclusive growth, reducing poverty, inequality and creating decent employment in the economy. This course will give an understanding about the issues faced by an economy in achieving sustainable development.

Course Contents:

UNIT I

Introduction and features:

Changing structure of the Indian economy Changing paradigms of Development Strategies and Economic Reforms.

UNIT II

Poverty, Inequality and Employment:

Various concepts and estimates of poverty; Income inequality; Problem of unemployment; Interface among growth, poverty and employment; Inclusive growth and Human Development; Sustainable Development Goals—Targets for reduction in Poverty, Inequality and Decent Employment.

UNIT III

Demographic Issues:

Demographic trends, size and structure of population; Health and Education; Skill challenges and demographic dividends; Sustainable Development Goals—Targets forGreater Wellbeing and Better Human Capital.

UNIT IV

Perspectives in Agriculture, Industry and Services:

Agricultural growth performance and food security; Growth, trends and changing pattern of Indian industries, industrial reforms and policies; Services in India's growth process; Sustainable Development Goals—Targets for Inclusive and Sustainable Growth.

UNIT V

External Sector and Issues in Indian Public Finance

Foreign trade and trade policy; fiscal devolution, Indian Union Budget and Tax System

Course Outcomes:

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

CO1 : Interpret the changing structure of Indian economy,
CO2 : Perceive the issues and challenges faced by Indian economy,
CO3 : Evaluate the policies and programmes required to achieve inclusive growth,
CO4 : Realise the importance of human capital in triggering economic development,
CO5 : Comprehend the state and role of external sector in strengthening Indian economy, and
CO6 : Help in achieving sustainable development for the economy.

Textbooks:

1. Uma Kapila, Indian Economy Perfomance and Policies,academic foundation, 2020,ISBN:978-933270545

Reference Books:

1. S.K. Mishra, and V. K. Puri, Indian Economy, Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6
2. 2. Gaurav Datt and Ashwani Mahajan, Indian Economy, GENERIC. Classic Edition, 2022 ISBN-10 : 9352531299 ISBN-13 : 978-9352531295

Course Title	**Socio-Political Environment**
Course Code (Credit)	**SO10043 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

The objective of this paper include providing basic knowledge on socio-political environment of India and to equip the students with an understanding of their roles, duties and responsibilities in a democratic set up.

Course Contents:

UNIT I

Social Problem in India:

Meaning and Definition of Social Problems, Characteristics, Causes and Consequences, Problems of Poverty, Unemployment, Population growth, Problems ofWomen and Aged, Corruption and Nepotism, Illiteracy, Substance Abuse, and Terrorism.

UNIT II

Social Stratification:

Equity and Equality, Caste, Religion, Class, Gender Discrimination, Urban Slums.

UNIT III

Political Institutions:

Meaning and Basic Concepts of Political Institutions: Legislative, Executive and Judiciary Systems of the Indian Constitution.

UNIT IV

Fundamental Rights and Duties:

Fundamental Rights and Duties in Indian Constitution, Directive Principles of State Policy.

UNIT V

Contemporary Changes in Political Institutions:

Changing Role of the Government in Contemporary India, Role of Government in the Formation of National and International Policies and Their Impact on Business and Trade.

Course Outcomes:

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

CO1 : Understand contemporary Indian social problems,

CO2 :Understand the roles and functions of the three political institutions in our democraticup,

CO3 : Familiarize the students with the Rights and Duties enlisted in the Indian Constitution,

CO4 : Grasp the interrelationships among political, social and economic issue,

CO5 :Visualize contemporary changes in Political Institutions, and

CO 6: Realize the importance of equity, equality, and dignity in a democratic system.

Textbooks:

1. C. N. Shankar Rao, S. Chand., Indian Social Problems,by S.cahand Publication,2017
2. M. Laxmikanth., Constitution of India,Cengage Learning,2020.
3. Himanshu Roy & M.P Singh Indian Political System, Pearson publisher,4th Edition,2018.
4. Ram Ahuja ,Social Problems in India, Rawat publisher,4th Edition,2014.

Reference Books:

1. Our Parliament, Subhash C Kashyap, NBT, 2021.
2. Social Stratification, Dipankar Gupta (Ed), Oxford India Publication, 1997.
3. Modernisation of Indian Tradition, Yogendra Singh, Rawat Publication, 1986.

Course Title	**Thinking Perspectives**
Course Code (Credit)	**PS10043 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

Cognition plays a significant role in accumulation and processing of information. This subject provides an in-depth understanding of some of the cognitive processes in terms of current theories, models and applications. It helps learners to understand the importance of these cognitive processes and the rationale behind cognition, problem solving, critical thinking, and scientific thinking. It facilitates students to identify and analyze the key conceptual and theoretical frameworks underpinning cognitive process.

Course Contents:

UNIT I

Basics of Cognition:

A Brief History, Emergence of Modern Cognitive Approach, Thinking, Basic Elements of Thought: Forming Concepts, Propositions, Images.

Reasoning, some Basics sources of error, Information-processing approach, connectionist approach, evolutionary approach, ecological approach.

UNIT II

Memory Processes and Critical Thinking:

Organization of Long Term Memory, Forgetting, Retrieval and Metamemory; Proactive and Retroactive inference; Amnesia and Retrieval, Flashbulb Memory, Eyewitness Memory, Traumatic Memory, False Memories.

Phases of Critical Thinking: Intellectualization, Suggestion, Hypothesis, Reasoning, and Testing, Critical Thinking Abilities: Thinking, Observational, and Questioning and Dispositions, Critical Thinking Skills: Analysis, Communication, Creativity, Problem-solving Skills, and Open-mindedness.

UNIT III

Systems Thinking and Scientific Thinking:

System Definition and Characteristics, Approaches to System Modelling, Causal-Loop Diagramming, System Archetypes, Micro world and Learning Laboratory, The Learning Organization and the Fifth Discipline, Systems Thinking Study, Examples.

Characteristics of Science: Systematic observation and experimentation, Inductive and deductive reasoning, Lessons from Scientific Thinking: Empirical Evidence, Logical Reasoning.

UNIT IV

Creativity and Designing Thinking:

Creative Thinking, Stages in Creative Thinking, Nature of Creative Thinking, Features of Creativity—Novelty, Originality and Usefulness, Guilford's Measure of Creativity—Fluency, Flexibility, and Originality, Barriers to Creativity, Enhancing Individual and Organizational Creativity.

Designing Thinking as a Process of Problem Solving: Defining Problems, Challenging Assumptions, Developing Concepts, identifying Alternative Strategies and Solutions, Prototyping, and Experimenting Problem Solving through Innovative Solutions, Stages of Design Thinking—Empathize, Define, Ideate, Prototype and Test.

Course Outcomes:

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

CO1 : Understand the definition and scope of cognition, problem solving, and creativity,

CO2 :Understand the theories related to cognition, decision making, and critical thinking, CO3 : Understand the classic and current experimental research in cognitive processes,

CO4 : Develop skills essential in designing and conducting experiments in cognition, reasoning, and problem solving,

CO5 : Understand various aspects of critical thinking, scientific thinking, and design thinking process, and

CO6 : Apply the knowledge of cognitive processes to one's own personal life and to real life issues.

Textbooks:

1. Solso, R. L.,Cognitive Psychology, Pearson Education, 6th Edition. 2004.
2. Baron, R. A. Psychology,Pearson Education, 5th Edition, 2002
3. Rathus, S.A. Introductory Psychology Wadsworth Cengage,5th Edition, 2016.
4. Ciccarelli, S. & White, N.J, Psychology 5th Edition, Pearson Education.2017
5. The Fifth Discipline: The Art & Practice of the Learning Organization, Cengage Publication,2nd Edition, 2006.
6. Cross, N., Design Thinking: Understanding How Designers Think and Work, Berg Publishers.

Reference Books:

1. Baddley, A.,Human memory: Theory and practice. New York Psychology Press,1997.
2. Treror, A.,The psychology of language: From data to theory. Taylor Francis,2002
3. Smith, E.E. &Kosslyn, Cognitive psychology: Mind and brain. Prentice Hall,2007.
4. Tripathi, A.N. &Babu, Nandita (2008). Cognitive processes. In Misra, G. Psychology in India: Advances in Research, Vol. 1,Pearson Education.
5. Vaid, J., & Gupta, Ashum,Exploring word recognition in a semi-alphabetic script: the case of Devanagari. Brain and Language, 81, 679-690.

Course Title	**Creativity, Innovation And Entrepreneurship**
Course Code (Credit)	**PS10045 (L-T-P-Cr: 2-0-0-2)**

Course Objective:

The course is designed for students who want to enhance their creative and innovative skills and apply them to prepare business plans to form entrepreneurial enterprises. More specifically, the course is designed to help students to stimulate creativity in themselves and learn the impact of innovation on growth creation and design thinking in real-world business situations. In this course, the concepts of entrepreneurship and the environment in which the entrepreneurs act will be developed along with business plans and business models for start-ups.

Course Contents:

UNIT I

Introduction:

Definitions, Importance, and Relationships among Creativity, Innovation, and Entrepreneurship; Examples.

UNIT II

Creativity:

Definitions, Importance, and Relationships among Creativity, Innovation, and Entrepreneurship; Examples, Creative Thinking and Stages of Creative Thinking, Barriers to Creativity, Enhancing Individual Creativity, Guilford's Usual Unusual Test, Psychometric Approaches to Tests of Creativity, Structured tools of Creativity (Developing Creative Focus, Exercising Mind, Setting Directions, Suspending Rules, Thinking Differently, Establishing Formatted Work Space, Stimulating Mechanisms, Utilizing Experiences.

UNIT III

Innovation:

Innovation, Benefits, Keys to Successful Innovations, Types of Innovation, Barriers to Innovation, Methods of Generating Ideas, Design Thinking. Creative Problem Solving, and Measures of Innovation.

UNIT IV

Entrepreneurship:

Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Intrapreneur, Social Entrepreneur, Case Study on the Entrepreneurial Excellence of N. R. Narayan Murthy, Introduction to Agricultural, Rural, Tourism, Social and Digital Entrepreneurship, Entrepreneurial Motivational Behavior (Creativity, Self-Efficacy, Locus of Control, Risk Taking, Leadership, Communication), Converting Ideas into Products/Services with Differentiating Features, Niche Market, Design of the Products/Services, Bootstrap Marketing, Formulation of Business Plan, Business Model, Financial Planning, and Sources of Finance.

Practical classes will be devoted to organizing practicing sessions on creativity, case study discussion sessions and market analysis sessions on generating novel ideas, and developing and presenting business plans. Students, in groups, will design a new product/service, do a bootstrap market study, develop a business plan, and make an elevator pitch.

Course Outcomes:

Upon completion of this course, the students will be able to:
CO1 : Understand the key elements of creativity and innovation,
CO2 : Visualize the impact of innovation on growth creation,
CO3 : Apply creative and design thinking to real-world business situations,
CO4 : Create a foundation of entrepreneurship development and its theories,
CO5 : Develop business plans and business models to start entrepreneurial enterprises, and
CO6 : Analyze the business plan and implement it in real field.

Textbooks:

1. Khanka, S. S. Creativity, Innovation, and Entrepreneurship, S.Chand .
2. Praveen Gupta, Business Innovation, S. Chand , 2007

Reference Books:

1. Barringer B. R. and R. Duane, Entrepreneurship: Successfully Launching New Ventures: Pearson Prentice Hall, Ireland, 3rd Edition 2009.
2. Duening, T. N., R. D. Hisrich, and M. A. Lechter , Technology Entrepreneurship: Taking Innovation to the Marketplace, Elsevier, Amsterdam, 2nd Edition 2015.
3. Harrington, H. J., Creativity, Innovation, and Entrepreneurship: The Only Way to Renew Your Organization, Routledge, 2019.

Course Title	**Community/Environment-Based Projects**
Course Code (Credit)	**EX17001 (L-T-P-Cr: 0-0-4-2)**

Course Objective:

This course is offered to give the students an opportunity to connect with the community and the environment, learn and prioritize their problems, and define the problems in ways that make them amenable to scientific analysis and pragmatic solution. Appreciating the community problems, visualizing and experiencing them in person, self-learning, applying to realities, searching for and finding implementable solutions are the primary benefits of this project-based subject.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1 : Identify need of the community,
CO2 : Formulate objective of a project,
CO3 : Communicate orally and through formal technical write-ups,
CO4 : Analyze and interpret data wherever essential,
CO5 : Provide an implementable solution to the problem, and

CO6 : Work in team following ethical manners.

The projects will be applied to problems uppermost in the minds of the community regarding the problems that they confront regularly. The problems may range from social inequality and social justice to lack of common services such as health, education, water, power, banking, and from lack of access to government subsidies and policies to deforestation and environmental problems.

COUTRSE STRUCTURE FOR B.TECH IN COMPUTER SCIENCE & ENGINEERING

SEMESTER III

Theory							
Sl. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1.	EX20003	Scientific and Technical Writing OR	2	0	0	2	2
1.		HASS Elective- II	3	0	0	3	3
2.	MA21001	Probability and Statistics	3	1	0	4	4
3	EX20001	Industry 4.0 Technologies	2	0	0	2	2
4.	CS21001	Data Structures	3	1	0	4	4
5.	EC20005	Digital Systems Design	3	0	0	3	3
6.	CS21003	Automata Theory and Formal Languages	3	1	0	4	4
Total of Theory						**19**	**19/20**
Practical							
1.	CS29001	Data Structures Laboratory	0	0	2	2	1
2.	EC29005	Digital Systems Design Laboratory	0	0	2	2	1
Total						**23**	**21/22**

SEMESTER IV

Theory							
Sl. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1.	EX20003	Scientific and Technical Writing OR	2	0	0	2	2
1.		HASS Elective II	3	0	0	3	3
2.	MA21002	Discrete Structures	3	1	0	4	4
3.	CS20002	Operating Systems	3	0	0	3	3
4.	CS20004	Object Oriented Programming using Java	3	0	0	3	3

5.	CS20006	Database Management Systems	3	0	0	3	3
6.	CS21002	Computer Organization and Architecture	3	1	0	4	4
Total of Theory						**20**	**19/20**
Practical							
1.	CS29002	Operating Systems Laboratory	0	0	2	2	1
2.	CS29004	Java Programming Laboratory	0	0	2	2	1
3.	CS29006	Database Management Systems Laboratory	0	0	2	2	1
4.	CS28001	Vocational Electives	0	0	2	2	1
Total						**27**	**23/24**

SEMESTER V

Theory							
Sl. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1.	HS30101	Engineering Economics	3	0	0	3	3
2.	CS30001	Design and Analysis of Algorithms	3	0	0	3	3
3.	CS31001	Software Engineering	3	1	0	4	4
4.	CS30003	Computer Networks	3	0	0	3	3
5.		Professional Elective-I	3	0	0	3	3
6.		Professional Elective-II	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1.	CS39001	Algorithms Laboratory	0	0	2	2	1
2.	CS39003	Computer Networks Laboratory	0	0	2	2	1
3.		K-Explore Open Elective-I	0	0	2	2	1
Total						**25**	**22**

SEMESTER VI

Theory							
Sl. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1.		HASS Elective- III	3	0	0	3	3
2.	CS31002	Machine Learning	3	1	0	4	4
3.	CS30002	Artificial Intelligence	3	0	0	3	3
4.		Professional Elective-III	3	0	0	3	3
5.		Open Elective-II/MI-1	3	0	0	3	3
6.	HS30401	Universal Human Values	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1.	CS39002	Artificial Intelligence Laboratory	0	0	2	2	1
2.	CS33002	Applications Development Laboratory	0	1	2	2	2
3.	CS37001	Mini Project	0	0	4	4	2
Total						**28**	**24**

SEMESTER VII (for B. Tech. (Hons.)

Theory							
Sl. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1.		Professional Elective-IV	3	0	0	3	3
2.	EX40003	Engineering Professional Practice	2	0	0	2	2
3.		Open Elective-III/ (MI-II)	3	0	0	3	3
4.		Minor –III (Optional)	3	0	0	3	(3)
5.		Minor –IV (Optional)	3	0	0	3	(3)
Total of Theory						**8**	**8**
Sessional							
1.	CS47001	Project- I	0	0	10	10	5
2.	CS48001	Internship	-	-	-	-	2

3.	CS39008	MI- (Computing Laboratory)	0	1	2	2	2
Total						**18**	**15**

SEMESTER VIII (B. Tech. (Hons.))

Theory							
Sl. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1.		Professional Elective-V	3	0	0	3	3
2.		Open Elective–IV/Minor-V (Optional)	3	0	0	3	3
3.		Minor- VI	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1.	CS47002	Project- II	0	0	18	18	9
Total						**24**	**15**

SEMESTER VII (B.Tech.(Research))

Theory							
Sl. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1.		Research Elective-I	3	0	0	3	3
2.	EX40001	Research Methods and Ethics	3	0	0	3	3
3.	EX40003	Engineering Professional Practice	2	0	0	2	2
4.		Minor-II (Optional)	3	0	0	3	(3)
5.		Minor-III (Optional)	3	0	0	3	(3)
6.		Minor-IV (Optional)	3	0	0	3	(3)
Total of Theory						**8**	**8**
Sessional							
1.	CS47001	Research Project- I	0	0	10	10	5
2.	CS48001	Internship	-	-	-	-	2
Total						**18**	**15**

SEMESTER VIII B.Tech.(Research)

Sl. No	Course Code	Course Title	L	T	P	Total	Credit
Theory							
1.		Research Elective-II	3	0	0	3	3
2.		Minor –V (Optional)	3	0	0	3	(3)
3.		Minor- VI (Optional)	3	0	0	3	(3)
Total of Theory						**3**	**3**
Sessional							
1.	CS47002	Research Project- II	0	0	24	24	12
Total						**27**	**15**

Credit Distribution

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credit	21	20	22	23	22	24	15	15	162

SCIENCE CORE COURSES

Sl. No.	Course Code	Course Title	Pre-requisites	Credits
1.	MA21001	Probability and Statistics	-	4
2.	MA21002	Discrete Structures		4

PROGRAMME CORE COURSES

Sl. No.	Course Code	Course Title	Pre-requisites	Credits
1.	CS21001	Data Structures	CS13001	4
2.	EC20005	Digital Systems Design	EC10001	3

3.	CS21003	Automata Theory and Formal Languages	-	4
4.	CS20002	Operating Systems	-	3
5.	CS20004	Object Oriented Programming using Java	-	3
6.	CS20006	Database Management Systems	CS21001	3
7.	CS21002	Computer Organization and Architecture	-	4
8.	CS30001	Design and Analysis of Algorithms	CS21001	3
9.	CS31001	Software Engineering	-	4
10.	CS30003	Computer Networks	-	3
11.	CS31002	Machine Learning	-	4
12.	CS30002	Artificial Intelligence	-	3
		Total		**41**

PROGRAMME LABORATORY COURSES

Sl. No.	Course Code	Course Title	Pre-requisites	Credits
1.	CS29001	Data Structures Laboratory	CS13001	1
2.	EC29005	Digital Systems Design Laboratory		1
3.	CS29002	Operating Systems Laboratory	CS20002	1
4.	CS29004	Java Programming Laboratory		1
5.	CS29006	Database Management Systems Laboratory	CS20006	1
6.	CS39001	Algorithms Laboratory	CS30001	1
7.	CS39003	Computer Networks Laboratory	CS30003	1
8.	CS39002	Artificial Intelligence Laboratory	CS30002	1
9.	CS33002	Applications Development Laboratory	CS13001	2
			Total	**10**

PROGRAMME SESSIONAL COURSES

Sl. No.	Course Code	Course Title	Pre-requisites	Credits
1.	CS48001	Internship		2
2.	CS37001	Mini Project		2
3.	CS47001	Project-I		5
4.	CS47002	Project-II		9
5.	CS28001	Vocational Electives		1
			Total	**19**

PROFESIONAL ELECTIVE COURSES (PE)

Sl. No	Course Code	Course Title	Pre-requisites	Credits
		Professional Elective –I		
1.	CS30005	High Performance Computing	CS21002	3
2.	EC30007	ARM and Advanced Microprocessors	EC20002	3
3.	CS30007	Multi-Core Programming	CS21002	3
4.	CS30009	Distributed Operating Systems	CS20002	3
		Professional Elective –II		
1.	CS30011	Computational Intelligence	-	3
2.	CM30006	Compiler	CS21001	3
3.	CS30013	Data Mining and Data Warehousing	CS20006	3
4.	CS30015	Image Processing and Applications	MA21002	3
		Professional Elective –III		
1.	CS30010	Cloud Computing	CS20002	3
2.	CS30026	Computer Vision	CS40007	3
3.	CS30012	Software Project Management	CS31001	3
4.	CS30014	Time Series Forecasting	MA21002	3
5.	CS30016	Natural Language Processing	CM30006	3
		Professional Elective –IV/ Research Elective-I		
1.	CS40001	Deep Learning Techniques	CS31002	3
2.	CS40003	Software Testing and Automation	CS31001	3

3.	CS40005	Human Computer Interaction	CS30002	3
4.	CS40007	Computer Graphics and Multimedia Systems	MA21002	3
5.	CS40009	Principles of Cryptography	MA21002	3
		Professional Elective –V/ Research Elective-II		
1.	CS40002	Nature Inspired Computing	-	3
2.	CS40004	IOT and Applications	EC20005	3
3	CS40006	Agile Software Development	-	3
4.	CS40008	Social Network Analysis	-	3
5.	CS40010	Augmented and Virtual Reality	CS30015	3

Sl. No.	Specialization	Elective	Course Name
1.	Software Engineering	Elective-III	Software Project Management
		Elective-IV	Software Testing and Automation
		Elective-V	Agile Software Development
2.	Artificial Intelligence	Elective-III	Natural Language Processing
		Elective-IV	Deep Learning Techniques
		Elective-V	Augmented and Virtual Reality

HASS ELECTIVE COURSES

Sl. No	Course Code	Course Title	Credits
		HASS Elective- II	
1.	HS20220	Organizational Behavior	3
2.	HS20120	Economics of Development	3
3.	HS20122	International Economic Cooperation	3
		HASS Elective- III	
1.	HS30223	Business Ethics and Corporate Governance	3

2.	HS30225	Leadership and Team Effectiveness	3
3.	HS30125	Market Structure and Pricing Policies	3
4.	HS30127	Pragmatic Inquiry	3
5.	HS30129	Economic Analysis of Decision Rules	3
6.	HS30131	Economics of Health and Education	3
7.	HS30421	Gender Studies	3
8.	HS30425	Indian Knowledge System	3
9.	HS30423	Tribal Resource Management	3

VOCATIONAL ELECTIVE COURSES OFFERED BY DIFFERNET SCHOOLS

Vocational courses offered by School of Computer Engineering		
Sl. No.	**Course Code**	**Course Title**
1.	CS28001	Web Design
Vocational courses offered by School of Civil Engineering		
1	CE28001	Building Drawing, Estimation & Costing (for Civil Engineering Students)
2	CE28003	GIS & GPS Applications (For other branch students)
Vocational courses offered by School of Electrical Engineering		
1	EE28011	Industrial wiring and control panel design
2	EE28013	Installation, operation and maintenance of solar power system
3	EE28015	Domestic wiring and home automation
4	EE28017	Cyber physics application in industrial IOT
5	EE28019	Industrial Control and Remote Monitoring
Vocational courses offered by School of Electronics Engineering		
1.	EC28001	Computational Photography
2.	EC28003	Sound Engineering
3.	EC28005	Sensors for Automation
4.	EC28007	PCB Design
Vocational courses offered by School of Mechanical Engineering		

1	ME28011	Additive Manufacturing(3-D Printing)
2	ME28013	Die development by CNC milling
3	ME28015	Concept Car Manufacturing
4	ME28017	Development of Autonomous Wheeled Robots
5	ME28019	Modelling of Micro-Wind turbine by 3D CAD Design

XPLORE OPEN ELECTIVE COURSES OFFERED BY KSAC

Course Code	**Course Title**
SA38001	Robotics
SA38003	Web Designing
SA38005	Civil-Tech
SA38007	Circuit Design & Control
SA38009	Indian Classical, Folk & Bollywood Dance
SA38011	Indian Classical & Western Music
SA38013	Graphic Designing & Editing
SA38015	Art & Craft
SA38017	Theatre & Street Play
SA38019	Film Making
SA38021	Debating, Public Speaking& Anchoring
SA38023	Creative Writing
SA38025	Photography & Videography
SA38027	Fashion Styling
SA38029	Culinary Arts
SA38031	Quiz Activity
SA38033	Social Outreach
SA38035	Health & Emergency Care

COURSE STRUCTURE FOR B.TECH IN INFORMATION TECHNOLOGY

SEMESTER III

Theory							
Sl. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1.	EX20003	Scientific and Technical Writing	2	0	0	2	2
2.	MA21001	Probability & Statistics	3	1	0	4	4
3	CS21001	Data Structures	3	1	0	4	4
4.	EC20008	Communication Engineering	3	0	0	3	3
5.	CS20004	Object Oriented Programming using Java	3	0	0	3	3
6.	CS21002	Computer Organization and Architecture	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
1.	CS29001	Data Structures Laboratory	0	0	2	2	1
2.	EC29002	Communication Engineering Laboratory	0	0	2	2	1
3.	CS29004	Java Programming Laboratory	0	0	2	2	1
Total						**26**	**23**

SEMESTER IV

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.	HS30101	Engineering Economics	3	0	0	3	3
2.	MA21002	Discrete Structures	3	1	0	4	4
3.	EX20001	Industry 4.0 Technologies	2	0	0	2	2
4.	CS20002	Operating Systems	3	0	0	3	3
5.	CS20006	Database Management Systems	3	0	0	3	3
6.	CS20008	Information Theory and Coding	3	0	0	3	3

Total of Theory						**18**	**18**
Practical							
5.	CS29002	Operating Systems Laboratory	0	0	2	2	1
6.	CS29004	Database Management Systems Laboratory	0	0	2	2	1
7.	CS28001	Vocational Electives	0	0	2	2	1
Total						**24**	**21**

SEMESTER V

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		HASS Elective-II	3	0	0	3	3
2.	CS30001	Design and Analysis of Algorithms	3	0	0	3	3
3.	CS31001	Software Engineering	3	1	0	4	4
4.	CS30003	Computer Networks	3	0	0	3	3
5.		Professional Elective-I	3	0	0	3	3
6.		Professional Elective-II	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1.	CS39001	Algorithms Laboratory	0	0	2	2	1
2.	CS39003	Computer Networks Laboratory	0	0	2	2	1
3.		K-Explore Open Elective-I	0	0	2	2	1
Total						**25**	**22**

SEMESTER VI

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		HASS Elective -III	3	0	0	3	3
2.	CS31002	Machine Learning	3	1	0	4	4
3.	CS30004	Data Science and Analytics	3	0	0	3	3

4.		Professional Elective-III	3	0	0	3	3
5.		Open Elective –II/ MI-I	3	0	0	3	3
6.	HS30401	Universal Human Values	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1.	CS39004	Data Analytics Laboratory	0	0	2	2	1
2.	CS39006	Advance Programming Laboratory	2	0	0	2	2
3.	CS37001	Mini Project	0	0	4	4	2
Total						**27**	**24**

SEMESTER VII (B. Tech. (Hons.))

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		Professional Elective-IV	3	0	0	3	3
2.	EX40003	Engineering Professional Practice	2	0	0	2	2
3.		Open Elective-III/ (MI-II)	3	0	0	3	3
4.		Minor -III(Optional)	3	0	0	3	(3)
5.		Minor -IV(Optional)	3	0	0	3	(3)
Total of Theory						**8**	**8**
Sessional							
1.	CS48001	Internship	-	-	-	-	2
2.	CS47001	Project – I	0	0	10	10	5
3.	CS39008	MI- (Project/Computing Laboratory)	0	1	2	2	(2)
Total						**18**	**15**

SEMESTER VIII (B. Tech. (Hons.))

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		Professional Elective-V	3	0	0	3	3
2.		Open Elective–IV/Minor-V (Optional)	3	0	0	3	3
3.		Minor- VI	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1.	CS47002	Project- II	0	0	18	18	9
Total						**24**	**15**

SEMESTER VII (B.Tech.(Research))

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		Research Elective-I	3	0	0	3	3
2.	EX40001	Research Methods and Ethics	3	0	0	3	3
3.	EX40003	Engineering Professional Practice	2	0	0	2	2
4.		Minor-II (Optional)	3	0	0	3	(3)
5.		Minor-III (Optional)	3	0	0	3	(3)
6.		Minor-IV (Optional)	3	0	0	3	(3)
Total of Theory						**8**	**8**

Sessional							
1.	CS47001	Research Project- I	0	0	10	10	5
2.	CS48001	Internship	-	-	-	-	2
Total						**18**	**15**

SEMESTER VIII B.Tech.(Research)

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		Research Elective-II	3	0	0	3	3
2.		Minor -V(Optional)	3	0	0	3	(3)
3.		Minor- VI (Optional)	3	0	0	3	(3)
Total of Theory						**3**	**3**
Sessional							
1.	CS47002	Research Project- II	0	0	24	24	12
Total						**27**	**15**

Credit Distribution

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credit	21	20	23	21	22	24	15	15	161

SCIENCE CORE COURSES

Sl. No.	**Course Code**	**Course Title**	**Pre-requisites**	**Credits**
1.	MA21001	Probability and Statistics	-	4
2.	MA21002	Discrete Structures	-	4

PROGRAMME CORE COURSES

Sl. No.	**Course Code**	**Course Title**	**Pre-requisites**	**Credits**
1.	CS21001	Data Structures	CS13001	4
2.	CS20004	Object Oriented Programming using Java	-	3

3.	CS21002	Computer Organization and Architecture	CS13001	4
4.	EC20008	Communication Engineering	EC20001	3
5.	CS20002	Operating Systems	CS21001	3
6.	CS20006	Database Management Systems	CS21001	3
7.	CS20008	Information Theory and Coding	MA21002	3
8.	CS30001	Design and Analysis of Algorithms	CS21001	3
9.	CS31001	Software Engineering	CS13001	4
10.	CS30003	Computer Networks	-	3
11.	CS31002	Machine Learning	-	4
12.	CS30004	Data Science and Analytics	MA21002	3
		Total		**40**

PROGRAMME LABORATORY COURSES

Sl. No.	Course Code	Course Title	Pre-/ Co-requisites	Credits
1.	CS29001	Data Structures Laboratory	CS13001	1
2.	EC29002	Communication Engineering Laboratory	EC20001 EC21001	
3.	CS29004	Java Programming Laboratory	-	1
4.	CS29002	Operating Systems Laboratory	CS20002	1
5.	CS29006	Database Management Systems Laboratory	CS20006	1
6.	CS39001	Algorithms Laboratory	CS21001	1
7.	CS39003	Computer Networks Laboratory	CS30003	1
8.	CS39004	Data Analytics Laboratory	CS30004	1
9.	CS39006	Advance Programming Laboratory	-	2
			Total	**9**

PROGRAMME SESSIONAL COURSES

Sl. No.	Course Code	Course Title	Pre-/ Co-requisites	Credits
1.	CS48001	Internship	-	2
2.	CS37001	Mini Project	-	2

3.	CS47001	Project-I	-	5
4.	CS47002	Project-II	-	9
5.	CS28001	Vocational Electives	-	1
			Total	**19**

PROFESIONAL ELECTIVE COURSES (PE)

Sl. No	Course Code	Course Title	Pre-requisites	Credits
Professional Elective –I				
1.	CS30002	Artificial Intelligence	-	3
2.	CS21003	Automata Theory and Formal Languages	-	3
3.	CS30014	Time Series Forecasting	MA21002	3
4.	CS30015	Image Processing and Applications	MA21002	3
5.	CS30019	Web Technology and Applications	-	3
Professional Elective –II				
1.	CS30017	Big Data	CS20006	3
2.	CS30021	Real Time Systems	-	3
3.	CS30011	Computational Intelligence	-	3
4.	CS30023	Software Defined Networking	CS30003	3

Professional Elective –III				
1.	CS30012	Software Project Management	CS31001	3
2.	CS40010	Augmented and Virtual Reality	CS30015	3
3.	CS20010	Information Security	MA21002	3
4.	CS30010	Cloud Computing	CS20002	3
Professional Elective –IV/ Research Elective-I				
1.	CS40003	Software Testing and Automation	-	3
2.	CS40001	Deep Learning Techniques	CS31002	3
3.	CS40005	Human Computer Interaction	CS30002	3
4.	CS40009	Principles of Cryptography	MA21002	3
5.	CS40011	Mobile Computing	-	3

Professional Elective –V/ Research Elective-II				
1.	CS40006	Agile Software Development	CS31001	3
2.	CS40002	Nature Inspired Computing	-	3
3	CS40008	Social Network Analysis	-	3
4.	CS40012	Block Chain	-	3
5.	CS40014	Game Theory	-	3

Sl. No.	Specialization	Elective	Course Name
1.	Software Engineering	Elective-III	Software Project Management
		Elective-IV	Software Testing and Automation
		Elective-V	Agile Software Development
2.	Information Security	Elective-III	Information Security
		Elective-IV	Principles of Cryptography
		Elective-V	Block Chain

COURSE STRUCTIURE FOR B.TECH IN COMPUTER SCIENCE & COMMUNICATION ENGINEERING

SEMESTER III

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.	EX20003	Scientific and Technical Writing	2	0	0	2	2
2.	MA21001	Probability & Statistics	3	1	0	4	4
3.	EX20001	Industry 4.0 Technologies	2	0	0	2	2
4.	CS21001	Data Structures	3	1	0	4	4
5.	EC20005	Digital Systems Design	3	0	0	3	3
6.	EC20008	Communication Engineering	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1.	CS29001	Data Structures Laboratory	0	0	2	2	1
2.	EC29005	Digital Systems Design Laboratory	0	0	2	2	1
3.	EC 29002	Communication Engineering Laboratory	0	0	2	2	1
Total of Practical						**6**	**3**
Total						**24**	**21**

SEMESTER IV

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.	HS30101	Engineering Economics	3	0	0	3	3
2.	MA21002	Discrete Structures	3	1	0	4	4
3.	CS20002	Operating Systems	3	0	0	3	3
4.	CS20006	Database Management Systems	3	0	0	3	3
5.	CS20004	Object Oriented Programming using Java	3	0	0	3	3
6.	CS20010	Information Security	3	0	0	3	3

Total of Theory						**19**	**19**
Practical							
1.	CS29002	Operating Systems Laboratory	0	0	2	2	1
2.	CS29006	Database Management Systems Laboratory	0	0	2	2	1
3.	CS29004	Java Programming Laboratory	0	0	2	2	1
4.	CS28001	Vocational Electives	0	0	2	2	1
Total of Practical						**8**	**4**
Total						**27**	**23**

SEMESTER V

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		HASS Elective - II	3	0	0	3	3
2.	CS30001	Design and Analysis of Algorithms	3	0	0	3	3
3.	CS31001	Software Engineering	3	1	0	4	4
4.	CS30003	Computer Networks	3	0	0	3	3
5.		Professional Elective - I	3	0	0	3	3
6.		Professional Elective - II	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1.	CS39001	Algorithms Laboratory	0	0	2	2	1
2.	CS39003	Computer Networks Laboratory	0	0	2	2	1
3.		K-Explore Open Elective - I	0	0	2	2	1
Total of Practical						**6**	**3**
Total						**25**	**22**

SEMESTER VI

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		HASS Elective – III	3	0	0	3	3
2.	CS30010	Cloud Computing	3	0	0	3	3
3.	EC30002	Wireless Mobile Communication	3	0	0	3	3
4.		Professional Elective - III	3	0	0	3	3
5.		Open Elective – II / MI-I	3	0	0	3	3
6.	HS30401	Universal Human Values	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1.	EC39002	Wireless Communication & Networking Lab	0	0	2	2	1
2.	CS39006	Advance Programming Laboratory	2	0	0	2	2
3.	CS37001	Mini Project	0	0	4	4	2
Total of Practical						**8**	**5**
Total						**26**	**23**

SEMESTER VII (for B. Tech. (Hons.)

Theory							
Sl. No		**Course Title**	L	T	P	Total	Credit
1		Professional Elective-IV	3	0	0	3	3
2.	EX40003	Engineering Professional Practice	2	0	0	2	2
3.		Open Elective – III / MI-II	3	0	0	3	3
4.		Minor –III (Optional)	3	0	0	3	3
5.		Minor –IV (Optional)	3	0	0	3	3

Total of Theory						8	8
Practical							
1.	CS48001	Internship	-	-	-	-	2
2.	CS47001	Project – I	0	0	10	10	5
3.	CS39008	MI- (Project/ Computing Laboratory)	0	1	2	2	(3)
Total						**18**	**15**

SEMESTER VIII (B. Tech. (Hons.))

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		Professional Elective-V	3	0	0	3	3
2.		Open Elective-IV/ Minor-V (Optional)	3	0	0	3	3
3.		Minor-VI (Optional)	3	0	0	3	(3)
Total of Theory						**6**	**6**
Sessional							
1.	CS47002	Project- II	0	0	18	18	9
Total						**24**	**15**

SEMESTER VII (B.Tech.(Research))

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		Research Elective-I	3	0	0	3	3
2.	EX40001	Research Methods and Research Ethics	3	0	0	3	3
3.	EX40003	Engineering Professional Practice	2	0	0	2	2
4.		Minor -II(Optional)	3	0	0	3	(3)
5.		Minor -III(Optional)	3	0	0	3	(3)
6.		Minor -IV(Optional)	3	0	0	3	(3)
Total of Theory						**8**	**8**

Sessional							
1.	CS47001	Project- I	0	0	10	10	5
2.	CS48001	Internship	-	-	-	-	2
Total						**18**	**15**

SEMESTER VIII (B.Tech.(Research)

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		Research Elective-II	3	0	0	3	3
2.		Minor -V(Optional)	3	0	0	3	(3)
3.		Minor -VI(Optional)	3	0	0	3	(3)
Total of Theory						**3**	**3**
Sessional							
1.	CS47002	Project- II	0	0	24	24	12
Total						**27**	**15**

Credit Distribution

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credit	**21**	**20**	**21**	**23**	**22**	**23**	**15**	**15**	**160**

PROGRAMME CORE COURSES

Sl. No.	Course Code	Course Title	Pre-requisites	Credits
1.	CS21001	Data Structures	CS13001	4
2.	EC20005	Digital Systems Design	EC10001	3
3.	EC20008	Communication Engineering	EC20001	3
4.	CS20002	Operating Systems	CS21001	3
5.	CS20006	Database Management Systems	CS21001	3
6.	CS20004	Object Oriented Programming	CS13001	3

		using Java		
7.	CS20010	Information Security	MA21002	3
8.	CS30001	Design and Analysis of Algorithms	CS21001	3
9.	CS31001	Software Engineering	CS13001	4
10.	CS30003	Computer Networks	-	3
11.	CS30010	Cloud Computing	CS20002	3
12.	EC30002	Wireless Mobile Communication	EC21002/ EC20008	3
		Total		**38**

PROGRAMME LABORATORY COURSES

Sl. No.	Course Code	Course Title	Pre-/ Co-requisites	Credits
1.	CS29001	Data Structures Laboratory	CS13001	1
2.	EC29005	Digital Systems Design Laboratory	EC20005	1
3.	EC 29002	Communication Engineering Laboratory	EC20001/ EC21001	1
4.	CS29002	Operating Systems Laboratory	CS20002	1
5.	CS29004	Java Programming Laboratory	-	1
6.	CS29006	Database Management Systems Laboratory	CS20006	1
7.	CS39001	Algorithms Laboratory	CS21001	1
8.	CS39003	Computer Networks Laboratory	CS30003	1
9.	EC39002	Wireless Communication & Networking Lab	EC21002	1
10.	CS39006	Advance Programming Laboratory	-	2
Total				**11**

PROGRAMME SESSIONAL COURSES

Sl. No.	Course Code	Course Title	Pre-/ Co-requisites	Credits
1.	CS48001	Internship	-	2
2.	CS37001	Mini Project	-	2

3.	CS47001	Project-I	-	5
4.	CS47002	Project-II	-	9
5.	CS28001	Vocational Electives	-	1
			Total	**19**

PROFESIONAL ELECTIVE COURSES (PE)

Sl. No	Course Code	Course Title	Pre-requisites	Credits
Professional Elective –I				
1.	CS20008	Information Theory and Coding	MA21002	3
2.	EC30023	Digital Signal Processing	EC20006	3
3.	CS40011	Mobile Computing	-	3
4.	CS30004	Data Science and Analytics	MA21002	3

Professional Elective –II				
1.	CS30011	Computational Intelligence	-	3
2.	CS40002	Nature Inspired Computing	-	3
3.	CS40004	IOT and Applications	-	3
4.	EC30025	Fiber Optic Communication Systems & Networks	EC20008	3
Professional Elective –III				
1.	CS40012	Block Chain	-	3
2.	EC40018	Smart Antennas	-	3
3.	EC30022	Satellite Communication System	-	3
4.	CS40006	Agile Software Development	-	3
5.	CS40007	Computer Graphics and Multimedia Systems	MA21002	3
Professional Elective –IV/ Research Elective-I				
1.	CS40001	Deep Learning Techniques	CS31002	3
2.	CS40005	Human Computer Interaction	CS30002	3

3.	CS30015	Image Processing and Applications	-	3
4.	CS40013	Multimedia Systems	-	3
5.	CS30012	Software Project Management	CS31001	
		Professional Elective –V/ Research Elective-II		
1.	CS40003	Software Testing and Automation	CS31001	3
2.	CS30026	Computer Vision	-	3
3.	CS40008	Social Network Analysis	-	3
4.	CS40010	Augmented and Virtual Reality	-	3

Sl. No.	**Specialization**	**Elective**	**Course Name**
1.	Computer Vision	Elective-III	Computer Graphics and Multimedia Systems
		Elective-IV	Image Processing and Applications
		Elective-V	Computer Vision

COURSE STRUCTURE FOR B.TECH IN COMPUTER SCIENCE & SYSTEM ENGINEERING

SEMESTER III

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.	EX20003	Scientific and Technical Writing	2	0	0	2	2
2.	MA21001	Probability & Statistics	3	1	0	4	4
3.	CS21001	Data Structures	3	1	0	4	4
4.	EC20005	Digital Systems Design	3	0	0	3	3
5.	CS20004	Object Oriented Programming using Java	3	0	0	3	3
6.	CS21002	Computer Organization and Architecture	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
1.	CS29001	Data Structures Laboratory	0	0	2	2	1
2.	EC29005	Digital Systems Design Laboratory	0	0	2	2	1
3.	CS29004	Java Programming Laboratory	0	0	2	2	1
Total						**26**	**23**

SEMESTER IV

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.	HS30101	Engineering Economics	3	0	0	3	3
2.	MA 21002	Discrete Structures	3	1	0	4	4
3.	EX20001	Industry 4.0 Technologies	2	0	0	2	2
4.	CS20002	Operating Systems	3	0	0	3	3
5.	CS20006	Database Management Systems	3	0	0	3	3

6.	EC20006	Principle of Signals & Systems	3	1	0	4	4
Total of Theory						**19**	**19**
Practical							
1.	CS29002	Operating Systems Laboratory	0	0	2	2	1
2.	CS29004	Database Management Systems Laboratory	0	0	2	2	1
3.	CS28001	Vocational Electives	0	0	2	2	1
Total						**25**	**22**

SEMESTER V

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		HASS Elective-II	3	0	0	3	3
2.	CS30001	Design and Analysis of Algorithms	3	0	0	3	3
3.	CS31001	Software Engineering	3	1	0	4	4
4.	CS30003	Computer Networks	3	0	0	3	3
5.		Professional Elective-I	3	0	0	3	3
6.		Professional Elective-II	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1.	CS39001	Algorithms Laboratory	0	0	2	2	1
2.	CS39003	Computer Networks Laboratory	0	0	2	2	1
3.		K-Explore (Open Elective-I)	0	0	2	2	1
Total						**25**	**22**

SEMESTER VI

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		HASS Elective -III	3	0	0	3	3
2.	CS30006	Compilers	3	0	0	3	3
3.	EC30007	ARM and Advanced Microprocessors	3	0	0	3	3
4.		Professional Elective-III	3	0	0	3	3
5.		Open Elective –II / MI-I	3	0	0	3	3
6.	HS30401	Universal Human Values	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1.	EC39006	ARM Laboratory	0	0	2	2	1
2.	CS39006	Advance Programming Laboratory	2	0	0	2	2
3.	CS37001	Mini Project	0	0	4	4	2
Total						**26**	**23**

SEMESTER VII (for B. Tech. (Hons.)

Theory							
Sl. No		**Course Title**	L	T	P	Total	Credit
1		Professional Elective-IV	3	0	0	3	3
2.	EX40003	Engineering Professional Practice	2	0	0	2	2
3.		Open Elective – III/ MI-II	3	0	0	3	3
4.		Minor - III (Optional)	3	0	0	3	(3)
5.		Minor - IV (Optional)	3	0	0	3	(3)
Total of Theory						**8**	**8**
Practical							
1.	CS48001	Internship	-	-	-	-	2

2.	CS47001	Project – I	0	0	10	10	5
3	CS39008	MI-(Project / Computing Laboratory)	0	1	2	2	(2)
Total						**18**	**15**

SEMESTER VIII (B. Tech. (Hons.))

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		Professional Elective-V	3	0	0	3	3
2.		Open Elective-IV / Minor –V	3	0	0	3	3
3.		Minor-VI	3	0	0	3	(3)
Total of Theory						**6**	**6**
Sessional							
1.	CS47002	Project- II	0	0	18	18	9
Total						**24**	**15**

SEMESTER VII (B.Tech.(Research))

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		Research Elective-I	3	0	0	3	3
2.	EX40001	Research Methods and Research Ethics	3	0	0	3	3
3.	EX40003	Engineering Professional Practice	2	0	0	2	2
4.		Minor-II (Optional)	3	0	0	3	(3)
5		Minor-III (Optional)	3	0	0	3	(3)
6		Minor-IV(Optional)	3	0	0	3	(3)
Total of Theory						**8**	**8**
Sessional							
1.	CS47001	Project- I	0	0	10	10	5
2.	CS48001	Internship	-	-	-	-	2
Total						**18**	**15**

SEMESTER VIII (B.Tech.(Research)

Theory							
Sl. No	Course Code	**Course Title**	L	T	P	Total	Credit
1.		Research Elective-II	3	0	0	3	3
2.		Minor -V(Optional)	3	0	0	3	(3)
3.		Minor -VI(Optional)	3	0	0	3	(3)
Total of Theory						**3**	**3**
Sessional							
1.	CS47002	Project- II	0	0	24	24	12
Total						**27**	**15**

Credit Distribution

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credit	**21**	**20**	**23**	**22**	**22**	**23**	**15**	**15**	**161**

PROGRAMME CORE COURSES

Sl. No.	Course Code	Course Title	Pre-requisites	Credits
1.	CS21001	Data Structures	CS13001	4
2.	EC20005	Digital Systems Design	CS13001	3
3.	EC20006	Principle of Signals & Systems	-	3
4.	CS20002	Operating Systems	CS21001	3
5.	CS20004	Object Oriented Programming using Java	CS13001	3
6.	CS20006	Database Management Systems	-	3
7.	CS21002	Computer Organization and Architecture	CS13001	4
8.	CS30001	Design and Analysis of Algorithms	CS21001	3
9.	CS31001	Software Engineering	CS13001	4

10.	CS30003	Computer Networks	-	3
11.	CS30006	Compilers	CS21001	3
12.	EC30007	ARM and Advanced Microprocessors	EC20002	3
		Total		**39**

PROGRAMME LABORATORY COURSES

Sl. No.	Course Code	Course Title	Pre requisites	Credits
1.	CS29001	Data Structures Laboratory	CS13001	1
2.	EC29005	Digital Systems Design Laboratory	-	1
3.	CS29002	Operating Systems Laboratory	CS20002	1
4.	CS29004	Java Programming Laboratory	-	1
5.	CS29006	Database Management Systems Laboratory	CS20006	1
6.	CS39001	Algorithms Laboratory	CS21001	1
7.	CS39003	Computer Networks Laboratory	CS30003	1
8.	EC39006	ARM Laboratory	EC21002	1
9.	CS39006	Advance Programming Laboratory	-	2
			Total	**10**

PROGRAMME SESSIONAL COURSES

Sl. No.	Course Code	Course Title	Pre-/ Co-requisites	Credits
1.	CS48001	Internship		2
2.	CS37001	Mini Project		2
3.	CS47001	Project-I		5
4.	CS47002	Project-II		9
5.	CS28001	Vocational Electives		1
			Total	**19**

PROFESIONAL ELECTIVE COURSES (PE)

Sl. No	Course Code	Course Title	Pre-requisites	Credits
Professional Elective -I				
1.	CS30002	Artificial Intelligence	CS30001	3
2.	CS30025	Modeling and Simulation	-	3
3.	CS3005	High Performance Computing	CS21002	3
4.	CS30015	Image Processing and Applications	MA21002	3
Professional Elective -II				
1.	CS31002	Machine Learning	-	3
2.	CS30009	Distributed Operating Systems	CS20002	3
3.	EC30005	VLSI CIRCUITS & SYSTEMS	EC21001/ EC20005	3
4.	CS30011	Computational Intelligence	-	3

Professional Elective -III				
1.	CS30013	Data Mining and Data Warehousing	CS20006	3
2.	CS30027	Robotics and Applications	-	3
3.	EC30024	Embedded Systems	CS21002	3
4.	CS40006	Agile Software Development	-	3
Professional Elective –IV/ Research Elective-I				
1.	CS40001	Deep Learning Techniques	CS31002	3
2.	CS40005	Human Computer Interaction	CS30002	3
3.	CS40007	Computer Graphics and Multimedia Systems	MA21002	3
4.	CS30026	Computer Vision	CS40007	3
5.	CS30004	Data Science and Analytics	-	
Professional Elective –V/ Research Elective-II				
1.	CS40003	Software Testing and Automation	CS31001	3
2.	CS40002	Nature Inspired Computing	-	3
3.	CS40010	Augmented and Virtual Reality	CS30015	3
4.	CS40008	Social Network Analysis	MA21002	3

Sl. No.	Specialization	Elective	Course Name
1.	Human Robot Interaction	Elective-III	Robotics and Applications
		Elective-IV	Human Computer Interaction
		Elective-V	Augmented and Virtual Reality

Detailed Syllabus

Course Title	**Probability and Statistics**
Course Code (Credit)	**MA21001 (L-T-P-Cr: 3-1-0-4)**

Course Objectives:

The objective of this course is to familiarize the students with the foundation of probability and statistics and to use it in solving the problems arises in engineering and real life applications.

Course Contents:

UNIT I

Probability and random variables:

Basic concepts of sample space, events(with example), Axiom of Probability,Conditional Probability, Bayes' Theorem and its applications.Discrete random variable, probability mass function, cumulative distribution function and Moment Generating function for discrete random variable, some special distributions likeUniform distribution, Geometric distribution, Binomial distribution, Negative Binomial distribution, Poisson distribution, Hypergeometric distribution, mean and variance.Continuous random variable, density function, cumulative distribution function and Moment Generating function. Uniform distribution, normal distribution, mean, variance, percentile and critical value of normal distribution,normal approximation of the binomial distributionand exponential distribution.

UNIT II

Joint probability and distributions:

Joint probability mass function and marginal probability mass function, joint probability density function and marginal probability density function, concept of independent random variable(joint probability), conditional probability mass function and conditional probability density function. Expected value, covariance and correlation for jointly distributed random variable(both continuous and discrete).

UNIT III

Descriptive Statistics:

Frequency distribution, pictorial and tabular representation of data, stem and leaf display, dot plots, histogram, box plots and comparative box plots.Basic conceptson mean, median and mode, Skewness, Kurtosis, Correlation, Coefficient of Correlation, rank correlation, Regression Analysis: Least square method.

UNIT IV

Inferential statistics:

Population, sample, random sample, sampling distribution, distribution of sample mean, central limit theorem, point estimator, point estimation of parameter using method of maximum likelihood estimation, confidence interval, confidence interval for the mean of a normal population with known and unknown variance, confidence interval for the variance of a normal population, hypothesis testing, one sided and two sided alternatives, Tests for mean of the normal distribution with known variance, Tests for mean of the normal distribution with unknown variance, tests for variance of the normal distribution.

Course Outcomes:

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

CO1: Understand basic probability and its applications

CO2: ~~S~~tudy probability distributions and can use it in real life data analysis

CO3: Have a knowledge on univariate and bivariate distributions and their properties

CO4: Measure the central tendency and dispersion of a data set to draw conclusion from the data and interpret the data with the appropriate pictorial representation.

CO5: Have good understanding of the Central Limit Theorem and its applications

CO6: Analyze the statistical inference

Textbooks:

1. Probability and Statistics for Engineers and Sciences by J. L. Devore, CENGAGE Learning, 9th Edition.
2. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley, INC, 10th Edition.

Reference Books:

1. Introduction to Probability and Statistics for Engineers and Scientists by S.M. Ross, Elsevier/AP, 6th Edition.
2. Introduction to Probability and Statistics by J.S. Milton & J.C. Arnold, McGraw Hill, 4th Edition.
3. Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons Inc, 3rd Edition.
4. Fundamental of Mathematical Statistics by S.C. Gupta & V.K.Kapoor, S. Chand, 12th Edition.

Course Title	Discrete Structures
Course Code (Credit)	**MA21002 (L-T-P-Cr: 3-1-0-4)**

Course Objectives:

The main objective of this course is to provide mathematical concepts and build up strong mathematical fundamentals to support many subjects of computer science engineering such as design and analysis of algorithms, computability theory, software engineering, computer systems, syntactical analysis, information organization and retrieval, switching theory, computer representation of discrete structures and programming languages etc.

Course Contents:

UNIT I

Logic:

Proposition, Truth values, Connectives, Logical equivalence of composite statement (using truth table & without truth table), Predicates and Quantifiers, Rules of Inference, Methods of Induction.

UNIT II

Set, Relation & Function:

Set, Operations on set, Principles of Inclusion and Exclusion, Relation, Types of relations, Properties on Binary Relation, Equivalence relation, partial ordering relation, Hasse diagram, Lattice, Definition of function, Injection, Bijection, Surjection, Permutation function.

UNIT III

Recurrence Relation and their solutions:

Principles of counting, Discrete numeric function and their manipulation, Generating Function, Concept of Recurrence Relation with constant coefficients, Solution of Recurrence Relations (Substitution and generating function methods).

UNIT IV

Groups and Rings:

Concept of binary operations, Algebraic structures, Semigroup, monoid, Group, Abelian group with examples. Properties of groups, Cyclic groups and its generator, Sub group, cosets, Normal subgroup, Lagrange's Theorem, Homomorphism and Isomorphism, ring, field, Integral domain (Definition with examples)

UNIT V

Graph Theory:

Basic Terminology, Adjacency & Incident Matrix, graph Isomorphic Test, Paths, Circuit, Eulerian path and Eulerian Circuit, Hamiltonian path and circuit, shortest path Algorithms (Dijkstra),Tree, Rooted Tree, Binary Tree, spanning tree, Minimal Spanning Tree (MST) Algorithms(Prim's& Kruskal's

Algorithms), Planar and Nonplanar Graphs.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1. Convert sentences in natural language into mathematical statements and understand predicate and quantifiers, rules of inference and prove results by principle of mathematical induction.

CO2. Understand the principles of inclusion and exclusion of sets, concept of relations and functions and solve related problems.

CO3. Know the concepts of partition of sets, partial ordering relation, Hasse diagram and Lattice.

CO4.Solve problems on recurrence relations by substitution and method of generating functions and know a powerful method of counting

CO5. Understand the concept of algebraic structures, groups, semi group, subgroups and Lagrange theorem. Gets the idea of homomorphism and isomorphism of groups, definition and examples of ring, integral domain and field.

CO6. Apply Graph theory in related areas like Syntactic analysis, Fault detection and diagnosis in computers, Scheduling problems and Minimal-path problems, network flow problems.

Textbooks:

1. Discrete Mathematics and its Applications by Kenneth H Rosen (Mc Graw Hill 7th Edition)

Reference Books:

1. Elements of Discrete Mathematics. A Computer oriented approach by C.L Liu, D.P. Mohapatra (Tata Mc Graw Hill 4th Edition-2013)
2. Discrete Mathematics by Sudarsan Nanda, Allied Publisher Pvt. Ltd., 2022
3. Introduction to Graph Theory by Douglas B. West, Pearson, 2nd Edition, 2002
4. Discrete Mathematics by Iyeger et al., Vikas Publishing House Pvt.Ltd., 2020

Course Title	**Data Structures**
Course Code (Credit)	**CS21001 (L-T-P-Cr: 3-1-0-4)**

Course Objectives:

- To find the Time Complexity and Space Complexity for algorithm
- To understand the various techniques of sorting and searching
- To design and implement arrays, stacks, queues, and linked lists
- To understand the complex data structures such as trees and graphs
- To solve real life problems

Course Contents:

UNIT I

Introduction:

Development of Algorithms, Notations and analysis, Storage structures for arrays, Sparse matrices, Stacks and Queues: Representations and applications.

UNIT II

Linked List, Stacks, and Queues:

Linked Lists, Linked stacks and queues, Operations on polynomials, Doubly linked lists, Circularly linked lists, Dynamic storage management, Garbage collection and compaction.

UNIT III

Trees:

Tree representation, Binary Trees, Binary search trees, Tree traversal, Expression manipulation, Symbol table construction, Height balanced trees, AVL trees.

UNIT IV

Graphs:

Graphs, Representation of graphs, BFS, DFS, Topological sort, String representation and manipulations, Pattern matching.

UNIT V

Sorting and Searching:

Sorting Techniques: Selection, Bubble, Insertion, Merge, Heap, Quick, Radix sort, Linear search, Binary search, Hash table methods.

Course Outcomes:

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

CO1: Use the concepts of data structure, data type and abstract data type to develop solutions for engineering problems.

CO2: Develop programs to implement linear data structures such as stacks, queues, linked lists, etc.

CO3: Apply the concept of trees and graph data structures in real world scenarios

CO4: Comprehend the implementation of sorting and searching algorithms

CO5: Compare Time Complexity and Space Complexity for algorithm

CO6:Effectively choose the data structure that efficiently models the information in a problem.

Textbooks:

1. Fundamentals of Data Structures in C by E. Horowitz, S. Sahani and S. Anderson-Freed, Universities Press.

Reference Book:

1. Sartaj Sahni, “Data Structures, Algorithms and Applications in C++”, Universities Press Pvt. Ltd., 2008.

Course Title	**Digital Systems Design**
Course Code (Credit)	**EC20005 (L-T-P-Cr: 3-0-03)**
Pre-requisites	**EC10001**

Course Objectives:

- To understand the overview on the design principles of digital computing systems
- To learn the Verilog modelling techniques
- To learn Boolean Algebra and Understand the various logic gates
- To be familiar with various combinational circuits
- To be familiar with designing synchronous and asynchronous sequential circuits
- To be exposed to CMOS level gate design

Course Contents:
UNIT I
Basic VLSI System Design:
Introduction to digital systems and VLSI design, Moore’s Law, VLSI Design flow, Design hierarchy, Introduction to Verilog HDL, operators and Modelling techniques (gate-level, data-flow,and behavioral)

UNIT II
Binary Codes & Boolean Algebra:
Signed Binary numbers and its arithmetic (1’s and 2’s complement form), Binary codes (Weighted and non-weighted codes, Gray codes, BCD codes), Boolean Algebra-Laws and Axioms, SOP and POS (Min-term and Max-term), K-Maps (2-,3-,4- variables with don’t care condition)

UNIT III
Combinational Circuits:
Adders (Half adder, Full adders, Binary Parrallel Adders), Subtractor (Half Subtractor, Full Subtractor), Code conversion algorithms, Combined Adder-Subtractor Block, Design of code converters, Decoders and Encoders, Multiplexer and Demultiplexer. Implementation of Combinational Circuits using Gate-level and Data-flow level of modelling.

UNIT IV
Sequential Circuits:
Basic latch, Flip-flops (SR, D, JK, T, Master-Slave), Triggering of flip-flops, FF conversions, Shift Registers (SISO, SIPO, PISO, PIPO), Counter Design

(Synchronous and Asynchronous), Implementation of sequential circuits using Behavioral level of modelling.

UNIT V

Advanced Concepts:

Overview of CMOS, CMOS level gate design (Basic and Universal gates), Design of general Boolean circuits using CMOS gates, CMOS level design of latches and flip-flops. Verilog description of CMOS level design.

Course Outcomes:

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

CO1: Demonstrate the design principles of digital electronic and VLSI systems

CO2: Apply the concept of different Verilog HDL models in realising various digital circuits

CO3: Evaluate and simplify Boolean functions by using Boolean algebraic methods like K-maps

CO4: Design and analyse different combinational circuits

CO5: Design and analyse different sequential circuits

CO6: Design and analyse CMOS-based combinational and sequential logic circuits

Text Books

1. Morris Mano, and Michael D. Ciletti, “Digital Design”, Fifth Edition, PHI, 2012.
2. CMOS Digital Integrated Circuits – Sung-Mo Kang, Y. Leblebici, C. Kim, TMH, 4th Edition, 2016

Reference Books

1. Anand Kumar, “Fundamentals of Digital Logic”, Fourth Edition, PHI, 2016.
2. Samir Palnitkar, “Verilog HDL”, Second Edition, Pearson Education, 2003.

Course Title	**Automata Theory and Formal Languages**
Course Code (Credit)	**CS21003 (L-T-P-Cr: 3-1-0-4)**

Course Objectives

- To know about Chomsky hierarchy for organizing languages
- To introduce concepts in automata theory and theory of computation
- To identify different formal language classes and their relationships
- To design grammars and recognizers for different formal languages
- To understand undecidability and decide on languages that are undecidable

Course Contents:

UNIT I

Finite Automata:

Alphabets, Strings and Languages, Automata and Grammars, Deterministic Finite Automata (DFA), Formal Definition, Simplified notation: State transition graph, Transition table. Language of DFA, Non-deterministic Finite Automata (NFA), NFA with epsilon transition, Language of NFA, Equivalence of NFA and DFA, Minimization of Finite Automata, Distinguishing one string from other, Myhill Nerode Theorem.

UNIT II

Regular Expression (RE):

Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions, Kleen's Theorem, Regular expression to FA, DFA to Regular expression, Arden Theorem, Non Regular Languages, Pumping Lemma for regular Languages. Application of Pumping Lemma, Closure properties of Regular Languages, Decision properties of Regular Languages, FA with output: Moore and Mealy machine, Equivalence of Moore and Mealy Machine, Applications and Limitation of FA.

UNIT III

Context Free Grammar (CFG) and Context Free Languages:

Definition, Examples, Derivation, Derivation trees, Ambiguity in Grammar, Inherent ambiguity, Ambiguous to Unambiguous CFG, Useless symbols, Simplification of CFGs, Normal forms for CFGs: CNF and GNF, Closure properties of CFLs, Decision Properties of CFLs: Emptiness, Finiteness and Membership, Pumping lemma for CFLs.

UNIT IV

Push Down Automata (PDA):

Description and definition, Instantaneous Description, Language of PDA, Acceptance by Final state, Acceptance by empty stack, Deterministic PDA, Equivalence of acceptance by empty stack and final state, Conversion of CFG to PDA and PDA to CFG.UNIT V

UNIT V

Turing Machines (TM) and Undecidability:

Basic model, definition and representation, Instantaneous Description, Language acceptance by TM, Variants of Turing Machine, TM as Computer of Integer functions, Universal TM, Church's Thesis, Recursive and recursively enumerable languages, Halting problem, Introduction to Undecidability, Undecidable problems about TMs, Post correspondence problem (PCP), Modified PCP and undecidable nature of post correspondence problem, Introduction to recursive function theory.

Course Outcomes:

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

CO1: Acquire a fundamental understanding of the core concepts in automata theory and formal languages

CO2: Design finite automata or regular expression for any tokenization task

CO3: Construct a context free grammar for parsing any language

CO4: Design Turing machine for any language

CO5: Conclude the decidable / undecidable nature of any language

CO6: Apply mathematical and formal techniques for solving real-world problems

Textbooks:

1. John Hopcroft, Rajeev Motwani, and Jeffrey Ullman, "Introduction to Automata Theory, Languages and Computation", Third Edition, Pearson Education, 2014.

Reference Books:

1. John Hopcroft, Jeffrey Ullman, "Introduction to Automata Theory, Languages and Computation", Nineteenth Reprint, Narosa Publishing House, 2002.
2. Martin J. C., "Introduction to Languages and Theory of Computations", Fourth Edition, TMH, 2010.
3. Peter Linz, "An Introduction to Formal Language and Automata", Jones and Bertlett, 2011.
4. Papadimitriou C., Lewis C. L., "Elements of the Theory of Computation", Pearson, 1997.

Course Title	**Operating Systems**
Course Code (Credit)	**CS20002 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To provide knowledge about the services rendered by operating systems
- To explore the various scheduling policies and to provide solutions for critical section and deadlock problems
- To provide a detailed discussion of the various memory management techniques
- To discuss the various file-system design and implementation issues
- To discuss how the protection domains, help to achieve security in a system
- To explore the design and implementation issues of Distributed OS

Course Contents:

UNIT I

Introduction:

Need for Operating Systems, Computer Systems, OS Operations, Abstract view of OS, Virtualization, Computing Environments, OS Services, OS

Structures, System Calls, Building and Booting OS, Process, Threads, Multithreading.

UNIT II
Process Management:
Process Scheduling, Process Co-ordination, Synchronization, Semaphores, Monitors, Hardware Synchronization, Deadlocks, Methods for Handling Deadlocks.

UNIT III
Memory Management:
Memory Management Strategies, Contiguous and Non-Contiguous allocation, Virtual memory Management, Demand Paging, Page Placement and Replacement Policies.

UNIT IV
File Management:
File System, Basic concepts, File System design and Implementation, Case Study: Linux File Systems, Mass Storage Structure, Disk Scheduling, Disk Management, I/O Systems, System Protection and Security.

UNIT V
Distributed Systems:
Distributed Systems, Distributed operating systems, Distributed file systems, Distributed Synchronization, OS architecture, Case study on LINUX and Windows OS.

Course Outcomes:
Upon completion of the course, the students will be able to:

CO1: Distinguish between different types of modern operating systems, virtual machines
CO2: Comprehend the techniques used to implement the process manager
CO3: Comprehend virtual memory abstractions in operating systems
CO4: Design and develop file system and I/O system
CO5: Apply various mechanisms in storage management
CO6: Design and develop OS modules for Distributed Environment

Textbooks:

1. Silberschatz, Galvin, Gagne, “Operating System Concepts”, Tenth Edition, Wiley, 2018.

Reference Books:

1. William Stallings, “Operating Systems: Internals and Design Principles”, Ninth Edition, Pearson Publication.
2. Andrew S. Tanenbaum and Herbert Bos, “Modern Operating Systems”, Fourth Edition, Pearson Publication.

Course Title	Object Oriented Programming using Java
Course Code (Credit)	CS20004 (L-T-P-Cr: 3-0-0-3)

Course Objectives:

- To understand the basic concepts of Object-Oriented Programming
- To nurture syntax and semantics of Java Programming language
- To write java programmes using basic concepts of OOP principles
- To be able to know multi tasking Java and multithreading techniques
- To understand Packages, Interfaces, and Exception Handling

Course Contents:

Unit I

Evolution of Programming Paradigm:

Procedure oriented programming vs Objects oriented programming, Object oriented programming concepts: Object, Classes, Encapsulation and abstraction, Inheritance, Polymorphism

Unit II

Java Overview:

JDK, JRE, Java Virtual Machine, Byte code, Java Characteristics, Data types, Operators, Control statements, Class fundamentals, Objects, Methods, Parameterized method, Use of static keyword, Input stream reader, Scanner class,Command Line Argument,Constructors, Overloading, Array

Unit III

Inheritance:

Basics of Inheritance, Use of super and final keywords, Method overriding, Abstract classes, Dynamic Method Dispatch, Defining and importing packages, Access protection, Interfaces, Inner class

Exception handling: Exception fundamentals, Types, Understanding different keywords (try, catch, finally, throw, throws), User defined exception handling;

String Handling: Basics of String handling, String class, String Buffer class, constructor and methods of both classes

Unit IV

Multithreading:

Basic thread concept, Life cycle of thread, Thread Model, Thread Priorities, Synchronization, Thread Class and Runnable Interface, Inter Thread Communication.

Input/Output:

Stream classes, Byte stream, Character stream, Reading and writing from console, Files, Reading and writing onto file using Byte stream and character stream, Random Access File

Unit V

GUI Programming:

Introduction to Swing, Swing controls, Event handling: Delegation event model, Event classes, Sources, Listeners, Adapter class.

JDBC: JDBC API, Comparison between JDBC & ODBC, Type of JDBC Drivers, JDBC Architecture, JDBC classes and interfaces, Basic steps in Developing JDBC Applications, Working with DataBase, Result Set, Statement & Prepared Statement interfaces, Result Set MetaData

Course Outcomes:

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

CO1: Examine the basic concepts of Object-Oriented Programming
CO2: Perceive syntax and semantics of Java Programming language
CO3: Design Java application programs using basic concepts of OOP principles, abstract classes, interfaces and packages
CO4: Develop robust and multi tasking Java programs using exception handling and multithreading techniques
CO5: Design java programs using string classes and I/O operations,.
CO6: Design GUI applications using Swing and interactive application using event handling and java database connectivity.

Textbooks:

1. Herbert Schildt, "Java-The Complete Reference", Twelfth Edition, McGraw Hill Education, 2021

Reference Books:

1. Herbert Schildt, "Java-The Complete Reference", Twelfth Edition, McGraw Hill Education, 2021
2. Y. Daniel Liang, "Introduction to JAVA Programming", Tenth Edition, Pearson Education, 2019

Course Title	**Database Management Systems**
Course Code (Credit)	**CS20006 (L-T-P-Cr: 3-1-0-3)**

Course Objectives

- To learn data models, conceptualize and depict a database system using ER diagram
- To understand the internal storage structures in a physical DB design
- To know the fundamental concepts of transaction processing techniques
- To understand the concept of Database Design in Normalization techniques
- To know the manipulation of SQL Queries

Course Contents:

UNIT I
Introduction:

Purpose of Database System, Views of data, Data Models, Database Languages, Database System Architecture, Components of DBMS, Entity, Relationship model (E-R model), E-R Diagram notation, EER notations, Examples.

UNIT II
Relational Model:
Relational Data Model, Concept of relations, Schema-instance distinction, keys, integrity rules, Relational algebra operators, SQL: Data definition, Data manipulation, Aggregate function, Null Values, Nested sub queries, Joined relations.

UNIT III
Database Design:
Dependencies and Normal forms, Dependency theory, Functional dependencies, Armstrong's axioms for FD's, Closure of a set of FD's, minimal covers, Definitions of 1NF, 2NF, 3NF and BCNF, 4NF, 5NF, Decompositions and desirable properties of them.

UNIT IV
Transaction Management:
ACID properties, Serializability and concurrency control, Lock based concurrency control (2PL), Timestamp ordering protocol, Database recovery management.

UNIT V
Implementation Techniques:
Overview of Physical Storage Media, Magnetic Disks, RAID, Tertiary storage, Organization of Records in Files, Indexing and Hashing, Ordered Indices, primary, Secondary index structures.

Course Outcomes:

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

CO1: Install, configure, and interact with a relational database management system

CO2: Conceptualize and depict a database system using ER diagram.

CO3: Master the basics of SQL and construct queries using SQL
CO4: Design and develop a large database with optimal query processing
CO5: Develop efficient storage scheme of saving and retrieving Records and Files
CO6: Design the database with normalization techniques

Textbooks:

1. Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2006.
2. C. J. Date, A. Kannan, S. Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.

Reference Books:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson, 2007.

Course Title	**Computer Organization and Architecture**
Course Code (Credit)	**CS21002 (L-T-P-Cr: 3-1-0-4)**

Course Objectives:

- To understand the basic hardware and software issues of computer organization
- To understand how computations are performed at machine level
- To understand how data storage is happening at machine level
- To understand the memory hierarchies, cache memories and virtual memories
- To learn the different ways of communication with I/O devices

Course Contents:

UNIT I

Basic Structure of Computers:

Computer Types, Functional Units, Basic Operational Concepts, Bus Structures, Machine Instructions and Programs: Memory Locations and Addresses, Memory Operations, Encoding of Machine Instructions, Addressing Modes, Instruction Types, Instruction Format, Instruction Length, Assembly Language, Subroutines, Additional Instructions, RISC vs CISC.

UNIT II

Basic Processing Unit:

Fundamental Concepts, Execution of a Complete Instruction, Single and Multiple Bus CPU Organization, Hard-wired Control, Micro programmed Control unit.

UNIT III

Memory System:

Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed, Size, and Cost, memory module design, Memory Hierarchy, Cache Memories, Mapping Functions, Replacement Algorithms, Memory Performance Considerations, Memory interleaving, Virtual Memories.

UNIT IV

Arithmetic:

Design of fast adders, Multiplication of Positive Numbers, Signed Operand Multiplication, Fast Multiplication, Integer Division, Floating-point Numbers and Operations.

UNIT V

Input/ Output Organization:

Accessing I/O Devices, Modes of I/O Transfer, Program Controlled I/O, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Exceptions, Direct Memory Access.

UNIT VI

Case Study:

IA-32 Register Structure, IA-32 Addressing Modes, IA-32 Instructions, Machine Instruction Format, IA-32 Assembly Language, Program Flow Control, Logic and Shift/Rotate Instructions, Subroutines for IA-32, Programming examples.

Course Outcome:

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

CO1: Perceive the functions of hardware components of computer and its requirements for the execution of instructions.

CO2: Choose Instruction Set Architecture (ISA): Instruction format, types, and various addressing modes.

CO3: Apply the basic components to design the CPU: the ALU and control unit.

CO4: Assess the different levels of memory organization: SRAM, DRAM, Cache memory, Virtual Memory.

CO5: Design the ALU and it's operations: Addition, Subtraction, Multiplication, and Division.

CO6: Classify and compare the I/O Organization and types of I/O Transfer.

Textbooks:

1. Computer Organization and Embedded Systems by Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 6th Edition, MGH, 2022.

Reference Books:

1. M. Morris Mano, Computer System Architecture, Pearson Education India, 3rd Edition
2. William Stallings, Computer Organization & Architecture, 11th Edition, Pearson Education, 2006.

Course Title	**Design and Analysis of Algorithms**
Course Code (Credit)	**CS30001 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS21001**

Course Objectives:

- To understand the importance of algorithm
- To analyze the complexity of an algorithm in terms of time and space complexities
- To understand various problem solving techniques
- To learn about amortized analysis of algorithms
- To design and implement various programming paradigms and its complexity

Course Contents:

UNIT I
Introduction:
Concepts in algorithm analysis & design motivation, Space and Time Complexity of algorithm, Asymptotic Notations (Big Oh, Omega, Theta), Analysis of time complexity of Insertion Sort by step count method, Solving recurrences using Iterative, Substitution, Recurrence Tree, Master theorem

UNIT II
Divide & Conquer and Greedy Approaches:
Divide and Conquer method, Greedy method, Huffman code, Minimum spanning trees, Dijkstra algorithm, Knapsack problem, Job sequencing with deadlines.

UNIT III
Dynamic Programming Approaches:
Dynamic Programming, Knapsack problem, Matrix Chain Multiplication, longest common subsequence Multistage graphs, All pair’s shortest paths,

Optimal binary search trees, Travelling salesman problem.

UNIT IV
Amortization:
Randomized Algorithms and Amortized Analysis, Las Vegas and Monte Carlo types, Randomized quick sort and its analysis, Min-Cut algorithm.

UNIT V
NP Problems:
NP-Hard and NP-complete problems, Basic concepts, Reducibility, Vertex cover, 3CNF_SAT, clique, Hamiltonian cycle, TSP, Approximation algorithms, Vertex cover, TSP.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: Analyze the time and space complexity for any algorithm

CO2: Compare and contrast different algorithm techniques

CO3: Apply the design techniques of algorithm in solving real world problems

CO4: Perform amortize analysis for any algorithm

CO5: Modify existing algorithms to apply in common engineering design situations

CO6: Use NP class of problems to propose approximation algorithms

Textbooks:
1. T. Cormen, C. Lieserson, R. Rivest, C. Stein, "Introductions to Algorithms", Third Edition, Prentice-Hall/India, 2009.

Reference Books:
1. A. M. Tenenbaum, Y. Langsam, M. J. Augestien, "Data Structures using C", First Edition, Pearson Education, 2007.
2. E. Harowitz, S. Sahni, S. Rajsekaran, "Fundamentals of Computer Algorithms", Universities press.

Course Title	**Software Engineering**
Course Code (Credit)	**CS31001(L-T-P-Cr: 3-1-0-4)**

Course Objectives:

- To understand the Software Engineering Practice
- To understand the Software Engineering Process Models
- To understand Design Engineering, Web applications
- To gain knowledge of the software testing
- To understand Software Project Management

Course Contents:

UNIT I

Introduction:

Role of Software Engineer, Software Components, Software Characteristics, Software Crisis, Software Engineering Processes, Similarity and Differences from Conventional Engineering Processes, Quality Attributes.

Assessment:

How Software Engineering Changes? Software Development Life Cycle (SDLC) Models: Water Fall Model, Prototype Model, Spiral Model, Evolutionary Development Models, Iterative Enhancement Models, Choosing a social relevant problem, Summary Team Report.

UNIT II

Requirement Engineering Process:

Elicitation, Analysis, Documentation, Review and Management of User Needs, Feasibility Study, Information Modeling, Data Flow Diagrams, Entity Relationship Diagrams, Designing the architecture.

Assessment: Impact of Requirement Engineering in their problem, Decision Tables, SRS Document, IEEE Standards for SRS, Architectural design, component level design, user interface design, WebApp Design, Submission of SRS Document for Team Project.

UNIT III

Quality concepts, Review techniques, Software Quality Assurance (SQA): Verification and Validation, SQA Plans, Software Quality Frameworks.

Assessment: Framing SQA Plan, ISO 9000 Models, SEI-CMM Model and their relevance to project Management, Other emerging models like People CMM.

UNIT IV

Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Testing for Functionality and Testing for Performance, Top-Down and Bottom-Up Testing, Software Testing Strategies, Strategies: Test Drivers and Test Stubs, Structural Testing (White Box Testing), Functional Testing (Black Box Testing), Testing conventional applications, object oriented applications, Web applications, Formal modeling and verification, Software configuration management, Product metrics.

Assessment: Team Analysis in Metrics Calculation.

UNIT V:

Project Management Concepts, Process and Project Metrics, Estimation for Software projects, Project Scheduling, Risk Management, Maintenance and Re-engineering. Assessment: Preparation of Risk mitigation plan.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Identify appropriate software process models for developing real life projects

CO2: Assess each module given the overall Software engineering practice

CO3: Enhance the software project management skills

CO4: Comprehend the systematic methodologies involved in SE

CO5: Work ethically in a team as well as independently on software projects and adapt to the ever changing dynamic real world situations.

CO6:Design and develop a software product in accordance with SE principles

Textbooks:

1. R. S. Pressman, "Software Engineering: A Practitioners Approach", Eighth Edition, McGraw Hill, 2010.
2. Rajib Mall, "Fundamentals of Software Engineering", Fifth Edition, PHI Publication, 2009.
3. Pankaj Jalote, "Software Project Management in Practice", Pearson Education, New Delhi, 2002.

Course Title	**Computer Networks**
Course Code (Credit)	**CS30003 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To provide insight about fundamental concepts and reference models (OSI and TCP/IP) and its functionalists
- To gain comprehensive knowledge about the principles, protocols, and significance of Layers in OSI and TCP/IP
- To know the implementation of various protocols and cryptography techniques
- Learn the flow control and congestion control algorithms

Course Contents:

UNIT I

Data Communications:

Data Transmission, Multiplexing, Data Encoding Techniques, Introduction to computer networks, Network, Topologies, Reference Models: ISO/OSI Model and TCP/IP Model.

UNIT II

Physical Layer:

Transmission Media, Analog signals, Digital Signals, Data Link Layer, Error Detection and Correction, Parity, LRC, CRC, Hamming Code, Flow Control and Error Control, Stop and wait, ARQ, Sliding window – IEEE, Ethernet.

UNIT III

Network Layer:

Packet Switching and Circuit Switching, IP addressing methods, Subnetting, Supernetting, Routing Protocols: IP, ARP, RARP, DHCP, Routing Algorithms: Distance Vector Routing, Link State Routing.

UNIT IV
Transport Layer:
Transport Services, UDP, TCP, Congestion Control, Quality of Services (QOS).

UNIT V
Application Layer:
Domain Name Space (DNS), Electronic Mail, HTTP, WWW.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: Use of different models for study of computer networks
CO2: Identify the components required to build different types of networks
CO3: Choose the required functionality at each layer for given application
CO4: Identify solution for each functionality at each layer
CO5: Trace the flow of information from one node to another node in the network
CO6: Build networking solutions using the concepts of world wide web and electronic mail technologies

Textbooks:
1. Andrew S. Tanenbaum, David J. Wetherall, "Computer Networks", Sixth Edition, Pearson Publication, 2011.

Reference Books:
1. W. Stallings, "Data and Computer Communication", Tenth Edition, Pearson Education, 2018.
2. Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Sixth Edition, Morgan Kaufmann Publishers, 2011.
3. Nader. F. Mir, "Computer and Communication Networks", First Edition, Pearson Publishers, 2007.

Course Title	**Machine Learning**
Course Code (Credit)	**CS31002 (L-T-P-Cr: 3-1-0-4)**

Course Objectives:
- To provide a broad survey of different machine learning approaches and techniques
- To understand the principles and concepts of machine learning
- To understand neural networks concepts
- To learn regression and reinforcement learning
- To develop programming skills that helps to build real world applications based on machine learning

Course Contents:
UNIT I
Introduction:

Introduction: Machine learning: What and why? Types of Machine Learning, Supervised Learning, Unsupervised Learning, The Curse of dimensionality, Over and under fitting, Model selection, Error analysis and validation, Parametric vs. non-parametric models.

UNIT II
Machine Learning:
Types of Machine Learning, Supervised Learning, Classification models, Naïve Bayes Classifier, Decision trees, Support Vector Machines, KNN model, Dimensionality reduction, PCA.

UNIT III
Clustering:
Clustering approaches, Mean Shift clustering, Clustering data points and features, Bi-clustering, Multi-view clustering, K-Means clustering, K-medians clustering, Expectation Maximization (EM).

UNIT IV
Neural Networks:
Neural networks, Biological motivation for Neural Network, Neural network Representation, Perceptron, Feed forward networks, Multilayer Networks and Back Propagation Algorithms, Hidden layer representation, Application of neural network.

UNIT V
Applications and Tools:
Linear models for regression, Reinforcement Learning, Machine Learning Tools, Engineering applications.

Course Outcomes:
Upon completion of the course, the students will be able to:

CO1: Solve typical machine learning problems

CO2: Compare and contrast different data representation to facilitate learning

CO3: Apply the concept of regression methods, classification methods and clustering methods.

CO4: Suggest supervised /unsupervised machine learning approaches for any application

CO5: Implement algorithms using machine learning tools

CO6: Design and implement various machine learning algorithms in a range of real-world applications.

Textbooks:
1. Kevin P. Murphy, “Probabilistic Machine Learning”, The MIT Press, 2023.
2. Ethem Alpaydin, “Introduction to Machine Learning”, Fourth Edition, MIT Press, 2010.

Reference Books:

1. Laurene Fausett, “Fundamentals of Neural Networks, Architectures, Algorithms and Applications”, Pearson Education, 2008.
2. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.
3. Simon Haykin, “Neural Networks and Learning Machines”, Pearson 2008.

Course Title	**Artificial Intelligence**
Course Code (Credit)	**CS30002 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS30001**

Course Objectives:

- To understand the various characteristics of Intelligent agents
- To learn the different search strategies in AI
- To learn to represent knowledge in solving AI problems
- To understand the ways of planning and acting in the real world
- To know about the models behind the AI application

Course Contents:

UNIT I

Introduction:

Introduction, Definition, Future of Artificial Intelligence, Characteristics of Intelligent Agents, Typical Intelligent Agents, Problem Solving Approach to Typical AI problems.

UNIT II

Problem Solving Methods:

Problem solving Methods, Search Strategies, Uninformed, Informed, Heuristics, Local Search Algorithms and Optimization Problems, Searching with Partial Observations, Backtracking Search, Performance of search algorithms.

UNIT III

Knowledge Representation:

First Order Predicate Logic, Unification, Forward Chaining, Backward Chaining, Resolution, Knowledge Representation using First order Predicate logic, Reasoning Systems.

UNIT IV

Planning:

Planning with state-space search, Partial-order planning, Planning graphs, planning and acting in the real world, Plan generation systems.

UNIT V
Uncertain Knowledge and Reasoning:
Uncertainty, Review of probability, Probabilistic Reasoning, Bayesian networks, Inferences in Bayesian networks, Temporal models, Hidden Markov models.

Course Outcomes:
CO1: Discover the concepts, applications, and the theory underlying AI.
CO2: Identify problems that are amenably solved by AI methods
CO3: Analyze the issues of knowledge representation and search techniques.
CO4: Analyze the engineering issues underlying the design of AI systems.
CO5: Discuss the uncertain knowledge on reasoning concepts in AI.
CO6: Apply AI techniques to develop programs to solve real life problems in different domains.

Textbooks:

1. Stuart Russel, Peter. Norvig, "Artificial Intelligence – A Modern Approach", Fourth Edition, Pearson Education, 2022

Reference Books:

1. Introduction to Artificial Intelligence and Expert Systems, Dan W. Patterson, Pearson Education.

Course Title	**High Performance Computing**
Course Code (Credit)	**CS30005 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS21002**

Course Objectives:

- To understand the concept of advanced pipelining techniques
- To understand the current state of art in memory system design
- To know the working principle of I/O devices
- To understand the memory management techniques

Course Contents:

UNIT I:
Introduction, Classes of computers, Defining Computer Architecture, Trends in Technology, Trends in Power and Energy in Integrated Circuits, Trends in Cost, Dependability, Measuring, Reporting and Summarizing Performance, Quantitative Principles of Computer Design

UNIT II:
Basic and Intermediate pipelining Concepts, The Major Hurdle of Pipelining, Pipeline Hazards, Pipelining Implementation, Implementation issues that makes Pipelining hard, Extending the MIPS Pipeline to Handle Multicycle Operations, The MIPS R4000 Pipeline.

UNIT III:
Instruction, Level Parallelism: Concepts and Challenges, Basic Compiler Techniques for Exposing ILP, Reducing Branch Costs with Prediction,

Overcoming Data Hazards with Dynamic Scheduling, Dynamic Scheduling, Hardware, Based Speculation, Exploiting ILP Using Multiple Issue and Static Scheduling, Exploiting ILP, Advanced Techniques for Instruction Delivery and Speculation, Studies of the Limitations of ILP.

UNIT IV:
Vector Architecture, SIMD Instruction Set Extensions for Multimedia, Graphics Processing Units, Detecting and Enhancing Loop-Level Parallelism, Centralized Shared-Memory Architectures, Performance of Shared-Memory Multiprocessors, Distributed Shared Memory, Models of Memory Consistency, Multicore Processors and their Performance.

UNIT V:
Review of Memory Hierarchy Design, Cache Performance, Basic Cache Optimizations, Virtual Memory, Protection and Examples of Virtual Memory, Advanced Optimizations of Cache Performance, Memory Technology and Optimizations, Protection: Virtual Memory and Virtual Machines, Crosscutting Issues: The Design of Memory Hierarchies, Case Studies / Lab Exercises.

Course Outcomes:
Upon completion of the course, the students will be able to:
CO1 : Choose performance metrics to find the performance of systems
CO2 : Identify the program block that requires parallelism for any program
CO3: Comprehend the concept of different types of hazards along with theistructural implementation and applications.
CO4: Elaborate the criteria to enhance the performance of the pipelined processors.
CO5: Design algorithms for memory management techniques for multiprocessor system
CO6: Identify various parallel architecture like centralized anddistributed memory architecture require for real life application

Textbooks:

1. David. A. Patterson, John L. Hennessy, “Computer Architecture: A Quantitative approach”, Sixth Edition, Morgan Kaufmann, 2012.

Reference Books:

1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, “Computer Organization and Embedded Systems”, Sixth Edition, McGraw Hill Inc, 2022.
2. William Stallings “Computer Organization and Architecture”, Eleventh Edition, Pearson Education, 2006.

Course Title	ARM and Advanced Microprocessors
Course Code (Credit)	EC30007 (L-T-P-Cr: 3-0-0-3)

Course Objective:

The objective of this course is to teach the higher-level concepts of Advanced Microprocessors (like 80286, 80386 and Pentium) and ARM to the students. The students learn about Multitasking, Virtual memory, Memory management, Paging, TLB, RISC features, Pipelining and Branch Prediction like concepts. They develop skills for writing programs on ARM to solve simple problems as well as some real time applications.

Course Contents:

UNIT I

Introduction:

Overview of Intel higher level Processors, Concept of Multitasking, Virtual memory & Memory management.

UNIT II

Intel 80286 & 80386:

Brief outline of Processor Architecture, Mode of operation, Segment descriptor, Privilege level & protection and Task switching in 80286, Virtual 86 mode, Paging and TLB in 80386

UNIT III

Pentium Processor:

Features of RISC processors & Implementation of RISC features in Pentium, Pipelining, Superscalar execution & Branch prediction Technique

UNIT IV

ARM & Interfacing:

ARM design, ARM Processor fundamentals: Registers, CPSR, Memory map, Pipelines, Exceptions, Interrupt Vector Table, Introduction to ARM Instruction set and Thumb instructions, Interfacing – LCD, ADC, DAC, Stepper motor, UART.

Course Outcomes:

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

CO1:U*nderstand the concepts implemented in higher level Processors like Multitasking, Virtual Memory, and Memory Management etc.*

CO2: Examine the mode of Operation of 80286, Concept of program invisible registers, Segment Descriptors etc.

CO3: Analyze Segment Descriptors, Privilege level and Protection, Virtual '86 Mode and Paging in 80386, *enhanced features incorporated in 80486*

CO4: A*nalyze the RISC features implemented in the design of Pentium Processors, Parallel processing through U & V Pipelines / Superscalar Execution and Branch Prediction Techniques*

CO5: Acquire the knowledge of a 32-bit ARM Processor, its RISC features, Registers, Pipelining and Interrupts

CO6: E*xamine the 32-bit ARM instruction set, 16-bit Thumb instructions and Interfacing*

Textbooks:

1. Advanced Microprocessor and Peripherals - Architecture, Programming and Interfacing by A. K. Ray and K. M. Bhurchandi - McGraw Hill Eduction Pvt Ltd - 3rd Edition
2. ARM Assembly Language Programming & Architecture - M A Mazidi & others, Micro Digital Ed, ISBN: 9780997925906.

Reference Books:

1. The Intel Microprocessors 8086/8088, 80186/80188, 80386, 80486, Pentium and Pentium Pro - Processor by B. B. Brey - PHI - 8th Edition
2. Microprocessors & Interfacing, Programming & Hardware by D. V. Hall - TMH - 3rd Edition.
3. ARM Assembly Language: Fundamentals and Techniques by William Hohl
4. ARM System Developers Guide Design & Optimizing System Software – Andrew N. Sloss & others - Elsevier.

Course Title	**Multi-Core Programming**
Course Code (Credit)	**CS30007 / L- T- P-Cr: 3-0-0-3**
Pre-requisites	**CS21002**

Course Objectives:

- To understand the fundamentals of multi-core architecture
- To be able to know the basic concepts of multi core programming using threads
- To be able to understand various programming constructs in multi-core architecture
- To be able to understand Multithreaded applications

Course Contents:

UNIT I

Introduction to Multiprocessors and Scalability Issues:

Scalable design principles, Principles of processor design, Instruction Level Parallelism, Thread level parallelism, Parallel computer models, Symmetric and distributed shared memory architectures, Performance Issues, Multi-core Architectures, Software and hardware multithreading, SMT and CMP architectures, Design issues, Case studies, Intel Multi-core architecture, SUN CMP architecture.

UNIT II
Parallel Programming:
Fundamental concepts, Designing for threads, scheduling, Threading and parallel programming constructs, Synchronization, Critical sections, Deadlock, Threading APIs.

UNIT III
OpenMP Programming:
OpenMP, Threading a loop, Thread overheads, Performance issues, Library functions, Solutions to parallel programming problems, Data races, deadlocks and livelocks, Non-blocking algorithms, Memory and cache related issues.

UNIT IV
MPI Programming:
MPI Model, Collective communication, Data decomposition, Communicators and topologies, Point-to-point communication, MPI Library.

UNIT V
Multi Threaded Application Development:
Algorithms, Program development and performance tuning

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: Assess the fundamentals of multi-core architecture
CO2: Comprehend the programming constructs of multi-core systems
CO3: Exploit the benefit of parallel programming
CO4: Identify problems of concurrency for parallel programming
CO5: Design and develop OpenMP Programming
CO6: Design and develop APIs for Multithreaded Applications

Textbooks:

1. Michael J Quinn, “Parallel programming in C with MPI and OpenMP”, Tata McGraw Hill, 2003. (Not Available with the Publisher’s Site)

Reference Books:

1. John L. Hennessey, David A. Patterson, “Computer Architecture – A Quantitative Approach”, Sixth Edition, Morgan Kaufmann Publishers, 2007
2. David E. Culler, Jaswinder Pal Singh, “Parallel Computing Architecture: A Hardware/Software Approach”, Morgan Kaufmann/Elsevier Publishers, 1999.

Course Title	**Distributed Operating Systems**
Course Code (Credit)	**CS30009 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS20002**

Course Objectives:

- To understand the fundamentals of distributed system
- To be able to know the basic concepts of shared memory architecture
- To be able to understand various implementation difficulties of distributed operating systems
- To be able to understand transparency in distributed operating systems

Course Contents:

UNIT-I

Fundamentals of Distributed Systems:

Introduction to distributed systems, Goals of Distributed Systems, Hardware Concepts, Software Concepts, Design Issues, Network Operating Systems, True Distributed System and Time sharing Multiprocessor Operating System, System Architectures.

UNIT-II

Communication in Distributed Systems:

Basics of Communication Systems, Layered Protocols, ATM Models, Client Server Model, Blocking Primitives and Non Blocking Primitives, Buffered Primitives and Unbuffered Primitives, Reliable and Unreliable primitives, Message Passing, Remote Procedure Call.

UNIT-III

Synchronization and Processes:

Clock Synchronization, Mutual Exclusion, Election Algorithm, Atomic Transactions, Deadlock in Distributed Systems, Process and Threads, System Models, Processor Allocation, Process Scheduling.

UNIT-IV

Consistency, Replication and Fault Tolerance:

Data Centric Consistency Models, Client-Centric Consistency Models, Replica Management, Consistency protocols, Fault Tolerance, Process Resilience, Distributed Commit, Reliable Client Server Communication, Reliable Client Server Communication.

UNIT-V

Overview of shared memory:

Architecture, Algorithm, Protocols, Design Issues, consistency model, Page based Distributed Shared Memory, Shared variable Distributed shared Memory, and Object based Distributed Shared Memory.

Course Outcomes:

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

CO1: Assess the concept of Distributed Operating Systems
CO2: Enlist the communication techniques in Distributed Operating Systems
CO3: Determine the clock synchronous concepts and algorithms
CO4: Examine the distributed system that fulfills requirements with regards to key distributed systems properties
CO5: Discuss distributed shared memory architectures and algorithms
CO6: Analyze the distributed files systems

Textbooks:

1. Andrew S. Tanenbaum, "Distributed Operating Systems", Pearson Education, 1995.

Reference Books:

1. G. Coulouris, J. Dollimore, and T. Kindberg, "Distributed Systems: Concepts & Design", Pearson Publication, 4th Edition,2005.
2. Pradeep K. Sinha, "Distributed Operating Systems Concepts and Design", PHI, 1998.

Course Title	**Computational Intelligence**
Course Code (Credit)	**CS30011 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To understand the basic concepts and characteristics of soft computing
- To understand and analyse fuzzy rules, fuzzy reasoning and various fuzzy inference systems
- To be able to know derivative free optimization and apply genetic algorithms to optimization problems
- To apply neural networks to various classification problems.
- To know some hybrid models such as adaptive Neuro-fuzzy inference systems

Course Contents:

UNIT I

Introduction:

Introduction, Soft Computing constituents and Conventional AI, Neuro-Fuzzy and Soft Computing characteristics

UNIT II

Artificial Neural Networks:

Introduction to ANN, Perceptrons and MLP, Adaline and Madaline, Back-propagation Multilayer Perceptrons (BPMLP), Radial Basis Function Networks (RBF), Kohonen Self-Organizing Networks, Learning Vector Quantization, Hebbian Learning, Hopfield networks

UNIT III

Fuzzy Set Theory:

Fuzzy sets, Basic Definition and Terminology, Set-theoretic Operations, Member Function Formulation and Parameterization, More on Union, Intersection and Complement, Extension Principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning, Fuzzy Inference Systems, Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models, Adaptive Neuro-Fuzzy Inference Systems(ANFIS), ANFIS Architecture, Hybrid Learning Algorithm

UNIT IV

Particle Swarm Optimization:

PSO Model, Global Best, Local Best, Velocity Update Equations, Position Update Equations, Velocity Clamping, Inertia Weight, Constriction Coefficients, Synchronous and Asynchronous Updates, Binary PSO.

UNIT V

Differential Evolution:

DE as modified GA, generation of population, operators and their implementation.

UNIT VI

Ant Colony Optimization:

Basic Concepts, Ant System, Application.

UNIT VII

Artificial Bee Colony:

Historical Development, Types of Bees and Their Role in the Optimization Process.

Course Outcomes:

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

CO1: Identify the basic concepts and characteristics of soft computing and also its associated methodologies.
CO2: Apply various set theoretic operations in fuzzy sets.
CO3: Analyze fuzzy rules, fuzzy reasoning and various fuzzy inference systems.
CO4: Choose derivative free optimization and apply genetic algorithms to optimization problems.
CO5: Assess concepts of artificial neural networks and apply neural networks to various classification problems.
CO6: Analyze some hybrid models such as adaptive neuro-fuzzy inference systems.

Textbooks:

1. Neuro-Fuzzy and Soft Computing, Jang, Sun, Mizutani, PearsonEducation

Reference Books:

1. Swarm Intelligence Algorithms: A Tutorial, Adam Slowik, Ed: CRC Press, 2020
2. Neural Networks: A Comprehensive Foundation, Simon Haykin, Pearson Education
3. Genetic Algorithms, David E. Goldberg, Pearson Publication, 2003

Course Title	**Compiler**
Course Code (Credit)	**CM30006 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS21003**

Course Objectives:

- To introduce the major concept areas in compiler design and know the various phases of the compiler
- To understand the various parsing algorithms and comparison of the same
- To provide practical programming skills necessary for designing a compiler
- To gain knowledge about the various code generation principles
- To understand the necessity for code optimization

Course Contents:
UNIT I
Introduction to Compilation:

Compilers, Analysis of the source program, Phases of a compiler, Cousins of the Compiler, Grouping of Phases, Compiler construction tools, Lexical Analysis, Role of Lexical Analyzer, Input Buffering, Specification of Tokens.

Lab Component: Tutorial on LEX / FLEX tool, Tokenization exercises using LEX.

UNIT II
Syntax Analysis:
Role of the parser, Writing Grammars, Context, Free Grammars, Top Down parsing, Recursive Descent Parsing, Predictive Parsing, Bottom-up parsing, Shift Reduce Parsing, Operator Precedent Parsing, LR Parsers, SLR Parser, Canonical LR Parser, LALR Parser.

Lab Component: Tutorial on YACC tool, Parsing exercises using YACC tool.

UNIT III
Intermediate Code Generation:
Intermediate languages, Declarations, Assignment Statements, Boolean Expressions, Case Statements, Back patching, Procedure calls.

Lab Component: A sample language like C-lite is to be chosen. Intermediate code generation exercises for assignment statements, loops, conditional statements using LEX/YACC.

UNIT IV
Code Optimization and Run Time Environments:
Introduction, Principal Sources of Optimization, Optimization of basic Blocks, DAG representation of Basic Blocks, Introduction to Global Data Flow Analysis, Runtime Environments, Source Language issues, Storage Organization, Storage Allocation strategies, Access to non-local names, Parameter Passing, Error detection and recovery.

Lab Component: Local optimization to be implemented using LEX/YACC for the sample language.

UNIT V
Code Generation:
Issues in the design of code generator, The target machine, Runtime Storage management, Basic Blocks and Flow Graphs, Next-use Information, A simple Code generator, DAG based code generation, Peephole Optimization.
Lab Component: DAG construction, Simple Code Generator implementation, DAG based code generation using LEX/YACC for the sample language.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: Identify the phases of a compiler to translate from source code to executable code

CO2: Apply the knowledge of LEX & YACC tool to develop a scanner and parser

CO2: Design and develop software system for backend of the compiler

CO3: Suggest the necessity for appropriate code optimization techniques

CO4: Conclude the appropriate code generator algorithm for a given source language

CO5: Identify the effectiveness of optimization and learn various machine independent and machine dependent optimization techniques.

CO6: Design a compiler for any programming language

Textbooks:

1. Alfred V. Aho, Jeffrey D Ullman, "Compilers: Principles, Techniques and Tools", Pearson Education, 2012.

Reference Books:

1. Allen I. Holub, "Compiler Design in C", Prentice Hall of India, 2003.
2. C. N. Fischer, R. J. LeBlanc, "Crafting a compiler with C", Benjamin Cummings, 2003.
3. Henk Alblas, Albert Nymeyer, "Practice and Principles of Compiler Building with C", PHI, 2001.
4. Kenneth C. Louden, "Compiler Construction: Principles and Practice", Thompson Learning, 2003.

Course Title	**Compiler**
Course Code (Credit)	**CM30006 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS21003**

Course Objectives:

- To introduce the major concept areas in compiler design and know the various phases of the compiler
- To understand the various parsing algorithms and comparison of the same
- To provide practical programming skills necessary for designing a compiler
- To gain knowledge about the various code generation principles
- To understand the necessity for code optimization

Course Contents:

UNIT I

Introduction to Compilation:

Compilers, Analysis of the source program, Phases of a compiler, Cousins of the Compiler, Grouping of Phases, Compiler construction tools, Lexical Analysis, Role of Lexical Analyzer, Input Buffering, Specification of Tokens.

Lab Component: Tutorial on LEX / FLEX tool, Tokenization exercises using LEX.

UNIT II
Syntax Analysis:
Role of the parser, Writing Grammars, Context, Free Grammars, Top Down parsing, Recursive Descent Parsing, Predictive Parsing, Bottom-up parsing, Shift Reduce Parsing, Operator Precedent Parsing, LR Parsers, SLR Parser, Canonical LR Parser, LALR Parser.

Lab Component: Tutorial on YACC tool, Parsing exercises using YACC tool.

UNIT III
Intermediate Code Generation:
Intermediate languages, Declarations, Assignment Statements, Boolean Expressions, Case Statements, Back patching, Procedure calls.

Lab Component: A sample language like C-lite is to be chosen. Intermediate code generation exercises for assignment statements, loops, conditional statements using LEX/YACC.

UNIT IV
Code Optimization and Run Time Environments:
Introduction, Principal Sources of Optimization, Optimization of basic Blocks, DAG representation of Basic Blocks, Introduction to Global Data Flow Analysis, Runtime Environments, Source Language issues, Storage Organization, Storage Allocation strategies, Access to non-local names, Parameter Passing, Error detection and recovery.

Lab Component: Local optimization to be implemented using LEX/YACC for the sample language.

UNIT V
Code Generation:
Issues in the design of code generator, The target machine, Runtime Storage management, Basic Blocks and Flow Graphs, Next-use Information, A simple Code generator, DAG based code generation, Peephole Optimization.
Lab Component: DAG construction, Simple Code Generator implementation, DAG based code generation using LEX/YACC for the sample language.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: Identify the phases of a compiler to translate from source code to executable code

CO2: Apply the knowledge of LEX & YACC tool to develop a scanner and parser

CO2: Design and develop software system for backend of the compiler

CO3: Suggest the necessity for appropriate code optimization techniques

CO4: Conclude the appropriate code generator algorithm for a given source language

CO5: Identify the effectiveness of optimization and learn various machine independent and machine dependent optimization techniques.

CO6: Design a compiler for any programming language

Textbooks:

2. Alfred V. Aho, Jeffrey D Ullman, "Compilers: Principles, Techniques and Tools", Pearson Education, 2012.

Reference Books:

5. Allen I. Holub, "Compiler Design in C", Prentice Hall of India, 2003.
6. C. N. Fischer, R. J. LeBlanc, "Crafting a compiler with C", Benjamin Cummings, 2003.
7. Henk Alblas, Albert Nymeyer, "Practice and Principles of Compiler Building with C", PHI, 2001.
8. Kenneth C. Louden, "Compiler Construction: Principles and Practice", Thompson Learning, 2003.

Course Title	**Data Mining and Data Warehousing**
Course Code (Credit)	**CS30013 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS20006**

Course Objective:

- To understand the basic principles, concepts, applications of data mining and data mining tools.
- To know the kinds of patterns discovered by association rule mining algorithms
- To understand various classification and prediction algorithms
- To be able to apply data mining techniques on web, spatial, temporal, text and multimedia data mining.

Course Content:

UNIT I

Introduction to Data Mining Systems:

Knowledge Discovery Process, Data Mining Techniques, Issues, applications, Data Objects and attribute types, Statistical description of data.
Data Preprocessing: Cleaning, Integration, Reduction, Transformation and discretization, Data Visualization, Data similarity and dissimilarity measures

UNIT II
Data Warehousing and Online Analytical Processing:
Basic Concepts, Data Warehousing Architecture, Multidimensional Data Model, Data Warehouse Schemas for Decision Support, Building a Data Warehouse , Concept Hierarchies, Characteristics of OLAP Systems, Typical OLAP Operations, OLAP and OLTP.

UNIT III
Frequent Pattern Analysis:
Mining Frequent Patterns, Market Basket Analysis: The Apriori Algorithm: Finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiently of Apriori, Mining Frequent Itemsets without Candidate Generation, Measuring the Quality of Rules, Association Mining to Correlation Analysis.

UNIT IV
Classification and Prediction:
Issues Regarding Classification and Prediction, Classification by Decision Tree Introduction, Naïve Bayesian Classification, Rule Based Classification, Classification by Back propagation, Support Vector Machines, Lazy Learners, Other Classification Methods, Prediction: Simple linear regression, Accuracy and Error Measures, Evaluating the Accuracy of a Classifier or Predictor.

UNIT V
Clustering:
Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Partitioning Methods: K-Means, K-medoids, Hierarchical methods: Agglomerative and Divisive Hierarchical Clustering, Density, Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Clustering High, Dimensional Data.

Course Outcome:

Upon completion of this course, the students will be able to:
CO1: Compile the basic principles, concepts, applications of data mining and familiar with mathematical foundations of data mining tools.
CO2: Interpret the fundamental concepts, benefits, operations associated with data warehousing and develop data warehousing models.
CO3: Evaluate the kinds of patterns discovered by association rule mining algorithms.

CO4: Analyze various classification and prediction algorithms for model designing.
CO5: Apply various clustering algorithms to solve the real problems.
CO6: Adapt various data mining techniques on web, spatial, temporal, text and multimedia data mining.

Textbooks:

1. J. Han and M. Kamber, “Data Mining: Concepts and Techniques”, 4th Edition, Morgan Kaufman, 2015.

Reference Books:

1. M. H. Dunham, “Data Mining: Introductory and Advanced Topics”, Pearson Education, 2006.
2. I. H. Witten and E. Frank, “Data Mining: Practical Machine Learning Tools and Techniques,” Morgan Kaufmann, 2000.
3. D. Hand, H. Mannila and P. Smyth. Principles of Data Mining. The MIT Press. 2001.

Course Title	**Image Processing and Applications**
Course Code (Credit)	**CS30015 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**MA21002**

Course Objectives

- To learn the fundamentals of image processing and various transformation applied in an image
- To learn image enhancement techniques
- To understand image restoration
- To impart knowledge on different compression techniques
- To discuss on image segmentation and feature representations

Course Contents:

UNIT I
Introduction:
Introduction to Digital Image Processing, Characteristics of Digital Image, Basic relationship between pixels, Image sampling and quantization, Color models, Basic Geometric Transformations, Fourier Transform, Cosine, Sine and Hartley Transform, Hadamard-Haar-Slant Transform, Discrete Fourier Transform.

UNIT II
Image Enhancement Techniques:
Spatial Domain Methods, Basic Grey Level Transformation, Histogram Processing, Image subtraction, Im Agile Software Development age averaging, Spatial filtering, Smoothing, Sharpening filters, Laplacian

filters, Frequency domain filters, Smoothing, Sharpening filters, Homomorphic filtering.

UNIT III

Image Restoration:

Model of Image Degradation/restoration process, Noise models, Spatial and Frequency Filters, Inverse filtering & Wiener Filtering, Least mean square filtering, Constrained least mean square filtering.

UNIT IV

Image Compression Fundamentals:

Image Compression Models, Lossless compression: Variable length coding, LZW coding, Bit plane coding, Predictive coding, DPCM, Lossy Compression: Lossy Predictive Coding, Transform coding, Wavelet coding.

UNIT V

Image Segmentation & Analysis:

Image Segmentation techniques, Edge detection, Thresholding, Region, Boundary Extraction & Representation, Region, Moment representation, chain codes, Polygonal approximation, Texture, Pattern Recognition. Applications, Finger print/iris recognition, Remote sensing, Automatic character recognition, Medical image processing.

Course Outcomes:

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

CO1: Compare various image enhancement techniques

CO2: Construct the image from the degraded image

CO3: Analyze and use appropriate image compression techniques

CO4: Suggest proper image feature for classification problems

CO5: Apply the theory and algorithms that are widely used in digital image processing

CO5: Build image processing applications for real world problems

Textbooks:

1. Rafael C. Gonzalez, Richard E Woods, “Digital Image Processing”, Fourth Edition, Pearson Education, 2018.

Reference Books:

1. A.K. Jain, “Fundamentals of Digital Image Processing”, PHI, New Delhi, 1995.
2. S E Umbaugh, “Digital Image Processing and Analysis: Application with MATLAB and CVIP Tools”, Third Edition, Taylor & Francis, CRC Press, 2018.
3. Frank Y. Shih, “Image Processing and Pattern Recognition”, Wiley – IEEE Press, 2010.

Course Title	**Cloud Computing**
Course Code (Credit)	**CS30010 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS20002**

Course Objectives

- To provide an in-depth and comprehensive knowledge of the deployment models in Cloud Computing
- To understand the enabling technologies needed for establishing cloud environment
- To motivate students to do programming and experiment with the various cloud computing environments
- To shed light on the cloud providers and software platforms
- To introduce about different programming models in cloud computing

Course Contents:

UNIT I
Introduction:
Evolution: Clustering, Grid computing, Virtualization, Basic concepts, Benefits and Risks, Roles and Boundaries, Characteristics, XaaS based service offerings, Basic Deployment models.

UNIT II
Enabling Technologies:
Networks: ISPs, Connectionless Packet Switching, Router-based Interconnectivity, Technical and Business Considerations, Data Center: Standardization and Modularity, Automation, Remote Operation, High Availability, Hardware Virtualization: Hardware Independence, Server Consolidation, Resource Replication, OS and hardware based Virtualization, Web Technology, Multitenant Technology, Service Technology.

UNIT III
Computing Mechanisms:
Infrastructure: Logical Network Perimeter, Virtual Server, Storage Device, Usage Monitor, Resource Replication, Specialized: Automated Scaling Listener, Load Balancer, Monitors, Failover System, Hypervisor, Resource Cluster, Multi-Device Broker, State Management Database, Management: Resource, SLA, Billing, Remote Administration, Security.

UNIT IV
Cloud Providers & Software Platforms:
Globally available public clouds (Microsoft Azure, Amazon Web Services, Google Cloud Platform): Overview and Comparison, Instances, Images, Networking and Security, Storage, Monitoring and Automation, Introduction to Open-source softwares: Eucalyptus, Open Nebula, Open Stack, Apache Cloud Stack.

UNIT V

Programming Models & Advances:

Introduction to Map Reduce, Apache Spark, Tensor Flow, Inter cloud: Architecture, Resource Provisioning, Billing, Security, Mobile Cloud Computing: Resource Allocation, Security, Business Aspects, Application, Future Scope, Introduction to Edge and Fog Computing.

Course Outcomes

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

CO1: Articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing

CO2: Compare the various cloud services and cloud platforms

CO3: Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, Public cloud, Private cloud, Hybrid cloud

CO4: Adopt suitable computing mechanisms for establishing a cloud environment

CO5: Examine various cloud applications and issues.

CO6: Provide the appropriate cloud computing solutions and recommendations according to the applications used

Textbooks:

1. Kai Hwang, Geoffrey C. Fox, and Jack J. Dongarra, "Distributed and Cloud Computing from Parallel Processing to the Internet of Things", Morgan Kaufmann, Elsevier, 2012.

Reference Books:

1. Tim Mather, Subra Kumaraswamy, Shahed Latif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance", O'Reilly, 2009.

Course Title	**Computer Vision**
Course Code (Credit)	**CS30026 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS40007**

Course Objective:

- To understand image formation and camera calibration
- To understand stereo vision and stereo camera geometry
- To be able to know structures from motions
- To know machine learning for computer vision

Course Contents:

UNIT I

Image formation and camera calibration:

Introduction to computer vision, Geometric camera models, Orthographic and perspective projections, Weak perspective projection, Intrinsic and extrinsic camera parameters, Linear and nonlinear approaches of camera calibration.

UNIT II

Feature detection and matching:

Edge detection, Interest points and corners, Local image features, Feature matching and Hough transform, Model fitting and RANSAC, Scale invariant feature matching.

UNIT III

Stereo Vision:

Stereo camera geometry and epipolar constraints, Essential and fundamental matrix, Image rectification, Local methods for stereo matching: Correlation and multi-scale approaches, Global methods for stereo matching: Order constraints and dynamic programming, Smoothness and graph-based energy minimization, Optical flow.

UNIT IV

Shape from Shading:

Modeling pixel brightness, Reflection at surfaces, The Lambertian and specular model, Area sources, Photometric stereo: Shape from multiple shaded images, Modeling inter-reflection, Shape from one shaded image.

UNIT V:

Structure from motion:

Camera self-calibration, Euclidean structure and motion from two images, Euclidean structure and motion from multiple images, Structure and motion from weak-perspective and multiple cameras.

UNIT VI:

Machine Learning for Computer Vision:

Introduction to Machine Learning, Image Classification, Object Detection, Semantic Segmentation, Case study on computer vision and machine learning for applied research.

Course Outcome:

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

CO1: Categorizing of image formation and camera calibration
CO2: Apply the concepts of feature detection, Feature reduction, and matching.
CO3: Analyze the concepts of stereo vision and stereo camera geometry.
CO4: Design the concepts of generating shapes from shading.
CO5: Identifying the concepts of structures from motions.

CO6: Determine the concepts of machine learning for computer vision for applied research.

Textbooks:

1. Forsyth, D. A. and Ponce, J., "Computer Vision: A Modern Approach", 2nd Ed., Pearson Education.

Reference Books:

1. Hartley, R. and Zisserman, A., "Multiple View Geometry in Computer Vision", Cambridge University Press.

Course Title	**Software Project Management**
Course Code (Credit)	**CS30012 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS31001**

Course Objectives:

- Recognize basic concepts and issues of software project management
- Emphasize successful software projects that support organization's strategic goals
- Comprehend software quality issues
- Comprehend software risk issues
- Analyse SPM tools

Course Contents:

UNIT I

SPM Concepts:

Definition, Components of SPM, Challenges and opportunities, Tools and techniques, Managing human resource and technical resource, Costing and pricing of projects, Training and development, Project management techniques.*

UNIT II

Software Measurements:

Monitoring & measurement of SW development, Cost, Size and time metrics, Methods and tools for metrics, Issues of metrics in multiple projects.*

UNIT III

Software Quality:

Quality in SW development, Quality assurance, Quality standards and certifications, The process and issues in obtaining certifications, The benefits and implications for the organization and its customers, Change management.*

UNIT IV

Risk Issues:

The risk issues in SW development and implementation, Identification of risks, Resolving and avoiding risks, Tools and methods for identifying risk management.*

UNIT V
SPM Tools:
Software project management using Primavera & Redmine, Case study on SPM tools.*
*Programming assignments are mandatory.

Course Outcomes:
Upon completion of this course, the students will be able to:
CO1: Identify the job roles of an IT project manager to conduct project planning activities
CO2: Plan to maintain and monitor software projects and processes
CO3: Design and develop project modules and assign resources
CO4: Comprehend, assess, and estimate the cost of risk involved in a project management
CO5: Analyze the tools for risk management
CO6: Design a Case study using SPM tools

Textbooks:
1. Richard H. Thayer, “Software Engineering Project Management”, Second Edition, John Wiley & Sons, 2001.
2. Royce, Walker, “Software Project Management”, First Edition, Pearson Education, 1998.

Reference Books:
1. Kelker S. A., “Software Project Management”, Third Edition, PHI, 2003
2. Kan, Stephen H., “Metrics and Models in Software Quality Engineering”, Addison-Wesley Longman Publishing Co. Inc., 2002.
3. Galin, Daniel, “Software Quality Assurance: From Theory to Implementation”, Addison-Wesley, 2004.

Course Title	**Time Series Forecasting**
Course Code (Credit)	**CS30014 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**MA21002**

Course Objective:
- To understand time series models
- To be able to know Stationary process and ARMA models
- To understand parallel programming models
- To understand forecasting algorithm

Course Contents:
UNIT I:

Introduction to time series forecasting:
Introduction: Examples of time series, Stationary models and auto correlation function, Estimation and elimination of trend and seasonal components. Stationary Process and ARMA Models: Basic properties and linear processes, Introduction to ARMA models, Properties of sample mean and autocorrelation function, Forecasting stationary time series, ARMA (p, q) processes, ACF and PACF, Forecasting of ARMA processes.

UNIT II:
Spectral Analysis:
Spectral densities, Time-invariant linear filters, the spectral density of an ARMA process. Modeling and Forecasting with ARMA Processes: Preliminary estimation, Maximum likelihood estimation, Diagnostics, Forecasting, Order selection.

UNIT III:
Non-stationary and Seasonal Time Series Models:
ARIMA models, Identification techniques, Unit roots in time series, Forecasting ARIMA models, Seasonal ARIMA models, Regression with ARMA errors.

UNIT IV:
Multivariate Time Series:
Second-order properties of multivariate time series, Estimation of the mean and covariance, Multivariate ARMA processes, Best linear predictors of second-order random vectors, Modeling and forecasting.

UNIT V:
State-Space Models:
State-space representations, The basic structure model, State-space representation of ARIMA models, The Kalman Recursions, Estimation for state-space models.

Forecasting Techniques: The ARAR algorithm, The Holt-Winter algorithm, The Holt-Winter seasonal algorithm.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: Determine and analyzing important time series models and their applications in various fields.
CO2: Analyzing real life problems using Stationary process and ARMA models
CO3: Estimate the models from real data by using statistical software to and draw conclusions and develop solutions.
CO4: Implementation of parallel systems to critically evaluate the strengths

and weaknesses of parallel programming models.

CO5: Implementation of the ARIMA model.

CO6: Discussing different forecasting algorithm to analyze larger and more complex data.

Textbooks:

1. Brockwell, Peter J. and Davis, Richard A. (2002). Introduction to Time Series and Forecasting, 3rd edition. Springer-Verlag, New York.
2. Box, G. E. P., Jenkins, G.M. and Reinsel, G. C. (1994). Time Series Analysis: Forecasting and Control, Third Edition, Prentice Hall, New Jersey.

Reference Books:

1. Box, G. E. P., Jenkins, G. M. and Reinsel, G.C. (1994). Time Series Analysis: Forecasting and Control, 3rd Edition, Prentice Hall, New Jersey.
2. Chatfield, C. (1996). The Analysis of Time Series, 5th edition, Chapman and Hall, New York.
3. Shumway, R.H., Stoffer, D.S. (2006). Time Series Analysis and Its Applications (with R examples). Springer-Verlag, New York.
4. James D. Hamilton (1994). Time Series Analysis, 1st Edition, Princeton University Press.
5. Galit Shmueli and Kenneth C. Lichtendahl Jr (2016). Practical Time Series Forecasting with R: A Hands-On Guide, 2nd Edition, Axelrod Schnall Publishers.

Course Title	**Natural Language Processing**
Course Code (Credit)	**CS30016 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CM30006**

Course Objectives:

- To understand the steps involved in Natural language processing
- To learn about the lexical, syntactic and semantic analysis of natural language processing
- To explore the various parsing techniques for natural languages
- To understand the statistical models for Natural language processing
- To learn about the various applications involved in Natural language processing

Course Contents:

UNIT I

Lexical Analysis:

Lexical Analysis, Regular expression and Automata for string matching, Words and Word Forms, Morphology fundamentals, Morphological Diversity of Indian Languages, Morphology Paradigms, Finite State

Machine, Transducers Based Morphology, Automatic Morphology Learning, Parts of Speech, N-gram Models, Hidden Markov Models.*

UNIT II
Speech Processing:
Biology of Speech Processing, Place and Manner of Articulation, Word Boundary Detection, Argmax based computations, HMM and Speech Recognition, Text to Speech Synthesis, Rule based, Concatenative based approach.

UNIT III
Parsing:
Theories of Parsing, Parsing Algorithms, Earley Parser, CYK Parser, Probabilistic Parsing, CYK, Resolving attachment and structural ambiguity, Shallow Parsing, Dependency Parsing, Named Entity Recognition, Maximum Entropy Models, Conditional Random Fields.*

UNIT IV
Lexical Knowledge Networks:
Meaning: Lexical Knowledge Networks, Wordnet Theory, Indian Language Wordnets and Multilingual Dictionaries, Semantic Roles, Word Sense Disambiguation, WSD and Multilinguality, Metaphors, Coreference and Anaphora Resolution.*

UNIT V
Applications:
Applications: Sentiment Analysis, Text Entailment, Machine Translation, Question Answering System, Information Retrieval, Information Extraction Cross Lingual Information Retrieval (CLIR).*

*Programming Assignments are mandatory.

Course Outcomes:
Upon completion of the course, the students will be able to:

CO1: Evaluate different computing architectures for natural language processing for various parameters
CO2: Justify the various steps necessary for processing natural language
CO3: Suggest appropriate lexical and parsing techniques for a given natural language
CO4: Apply appropriate statistical models for a given natural language application
CO5: Modify existing algorithms to suit any natural language for processing
CO6: Suggest appropriate pre-processing steps essential for the various applications involving natural language processing

Textbooks:

1. Christopher Manning, Schutze Heinrich, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.

Reference Books:

1. Allen James, "Natural Language Understanding", Second Edition, Benjamin Cumming, 1995.

Course Title	Deep Learning Techniques
Course Code (Credit)	**CS40001 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS31001**

Course Objectives:

- To introduce building blocks of deep neural network architecture
- To learn deep learning algorithms and its problem settings
- To understand representation and transfer of knowledge using deep learning
- To learn to use deep learning tools and framework for solving real-life problems
- To use Python for Deep Learning

Course Contents:

UNIT I

Deep Networks:

Deep Feedforward Networks, Learning XOR, Gradient Based learning, Hidden Units, Back-propagation and other Differential Algorithms, Regularization for Deep Learning, Optimization for training Deep Models.

UNIT II

Convolutional Networks:

Convolution operation, Motivation, Pooling, Convolution and Pooling as strong prior, Efficient convolution algorithms, Unsupervised features, Sequence Modeling: Recurrent and Recursive Nets, LSTM Networks, Applications, Computer Vision, Speech Recognition, Natural Language Processing.

UNIT III

Linear factor Models:

Probabilistic PCA and Factor Analysis, Independent Component Analysis (ICA), Auto encoders, Regularized Auto encoders, Representational Power, Layer size and Depth, Stochastic Auto encoders, Applications.

UNIT IV

Representation Learning:

Greedy Layer-wise Unsupervised Pre-Training, Transfer learning and

Domain Adaptation, Deep Generative Models.

UNIT V
Deep Learning with Python:
Introduction to Keras and Tensor flow, Deep Learning for computer vision, convnets, Deep Learning for Text and Sequences, Generative Deep Learning, Text Generation with LSTM, DeepDream, Neural Style Transfer, Generating images with variational auto encoders, Generative Adversarial Networks (GAN).

Course Outcomes:

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

CO1: Assess the concept of deep learning

CO2: Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains

CO3: Incorporate transfer of knowledge in machine learning algorithms

CO4: Implement deep learning algorithms and solve real-world problems

CO5: Develop Deep Learning techniques using Python

CO6: Represent learning Models

Textbooks:
1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, The MIT Press, 2016.

Reference Books:
1. Francois Chollet, “Deep Learning with Python”, Manning Publications, 2017.
2. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems”, First Edition, O'Reilly Media, 2017.
3. Josh Patterson, “Deep Learning: A Practitioner's Approach”, First Edition, O'Reilly Media.

Course Title	**Software Testing and Automation**
Course Code (Credit)	**CS40003 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS31001**

Course Objectives:
- To understand the criteria for test cases
- To Develop and design test cases
- To Analyse test management and test automation techniques
- To Assess test metrics and measurements

- To Design and validate website testing

Course Contents:

UNIT I

Introduction:

Testing as an Engineering Activity, Testing as a Process, Testing Maturity Model, Testing axioms, Basic definitions, Software Testing Principles, The Tester‘s Role in a Software Development Organization, Origins of Defects, Cost of defects, Defect Classes, The Defect Repository and Test Design, Defect Examples, Developer/Tester Support of Developing a Defect Repository.

UNIT II

Test Case Design Strategies:

Test case Design Strategies, Using Black Box Approach to Test Case Design, Boundary Value Analysis, Equivalence Class Partitioning, State based testing, Cause-effect graphing, Compatibility testing, User documentation testing, Domain testing, Random Testing, Requirements based testing, Using White Box Approach to Test design, Test Adequacy Criteria, Static testing vs. Structural testing, Code functional testing, Coverage and Control Flow Graphs, Covering Code Logic, Paths, Code complexity testing, Additional White box testing approaches, Evaluating Test Adequacy Criteria.

UNIT III

Levels of Testing:

The need for Levels of Testing, Unit Test, Unit Test Planning, Designing the Unit Tests, The Test Harness, Running the Unit tests and Recording results, Integration tests, Designing Integration Tests, Integration Test Planning, Scenario testing, Defect bash elimination System Testing, Acceptance testing, Performance testing, Regression Testing, Internationalization testing, Ad-hoc testing, Alpha Beta Tests, Testing OO systems, Usability and Accessibility testing, Configuration testing, Compatibility testing, Testing the documentation, Website testing.

UNIT IV

Test Management:

People and organizational issues in testing, Organization structures for testing teams, Testing services, Test Planning, Test Plan Components, Test Plan Attachments, Locating Test Items, Test management, Test process, Reporting Test Results, Introducing the test specialist, Skills needed by a test specialist, Building a Testing Group, The Structure of Testing Group, The Technical Training Program.

UNIT V

Test Automation:

Software test automation, skills needed for automation, Scope of automation, Design and architecture for automation, Requirements for a test tool, Challenges in automation, Test metrics and measurements –

project- progress and productivity metrics.

Course Outcomes:

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

CO1: Identify suitable tests to be carried out
CO2: Design test cases suitable for a software development for different domains
CO3: Prepare test planning based on the document
CO4: Document test plans and test cases designed
CO5: Apply automatic testing tools
CO6: Develop and validate a test plan

Textbooks:

1. Srinivasan Desikan, Gopalaswamy Ramesh, "Software Testing: Principles and Practices", Pearson Education, 2006.
2. Ron Patton, "Software Testing", Second Edition, Second Edition, Sams Publishing, 2007.

Reference Books:

1. Ilene Burnstein, "Practical Software Testing", Springer International Edition, 2003.
2. Edward Kit, "Software Testing in the Real World – Improving the Process", O'Reilly(Sams), 1995.
3. Boris Beizer, "Software Testing Techniques", Second Edition, Wiley, 1990.
4. Aditya P. Mathur, "Foundations of Software Testing Fundamental Algorithms and Techniques", Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 2008

Course Title	**Human Computer Interaction**
Course Code (Credit)	**CS40005 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To provide an overview of the concepts of human-computer interfaces
- To understand the theoretical dimensions of human factors involved in the acceptance of computer interfaces
- To understand the implementation of human-computer interfaces
- To identify the various tools and techniques for interface analysis, design and evaluation

Course Contents:

UNIT I:

HCI Foundations: Input–output channels, Human memory, Thinking: reasoning and problem solving, Emotion, Individual differences, Psychology and the design of interactive systems, Text entry devices, Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction, Physical controls, Sensors and special devices, Paper: Printing and scanning.

UNIT II:
Designing, Programming Interactive systems, Models of interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of the WIMP interface, The context of the interaction, Experience, Engagement and fun, Paradigms for interaction. Cantered Design and testing, Interaction design basics, The process of design, User focus, Scenarios, Navigation design, Screen design and layout, Iteration and prototyping.

UNIT III:
HCI in the software process, Iterative design and prototyping, Design rules, Principles to support usability, Standards and Guidelines, Golden rules and heuristics, HCI patterns. Implementation support, Elements of windowing systems, Programming the application, Using toolkits, User interface management systems.

UNIT IV:
Evaluation techniques, Evaluation through expert analysis, Evaluation through user participation, Universal design, User support. Models and Theories, Cognitive models, Goal and task hierarchies, Linguistic models, The challenge of display- based systems, Physical and device models, Cognitive architectures.

UNIT V:
Collaboration and communication, Face-to-face communication, Conversation, Text-based communication, Group working, Dialog design notations, Diagrammatic notations, Textual dialog notations, Dialog semantics, Dialog analysis and design Human factors and security, Groupware, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware, Implementing synchronous groupware, Mixed, Augmented and Virtual Reality.

Course Outcomes:
Upon completion of the course, the students will be able to:

CO1: Describe the Human Computer Interaction and its fundamentals.
CO2: Design and Develop processes and life cycle of Human Computer Interaction
CO3: Analyze product usability evaluations and testing methods
CO4: Apply the interface design standards/guidelines for cross cultural and disabled users
CO5: Categorize, Design and Develop Human Computer Interaction in proper architectural structures
CO6: Build the application oriented human computer interface for solving real life problems.

Textbooks:

1. Alan Dix, Janet Finlay, G D Abowd, R Beale, "Human, Computer Interaction", Third Edition, Pearson Publishers, 2008.
2. Shneiderman, Plaisant, Cohen, Jacobs, "Designing the User Interface: Strategies for Effective Human Computer Interaction", Fifth Edition, Pearson Publishers, 2010.

Course Title	**Computer Graphics and Multimedia Systems**
Course Code (Credit)	**CS40007 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**MA21002**

Course Objectives

- To understand the basics of various inputs and output computer graphics hardware devices
- Exploration of fundamental concepts in 2D and 3D computer graphics
- To know 2D raster graphics techniques, 3D modeling, geometric transformations, 3D viewing and rendering
- Exploration of fundamental concepts in multimedia systems, file handling, hypermedia

Course Contents:

UNIT I
Basic of Computer Graphics:

Applications of computer graphics, Display devices, Random and Raster scan systems, Color models, Graphics Primitives: Points, Lines, Circles and ellipses as primitives, Scan conversion algorithms for primitives.*

UNIT II
Two-Dimensional Graphics:
Two dimensional geometric transformations, Matrix representations and homogeneous coordinates, Composite transformations, Two dimensional viewing, Viewing pipeline, Viewing coordinate reference frame, Window to viewport coordinate transformation, Two dimensional viewing functions, Clipping operations, Point, Line, Polygon clipping algorithms.*

UNIT III
Three-Dimensional Graphics:
Three dimensional concepts, Three dimensional object representations, Polygon surfaces, Polygon tables, Plane equations, Polygon meshes, Curved Lines and surfaces, Quadratic surfaces, Blobby objects, Spline

representations, Bezier curves and surfaces, B-Spline curves and surfaces, Transformation and Viewing: Three dimensional geometric and modeling transformations, Translation, Rotation, Scaling, composite transformations, Three dimensional viewing, Viewing pipeline, Viewing coordinates, Projections, Clipping.*

UNIT IV
Multimedia System Design & Multimedia File Handling:
Data and File Formats, Multimedia basics, Multimedia applications, Multimedia system architecture, Evolving technologies for multimedia, Defining objects for multimedia systems, Multimedia data interface standards, Multimedia databases, Compression and decompression, Data and file format standards, Multimedia I/O technologies, Digital voice and audio, Video image and animation, Full motion video, Storage and retrieval technologies.*

UNIT V:
Hypermedia:
Multimedia authoring and user interface, Hypermedia messaging, Mobile messaging, Hypermedia message component, Creating hypermedia message, Integrated multimedia message standards, Integrated document management, Distributed multimedia systems.*

*Programming assignments are mandatory.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Make use of various computer graphics hardware and display technologies
CO2: Analyze and implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling

CO3: Identify the use of three dimensional graphics, 3D geometric transformations, projections to detect visible surfaces
CO4: Apply 2D and 3D viewing technologies into the real world applications

CO5: Implement multimedia components efficiently
CO6: Design and develop of modeling, rendering, shading and animation.

Textbooks:

1. James. D. Foley, A. Van Dam, S. K. Feiner, J. F. Hughes, “ComputerGraphics: Principles and practice”, Third Edition, Pearson, 1997.

2. Donald Hearn, Pauline Baker M, "Computer Graphics in C Version", Pearson Education, 2007.
3. Andleigh, P. K, Kiran Thakrar, "Multimedia Systems and Design", Pearson Education, 2003.

Reference Books:

1. D. F. Rogers, J. A. Adams, "Mathematical Elements for Computer Graphics", Second Edition, McGraw Hill International Edition, 1990.
2. F. S. Hill Jr., "Computer Graphics using OpenGL", Third Edition, Pearson Education, 2003.
3. "The OpenGL Reference Manual, The Bluebook", Version 1.4, Fourth Edition, Addison-Wesley.
4. Judith Jeffcoate, "Multimedia in Practice: Technology and Applications", Pearson Education, 1998.
5. "The OpenGL Programming Guide, The Redbook", Version 2, Fifth Edition, Addison-Wesley.

Course Title	**Principles of Cryptography**
Course Code (Credit)	**IT40009 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To gain knowledge about the mathematics of the cryptographic algorithms
- To get an insight into the working of different existing cryptographic algorithms
- To learn about key exchange protocols and attacks on such protocols
- To introduce the fundamental concepts of hash functions and digital signatures
- To learn how to use cryptographic algorithms in security

Course Contents:

UNIT I

Mathematical Foundations:

Number Theory: Fermat's theorem, Cauchy 's theorem, Chinese remainder theorem, Primality testing algorithm, Euclid's algorithm for integers, quadratic residues, Legendre symbol, Jacobi symbol.*

UNIT II

Classical Cryptosystems:

Cryptography and cryptanalysis, Classical Cryptography, different type of attack: CMA, CPA, CCA, Shannon perfect secrecy, OTP, Pseudo random bit generators, stream ciphers and RC4.*

UNIT III

Symmetric Key Ciphers:
Block ciphers: Modes of operation, DES and its variants, finite fields (2^n), AES, linear and differential cryptanalysis.*

UNIT IV
Asymmetric Key Ciphers:
One-way function, Trapdoor one-way function, Public key cryptography, RSA cryptosystem, Diffie-Hellman key exchange algorithm, ElGamal Cryptosystem.*

UNIT V
Message Authentication:
Cryptographic hash functions, secure hash algorithm, Message authentication, digital signature, RSA digital signature.*
*Programming assignments are mandatory.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: Identify the relevance of number theory, group, ring, finite fields and modular arithmetic in various contexts of Cryptography
CO2: Assess use of symmetric cryptosystem, public key cryptosystem and digital signature scheme
CO3: Design and implement cryptographic protocols
CO4: Discuss the security of cryptographic algorithms
CO5: Evaluate the security of a protocol based on security metrics
CO6: Justify the usage of security principles and digital signatures for any application

Textbooks:
1. Stinson. D., "Cryptography: Theory and Practice", Third Edition, Chapman & Hall/CRC, 2012.
2. Douglas Robert Stinson, Maura Paterson. "Cryptography: Theory and Practice", Fourth Edition, Chapman & Hall/CRC, 2012.

Reference Books:
1. W. Mao, "Modern Cryptography: Theory & Practice", Pearson Education, 2010.
2. William. Stallings, "Cryptography and Network Security Principles and practice", Seventh Edition, Pearson Education, 2013.

Course Title	**Nature Inspired Computing**
Course Code (Credit)	**CS40002 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To gain knowledge on present and future computing paradigm changes with examples found in the real world
- To design of various computing models using cellular automata, biological and quantum computing.
- To be able to explain the application of NIC for solving real world problem.

Course Contents:

UNIT I

Introduction to NIC Computers:

Computing paradigms inspired by nature, Cellular automata, biological computers, quantum computers, neural networks and molecular computing.

UNIT II

Nature Inspired Computing for Problem-Solving:

Artificial neural networks, Artificial immune systems, Swarm intelligence; Evolutionary algorithms, Ant colony optimization, Particle swarm optimization; Diffusion search

UNIT III

Nature Inspired Computing for Modeling:

Artificial life like forms and behaviour, Creative evolutionary art, Foraging and satisfying, Autonomous self-organizing systems, Competition and cooperation, Collective/crowd behaviour, Social trend and consensus.

UNIT IV

Immunocomputing:

Introduction, Immune System, Physiology and main components, Pattern Recognition and Binding , Immune Network Theory, Danger Theory, Evaluation Interaction, Immune Algorithms , Introduction, Genetic algorithms, Bone Marrow Models , Forest's Algorithm**,** Artificial Immune Networks

UNIT V

Computing With New Natural Materials:

DNA Computing: Motivation, DNA Molecule , Adleman's experiment , Test tube programming language, Universal DNA Computers , PAM Model, Splicing Systems, Lipton's Solution to SAT Problem , Scope of DNA Computing , From Classical to DNA Computing

Course Outcomes:

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

CO1: Identify the needs for present and future computing paradigm changes with examples found in the real world

CO2: Formulate and implement the nature-inspired computing (NIC) approaches in the contexts of problem-solving and modeling.

CO3: Design of various computing model and use of cellular automata, biological and quantum computing.

CO4: Explain the application of NIC for solving real world problem.

CO5: Describe the nature and characteristics of case study problems or applications

CO6: Recommend new NIC methods and their general applicability to solve the critical problems.

Textbooks:

1. D. Floreano and C. Mattiussi, Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies, MIT Press, 2008.

Reference Books:

1. L. Nunes de Castro, Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications. Chapman and Hall/CRC, Boca Raton, Florida, 2006.
2. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA, 2008.
3. Albert Y.Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006.

Course Title	**IOT and Applications**
Course Code (Credit)	**CS40004 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To learn the basic issues, policy and challenges in the Internet
- To get an idea of some of the application areas where Internet of Things can be applied
- To understand the cloud and internet environment
- To understand the various modes of communications with Internet
- To understand about web of things

Course Contents:

Unit I
Introduction:
Definition, Foundations, Challenges and Issues, Identification, Security, Components in internet of things**:** Control Units, Sensors, Communication modules, Power Sources, Communication Technologies, RFID, Bluetooth, Zigbee, Wifi, Rflinks, Mobile Internet, Wired Communication, IoT Platform Overview, Raspberrypi, Arduino boards.*

Unit II
IoT Protocols:

Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Protocols, IEEE 802.15.4, BACNet Protocol, Zigbee Architecture, Network layer, APS Layer Security.*

Unit III
Resource Management in the Internet of Things:
Clustering, Software Agents, Data Synchronization, Clustering Principles in an Internet of Things Architecture, The Role of Context, Design Guidelines, Software Agents for Object Data Synchronization, Types of Network Architectures, Fundamental Concepts of Agility and Autonomy, Enabling Autonomy and Agility by the Internet of Things, The Evolution from the RFID-based EPC Network to an Agent based Internet of Things, Agents for the behaviour of Objects.*

Unit IV
Case Study and IoT Application Development:
IoT applications in home infrastructures security Industries, IoT electronic equipments, Use of Big Data and Visualization in IoT, Industry 4.0 concepts, Sensors and sensor Node, Interfacing using Raspberry Pi/Arduino, Web Enabled Constrained Devices.*

Unit V
Web of Things:
Web of Things versus Internet of Things, Architecture Standardization for WoT, Platform Middleware for WoT, WoT Portals and Business Intelligence, Cloud of Things: Grid/SOA and Cloud Computing, Cloud Standards, Cloud of Things Architecture, Open Source e-Health sensor platform.*

*Programming assignments are mandatory.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: Identify the components of IoT

CO2: Analyze various protocols of IoT

CO3: Examine the working of sensors and embedded systems

CO4: Design portable IoT using appropriate boards

CO5: Develop schemes for the applications of IOT in real time scenarios

CO6: Design business Intelligence and Information Security for WoT

Textbooks:

1. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012.
2. Dieter Uckelmann, Mark Harrison, “Architecting the Internet of Things”, Springer, 2011.

Reference Books:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things (A Hands-On-Approach)”, Universities Press, 2014.

2. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things – Key Applications and Protocols”, John Wiley and Sons, 2012.

Course Title	Agile Software Development
Course Code (Credit)	**CS40006 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To develop an understanding on agile software development
- To learn about the principles, planning and requirement in agile software development
- To understand the testing methodologies in agile software development
- To explore the metrics and measurement in agile software development

Course Contents:

UNIT I

Introduction:

Agile Software Development: Basics and Fundamentals of Agile Process Methods, Values of Agile, Principles of Agile, Stakeholders, Challenges Lean Approach: Waste Management, Kaizen and Kanban, Add process and products add value, Roles related to the lifecycle, Differences between Agile and traditional plans, Differences between Agile plans at different lifecycle phases, Testing plan links between testing, Roles and key techniques, principles, Understand as a means of assessing the initial status of a project/ How Agile helps to build quality.

UNIT II

Principles:

Agile and Scrum Principles: Agile Manifesto, Twelve Practices of XP, Scrum Practices, Applying Scrum, Need of scrum, Working of scrum, Advanced Scrum Applications, Scrum and the Organization, Scrum values.

UNIT III

Planning and Product Management:

Agile Product Management: Communication, Planning, Estimation, Managing the Agile approach, Monitoring progress, Targeting and motivating the team, Managing business involvement, Escalating issue, Quality, Risk, Metrics and Measurements.

UNIT IV

Requirements and Testing:

Agile Requirements: User Stories, Backlog Management, Agile Architecture: Feature Driven Development, Agile Risk Management: Risk and Quality Assurance, Agile Tools, Agile Testing: Agile Testing Techniques, Test-Driven Development, User Acceptance Test, Agile Review: Agile Metrics and Measurements, The Agile approach to estimating and project variables.

UNIT V
Measurement:
Agile Measurement, Agile Control, Control parameters, Agile approach to Risk, The Agile approach to Configuration Management, The Atern Principles, Atern Philosophy, Rationale for using Atern, Refactoring, Continuous integration, Automated Build Tools, Scaling Agile for large projects: Scrum of Scrums, Team collaborations, Scrum, Estimate a Scrum Project, Track Scrum Projects, Communication in Scrum Projects, Best Practices to Manage Scrum.

Course Outcomes:

CO1: Assess principles, planning and requirement in agile software development

CO2: Distinguish between agile software development and traditional software development

CO3: Identify Agile Requirements

CO4: Suggest agile software development approaches for any real-time problem

CO5: Provide measurement, metrics necessary for problems involving agile software development

CO6: Inference best practices of traditional and agile software development and use in real-time problem solving

Textbooks:
1. Robert C. Martin, "Agile Software Development, Principles, Patterns, and Practices", First Edition, Pearson Education India, 2002.
2. Mike Cohn "Succeeding with Agile: Software Development Using Scrum", Pearson Education, 2010.

Reference Book
1. Robert C Martin, Micah Martin, "Agile Principles, Patterns and Practices in C#", Pearson Education, 2007.

Course Title	**Social Network Analysis**
Course Code (Credit)	**CS40008 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:
- Recognize the concept of semantic web and related applications
- Employ learn knowledge representation using ontology
- Recognize human behavior in social web and related communities
- Sketch and learn visualization of social networks
- Investigate variety of descriptive measures for networks and software to calculate them

Course Contents:

UNIT I
Introduction:
Introduction to Semantic Web: Limitations of current Web, Development of Semantic Web, Emergence of the Social Web, Social Network analysis: Development of Social Network Analysis, Key concepts and measures in network analysis, Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities, Web-based networks, Applications of Social Network Analysis.

UNIT II
Modelling, Aggregating and Knowledge Presentation:
Ontology and their role in the Semantic Web: Ontology-based knowledge Representation, Ontology languages for the Semantic Web: Resource Description Framework, Web Ontology Language, Modelling and aggregating social network data: State-of-the-art in network data representation, Ontological representation of social individuals, Ontological representation of social relationships, Aggregating and reasoning with social network data, Advanced representations.

UNIT III
Extraction and Mining Communities in Web Social Networks:
Extracting evolution of Web Community from a Series of Web Archive, Detecting communities in social networks, Definition of community, Evaluating communities, Methods for community detection and mining, Applications of community mining algorithms, Tools for detecting communities, social network infrastructures and communities, Decentralized online social networks, Multi-Relational characterization of dynamic social network communities.

UNIT IV
Predicting Human Behavior and Privacy Issues:
Understanding and predicting human behavior for social communities, User data management, Inference and Distribution, Enabling new human experiences, Reality mining, Context, Awareness, Privacy in online social networks, Trust in online environment, Trust models based on subjective logic, Trust network analysis, Trust transitivity analysis, Combining trust and reputation, Trust derivation based on trust comparisons, Attack spectrum and counter measures.

UNIT V
Visualization and Applications of Social Networks:
Graph theory, Centrality, Clustering, Node-Edge Diagrams, Matrix representation, Visualizing online social networks, Visualizing social networks with matrix-based representations, Matrix and Node-Link Diagrams, Hybrid representations, Applications, Cover networks, Community welfare, Collaboration networks, Co- Citation networks.

Course Outcomes:

Upon completion of this course, the students will be able to:
CO1: Develop semantic web related applications
CO2: Describe and Represent knowledge using ontology
CO3: Recognize human behavior in social web and related communities
CO4: Inspect and Predict human behavior in social web and related communities
CO5: Organize and Visualize social networks
CO6: Analyze tools for detecting communities social network infrastructures

Textbooks:

1. Peter Mika, “Social Networks and the Semantic Web”, First Edition, Springer 2007.
2. Borko Furht, “Handbook of Social Network Technologies and Applications”, First Edition, Springer, 2010.

Reference Books:

1. Guandong Xu, Yanchun Zhang, Lin Li, “Web Mining and Social Networking – Techniques and Applications”, First Edition, Springer, 2011.
2. Dion Goh, Schubert Foo, “Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively”, IGI Global Snippet, 2008.
3. Max Chevalier, Christine Julien, Chantal Soulé-Dupuy, “Collaborative and Social Information Retrieval and Access: Techniques for Improved User Modelling”, IGI Global Snippet, 2009.
4. John G. Breslin, Alexander Passant, and Stefan Decker, “The Social Semantic Web”, Springer, 2009.

Course Title	**Augmented and Virtual Reality**
Course Code (Credit)	**CS40010 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS30015**

Course Objectives:

- To know basic concepts of virtual reality
- To understand visual computation in computer graphics
- To understand interaction between system and computer
- To know application of VR in Digital Entertainment
- To know basic concepts of augmented reality

Course Contents:

UNIT I:
Introduction of Virtual Reality:

Fundamental Concept and Components of Virtual Reality, Primary Features and Present Development on Virtual Reality, Multiple Models of Input and Output Interface in Virtual Reality: Input, Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner, Output, Visual /Auditory / Haptic Devices.

UNIT II:
Visual Computation in Virtual Reality:
Fundamentals of Computer Graphics, Software and Hardware Technology on Stereoscopic Display, Advanced Techniques in CG: Management of Large Scale Environments & Real Time Rendering.

UNIT III:
Interactive Techniques in Virtual Reality:
Body Track, Hand Gesture, 3D Manus, Object Grasp.
Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega, MultiGen, Virtools.

UNIT IV:
Application of VR in Digital Entertainment:
VR Technology in Film & TV Production, VR Technology in Physical Exercises and Games, Demonstration of Digital Entertainment by VR.

UNIT V:
Augmented and Mixed Reality: Taxonomy, Technology and features of augmented reality, Difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, Visualization techniques for augmented reality, Wireless displays in educational augmented reality applications, Mobile projection interfaces, Marker-less tracking for augmented reality, Enhancing interactivity in AR environments, Evaluating AR systems.

Course Outcomes:
Upon completion of this course, the students will be able to:
CO1: Discuss the fundamentals and I/O components of the augmented and virtual reality system
CO2: Evaluate different computing architectures for virtual reality
CO3: Provide opportunity to explore the research issues in Augmented Reality and Virtual Reality (AR & VR)
CO4: Apply the different modeling concepts to visual virtualization
CO5: Explore the role of virtual reality in traditional & emerging applications
CO6: Develop prototypes using the concepts for virtual reality

Textbooks:

1. Burdea, G. C., P. Coffet., “Virtual Reality Technology”, Second Edition, Wiley-IEEE Press, 2003/2006.

2. Alan B. Craig, “Understanding Augmented Reality, Concepts and Applications”, Morgan Kaufmann, 2013.

Reference Books:

1. Alan Craig, William Sherman, Jeffrey Will, “Developing Virtual Reality Applications, Foundations of Effective Design”, Morgan Kaufmann, 2009.

PROGRAMME LABORATORY COURSES

Course Title	**Data Structures Laboratory**
Course Code (Credit)	**CS29001 (L-T-P-Cr: 0-0-2-1)**

Course Objectives:

- To understand the practical application of linear and nonlinear data structures
- To introduce and practice advanced algorithms, programming techniques
- To write modules for developing sophisticated computer application programs

Topics Covered:

1. Problems in C/C++ using data structures involving arrays, stacks, queues, strings, linked lists, trees, graphs.
2. Operations on stacks, queues and linked lists.
3. Applications of stack, Conversion of infix expressions to postfix and evaluation of postfix expressions.
4. Application of linked lists – Singly, Doubly.
5. Implementation of priority queue.
6. Implementation of Binary Tree, Binary Search Tree, AVL Trees.
7. Implementation of BFS, DFS – Application of stack, queues.
8. Implementation of Sorting Techniques.

Course Outcomes:

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

CO1: Apply and implement the learned algorithm for problem solving
CO2: Identify the data structure to develop program for real time applications
CO3:Design and develop optimal algorithms using appropriate data structures
CO4: Implementation of priority queue for optimal algorithms
CO5: Implement Binary Tree, Binary Search Tree, AVL Trees for problem solving
CO6: Implement sorting techniques for real time applications

Reference Book:

1. Aaron M. Tenenbaum, Yedidyah Langsam, Moshe J. Augenstein "Data Structures using C", Third Edition, Pearson Education, 2007.

Course Title	Digital Systems Design Lab
Course Code (Credit)	**EC29005 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

Students will be able to gain knowledge and investigate different basic digital circuits to apply in practical digital system design. They will gain knowledge about verilog HDL and how to simulate the digital circuit of both combinational and sequential logic circuits using verilog HDL.

Course Outcomes:

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

CO1: Students will be able to gain knowledge about Verilog HDL and also able to design and simulate various boolean functions.

CO2: Students will be able to simulate and design adder and parallel binary adder.

CO3: Students will be able to simulate and design combinational logic circuits like decoder and Multiplexer.

CO4: Students will be able to simulate and design sequential logic circuits like Synchronous type counter and Asynchronous type counters.

CO5: Students will be able to simulate and design sequential logic circuits using shift registers.

CO6: Students will be able to simulate and design synchronous sequential circuit using concept of finite state machine.

Course Title	Operating Systems Laboratory
Course Code (Credit)	**CS29002 (L-T-P-Cr: 0-0-2-1)**
Pre-requisites	**CS20002**

Course Objectives:

- To understand the concept of Operating System
- To have insight knowledge on different system calls and Unix Utilities
- To experience the practical side of the functioning of various blocks in OS

- To design a real world application by considering process synchronization, Memory management

List of Experiments:

1. Hands on Unix Commands.
2. Shell programming for file handling.
3. Shell Script programming using the commands grep, awk, and sed.
4. Programs on Multithread using P-thread.
5. Implementation of CPU scheduling algorithms.
6. Implementation of Synchronization problems using Semaphores, Message Queues and Shared Memory.
7. Implementation of Memory Management, Allocation, Placement and replacement Algorithms.
8. Implementation of various Disk scheduling algorithms.

Course Outcomes:

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

CO1: Experiment on shell script and P-thread

CO2: Solve synchronization problems

CO3: Develop programs for CPU scheduling, Memory allocation policy

CO4: Devise algorithm for deadlock avoidance

CO5: Implement memory management techniques

CO6: Implement various disk scheduling algorithms

Reference Books:

1. Silberschatz, Galvin, Gagne, “Operating System Concepts”, Ninth Edition,Wiley , 2013.
2. William Stallings, “Operating Systems – Internals and Design Principles”, Nineth Edition, Pearson Publications, 2014.
3. Behrouz A. Forouzan, and Richard F. Gilberg, “UNIX and Shell Programming”, Cengage Learning, 2003.
4. Andrew S. Tanenbaum, “Modern Operating Systems”, Fourth Edition, Pearson Publications, 2014.

Course Title	**Java Programming Laboratory**
Course Code (Credit)	**CS29004 (L-T-P-Cr: 0-0-2-1)**

Course Objectives:

- To impart hands on experience with java programming.
- To learn basic object oriented programming concepts

- To write programs using abstract classes, interfaces and packages
- To handle errors using exception handling technique
- To be able to write program using string and I/O classes.
- To write GUI programs using swing controls in Java.

List of Experiments:

1. Write a class file – box with three data members(length, width, height) and a method volume() . Also implement the application class Demo where an object of the box class is created with user entered dimensions and volume is printed.
2. Write a program to overload addition method with various parameters in a class in Java
3. Write a program which will overload the area () method and display the area of a circle, triangle and square as per user choice and user entered dimensions.
4. A plastic manufacturer sells plastic in different shapes like 2D sheet and 3D box. The cost of sheet is Rs 40/ per square ft. and the cost of box is Rs 60/ per cubic ft. Implement it in Java to calculate the cost of plastic as per the dimensions given by the user where 3D inherits from 2D.
5. Illustrate the execution of constructors in multi-level inheritance with three Java classes – plate(length, width), box(length, width, height), wood box (length, width, height, thick).
6. Write a program in java to define a class Shape which has a data member 'area' and a member function showArea(). Derive two classes Circle and Rectangle from Shape class. Add appropriate data members and member functions to calculate and display the area of Circle and Rectangle.
7. Write a program to create an Account class containing acc_no, balance as data members and disp() to display the details. Write another class Person which inherits all the members of Account class and it has additional data members such as pname and aadharno. Also it overrides disp() method. Write the driver class to display the method overriding technique.
8. Illustrate the usage of abstract class with following Java classes-
   i) An abstract class 'student' with data members as roll no, reg no and an abstract method course()
   ii) A subclass 'kiitian' with course() method implementation

9. Define an interface Motor with a data member –capacity and two methods such as run() and consume(). Define a Java class 'Washing machine' which implements this interface and write the code to check the value of the interface data member thru an object of the class.
10. Define an interface with three methods – earnings(), deductions() and bonus() and define a Java class 'Manager' which uses this interface

without implementing bonus() method. Also define another Java class 'Substaff' which extends from 'Manager' class and implements bonus() method. Write the complete program to find out earnings, deduction and bonus of a sbstaff with basic salary amount entered by the user as per the following guidelines –

earnings → basic + DA (80% of basic) + HRA (15% of basic)

deduction PF → 12% of basic

bonus → 50% of basic

11. Define two packages as – General and Marketing. In General package define a class 'employee' with data members as empid(protected), ename(private) and a public method as earnings() which calculate total earnings as

Earnings, > basic + DA (80% of basic) + HRA (15% of basic)

In Marketing package define a class 'sales' which is extending from 'employee' class and has a method allowance() which calculates Travelling Allowance as 5% of total earning. Write the programs to find out total earning of a sales person for the given basic salary amount and print along with the emp id.

12. Write a program to perform following operations on user entered strings –

i) Change the case of the string
ii) Reverse the string
iii) Compare two strings
iv) Insert one string into another string

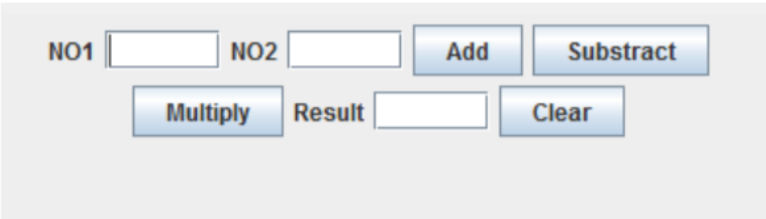
13. Write a Java program to generate an Array Index Out of Bounds Exception and handle it using catch statement.

14. Write a Java class which has a method called Process Input(). This method checks the number entered by the user. If the entered number is negative then throw an user defined exception called Negative Number Exception, otherwise it displays the double value of the entered number.

15. Create an user defined exception named Check Argument to check the number of arguments passed through command line. If the number of arguments is less than four, throw the Check Argument exception, else print the addition of squares of all the four numbers.

16. Design a user registration form using different controls of Swing package.

17. Design a calculator using Swing package as shown below.



18. Design a graphical user interface which consists of two buttons named as RED and BLUE. When the user clicks RED button, a message “you have passed RED” will be displayed in the window. Similarly when the user clicks BLUE button, a message “you have pressed BLUE” will be displayed in the window.

19. Write a program in Java to copy the content of a given file to another user entered file using character stream.

Course Outcomes:

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

CO1: Run java programs using java compiler
CO2: Write java programs using basic object oriented programming concepts
CO3: Write programs using abstract classes interfaces and packages
CO4: Write java program using multi-threading and exception handling
CO5: Design Java application using String and I/O classes
CO6: Design GUI application using Swing and interactive application using event handling and JDBC

Reference Books :

1. Java-The Complete Reference, Herbert Schildt, 10th Edition, McGraw Hill Education, 2014
2. Introduction to JAVA Programming, Y.Daniel Liang, 10th Edition, Pearson Education, 2007

Course Title	Database Management Systems Laboratory
Course Code (Credit)	CS29006 (L-T-P-Cr: 0-0-2-1)
Pre-requisites	CS20006

Course Objectives

- To explore the features of a Database Management Systems
- To interface a database with front end tools
- To understand the internals of a database system
- To identify Structure Query Language statements used in creation and manipulation of Database
- To identify the methodology of conceptual modeling through Entity Relationship model

List of Experiments

1. Working with DDL, DML and DCL.
2. Inbuilt functions in RDBMS.
3. Nested Queries & Join Queries.
4. Set operators & Views in SQL.
5. Control structures.
6. Working with cursors and exception handling
7. Working with Procedures and Functions.
8. Triggers.
9. Dynamic & Embedded SQL.
10. Database Design and implementation (Mini Project).
11. Working with XML*.
12. Forms & Reports*.

Course Outcomes:

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

CO1: Identify Structure Query Language statements used in creation and manipulation of Database

CO2: Use databases for building client server applications

CO3: Comprehend the internal working of a database system

CO4: Design and develop a database using SQL and the mechanism in connecting with a Web based GUI

CO5: Analyze and design a real database application

CO6: Evaluate the efficiency of the database design for real time applications.

Reference Books:

1. Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2006.
2. C. J. Date, A. Kannan, S. Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.

Course Title	Algorithms Laboratory
Course Code (Credit)	CS39001 (L-T-P-Cr: 0-0-2-1)
Pre-requisites	CS21001

Course Objectives:

- To learn how to analyze the complexity of algorithms
- To compare and evaluate algorithms in terms of time and space complexity
- To program brute force, divide and conquer, decrease and conquer, transform and conquer, greedy, and dynamic techniques

List of Experiments:

1. Estimating worst-case/average-case complexity of algorithms via programs.
2. Determining machine constants.
3. Programs involving some advanced data structures.
4. Implementing example problems.
5. Illustrating the different paradigms of algorithm design.
6. Solving miscellaneous problems e.g. problems in string manipulation, graph theory, optimization.

Course Outcomes:

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

CO1: Solve and analyze general algorithms based on space and time complexity
CO2: Implement and empirically compare fundamental algorithms and data structures to real-world problems
CO3: Design, develop, and optimize algorithms in different paradigms
CO4: Implement problems in string manipulation
CO5: Develop solutions using graph theory
CO6: Evaluate optimization techniques for real-world problems

Reference Books:

1. H. S. Wilf, "Algorithms and Complexity", CRC Press.
2. T. H. Cormen, C. E. Leiserson, R. L. Rivest, "Introduction to Algorithms", Prentice Hall.(Foreign Book Available)

Course Title	**Computer Networks Laboratory**
Course Code (Credit)	**CS39003 (L-T-P-Cr: 0-0-2-1)**
Pre-requisites	**CS30003**

Course Objectives:

- To create client and server applications using the "Sockets" API and the implementation of Data link layer protocol and TCP layer
- To conduct computer communication network simulations
- To have a hands on experience of computer network simulation and modelling techniques using NS-3 simulation software

List of Experiments

1. Exercises on Socket Programming using C and Java
2. Exercises using NS-3 Network Simulator

    a. Basics of Network Simulation

    - Introduction , Platform required to run network simulator, Backend Environment of Network Simulator, Agents and applications, Tracing

    b. Simulating a Local Area Network

    - Local Area Network, LAN Topologies, MAC Protocol, Taking turns, Ethernet, Ethernet Frame Structure, Ethernet Versions, Simulating a LAN using Network Simulator3
    - Implementation of various MAC protocols
    - Setting up of various network topologies
    - Measurement of routing protocols

    c. Measuring Network Performance

    - Network Performance Evaluation, Performance Evaluation Metrics, Parameters Affecting the Performance of Networks, Performance Evaluation Techniques, Network Performance Evaluation using NS-3
    - Setting up of network that carries various application protocols and analyzing the performances

3. Hands on experiments on Network equipments

    a. Switches, Routers

    b. Hardware firewall

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Invoke analytical studies of Computer Networks through network simulation
CO2: Design a network using NS-3 toolkit and its importance in designing a real network
CO3: Measure and analyze the network parameters for a high throughput network
CO4: Practice experiments on Network Equipments
CO5: Evaluate Network Performance Evaluation using NS-3
CO6: Build experiments on Network equipments

Reference Books:

1. W. Richard Stevens, “UNIX Network Programming – Networking APIs: Sockets and XTI”, Vol. 1, Second Edition, Prentice Hall, 1998.
2. Eitan Altman, Tania Jimenez, “NS Simulator for Beginners”, Morgan & Claypool Publishers, 2011.

Course Title	**Artificial Intelligence Laboratory**
Course Code (Credit)	**CS39002 (L-T-P-Cr: 0-0-2-1)**
Pre-requisites	**CS30002**

Course Objectives

- To provide skills for designing and analyzing AI based algorithms.
- To enable students to work on various AI tools.
- To provide skills to work towards solution of real life problems

List of Experiments

1. Installation and working on various AI tools viz. Python, R tool, GATE, NLTK, MATLAB, etc.
2. Data preprocessing and annotation and creation of datasets.
3. Implementation of searching techniques, e.g. BFS, DFS, Best First Search, A* search, etc.
4. Implementation of local search algorithms, such as Hill Climbing.
5. Adversarial searching through minimax search algorithm.
6. Solution of 4-queen problem and water jug problem.
7. Solution to the Tower of Hanoi problem.
8. Solution of the 8-puzzle problem.
9. Implementation of tic-tac-toe.
10. Basic classification and clustering algorithms

Course Outcomes:
Upon successful completion of the course, the students will be able to:

CO1: Utilize different AI tools.
CO2: Design and analyze AI based searching algorithms.
CO3: Implement local search algorithms.
CO4: Implement adversarial search and game-playing algorithms.
CO5: Build solutions for benchmark AI problems.
CO6: Develop solutions for real-world problems and understand basic methods of machine learning.

Reference Books:

1. Dan W. Patterson, “Introduction to Artificial Intelligence and Expert System”, Pearson Education, 2007

Course Title	**Applications Development Laboratory**
Course Code (Credit)	**CS33002 (L-T-P-Cr: 0-0-4-2)**

Course Objectives:

- To be familiar with Web page design using HTML/XML and style sheets
- To learn to write Client Server applications
- To be familiar with the PHP programming
- To be exposed to creating applications with AJAX
- Know the components and structure of mobile application development frameworks for Android and windows OS based mobiles
- Learn the basic and important design concepts and issues of development of mobile applications

List of Experiments:

A. **Web Applications**

1. Create a web page for user registration using HTML, CSS and validate the details using Javascript.

2. Write programs in Java using Servlets: (i) To invoke servlets from HTML forms; (ii) Session tracking using hidden form fields and Session tracking for a hit count.

3. Create three-tier applications using JSP for conducting on-line examination for displaying student mark list. Assume that student information is available in a database which has been stored in a database server.

4. Create a database with user information and books information and create a webpage in which books catalogue should be dynamically loaded from the database using AJAX.

5. Create and save an XML document at the server, which contains 10 users Information. Write a Program, which takes user Id as an input and returns the User details by taking the user information from the XML document.

6. Develop email verification application using PHP.

B. **Mobile Applications:**

1. Design restaurant data entry form using Table Layout and show different events using activity class.
2. Write a program to capture image using built in camera and store it in database.
3. Develop a banking application that registers the user by verifying OTP.
4. Develop a native application that uses GPS location information and convert into speech.
5. Write a program to call a number.

Course Outcomes:

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

CO1: Construct Web pages using HTML/XML and style sheets
CO2: Build dynamic web pages with validation using Java Script objects and by applying different event handling mechanisms
CO3: Develop Web application which makes use of PHP programming
CO4: Construct web applications using AJAX
CO5: Design and Implement various mobile applications using emulators
CO6: Deploy applications to hand-held devices

Reference Books:

1. Reto Meier, “Professional Android 4 Application Development”, Wiley, 2012
2. Matthew Gifford, “PhoneGap Mobile Application Development Cookbook”, Packt, 2012.
3. Adrian Kosmaczewski, “Mobile JavaScript Application Development”, O’Reilly, 2012.

Course Title	Internship
Course Code (Credit)	CS48001 (L-T-P-Cr: 2-0-0-2)

Course Objective:

In this course, the students will get opportunity to explore career augmentation aspects prior to graduation, integrate theory and practice, assess interests and abilities in their field of study, learn to appreciate work and its function in the economy, develop work habits and attitudes necessary for job success, develop communication, interpersonal and other critical skills in the job interview process and build a record of work experience.

Course Outcomes:

On completion of the internship, the students will be able to
CO1: apply engineering knowledge in solving real-life problems
CO2: acquire new skills in the engineering disciplines of their own interest
CO3: get exposure to real-life-working environment practices, and to attain the professionalisms
CO4: work with multi-tasking professionals and multidisciplinary team
CO5: prepare a technical report, to improve presentation and other soft skills
CO6: learn to appreciate work and its function in the economy

Course Title	MINI PROJECT
Course Code (Credit)	CS37001 (L-T-P-Cr: 0-0-4-2)

Course Objective:

- Students are required to undertake a mini project either as an individual or in a group in consultation with the project supervisor which may be completed in one semester.
- The project work is aligned with the discipline of the student and its allied areas. It is preferably related to certain research objective or advanced technical domain.
- Students will demonstrate higher level learning outcomes and cognitive skills in the implementation of the project.

Course Outcomes:

Upon completion of this course, the students will be able to:
CO1: perform a background study on certain technical aspect and formulate a project objective
CO2: outline a pathway for the implementation of the project within the time line
CO3: apply fundamental engineering concepts, advanced technical know-how, use modern engineering tools, perform experiments and critically analyze the data

CO4: provide engineering solutions, design system components or processes with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
CO5: function effectively as an individual, and as a member or leader in a team under Multidisciplinary settings following ethical practices
CO6: communicate effectively with a range of audiences and prepare technical reports

Course Title	Project – I / Research Project -I
Course Code (Credit)	**CS47001 (L-T-P-Cr: 0-0-10-5)**

Course Objective:
Students are required to undertake a final year major project either as an individual or in a group in consultation with the project guide which may be completed in one year. The project should be related to certain advanced technical domain. The work encompasses two semesters and to be carried out in two phases. In Project-I, students are expected to complete detailed literature review, identify their objective and start working on the same; perform experiments, carry out analyses and report their findings to their supervisors and the panel.

Course Outcomes:
Upon completion of this course, the students will be able to
CO1: conduct a detailed research survey or background study and summarize the theory and findings
CO2: formulate a research question or a general objective of the project
CO3: propose and outline the solution to the research question or a pathway for the implementation of the project with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
CO4: conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
CO5: function effectively as an individual, and as a member or leader in a team under Multidisciplinary settings following ethical practices
CO6: communicate effectively with a range of audiences and prepare technical reports.

Course Title	Project – II/ Research Project-II
Course Code (Credit)	**CS47002 (L-T-P-Cr: 0-0-18-9)**

Course Objective:
Project-II is a continuation of Project-I, the second phase of final year major project. Students should complete all related experiments, develop a final solution, product or system and validate the applicability of the same under real time scenario with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. They

produce a detailed technical report on their work as well as individual contribution reports. Throughout the implementation of the major final year project, students should demonstrate all cognitive skills and attainment of all program outcomes and student outcomes.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: readily apply fundamental concepts in their area of study for executing the projects
CO2: demonstrate skill in using modern technical tools, apply advanced technical knowledge integrate information from different sources, perform complex experiments and critically analyze the findings to draw conclusions
CO3: provide engineering solutions to predefined research question or project objective**,** design system components or processes with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
CO4: function effectively as an individual, and as a member or leader in a team under
multidisciplinary settings following ethical practices
CO5: communicate effectively with a range of audiences and prepare detailed technical reports
CO6: demonstrate knowledge and understanding of the management principles in executing their project as a member or leader of the team, and willingness to engage in life-long learning.

Course Title	**Web Design**
Course Code (Credit)	**CS28001 (L-T-P-Cr: 0-0-1-1)**

Course Objectives:
Web design and programming is a large field, with different types of technologies implemented by different tools. HTML, CSS, and JavaScript are known to be the three pillars of client-side web programming. After finishing this course, a student should be prepared to write nicely formatted, interactive web pages, with no dependencies on server-side technologies.

Course Contents:
UNIT I
HTML Fundamentals
HTML: Structure of a program, various tags and their roles in HTML programs, Lists: ordered, unordered, definition, Table

UNIT II
More with HTML

Form design,Frames, link and it's types, Images

UNIT III

CSS Essentials

Style sheets: Inline, Internal, External

UNIT IV

JavaScript Basics

Introduction, characteristics, Variables, Data types, Type casting and conversion Functions. Primitives, operators, Control statements, Array, Function, Function – Parameter Passing and dynamic argument and return statement

UNIT V

More with JavaScript

DOM - browser, window, document, image and form object, Properties and Methods of different objects, Predefined Java Script Object - Array, String and Date Object and their methods, Event handling – Link, Body, Image and events associated with different HTML tags

Course Outcome:

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

CO2: Understand the basics of web page design.
CO3: Use formatting instructions of HTML.
CO4: Apply the style formats using CSS.
CO5: Write basic scripts using JavaScript.
CO6: Apply DOM in web pages.
CO7: Create dynamic web pages using HTML and JavaScript.

Textbooks:

1. MASTERING HTML, CSS & Java Script Web Publishing, Laura Lemay, Rafe Colburn and Jennifer Kyrnin, BPB Publications.

Reference Books:

1. HTML, CSS and JavaScript All in One, Sams Teach Yourself, Julie C. Meloni and Jennifer Kyrnin, Pearson Education.
2. HTML 5 Black Book, DT Editorial Services, Dreamtech Press.

HASS ELECTIVE COURSES

Course Title	**Organizational Behaviour**
Course Code (Credit)	**HS20220 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

This course shall guide the students to learn the basic concepts of Organizational Behaviour and its applications in contemporary organizations.

Further, it help them to describe how people behave under different conditions and understand why people behave as they do. The students would be in a position to synthesize related information and evaluate options for the most logical and optimal solution such that they would be able to predict and control human behaviour and improve results. Lastly, this course would help the students to understand how individual, groups and structure have impacts on the organizational effectiveness and efficiency.

Course Contents:
UNIT I
Introduction to Organizational Behaviour:

Organizational Behaviour- nature and scope; Need for studying OB; contributing disciplines to OB; evolution of OB; OB approaches and models; OB opportunities and disruptions

UNIT II
Individual Perspective:
Introduction to Individual behaviour; Personality- concept, determinants, types and theories/models; Personality and OB; Perception- meaning, perceptual process, factors affecting perception; perception and its application in OB; Attitude- nature, components, formation and types; Values- concepts, types and formation; attitude, values and behaviour

UNIT III
Individual Perspective:
Learning- meaning, determinants, theories and principles; learning and behaviour; Motivation- nature, importance, process and theories; managerial implication of motivation- job design, quality of work life and employee engagement; organizational citizenship behaviour- meaning, theoretical perspective, determinants and predictors

UNIT IV
Group Perspective:
Foundation of group behaviour; meaning and characteristics of group; why do people form and join groups; types and groups; stages of group development; group decision making; Team building- meaning and types of team; team building process; Meaning, sources and types of conflict; conflict management and negotiation strategies; Leadership- meaning and importance; differentiating between leader and manager; leadership styles; leadership theories

UNIT V
Organizational Perspective:

Organizational structure- meaning and elements; Organizational culture- meaning, types and functions of culture; creating, sustaining and changing a culture; Organizational change- meaning and need; ; managing resistance to change; Organizational development- meaning, objectives, models and interventions

Course Outcomes:

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

CO1 : Know about organization, organizational behaviour, it's nature, scope and significance,
CO2 : Develop their personality as per industry requirement,
CO3 : Apply motivational techniques to make the employees work with confidence and satisfaction,
CO4 : Develop different leadership styles to adjust themselves in different organizational situations,
CO5 : Improve the knowledge of group behaviour and techniques of group decision making,and
CO6 : Apply the concepts for managing changes in organization as well as the development of an organization's human resources.

Textbooks:

1. Dr. S..S. Khanka,Organizational behaviour texts and cases Sultan Chand, OB text and cases S.S. Khanka, S chand, 2022
2. Stephen P. Robbins, Timothy A. Judg, Neharika Vohra Organizational Behaviour, Pearson, 18th edition, 2018

Reference Books:

1. Fiona M. Wilson,Organizational Behaviour and Work Oxford University Press,2014
2. K. Aswathappa ,Organizational Behaviour, , Himalaya Publishing House, 2013

Course Title	**Economics Of Development**
Course Code (Credit)	**HS20120 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

The objective of this course is to provide students with the essential tools and concepts of development economics, to prepare them to understand what makes underdevelopment persist and what helps development succeed. Students will explore diverse dimension and measures of development, as well as the application of microeconomic analysis to issues of development in poor countries, including the study of household decisions and the analysis of institutions and norms influencing development. And To enhance students understanding of the SDGs to create a better- informed citizenry, which will lead to a more sustainable action by all and for all.

Course Contents:

UNIT I

Economic Growth and Development:

Meaning of development and Economic growth, Characteristics of less developed countries. Factors in Economic development, Measuring development and development gap — per capita income, inequality of income and wealth, Gini coefficient, Human Development Index, Physical Quality of Life Index, and other indices of development.

UNIT II

Theories of Economic Growth and Development:

Theories of Economic Development: Classical (Smith, Ricardo, Malthus), Marxian – Theory of Social change, immutable laws, Crisis in capitalism, Schumpeter and capitalist development, Rostow's stages of growth. Partial theories of growth and development: Vicious circle of Poverty, Big push, balanced growth, unbalanced growth,

UNIT III

International aspects of Economic Development:

International trade as an engine of growth; Static and dynamic gains from trade; Prebisch, Singer and Myrdal theses vs. free trade; Export-led growth; Tariffs and effective protection; WTO and developing countries. External resources; FDI; Aid vs. trade;

UNIT IV

Development and Environment:

Economy linkage; Environment as a necessity and luxury; Population environment linkage. Allocation problem; Market failure for environmental goods; environment as a public good.

UNIT V

Sustainable Development:

Concept and indicators of sustainable development. Common Property Resources, Property right approach to environmental problem-property rights approach, property rights and environmental problems, Externalities and Pigovian tax, Coase theorem, Coase theorem and transaction cost. Prevention, control and abatement of pollution.

Course Outcome:

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

CO1: Understand key factors and issues in the process of economic development.
CO2: Enhance their ability in applying economic models to study development Problems,
CO3: Learning the role of the three basic components of ecosystems and environment and underlying causes of their degradation,
CO4: Understand the policy scenario and the existing environmental conventions/ regulations/ laws,
CO5: Development of sustainable planning for sustainable development of environment, economy and firms, and
CO6: select and apply appropriate economic techniques to solve environmental problems and measure the value of environmental goods.

Textbooks:

1. S.Ghatak, An Introduction to Development Economics, Allen and Unwin, London,2003
2. Kindleberger, C. P. Economic Development, McGraw Hill, New York, 1958
3. Todaro, M. P. Economic Development, Longman, London.

References Books:

1. Thirwal, A. P. Growth and Development, Macmillan, U. K,2017
2. Adelman, I. Theories of Economic Growth and Development. Stanford University Press, Stanford, 1966
3. Chenery, H. and T.N. Srinivasan (Eds) Handbook of Development Economics, Vols 1 & 2 Elsevier, Amsterdam, 2002
4. Myint, H. Economic Theory and Underdeveloped Countries, Oxford University Press, New York,1971

Course Title	**International Economic Cooperation**
Course Code (Credit)	**HS20122 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

This course's overarching objective is to equip students with knowledge of both the toretical concepts and the actual procedures involved in international trade. The specific purpose is to increase the knowledge of importing and exporting essentials and to offer the with the skills for understanding the international trading process.

Course Contents:

UNIT I

Theories of International Trade

Classical Theories of International Trade- Mercantilism, Absolute Advantage,Comparative advantage Theory, Gains from international trade; Terms of trade; Theory of Reciprocal Demand; Modern Theories of International Trade-Heckscher-Ohlin theory

UNIT II

Free Trade,Protection and Balance of Payment

Free trade and protection in developing countries; Forms, methods and effects of protection; Introduction of BoP; Structure of BoP; Disequilibrium in BoP; Measures to overcome disequilibrium in BoP., Tariff; Trade creation vs Trade diversion.

UNIT III

International Organizations:

International Monetary Fund; World Trade Organasation; Regional Trade Agreements; Trade Blocs.

UNIT IV

Foreign Exchange:

Foreign Exchange Market; Theories of foreign exchange; Factors affecting exchange rate; Fixed and flexible exchange rate; FERA and FEMA.

UNIT V

EXIM Policies

Recent budgetary policies and programs relating to inequality; Analysis of Economic Survey data.

Course Outcomes:

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

CO1 : Learn theories of international trade,
CO2 : Understand free trade, protection, and BOP,
CO3 : Analyse the role of international organisations,
CO4 : Understand the working of foreign exchange,
CO5 : Study the EXIM policies,and
CO6 : Analyse secondary data relating to international trade.

Text Books:

1. R. R Paul, *Money Banking and International Trade*, Kalyani Publishers; 12th edition,2015, ISBN-10 : 932725774X ISBN-13 : 978-9327257748
2. Bo Södersten and Geoffrey Reed, Palgrave Macmillan, International Economics. 1994, ISBN-10 : 0333612167 ISBN-13 : 978-0333612163

Reference Books:

1. Dominick Salvatore, International Economics: Trade and Finance, Wiley; Eleventh edition,2017, ISBN-10 : 8126552344 ISBN-13 : 978-8126552344

2. Paul R. Krugman, Maurice Obstfeld, Marc Melitz, *International Trade: Theory and Policy*, 2017, ISBN-10 : 9789332585768 ISBN-13 : 978-9332585768

Course Title	Business Ethics And Corporate Governance
Course Code (Credit)	HS30223 (L-T-P-Cr: 3-0-0-3)

Course objective:
This course focuses upon the fundamental principles and standards that should govern the business organizations. The objective of this paper is to make the students aware about the importance of ethics, corporate governance and role of CSR & sustainable development goals in the business to encourage moral practices and sensitivity towards the ethical dimension of managerial problems.

Course Contents:
UNIT I
Business Ethics: Concept, Principles & Theories:
Meaning, objective and types of Ethics; Business ethics- concept, need, scope, objectives and importance; factors influencing business ethics; Principles of Business ethics; Relationship between ethics and business ethics; theories of business ethics; Ethical dilemma and ethical decision making

UNIT II
Ethics in Practice across the domain:
Ethics in marketing- introduction, ethical dilemma in marketing, unethical marketing practices, measures to stop unethical practices in marketing; Ethics in Finance- introduction, code of ethics in finance, unethical practices in finance or frauds, measures to stop unethical practices in finance; Ethics in HRM- introduction, ethical issues in HRM (job discrimination, sexual harassment, employee privacy, whistle blowing, affirmative action); importance of workplace ethics and employee code of conduct

UNIT III
Corporate Governance:
Corporate Governance- concept, objective and need. Role of law in corporate governance; important issues in corporate governance; Corporate governance in India-past, present and Future; Importance and principles of Corporate Governance

UNIT IV
Introduction to Corporate Social Responsibility:

CSR- Concept, evolution and development; Why CSR; Apprehensions against CSR; Forms and dimensions of CSR; making business corporations socially responsible; CSR in India

UNIT V

Sustainable Development:

Introduction, meaning, history, features, objectives of sustainable development; The pillars and principles of sustainable development; SDG and its relevance in business

Course Outcomes:

Upon completion of the Course, the Student will be able to

CO1: Familiarize the learners with the concept and relevance of Business Ethics in the modern era,

CO2: Understand the value of business ethics which will guide them in maintaining firm moral values while taking managerial decision,

CO3: Apply the ability to make moral judgments in dilemmatic situations across the work domains,

CO4: Analyse the application of management practices by adhering to corporate law and ethics,

CO5: Evaluate the scope, opportunity and complexity of Corporate Social responsibility in the global and Indian context

CO6: Create an opportunity to understand the sustainable development goals in maintaining a balance between the economic, environmental and social needs.

Textbooks:

1. Dr. K. Nirmala, Dr. B.A. Karunakara Reddy & N. Aruna Rani, Business Ethics and Corporate Governance, Himalaya Publication House
2. C.S.V. Murthy, Business Ethics and Corporate Governance, Himalaya Publishing, 2022

Reference Books:

1. Prabhakaran Paleri,Corporate Social Responsibility (concept, cases and trends Cengage Learning India Pvt. Limited, 2020
2. Dr. S.S. Khanka,Business Ethics and Corporate Governance, Sultan Chand, 2019
3. C.U. Saraf, Corporate Social Responsibility (CSR), Corporate Governance, Sustainable Development and Corporate Ethics/Business Ethics Himalaya Publishing House 2017.

Course Title	**Leadership And Team Effectiveness**
Course Code (Credit)	**HS 30225 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

An effective leader understands the team dynamics, stimulates the morale of the followers and always aims at creating a participative workforce by enhancing team work. This course mainly focuses on individual, group and organization factors associated with leadership. There is a strong connection between emotional intelligence and leadership because the technical skills and knowledge will definitely help the students to fulfil the entry level requirements. Similarly, understanding employee empowerment would assist the students in acquiring the desirable professional skills.

Course Contents:

UNIT I

Leadership: concepts and practices:

Meaning, Definition and understanding of leadership; the role and functions of a leader; Differentiation between leadership and management; ; what makes a leader effective; characteristics of an effective leader; leadership in Indian organization

UNIT II

Leadership Perspectives:

Trait perspective of leadership (Great man theory and trait theory); Behavioural perspective of leadership (mangerial grid and likert system - four management); Studies on leadership (Hawthorne, IOWA, Michigan and Ohio); Contingency perspective of leadership (fiedler's contency theory, path goal, hersey blanchard situational theory); contemporary perspective to leadership (transformational, transactional, charasmatic, servant and Nurturant-task leadership style)

UNIT III

Team effectiveness and Leadership:

Characteristics and types of teams; types and functions of group; Group vs team; understanding an effective team; who is a team leader; tuckman's team development stages; team development and team building; team meetings and leadership; team effectiveness leadership model; high-performance teams and leadership;team cohesiveness; common threats to groups

UNIT IV

Emotional Intelligence and Leadership:

What are emotions; Meaning, type and source of emotions; Concept and competencies of emotional intelligence; Elements of emotional intelligence; importance of EI; EI at workplace; Emotional intelligence and leadership; Significance of EI for leaders; strategies to enhance EQ in our jobs; EQ vs. IQ; developing EQ; obstacles to the development of EQ

UNIT V

Leadership and empowerment:

Employee empowerment- concept, need and importance; approaches to empowerment; advantages and disadvantages of empowerment; empowerment skills of a leader; empowering vs. Dis-empowering; leader as a coach (coaching skill); delegation (advantages and levels of delegation, steps and principles of effective delegation); empowering interpersonal skills

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Learn the characteristics and need of an effective leader,
CO2: Understand the effectiveness of different leadership styles in different contexts from an instrumental, political and ethical perspective,
CO3: Apply leadership theories to the real business scenario,
CO4: Analyse group dynamics and importance of team work,
CO5: Evaluate the ways to handle emotions and stress and manage work-life flexibility,and
CO6: Create organizational environment that is psychologically safe and make the employees feel empowered.

Textbook:

1. Ranjana Mittal,Leadership Personal effectiveness and Team Building, Vikas Publishing House Pvt Ltd, 2015

Reference Book:

1. S. Bhargava and Gourav Bhargava,Team Building and Leadership Neelam Himalaya Publishing House, 2015

Course Title	**Market Structure And Pricing Policie**
Course Code (Credit)	**HS30125 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

Develop the ability for getting conceptual clarity about the various types of markets along with their functions and understand the pricing policy operations in the different markets.

Course Contents:

UNIT I

Cost and Revenue Analysis:

Concepts of cost (economic cost, production cost, real cost, opportunity cost, private & social cost), cost function, Output maximisation and cost minimisation, Derivation of cost function, traditional and modern theories of costs. Concepts of revenue (total, average, marginal revenue), relationship between TR, AR and MR.

UNIT II

Market Structures and Perfect Competition:

Meaning of market, characteristics of market, and types of market.
Perfectly competitive market and features, equilibrium of the firm and industry under perfect competition (short run and long run).

UNIT III

Monopoly Market:

Meaning, concepts and characteristics of monopoly market.
Equilibrium price and output determination under monopoly market in short and long run. Monopoly price discrimination. Degree of monopoly power and its measure.
Control and regulation of monopoly power.

UNIT IV

Duopoly and Oligopoly Market

Non-collusive oligopoly: Cournot's duopoly and Kinked-Demand Model.
Collusive oligopoly: Cartel; Cartels aiming at joint profit maximization and market sharing cartels.
Price leadership; low-cost price leadership, dominant firm price leadership and barometric price leadership.

UNIT V

Monopolistic Competition

Meaning, price determination of a firm under monopolistic competition; Chamberlin's group equilibrium; theory of excess capacity; selling costs; difference between perfect competition and monopolistic competition; difference between monopoly and monopolistic competition.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Comprehend the significance of different components of market,
CO2: Analyze the basic economic concepts required for various types of market and their policies,
CO3: Develop the problem solving aptitude through practical and case study problems faced by the economy,
CO4: Able to use the economic tools in the decision making process of fixing prices and quantities in different Market,
CO5: Differentiate between different markets and the policy measures to regulate it, and
CO6: Survey and map the impact of the current micro and macro-economic situations in the economy.

Textbooks:

1. Koutsoyiannis, Modern Microeconomics, St. Martin's Press, New York,2nd Edition 1979, ISBN 978-0-333-25349-6
2. G. S. Maddala , Ellen M. Miller ,Microeconomics: Theory and Applications, , McGraw-Hill Inc.,US-Publisher, 1989, 0070394156-ISBN
3. H L Ahuja, Modern Microeconomics: Theory & Applications, S Chand Publishing,2022, ISBN : 9789355011015,

Reference Books:

1. Robert Pindyck, Daniel Rubinfeld, Microeconomics ,Eighth Edition, 2017, 9789332585096-ISBN,
2. Pearson Education Publication
3. G. Fransico Stigler, Theory of Price, Prentice Hall of India, New Delhi, 4th Edition 1996.
4. H. Gravelle and R. Rees, Microeconomics, Person Education U.K. 3rd Edition 2007, 2007ISBN: 9788131716557, 8131716554
5. H. R. Varian , Micro Economic Analysis, W W Norton & Company; New York, 3rd edition 2019, ISBN-13 : 978-8130908632

Course Title	**Pragmatic Inquiry**
Course Code (Credit)	**HS30127 (L-T-P-Cr: 3-0-03)**

Course Objective:

As a foundation for lifelong inquiry, this course introduces students to research techniques and how they are used in both liberal arts, technical and professional courses.

Course Contents:

UNIT I

Pragmatic Inquiry:

Meaning, characteristics, need, type, and approaches.

UNIT II

Research Problem:

Meaning, definition, selection, and framing of problem statement.

UNIT III

Research Design:

Meaning, characteristics, need, type, approaches, and problems of research design.

UNIT IV

Sampling Design:

Meaning, characteristics, need, type, approaches, and problems.

UNIT V
Data Collection Method and Analysis:
Types of data, Source of data, Methods of data collection, data analysis.

Course Outcome:
Upon completion of the course, the students will be able to:
CO1 : Understand the meaning and importance of research in behavioral science
CO2 : Describe in detail different types of research methodologies,
CO3 : Identify the strengths and weaknesses of the different study designs,
CO4 : Assess whether research studies are using the most appropriate study design
CO5 : Discuss why various approaches may be appropriate/ inappropriate for their work-based research Question, and
CO6 : Apply the concepts in research related activity.

Textbooks:
1. Deepak Chawla & Neena Sodhi, Research Methodology: Concepts and Cases, Vikas Publishing House,2018, ISBN-10: 9325982390, ISBN-13: 978-9325982390.

Reference Books:
1. C R Kothari and Gaurav Garg, Research Methodology, New Age International Publishers,2019,ISBN-10 9386649225, ISBN-13- 978-9386649225
2. S.K. Mangal, Research Methodology in Behavioural Sciences, Prentice Hall India Learning Private Limited, 2013, ISBN-10 : 9788120348080, ISBN-13 : 978-8120348080
3. Sameer S. Phanse, Research Methodology-Logic, Methods, and Cases,OUP, Sameer S. Phanse,2016 ISBN: 9780199453788.

Course Title	**Economic Analysis Of Decision Rules**
Course Code (Credit)	**HS30129 (L-T-P-Cr: 3-0-03)**

Course Objective:

Analyze and understand investment decisions under the conditions of risk and uncertainty. Particular economic models are not the ends, but the means for illustrating the method of applying mathematical techniques to economic theory in general.

Course Contents:

UNIT I
Investment Decisions under Risk and Uncertainty:
Concepts of Risk and Uncertainty; Investment Decisions under Risk: The Pay-Off Matrix Method, Risk-Adjusted Discount Rate Method, Certainty-Equivalent Approach, Probability Theory Approach, Decision Tree Method, Simulation, Sensitivity Analysis.

UNIT II

Game Theory and Strategic behaviour of Firms:

Basics of Game Theory, Prisoners' Dilemma: The Problem of Oligopoly Firms; Application of Game Theory to Oligopolistic Strategy; Nash Equilibrium: Pure and Mixed Strategy

UNIT III

Optimization: Constrained & Extrema:

Free and constrained optimization, extrema of a function of two variables: graphical analysis, Lagrange method. Utility maximization & Cost minimization.

UNIT IV

Linear and Non-Linear Programming for Business Decisions:

Conditions for Application of Linear Programming; Concept of Feasible Solution; Assumptions of Linear Programming Application of Linear Programming Technique: Profit Maximization Problem, Formulation of Profit Maximization Problem in Linear Programming Mode; Graphical Method of Solving Linear Programming Problems; Simplex Method: Algebraic Solution, Simplex Tableau Method. Introduction to Non-Linear Programming

UNIT IV

Input-Output Analysis:

Input-output model, its structure and its derivation. The use of input output model in Economics.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Analyze and understand investment decisions under the conditions of risk and uncertainty,

CO2: Explain how game theory brings out the strategy used by the oligopoly firms to determine the best possible action to maximize profit-maximizing objective,

CO3: Understand functional formulation of the problem and application of linear programming,

CO4: Describes different concepts used in analysing the national income and the different methods applied to measure the national income,

CO5: Describe and explain the main channels of the monetary transmission mechanism through monetary and fiscal policy,and

CO6: Describe managerial decisions through the application of some economic concepts, theories and principles.

Textbooks:

1. D. N. Dwivedi, H L Bhatia, S N Maheshwari, VIKAS® PUBLISHING HOUSE PRIVATE LIMITED, 2022

Reference Books:

1. C. Chiang and K. Wainwright, Fundamental Methods of Mathematical Economics, McGraw Hill International Edition, 2017
2. K. Sydsaeter and P. J. Hammond:, Mathematics for Economic Analysis, Pearson Educational Asia, 2002

Course Title	Economics Of Health And Education
Course Code (Credit)	**HS30131 (L-T-P-Cr: 3-0-0-3)**

Course Objective:
The United Nations member states' adoption of the Millennium Development Goals, which include among other objectives achieving universal primary education, reducing child mortality, enhancing maternal health, and combating diseases, reflects the significance of education and health in enhancing wellbeing. This course offers a microeconomic framework to examine, among other things, individual preference in the demand for health and education, governmental involvement, and elements of inequality and discrimination in both sectors. An outline of India's health and education system is also provided.

Course Contents:
UNIT I
Role of Health and Education in Human Development:
Importance of health and education outcomes and their relationship with macroeconomic performance.

UNIT II
Health Economics Market:
Demand for health; uncertainty and health insurance market; alternative insurance mechanisms; market failure and rationale for public intervention; equity and inequality.

UNIT III
Education: Investment in Human Capital:
Rate of return to education: private and social; quality of education; signaling or human capital; theories of discrimination; gender and caste discrimination in India.

UNIT IV
Health and Education Sectors in India: An Overview
Health outcomes; health systems; health financing. Cost effectiveness and cost-benefit analysis; burden of disease. Literacy rates, school participation, school quality measures.

UNIT V
Trend in Health and Education Sector in India:

Secondary data analysis pertaining to health and education sector. Trend analysis and forecasting using time series data. Simple growth rate calculations.

Course Outcomes:
Upon completion of the course, the students will be able to:

CO1: Understanding role of health and education in human development,
CO2: Analysing microeconomic foundations of health economics,
CO3: Assessing the growth of health sector in India,
CO4: Appraising the benefits of investment in human capital,
CO5: Assessing the growth of education health sector in India, and
CO6: Examining the underling discrepancies in both sectors.

Textbooks:
1. S. K. Mishra, and V. K. Puri, *Indian Economy*, Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6

Reference Books:
1. William, Jack, *Principles of Health Economics for Developing Countries*, World Bank Institute Development Studies, 1999.
2. World Development Report, *Investing in Health*, The World Bank, 1993.
3. G.Ronald, Ehrenberg and S.Robert, Smith, *Modern Labor Economics: Theory and Public Policy*, Addison Wesley, 2005.
4. Charniack Eugene, "Statistical Language Learning", MIT Press, 1993.

Course Title	**Tribal Resource Management**
Course Code (Credit)	**HS30423 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

The course intends to impart a comprehensive knowledge about the reality, pertaining to economic alleviation of the poor and downtrodden. It is inter-disciplinary and based on utilization of natural resources employing traditional means of approach, conducive for societal growth and development. This shall hone socioeconomic environmental development for uplifting the condition of tribal population for igniting new ideas in the new economy.

Course Contents:
UNIT I
Natural Resource Management
Introduction to Natural Resources and their management: Natural Resource Management (NRM): Concept, Issue and Approaches; Need for developing extension strategies for NRM; Issues in management of NRM; Problems encountered while advocating strategies for NRM; Monitoring and auditing in

Natural Resource Management (NRM); Triple Bottom Line (TBL) and concept of Sustainable Natural Resource Management; NRM of Water, land and forests: Water resources and their management, Overview of irrigation management, Integrated Watershed management and rainwater harvesting, River Basin management; Scope of market mechanism in NRM

UNIT II

Agribusiness Management

Agricultural value chains and their relevance; Managerial Insights: Identifying agribusiness opportunities; Assessing feasibility – technical, commercial and financial and thereby identify feasible opportunities for projects; Analyzing influences of external environment factors and associated risks; Discussions on illustrative agribusiness projects; select models and opportunities of agribusiness opportunities and ventures.

UNIT III

Environmental Resource Management of Tribals

Environment and Development-Theories of optimal use of exhaustible and renewable resources; Sustainable Development - The concept of sustainable development; strong and weak sustainability; Mechanism for environment regulation in India; environmental laws and their implementation; Environmental Policy in India-Policy instruments for controlling water and air pollution and forestry policy; Institution for forest Management- The institutions of joint forest management , social foresty-rationale and benefits

UNIT IV

Tribal Health and Education Management

Role of Health and Education in Tribal Development: Importance in poverty alleviation; health and education outcomes and their relationship with macroeconomic performance; Tribal Health in India: An Overview Health outcomes; health systems; health; Evaluation of Health Programs for tribals: Costing, cost-effectiveness and cost benefit analysis; burden of disease; Tribal Education in India: An Overview Literacy rates, school participation, school quality measures

UNIT V

Agro forestry Management

Multiplicity of Agroforestry products and services- ecological and economic and cultural considerations- gender equality- preservation of indigenous knowledge. Socioeconomic benefits of agroforestry; Smallholder livelihood and the role of agroforestry- Food and nutritional security Fulfillment of food, fodder, fuelwood and shelter based needs- income generation vs. subsistence production; Adoption of AF- Determinants of adoption: feasibility, profitability, and acceptability; . Self-efficacy in farmer decision-making - policy aspects.

Course Outcome:
Upon completion of this course, the students will be able to:

CO1: Identify the concept of sustainable natural resource management,
CO2: Recognize agribusiness management, its opportunities and risks,
CO3: Discuss adequate skills to prepare and implement integrated development plan & projects for
the optimal use of tribal renewable resources for the sustainable development of the environment,
CO4: Illustrate the nuances of environmental policies and Laws in India and understand the core competencies required for resource mobilization and policy formulation based on the research insight,
CO5: Prioritize the role of health and education for the development of tribal community, considering tribal people as resources, and
CO6: Develop trainees or volunteers as competent change agent in the field of tribal resource management.

Text Books:

1. Madhusudan Bandi ,Tribals and Community Forest Management , Rawat Publication, 2013
2. Jumyir Basar,Indigenous Knowledge and Resource Management Shipra Publications, 2014
3. Laishram Herojit, Rethinking Resource Management: Sustainability and Indigenous Peoples, A.K. Publications, 2012.

Reference Book:

1. G.K. Bera, Tribal India's Traditional Wisdom and Indigenous Resource Management by, Abhjeet Publishers.

Course Title	**GENDER STUDIES**
Course Code (Credit)	**HS30421 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

The objective of this course is to make student understand the concepts of masculinity and femininity as analytical categories via analysing the role of communalism, patriarchy, violence as major hurdles to women's rights globally. Further, this course will enhance their understanding over the current health and education status of women to analyze impact of government health policy on women. Additionally, it will bring greater understanding over the integration of gender concerns and perspectives in policies and programmes for sustenance of environment at international, national, regional levels.

Course Contents:

UNIT I
Understanding Basic Concepts in Gender Studies
Concepts: Sex, Gender, Sexuality, Femininities, Masculinities and other sexualities, Patriarchy; WID: Women in Development; WAD: Women and Development; GAD: Gender and Development

UNIT II
Gender and Human Rights Discourse:
Women's Rights as Human Rights (FGM, FF, Rape, Honour Killing, IVP, Witch Hunting, Virginity Test, Communalism, Trafficking, Immigration); National Commission for Women and other State Commissions, Ministry and Department of Women and Child.

UNIT III
Gender and Health:
Sexual and reproductive health (ICPD, B.P.A. Family planning and Abortion); Impact of violence on women's health; Women's health movement: National and International; National health and population policy; National Family Health Survey (NFHS)

UNIT IV

Gender and Education:

Women's Education in Free India: Gender Disparity in Enrolment; Constraints of Women's Education: Social, Economic, Cultural, Geographical, other Factors; Important Committees and Commissions on Women's Education: Radhakrishnan Commission (1948), Mudaliar commission (1952), Kothari Commission (1964-1966), Ramamurthy Commission (1991).

UNIT V
Gender and Environment:
Role of women in environment conservation; Role of Women in Waste Management; Women's Resistance to Environmental Destruction: Joint Forest Management – CHIPKO Movement – Narmada Bachao Aandolan

Course Outcome:

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

CO 1: Familiarise the students with the concepts of sex, gender and sexuality commonly used in gender studies,
CO 2: Identifying major human rights violations faced by women worldwide,
CO 3: Learn about women's health movements and government health policies,
CO 4: Develop an insight into policy perspective issues, and concerns of girl's education in India,
CO 5: Delineate the characteristics and the issues of environment and the involvement of women in balancing ecosystem,and

CO 6: Understand on sustainable development, millennium development goal, and other global level development initiatives taken for uplifting women status in society.

Reading Materials

1. Gerda Lerner, Creation of Patriarchy, Oxford University Press,1985
2. Menon, Nivedita. ed. 2007. Sexualities. Women Unlimited. New Delhi.
3. Gnew, Sneja, A Reader in Feminist Knowledge, Routledge, New York,1991
4. Marjorie Agosin (ed.), Women, Gender and Human Rights: A Global Perspective, Rawat Publications, 2000
5. Monica Chawla, Gender Justice: women and law in India, Deep and Deep pub.,
   New Delhi, 2006, 2013
6. P D Kaushik, Women's rights; access to justice, Bookwell Publications, New Delhi, 2007
7. Paola Monzini, Sex Traffic, Prostitution, Crime and Exploitation, Zed Pub., 2005
8. Chloe E. Bird, Patricia P. Rieker, Gender and Health, Cambridge University Press, 2008.
9. Jasmine Gideon, Ed., Handbook on Gender and Health (International Handbooks on Gender series), Development Studies, Birkbeck, University of London, UK, 2016.
10. Nelson E, Zimmerman C. Household survey on domestic violence in Cambodia. Ministry of Women's Affairs, Project Against Domestic Violence, Cambodia,1996.
11. Parker B, McFarlane J, Soeken K. Abuse during pregnancy: effects on maternal complications and birth weight in adult and teenage women. Obstetrics and gynaecology, 1994, 84(3):323-328.
12. Madeleine Arnot and Mairtin Mac, An Ghaill, (2006) "Gender and Education" Routledge, New York
13. Aruna Goel, (2004) "Education and Socio-Economic Perspective of Women Development and Empowerment" Deep and Deep Publications, New Delhi
14. Eileen M. Byrne, (1978) "Women and Education" Tevi Stock Publications, Michigan
15. Payal Mago and Isha Gunwal, (2019). Role of Women in Environment Conservation.
16. M.S Swaminathan. (1998). "Gender Dimensions in Biodiversity management". Konark Publisher's Pvt. Ltd, New Delhi.
17. P.K.Rao. (2000). "Sustainable Development – Economics and Policy". Blackwell, New Delhi.
18. Swarup, Hemlata and Rajput, Pam. (2000). "Gender Dimensions of Environmental and Development Debate: The Indian Experience" in Stuart S. Nagel, (ed.) "India's Development and Public Policy". Ashgate, Burlington.

Course Title	Indian Knowledge System
Course Code (Credit)	**HS30425 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

The objective of the course is to promote interdisciplinary study on all aspects of the Indian Knowledge System (IKS), preserve and disseminate IKS for further study and societal applications. It will actively help students to engage in spreading the rich heritage of our country and traditional knowledge in the field of Liberal Arts, Literature, Basic Sciences, Engineering and Technology, Economics, mental and physical well being etc.

Course Contents:

UNIT I

Meaning of Traditional Knowledge System:

Overview of the Vedas, the Upanishads, the Puranas, and the Itihasas. Main Schools of Darshana/ Philosophy: Astika (Vedanta, Nyaya, Vaisheshika, Sankhya, Mimamsa, Yoga) and Nastika (Buddhist, Jainist, Lokayata). Types of Shastra (Vyakarana, Kavya, Alamkara, Shilpa, Vastu, Natya and Sangita). Types of Kavya (Drishya, Shravya, Chitra). Theory of Rasa: Natyashastra by Bharata (Chapter 6). Applied Traditional Knowledge: Myths, Rituals, Taboos and Superstitions, Folktales, Proverbs. Fundamental Concept of Dharma and Its Role in Various Streams of Indian Knowledge System

UNIT II

Yoga and Spiritualism:

Definition and Origin of Yoga. Significance of spirituality in Yoga, Historical development of Yoga; Yogic philosophy: The eight limbs of yoga according to Patanjali, Mind, body & spirit connection in yoga; Relevance of Asana, Pranayama & Dhyana in Yoga: Physical posture for physical, mental and spiritual development, Breathing techniques for energy restoration & consciousness, Meditation for inner stillness and mindfulness, Meditation for spiritual growth & self-discovery; Ethics & Moral Values in Yoga: Exploring the ethical principles Yama and Niyama, Application of yogic principles to daily life for spiritual growth; Yoga & Spirituality in modern life.

UNIT III

Fun with mathematics without calculator

Arithmetic- Quick calculation with 11 and 12, Multiplication with 99999 in seconds, multiplication with numbers near the bases, vertical and cross multiplication, Magic squares and square roots, cubes, fractions, divisions, HCF and LMC in ancient style. Algebra- Factorising quadratic expressions, One variable linear equation, Simultaneous linear equations. Implementation of Vedic mathematics tools during competitive examinations.

UNIT IV

Ancient Indian Science and Technology

Technological development in India: Agriculture (Origin and development, ancient crops, Traditional practices), Water management (Overview, Harappan water management, other case studies, Medieval Water structures), Pottery (Overview, Technical aspects), Silpasastra (Architecture and Construction· An introduction to Silpasastra, Construction Technology), Metallurgy (Copper/Bronze/Zinc, Iron and Steel Technology in India).

UNIT V

Trade and Commerce in Ancient India

Internal, External, Trade routes Indo-Roman contacts and Maritime Trade of South India; Silk and Cotton Textiles, the Principal Maritime Trade Commodities of Ancient India; Trade routes in Ancient India: Silk Route and Spice Route.

Course Outcome:

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

CO1: Understand the concept of Indian traditional knowledge and its importance,

CO2: Know the need and importance of protecting traditional knowledge,

CO3: Develop an appreciation among the students for ancient scriptures,

CO4:Contrast and compare characteristics and important kinds of traditional knowledge,

CO5: Evaluate social change on traditional knowledge,and

CO6: Create innovative ways of bringing forward ancient knowledge to the forefront.

Reading Materials

1. Dasgupta, Surendranath. A History of Sanskrit Literature, Motilal Banarsidass
2. Banerji, Suresh Chandra. A Companion to Sanskrit Literature, Motilal Banrasidass
3. Chatterjee, Satischandra. An Introduction to Indian Philosophy, Motilal Banarsidass
4. Sharma, Chandradhar. A Critical Survey of Indian Philosophy, Motilal Banarsidass
5. A Text Book on Yoga and Health by Dr. Sajib Kumar Bhowmik, Sports Publication, 2020.
6. Light on the Yoga Sutras of Patanjali, B.K.S Iyengar, Element, 2005.
7. The Complete Book of Yoga: Karma Yoga, Bhakti Yoga, Raja Yoga, Jnana Yoga by Swami Vivekananda, Fingerprint Publishing, 2019.
8. Singhal, Aditi. How to Become A Human Calculator. ISBN : 9789352836543. S Chand Publishing

9. M. Tyra and K Kundan. Magical Book on Quicker Maths . ASIN : B07X93W2FC. BSC Publishing Co Pvt Ltd.
10. Singh, Balram. Science and Technology in Ancient texts. DK Print World ltd, 2012. ISSN 9788124606322.
11. Chandra Moti, Trade and Trade Routes in Ancient India. New Delhi: Abhinav Publications, 1977
12. Textiles in Ancient India: From Indus Valley Civilization to Maurya Period. Vishwavidyalaya Prakashan, 1994.
13. Duraiswamy, D. Silk and Cotton Textiles, the Principal Maritime Trade Commodities of Ancient India. ACTA VIA SERICA, Vol. 6, No. 2, Dec. 2021: 91-116, 6(2), 91–116.

OPEN ELECTIVE COURSES (OE)

Course Title	**Software Engineering Fundamentals**
Course Code (Credit)	**CS30018 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To know software process models
- To understand application of software process models
- To be able to know requirements of the software projects
- To apply the basic project management practices in real life projects.
- To be able to distinguish different testing methodologies

Course Contents:

Unit I

Software Process Models:

Software product, Software crisis, Handling complexity through Abstraction and Decomposition, Overview of software development activities. Process Models: Classical waterfall model, Iterative waterfall model, Prototyping model, Evolutionary model, Spiral model, RAD model. Agile models: Extreme programming and Scrum. Software Requirement Engineering

Unit II

Software Requirement Engineering:

Requirement Gathering and analysis, Functional and non functional requirements, Software Requirement Specification(SRS) , IEEE 830 guidelines, Decision tables and trees.

Unit III

Software Project Management:

Responsibilities of a Software project manager, Project planning, Metrics for project size estimation, Project estimation techniques, Empirical estimation techniques, COCOMO models, Scheduling, Organization & team structure, Staffing, Risk management, Software configuration management.

Unit IV
Structural Analysis & Design:
Overview of design process: High level and detailed design, Cohesion & coupling, Modularity and layering, Function–Oriented software design: Structural Analysis, Structural Design (DFD and Structured Chart), Object Oriented Analysis & Design, Command language, menu and iconic interfaces.

Unit V
Testing Strategies:
Coding, Code Review, Documentation, Testing:, Unit testing, Black-box Testing, White-box testing, Cyclomatic complexity measure, Coverage analysis, Debugging, Integration testing, System testing, Regression testing.

Course Outcome:

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

CO1: Elaborate on different software process models
CO2: Evaluate the requirements of the software projects.
CO3: Apply the basic project management practices in real life projects.
CO4: Translate the baseline requirement specifications into design process.
CO5: Distinguish different testing methodologies.
CO6: Work ethically in a team on software projects

Textbooks:
1. Fundamentals of Software Engineering, Rajib Mall , PHI, Latest edition.

Reference books:
1. Software Engineering: A Practitioner's Approach, Roger S. Pressman, Eighth edition, MGH.
2. Software Engineering, Ian Sommerville, Tenth Edition, Pearson Education.

Course Title	**Essentials of Computer Science**
Course Code (Credit)	**CS30020 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:
- To make the student understand the basic building blocks of a computing system

- To make the student understand the flow of Concept- Program-Input-Processing-Output
- To introduce low level language, translators, operating system

Course Contents:

UNIT I

Concept, Program, Input, Processing – Output:

Demo of simple high level language program to low level machine level language program, Tracing their execution from high level to circuit level/ gate level, Overview of the Hardware Description Language (HDL), Designing a set of elementary logic gates from primitive NAND gates. Design of binary adders, Culminating in the construction of a simple ALU (Arithmetic–Logic Unit) using logic gates, Design of memory hierarchy from elementary flip–flop gates to registers and RAM units of arbitrary sizes using logic gates.

UNIT II

Introduction to Low Level Language:

Introducing an instruction set in both binary and assembly (symbolic) versions, Writing some low-level assembly programs, Other details of computer architecture, Basic language translation techniques: parsing, symbol table, macro, assembly

UNIT III

Introduction to Virtual Machine:

The role of virtual machines in modern software architectures like Java and .NET, Introduction of a typical VM language, Focusing on stack–based arithmetic, Logical and memory access operations, VM abstraction and implementation, Focusing on stack-based flow-of-control and subroutine call-and-return techniques.

UNIT IV

Introduction to Compilers:

Context-free grammars and recursive parsing algorithms, Building a syntax analyzer (tokenizer and parser), The syntax analyzer to generate XML code reflecting the structure of the translated program, Code generation, Low- level handling of arrays and objects.

UNIT V

Introduction to OS:

Discussion of OS/hardware and OS/software design trade–offs, and time/space efficiency considerations, Design and implementation of OS, memory management, string processing, I/O handling algorithms.

Course Outcomes:

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

CO1: Trace the fundamentals of digital logic design

CO2: Classify programming languages

CO3: Explore the use of compiler

CO4: Generate low level code for simple programs
CO5: Understand functionality of an operating systems
CO6: Design simple arithmetic and memory units

Textbooks:

1. Noam Nisan, Shimon Schocken, "The Elements of Computing System: Building a Modern Computer from First Principles", MIT Press, 2005.

Course Title	**Object Oriented Programming**
Course Code (Credit)	**CS30022 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**C Programming**

Course Objectives

- To understand the difference between structure-oriented and object-oriented programming
- To know various object-oriented features
- To know exception handling and generic programming
- To test and debug solutions in C++

Course Contents:
Unit I
Introduction to Object Oriented Programming:
Object oriented programming concepts: Objects, Classes, Encapsulation and abstraction, Inheritance, Polymorphism, Dynamic binding, Message passing; C++ Programming basics: Character set, Keyword, Constant, Variable, Data types, Operator & expression, Control structure (branching & looping), typecasting, Array & strings, Streams based I/O, Type conversions and casting, Name space, Scope resolution operator (::); Function: Parameter passing (i) by value, (ii) by address, (iii) by reference, Inline function, Function overloading, Default arguments.

Unit II
Class and Object:
Class and Object: Defining class with functions and data members, Creating & deleting objects by using new and delete operators respectively, Array of Objects, Objects as function argument, Static Data members and member functions, Function with default arguments, Function overloading; Constructor and Destructors: Definition of constructors and its uses, Types of constructors: Default constructor, Parameterized constructor, Copy constructor, Constructor with dynamic allocation, Dynamic Constructors, Constructor Overloading, Destructors.

Unit III

Inheritance:

Concept of inheritance: Defining derived and base classes, Class hierarchies, public, private, and protected derivations; Types of Inheritance: Single Inheritance, Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Hybrid Inheritance, Virtual base class: Function overriding, Constructors/Destructors in derived classes: Constructors invocation and data members initialization in derived classes, Member classes: classes within classes.

Unit IV

Polymorphism:

Operator overloading: Overloading unary operators, Binary operators, overloading binary operators using friend function and member function, Rules for overloading operators; Polymorphism: Introduction to pointers: Pointers to objects, Pointer to derived class object, This pointer, Compile time polymorphism: Review of Function Overloading and Operator overloading; Run time polymorphism: Virtual functions, Pure virtual functions, Abstract class, Virtual constructors and destructors

Unit V

Exception Handling, Templates, Files and Streams:

Exception Handling: Basics of Exception Handling, Exception Handling Mechanism: The keyword try, Throw and catch. Templates: Need of template, Class Templates: Definition, Class Template with multiple parameters, Function Templates: Definition, Function Template with multiple parameters. Files and Streams: Introduction to file handling: text file Vs. binary file, Hierarchy of file stream classes: Functions of File Stream classes, Steps to process a File in a program. Different functions used in file, File modes(Sequential and random), File pointers and their Manipulations, Error handling during file operation

Course Outcome:

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

CO1: Compare the features between structure-oriented and object-oriented programming

CO2: Develop object-oriented programming language like C++ and associated libraries to develop object-oriented programs.

CO3: Apply various object-oriented features like class, object, inheritance, data abstraction, encapsulation polymorphism to solve various computing problems

CO4: Design application using operator-overloading, contracture and destructor

CO5: Apply exception handling and use built-in classes from STL

CO6: Implement, test and debug solutions in C++.

Textbooks:

1. Object Oriented Programming with C++, Reema Thareja, OXFORD University Press, Revised First Edition, 2018.
2. Object Oriented Programming with C++, E.Balaguruswamy, McGraw Hill Education; Seventh edition 2017.

Reference Books :

1. C++ completes reference, Herbert Schildt, MGH, 10th Edition, 2002
2. C++ How to Program, Deitel and Deitel, Pearson Education, 10th Edition, 2011.
3. Programming in C++ Ashok N Kamthane, Pearson Education, 2nd Edition, 2003

Course Title	**Fundamentals of Data Structures**
Course Code (Credit)	**CS30024 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To find the Time Complexity and Space Complexity for algorithm
- To understand the various techniques of sorting and searching
- To design and implement arrays, stacks, queues, and linked lists
- To understand the complex data structures such as trees and graphs
- To solve real life problems

Course Contents:

UNIT I

Introduction:

Development of Algorithms, Notations and analysis, Storage structures for arrays, Sparse matrices, Stacks and Queues: Representations and applications.

UNIT II

Linked List, Stacks, and Queues:

Linked Lists, Linked stacks and queues, Operations on polynomials, Doubly linked lists, Circularly linked lists, Dynamic storage management, Garbage collection and compaction.

UNIT III

Trees:

Tree representation, Binary Trees, Binary search trees, Tree traversal, Expression manipulation, Symbol table construction, Height balanced trees, AVL trees.

UNIT IV

Graphs:

Graphs, Representation of graphs, BFS, DFS, Topological sort, String representation and manipulations, Pattern matching.

Course Outcomes

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

CO1: Use the concepts of data structure, data type and abstract data type to develop solutions for engineering problems.

CO2: Develop programs to implement linear data structures such as stacks, queues, linked lists, etc.

CO3: Apply the concept of trees and graph data structures in real world scenarios

CO4: Comprehend the implementation of sorting and searching algorithms

CO5: Compare Time Complexity and Space Complexity for algorithm

CO6: Effectively choose the data structure that efficiently models the information in a problem.

Textbooks:

1. J. P. Tremblay, P. G. Sorenson, "An Introduction to Data Structures with Applications", Second Edition, Tata McGraw Hill, 1981.
2. M. Tenenbaum, Augestien, "Data Structures using C", Third Edition, Pearson Education, 2007.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Third Edition, Pearson Publishers, 2006.

Reference Book:

1. Sartaj Sahni, "Data Structures, Algorithms and Applications in C++", Universities Press (I) Pvt. Ltd., 2008.

Course Title	**Scientific And Technical Writing**
Course Code (Credit)	**EX20003 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

Technical documents take many forms depending on their purpose and the audience. A technical document can be a project proposal, minutes of a meeting, an advertisement in a newspaper, or even a research paper. A scientific document is a form of technical document where both the author and the audience are experts. The writing styles and the document density of technical documents depend on the nature of the document. The objective of this subject is to train the students in the art and science of writing a range of scientific and technical documents.

Course Contents:

UNIT I

Introduction:

Forms and features of creative, technical, scientific, and science writing; Audience types (general and specific experts, technicians, managers, laypersons, and mixed audience); Examples of documents for technical, professional, and scientific communications; Characteristics of effective technical writing: Accuracy, clarity, conciseness, coherence, appropriateness, and readability.

UNIT II

Language Issues:

Revisiting English grammar; Punctuation (period, comma, colon, semicolon, question mark, exclamatory mark, apostrophe, quotation marks, hyphen, dash, parentheses, and brackets); Mechanics (capitalization, italics, abbreviations, acronyms); Latin terms used popularly in English texts; Informal and colloquial English; Dangling modifiers, Faulty parallelism, Judicious use of common words and phrases; Active and passive voice; Nominalization; Common English errors; Pitfalls in writing; Adapting texts to issues of gender, race, and ethnicity; and Guarding against Plagiarism.
Paragraphing: Unity of idea, topic sentence, logical and verbal bridges through use of signposts, transitions, and link words; Patterns of development of an idea; and Lists.

UNIT III

Structure of Scientific Documents:

Prefatory Materials: Title, Copyright Notice, Declaration and Certificates, Abstract, Keywords, Acknowledgements and Conflict of Interest Statement, Symbols and Abbreviations, and Table of Contents.
Body of Scientific Documents: Introductory Materials—Context, problem and current response, research questions, hypotheses, and objectives and scope; Literature Review—Presentation styles, citations and referencing systems, quoting, paraphrasing, and summarizing; Materials and Methods—Mathematical Materials: Methodology, methods, tools, and techniques; Quantitative, qualitative, experimental, and mixed methods; Numbers and numerals, engineering and scientific notations of numbers, mathematical operators, equations, flowcharts, algorithms, SI units, significant digits and order of magnitude, figures, tables, and photographs; Experimental apparatus, materials, specifications, measuring instruments, procedure, data analysis; Concluding Materials—Conclusions, implications, generalization, limitations, scope for further work, and contributions of the work.
End Matters: References, Appendixes, and Supplementary materials.

UNIT IV

Structure of Selected Technical Documents:

PowerPoint presentation, Abstract of a paper, Laboratory reports, Progress report, Project proposal, Minutes of a meeting, Brochure, and News items.

Course Outcomes:

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

CO1 :Realize the need to articulate the purpose of the document, identify its audience, and decide the density of information to be included in scientific and technical documents;

CO2 :Internalize the art and science of scientific and technical writing;

CO4 :Make appropriate use of crisp language, illustrations, and symbols.

CO4 :Distinguish between bad and good writing. (Analyze and Evaluate)

CO5: Prepare a variety of scientific and technical documents, including laboratory and project reports; and

CO6:Write these documents in an accurate, clear, concise, coherent, appropriate, and readable manner.

Reading materials:

1. Lecture notes on Scientific and Technical Writing
2. Alred, G. J., C. T. Brusaw, and W. E. Oliu (2008), *Handbook of Technical Writing*, St. Martin's Press, New York, Ninth Edition.
3. Angelika H. Hofmann (2014), Scientific Writing and Communication, Papers, Proposals, and Presentations, Oxford: Oxford University Press.
4. Duke Graduate School Scientific Writing Resource (https://sites.duke.edu/scientificwriting/).
5. Gerald. J. Alred, Charles. T. Brusaw, and Walter. E. Oliu (2008), *Handbook of Technical Writing*, St. Martin's Press, New York, Ninth Edition.
6. OWL, The Purdue Online Writing Laboratory, https://owl.english.purdue.edu/owl/.
7. Perelman, L. C., J. Paradis, and E. Barrett (1998), The Mayfield Handbook of Technical and Scientific Writing, Mayfield Publishing (ed.), Available free at http://www.mhhe.com/mayfieldpub/tsw/toc.htm, Mayfield Publishing Company, Inc., 1280 Villa Street, Mountain View, CA 94041, 415.960.3222, <http://www.mayfieldpub.com>, <mailto:hypertext@mayfieldpub.com>
8. Rubens, P. (2001), Science and Technical Writing: A Manual of Style, 2nd Edition, Routledge, New York.

Course Title	Industry 4.0 Technologies
Course Code (Credit)	EX20001 (L-T-P-Cr: 2-0-0-2)

Course objectives:

The current manufacturing industries and businesses are moving from the third industrial revolution of the computers and automation to the fourth where the automation becomes even smarter fueled by data analytic and artificial intelligence. This course is designed to offer learners an introduction to use of Internet and Digital technology for better manufacturing and business. Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges.

Course Contents:

UNIT I

Introduction:

The Fourth Industrial Revolution, Difference between conventional automation and Industry 4.0, Case Studies: Health, Agriculture, Manufacturing

UNIT II

Industry 4.0 and its components:

Internet of Things (IoT) & Industrial Internet of Things (IIoT), Internet of Services, Value chains in manufacturing companies, Digital Twins

UNIT III

Digital Manufacturing and Design:

Cyber Physical Systems and Next Generation sensors, Collaborative Platform and Product Life-cycle Management, Robotics and Automation

UNIT IV

Industrial IoT:

Cloud Computing, Big Data Analytic, AI & ML, Virtual and Augmented Reality, Block-chain

UNIT V

Challenges & Opportunities in Industry 4.0: A Digital Strategy alongside Resource Scarcity, Standards and Data security, Financing conditions, availability of skilled workers, Comprehensive broadband infra- structure, Legal framework, protection of corporate data, liability, handling personal data.

Course Outcomes:

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

CO1: Understand the key components and enablers of Industry 4.0 Technology

CO2: Appreciate the smartness in Smart Factories, smart products and smart Services.

CO3: Outline Smart Factory technologies and their role in an Industry 4.0 world

CO4: Outline IoT technology and scope of implementing IoT in Industries and businesses.

CO5: Comprehend distributed cyber-physical and digital manufacturing system

CO6: Demonstrate the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits

Textbooks:

1. D. Pyo, J. Hwang, and Y. Yoon, *Tech Trends of the 4th Industrial Revolution*, Mercury Learning & Information publisher, 2021.

2. Bruno S. Sergi, Elena G. Popkova, Aleksei V. Bogoviz, and Tatiana N. Litvinova *Understanding Industry 4.0 : AI, the Internet of Things, and the Future of Work*, Pub: Emerald Publishing Limited, 2019

Reference Books:

1. S. Misra, A. Mukherjee, and A. Roy *Introduction to IoT*. Cambridge University Press, 1st edn. 2021
2. Dac-Nhuong Le, Chung Van Le, Jolanda G. Tromp , Gia Nhu Nguyen, *Emerging Technologies for Health and Medicine: Virtual Reality, Augmented Reality, Artificial Intelligence, Internet of Things, Robotics, Industry 4.0*, John Wiley publisher, 2018
3. Alasdair Gilchrist, *Industry 4.0: The Industrial Internet of Things*, Apress Berkeley publisher, CA 1st ed 2016.

Course Title	**Engineering Economics**
Course Code (Credit)	**HS30101(L-T-P-Cr: 3-0-0-3)**

Course Objective:

The objective of Engineering Economics is to aid in decision-making by focusing on the economic implications of technical analysis. It is committed to making operational level decisions and solving problems.

Course Contents:

UNIT I

Introduction to Economics and Engineering Economics:

Basic concepts of Engineering Economics: Demand Analysis, Supply Analysis, Market Equilibrium. Revenue Analysis. Demand Forecasting- Quantitative Methods, Consumer's Equilibrium.

UNIT II

Production and Cost Analysis:

Short Run and Long Run Production Functions, Producer's Equilibrium condition. Cobb-Douglas Production Function.

Cost Concepts: Short Run and Long Run Cost analyses. Break-Even Analysis.

Market: Concepts and Types;Perfect Competition, Monopoly

UNIT III

Time Value of Money:

Interest Formulae and their applications with cash flow diagram. Evaluation of Investment Proposals - Present Worth, Future worth and Annual Equivalent Method of comparison

UNIT IV

Economic Appraisal Techniques:

Net Present Value (NPV), Internal Rate of Return(IRR) ,Cost Benefit analysis. Depreciation calculation; Meaning and Definition, Methods.

UNIT V

Macroeconomic policies:

Functions of commercial banks and central bank, Fundamentals of Business cycle, Macroeconomic policies for stabilization.

Course Outcome:

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

CO1 : Comprehend the significance of different components of Engineering Economics,

CO2 : Analyze the basic economic concepts required for engineers and managers,

CO3 : Develop the problem solving aptitude in the students through practical and case problems,

CO4 : Decide the feasibility of a particular project by the application of different project evaluation Techniques,

CO5 : Use the economic tools in the decision making process, and

CO6 : Survey the current macroeconomic situations in the economy.

Textbooks:

1. Dominick Salvatore,Siddartha K.Rastogi, Managerial Economics: Principles and Worldwide Applications, Oxford University Press, ISBN 9780199467068 , 9th Edition,2020
2. D N Dwivedi, H L Bhatia, & S N Maheswari, Engineering Economics:, Vikas Publishing House, Noida, ISBN:978-93-5674-625-1, 2nd Edition 2023.
3. James Riggs, David D.Bedworth and Sabah U.Randhawa ,Engineering Economics–, 4th Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2016.

Reference Books:

1. William A. McEachern and Simrit Kaur Micro ECON-A South-Asian Perspective-, Cengage Learning, 2013.
2. Yogesh Maheshwari,Managerial Economics- 3rdEdition, PHI Learning Private Limited,2014.
3. A. Khan, Arshad Noor Siddiquee, Brajesh Kumar,Engineering Economy-Zahid Pearson Publication, 2012.
4. R.Panneerselvam Engineering Economics –, Pub: PHI Learning Private Limited, New Delhi, 9thEdition, 2008.
5. G.S Gupta Managerial Economics, , Tata McGraw Hill Education Private Limited, 2nd Edition, 2011.
6. D.M.Mithani, Managerial Economics – Theory and Applications –Himalaya Publication, New Delhi, 6th Edition, 2009.
7. S.B.Gupta, R7. Monetary Economics-Institutions, Theory and Policy-Publication: S.Chand, 1995.
8. R.D. Gupta R8. Macro – Economics –, Publication: Kalyani Publication, 1994.

Course Title	Universal Human Values
Course Code (Credit)	**HS30401 (L-T-P-Cr : 3-0-0-3)**

Course Objective:

The objective of the course is to develop a holistic perspective based on self-exploration, understand the harmony in the human being, strengthen self-reflection, and develop commitment and courage to act.

Course Contents:

UNIT I

Need, Basic Guidelines, Content and Process for Value Education:

Purpose and motivation for the course, recapitulation from Universal Human Values-I. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

UNIT II

Understanding Harmony in the Human Being - Harmony in Myself! :

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health. Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

UNIT III

Understanding Harmony in the Family and Society- Harmony in HumanHuman Relationship:

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship . Understanding the meaning of Trust; Difference between intention and competence . Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

UNIT IV

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence:

Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of naturerecyclability and selfregulation in nature. Understanding Existence as Co-existence of mutually interacting units in allpervasive space. Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT V

Implications of the above Holistic Understanding of Harmony on Professional Ethics:

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a) Ability to utilize the professional competence for augmenting universal human order b) Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c) Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers b) At the level of society: as mutually enriching institutions and organizations. Sum up. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Course Outcomes:

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

CO1: Understand the concept of value education and its need,
CO2: Apply their knowledge on value education for apt self-assessment,
CO3: Comprehend human-human relationship,
CO4: Build holistic perception of harmony at all levels of existence,
CO5: Develop the sense of natural acceptance of human values, and
CO6: Create people friendly and eco-friendly environment.

Textbooks:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. A.N. Tripathi, Human ValuesNew Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. Mohandas Karamchand Gandhi ,The Story of My Experiments with Truth
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)13. Gandhi - Romain Rolland (English)

Course Title	Engineering Professional Practice
Course Code (Credit)	EX40003 (L-T-P-Cr: 2-0-0-2)

Course Objective:

Engineers are expected to perform their tasks responsibly and ethically, following professional standards and guidelines. This subject allows the students to understand the roles and responsibilities of engineers in society, learn professional standards, codes of ethics, issues concerning employment contracts and other legal matters, and skills of working in teams, and to effectively communicate. The subject will be offered jointly by the faculty members of various schools of technology and will be coordinated by the School of Mechanical Engineering.

Course Contents:

UNIT I

Engineering and Engineer:

Engineering as a discipline and a profession; Attributes and functions of a practicing engineer; and Engineer as problem solver, designer, and change agent.

UNIT II

Selected Functions of Engineering:

Designing for safety and reliability; Quality and productivity management; Dealing with problem complexity, uncertainty, risk, and ambiguity; Project management; and managerial functions such as planning, organizing, motivating, and accounting.

UNIT III

Professional Aspects of Engineering:

Accreditation, certification, and licensing; Ethical issues: Ethics and morality, ethical dilemmas, codes of ethics, professional conduct, nature and role of professional societies, engineering standards; Legal issues—Legal forms of business organizations, employment contracts, trademarks, patents, copyrights, trade secrets, professional liability, contractual agreements, environment and information technology laws, and international legal framework such as WTO.

UNIT-IV

Group Dynamics:

Individual cognition; Dynamics of working in teams/groups; Interacting with stakeholders; Dealing with multicultural environments; Team and group communication; and Negotiation and conflict resolution.

Course Outcomes:

Upon completion of this course, the students will be able to

CO1 : Know (a) the features of engineering as a profession, (b) the roles and responsibilities of engineers in society, and (c) the skills for working in teams,
CO2: Realize the use of professional standards, codes of ethics, legal provisions surrounding engineering functions,
CO3 : Apply the above-stated standards, codes, legal provisions, and group communication skills in their decision-making situations,
CO4 : Break down a complex problem into smaller manageable tasks,
CO5 : Compare among alternatives in situations of uncertainty, risk, and ambiguity.
CO6 : Design engineering solutions to industrial environmental and social problems.

Textbooks:

1. Shrestha, R. K. and Shrestha, S. K. (2020), Textbooks: of Engineering Professional Practice, 3rd Edition, Heritage Publishers and Distributors Pvt. Ltd.

Reference Books

1. Habash, R. (2019), Professional Practice in Engineering and Computing: Preparing for Future Careers, 1st Edition, Boca Raton: CRC Press.
2. Walesh, S. G. (2012), Engineering Your Future: The Professional Practice of Engineering, 3rd Edition, Wiley.
3. Subramaniam, R. (2017), Professional Ethics, 2nd Edition, Oxford University Press
4. Lectures note on Engineering Professional Practice provide by Concerned faculty members.

Course Title	**Research Methods And Ethics**
Course Code (Credit)	**EX40001 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

The objective of this course is to introduce to the undergraduate students the various elements and methods of ethically conducting a piece of scientific research.

Course Contents:

UNIT I

Introduction to research:

Structure of research: Scientific method and Engineering design cycle, Defining and scoping Research problems, Formulating research objectives and research questions.

UNIT II

Literature Review:

Searching for literature; Narrative and systematic literature review; Summarizing, paraphrasing, and quoting; and Referencing styles.

UNIT III
Design of Experiments:
Basic Principles of randomization, replication, and Blocking; Factors and Responses; Analysis of variance, Experiments with blocking factors, and Factorial designs.

UNIT IV
Data Analytics:
Data pre-processing; Data visualization; Tests of hypothesis; Decision trees; and Artificial neural networks.

UNIT V
Theoretical Models:
Typology of models; Optimization models, forecasting models, and control models; Monte Carlo simulation; Genetic Algorithm; Model verification and validation; and Measurement and uncertainty analysis.

UNIT VI
Drawing Inferences:
Drawing inferences, Generalizing, Finding potential applications, Imagining future scope, and Highlighting novelty of research.

UNIT VII
Research Ethics:
Ethics and morality; Utilitarian and deontological theories of ethics; Fabrication, falsification, plagiarism, and questionable research practices; Issues related to privacy and confidentiality; and Ethical issues related to publications

Course Outcomes:
Upon completion of this course, the students will be able to:
CO1 : Select research topics and formulate research questions,
CO2: Conduct a literature search and make a review of literature,
CO3: Get acquainted with a range of qualitative, quantitative, experimental, and theoretical methods of Research,
CO4: Become familiar with the techniques of data collection, analysis, and interpretation,
CO5: Understand the importance of research ethics and the implications of the broader impact of research, and
CO6 : Conduct research with honesty and integrity.

Reading Materials :

1. Dunn, P. K. (2021), Scientific Research and Methodology: Tutorials, An Introduction to Quantitative Research and Statistics in Science,

Engineering, and Health: Tutorials, Available free at https://bookdown.org/pkaldunn/SRM-tutorials/.

2. Dunn, P. K. (2021), Scientific Research and Methodology: Software, An Introduction to Quantitative Research and Statistics in Science, Engineering, and Health: Using Software, Available free at https://bookdown.org/pkaldunn/SRM-software/. (Uses Jamovi and SPSS Software, Jamovi is a freely downable software)

Lectures note on Research Methods and Ethics provide by Concerned faculty members.

Course Title	**Building Drawing, Estimation & Costing**
Course Code (Credit)	**CE28001 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

This subject is designed to enrich the basic knowledge of engineering students to develop building drawings. The subject will also give students exposure about quantity estimation and costing of the building.

Course Contents:

UNIT I

Building Drawing:

Construction Standards and drawing techniques in projects. Introduction to basic principles of Computer-Aided Design (CAD), Orthographic projection including sectional views of buildings and parts of buildings and building details, e.g. foundations, walls (including openings), jambs, sills, lintels and arches, floors and roofs, doors and windows, simple stairs. Preparation of simple working drawings and details from free-hand sketches.

UNIT I

Estimation:

Estimation, units, item work, different kinds of estimates, different methods of estimation, estimation of materials in building, with different sections of walls, foundation. Bar Bending Schedule, Estimation of finishing works.

UNIT II

Specification of Works:

Necessity of specification types of specification, general specification, specification of bricks, cement, sand, reinforcement, detailed specification for earthwork, cement, concrete, brickwork, flooring, D.P.C, R.C.C, cement plastering, white and colour washing, distempering, painting.

UNIT III

Rate analysis:

Procedure of rate analysis for items - Earth work, concrete works, R.C.C works, reinforced brick work, plastering.

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: prepare the layout plan, elevation of building
CO2: understand the building drawings and details
CO3: learn the basic concept of estimation and its application in real construction projects.
CO4: analyze the rates of individual items for the preparation of the estimates.
CO5: prepare schedule of quantities required to be attached with the tender documents.
CO6: develop critical thinking ability to optimize the building construction cost.

Textbooks:

1. B. N. Dutta, Estimating and Costing in Civil Engineering – Theory & Practice, CBS Publishers & Distributors Pvt Ltd, 28th Edition, 2020.
2. M. Chakraborty, Estimating & Costing, Specification and Valuation in Civil Engineering, Chakraborty, 29th Edition, 2006, ISBN-10: 818530436X.

Reference Books:
1. B. S. Patil, Civil Engineering Contracts and Estimates, Universities Press, 3rd Edition 2006, ISBN-10: 8173715599.

Course Title	**Gis & Gps Applications**
Course Code (Credit)	**CE28003 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

The objective of the course is to understand the GIS principles, applications, preparation of study maps, creation of interpolation maps, delineation of watershed, explain the functions of GPS and operation of GPS.

Course Contents:
- Overview of Geographic Information System (GIS)
- Familiarization to ArcGIS Interface
- Layout of study area
- Preparation of interpolation map
- Watershed delineation
- Remote sensing satellites

- Basics of Global position system
- Basic operations of GPS Handset
- GPS field surveying and data processing

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: explain the fundamentals of GIS
CO2: understand the operations of ArcGIS tools and prepare the layout of study area
CO3: create interpolation maps
CO4: delineate watershed using ArcGIS
CO5: describe the principles and functions of GPS
CO6: operate GPS in the field for navigation

Reference Books:

1. Principles of geographical information systems by P.A. Burrough and R. A. McDonnell, Oxford University Press, UK.
2. Geographic information systems and science by M.F. Goodchild, P.A. Longley, D.J. Maguire and D.W. Rhind, John Wiley & Sons Ltd., England.
3. Global Positioning system: Principles and Applications by SatheeshGopi, McGraw Hill Education.

Course Title	**Industrial Wiring and Control Panel Design**
Course Code (Credit)	**EE28011 / L- T- P-Cr: 0-0-2-1**

Course Objective:

This vocational course will provide an overview of electrical occupations, including the training and the employment options available in electrical industry. It is also designed to provide related training in the electrical trade that will give students the proper coursework in installation and designing of control panel.

Course Contents:

Industrial wiring and Control Panel designing. (THEORY) QElectrotech software.

Hands on Practice:

1. Design multiwire circuit for a direct motor starter (DoL) with one operating (forward) direction using QElectrotech software.
2. Design multiwire circuit for a direct motor starter (DoL) with two operating (forward &reverse) direction using QElectrotech software.
3. Design multiwire circuit for a Star – Delta motor stator with one operating (forward) direction using QElectrotech software.

4. Design multiwire circuit for a Star – Delta motor stator with two operating (forward &reverse) direction using QElectrotech software.
5. Design &connect for a direct motor starter (DoL) with one operating (forward) direction in modular set up .
6. Design &connect for a direct motor starter (DoL) with two operating (forward & reverse) direction in modular set up .
7. Design &connect for a Star – Delta motor stator with one operating (forward) direction in modular set up.
8. Design &connect for a Star – Delta motor stator with two operating (forward& reverse) direction in modular set up.
9. Install & wire for a direct motor starter (DoL) with one operating (forward) direction in Industrial Control Panel.
10. Install & wire for a direct motor starter (DoL) with two operating (forward &reverse) direction in Industrial Control Panel.
11. Install & wire for a Star – Delta motor stator with one operating (forward) direction in Industrial Control Panel.
12. Install & wire for a Star – Delta motor stator with two operating (forward &reverse) direction in Industrial Control Panel.

Course Outcomes:

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

CO1 : Realise the purpose and general principles of control components and circuits

CO2: Install Industrial wiring circuits according to given specification and plan.

CO3: Analyze circuit operations on basic motors.(3ø induction Motor)

CO4: Interpret and install circuits according to rules and regulations of the National Electrical Codebook.

CO5: Connect motor controllers for specific applications with emphasis on safety practices and in accordance with National Electrical Code (NEC) requirements.

CO6: Select and size contactors, relays and timing relays and overload relays both physically and schematically and describe their operating principles.

References:

1. Installation, commissioning and maintenance of electrical equipment by Tarlok Singh.
2. Industrial Electrical Systems by B. P. PATIL and M. A. CHAUDHARI

Course Title	**Installation, operation and maintenance of solar power system**
Course Code (Credit)	**EE28013 / L- T- P-Cr: 0-0-2-1**

Course Objective:

To impart job-oriented training to students and make them well convergent on Installation, operation & maintenance of solar PV system. This vocational course is based on study of solar photovoltaic (PV) cells, modules, and system components; electrical circuits; PV system design and sizing for use on homes, commercial building etc., understanding energy conversion from sunlight to electricity, and working with solar conversion equipment. This Course will give students the book knowledge and hands on experience needed to become entrepreneur / self-employed.

Course Contents:

Designing of solar panel and installation (THEORY)

1. Homer
2. PVSYST
3. Helioscope

Hands on Practice:

1. To demonstrate the I-V and P-V Characteristics of PV module with varying radiation and temperature level.
2. To demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules.
3. To show the effect of variation in tilt angle on PV module power.
4. To demonstrate the effect of shading on module output power.
5. To demonstrate the working of diode as bypass diode and blocking diode.
6. To draw the charging and discharging characteristics of battery.
7. Observe the output waveform of the inverter in auto mode.
8. Workout power flow calculations of standalone PV system of AC load with battery.
9. Workout power flow calculations of standalone PV system of DC load with battery.
10. Find the MPP manually by varying the resistive load acrossthe PV panel.

Course Outcomes:

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

CO1:Demonstrate and apply the knowledge of solar electric systems terms and concepts

CO2:Size and design a photo voltaic system.

CO3:Mount, ground, position, install, wire and connect a photo voltaic system.

CO4:Test voltage generated by photo voltaic system.

CO5:To learn different types of solar PV modules and batteries used in solar PV plant
CO6:Design of solar PV plant based on estimated loads.

References:

1. Solar Photo Voltaic Technology and Systems by Chetan Singh Solanki
2. Non-Conventional Energy Resources by B.H.Khan.
3. Solar Energy - Principles of Thermal Collection and Storage by P.Sukhatme.
4. Solar Energy: Fundamentals, Design, Modelling and Applications by G.N.Tiwari.

Course Title	**Domestic Wiring and Home Automation**
Course Code (Credit)	**EE28015 / L- T- P-Cr: 0-0-2-1**

Course Objective:

This vocational course will provide an overview of electrical occupations, including the training and the employment options available in electrical consultancy. It is also designed to provide related training in the electrical wing that will give students the proper coursework in installation and designing of domestic wiring and home automation.

To develop electrical wiring skills in students through systematic training that would enable the students to construct and test various electrical circuits using appropriate electrician tools, wires, protective devices and wiring accessories as per IS standards.

Course Contents:

Domestic wiring and Home Automation. (THEORY)

QElectrotech software.

Hands on Practice:

1. Perform the assembly, wiring and implementation of a single switch (SPST Switch) in circuit.
2. Perform the assembly, wiring and implementation of a Double switch (SPST Switch) in circuit.
3. Perform the assembly, wiring and implementation of a power socket in circuit.
4. Perform the assembly, wiring and implementation of a controlled power socket circuit in housing.
5. Perform the assembly, wiringand implementation of a two ways switches (SPDT Switch) in circuit.
6. Perform the assembly, wiring and implementation of a impulse relay in circuit.
7. Perform the assembly, wiring and implementation of a time switch in

circuit
8. Perform the assembly, the wiring and the implementation of a timer lighting in circuit.
9. Perform the assembly, the wiring and the implementation of a twilight switch in circuit in house or in a shop.
10. Perform the assembly, wiring and implementation of a controlled lighting in circuit (time switch, timer, twilight switch).
11. Perform the assembly, the wiring and the implementation of a water heater in circuit.
12. Perform the assembly, wiring and implementation of a central impulse relay in circuit.
13. Study and implementation of Light sensitive switch.
14. Perform the assembly, wiring and implementation of a fan in circuit.
15. Perform the assembly, wiring and implementation of a distribution panel.
16. Home automation using KNX technology.
17. Application of Load shedding contactor and programmable time switch.

Course Outcomes:

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

CO1: Use appropriate electrician tools, wires, protective devices and wiring accessories

CO2: Rig up wiring diagrams using conduit system of wiring.

CO3: Apply IS standards for electrical wiring

CO4: Prepare different types of wiring joints.

CO5: Well convergent in drawing electrical wiring circuit.

CO6. Enhancement of knowledge regarding specification and application of different electrical devices.

References:

1. Home Automation - A Smart Home Guide: The Beginner's Manual Including Google Home, Echo Dot and Amazon Alexa. Easy Instructions, Directions and Commands ... and Home Automation Guide Series Book 1) Kindle Edition
2. Home Automation and Wiring by James Gerhart

Course Title	**Cyber Physics Application in Industrial IoT**
Course Code (Credit)	**EE28017 / L- T- P-Cr: 0-0-2-1**

Course Objective:

The students will utilize the principles of Cyber-Physical Systems (CPS) and Internet of Things (IoT) to develop applications, implement IoT applications by selecting appropriate hardware and software platform and also Develop IoT applications using open-source platforms.

Course Contents:

UNIT I

CYBER PHYSICAL SYSTEM. (THEORY)

1. CPS Realworld.
2. Design and Validation of CPS.
3. Smart city application CPS.
4. CPS Hardware Platforms (Process, Sensors and Actuators).

UNIT II

Industry 4.0.

1. IOT Fundamentals and protocols including layers.
2. Sensor and Interfacing.

Hands on Practice:

1. Architecture and pin diagram of Arduino UNO/MEGA and ESP8266
2. IDE installation for open source C++ or Phython
3. Analog and Digital voltage sensing and processing through Firmware
4. Analog and Digital voltage based actuator through Firmware
5. Display OLED/Seven segment integration through IDE
6. PCB Design Concept and implementation with uC.
7. Implementation of UI/UX through RestAPI based Thingspeak
8. DATA logging and Generating CSV through RestAPI
9. Writing a Firmware for ESP-8266 or NODEMCU(programming based knowledge)
10. IoT based transformer / condition monitoring system

Course Outcomes:

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

CO1: Basics of cyber physics components

CO2: Understanding of sensors and actuators

CO3: Layout diagram of open source microcontroller board

CO4: Understanding of analog and digital I/O for cyber-physics

CO5: Understanding of different protocols for IoT connectivity

CO6: Basic architecture for IoT enabled Cyber Physics

References:

1. Designing the Internet of Things, Adrian McEwen (Author), Hakim Cassimally
2. Asoke K Talukder and Roopa R Yavagal,“Mobile Computing,” Tata McGraw Hill, 2010.
3. Computer Networks; By:Tanenbaum, Andrew S; Pearson Education Pte. Ltd., Delhi, 4th Edition
4. Data and Computer Communications; By:Stallings, William; Pearson Education Pte. Ltd., Delhi, 6th Edition
5. F. Adelstein and S.K.S. Gupta, “Fundamentals of Mobile and Pervasive Computing,” McGraw Hill, 2009.

Course Title	Industrial Control and Remote Monitoring
Course Code (Credit)	EE28019 / L- T- P-Cr: 0-0-2-1

Course Objective:

To provide hands on experience in developing Industrial Control and remote monitoring by using PLC (Programmable logic Controller), thus by utilizing it in Process control applications

Course Contents:

UNIT I

Programmable logic Controller SYSTEM. (THEORY)

1. Introduction to Industrial Automation.
2. Introduction to PLC programmable logic controller
3. PLCs & related software and its major Components
4. Relay logic Hardware Platforms (Switches, Sensors and Actuators).
5. Study of Contactors, Timers, Counter and Comparator

UNIT II

Human Machine interface:

1. Introduction to HMI Communication with PLC
2. HMI tags and Assignments
3. Project on Industrial load sequential feedback control Using PLC HMI

Hands on Practice:

1. Introduction of PLC SOFTWARE as TIA Portal
2. Ladder Programming for Basic gates logics by using SPST Contacts
3. Ladder Programming on SPDT
4. Latching Concept and related Latching program
5. Study of program memory and Programming on Memory Bits
6. Study of TIMER BLOCKs and its Programming
7. Introduction to COMPARATOR BLOCK and its Programming
8. Introduction to COUNTER BLOCK and its Types with Programming
9. Project on Industrial Load OFF/ON control Using PLC and HMI
10. Introduction to analog Logic in PLC and its Programming

Course Outcomes:

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

CO1: Know about typical components of a Programmable Logic Controller

CO2: Know the concept of Electrical ladder logic and its relationship to PLC instructions

CO3: Understand the concept of digital electronics and data acquisition

CO4: Program PLC logical switching circuits for industrial applications

CO5: Choose and utilize Timer, Counter, and other intermediate programming functions
CO6: Design and program automated industrial production line

References:

1. Programmable logic Controller by Vijay R. Jadhav KHANNA PUBLISHERS Second Edition 2012
2. Industrial Automation Using PLC,SCADA and DCS by R.G JamkarLaxmi Publications Private Limited;
3. PLC and SCADA by Prof Rajesh Mehra and Er. Vikrant Vij Published by University Science Press, 1st
4. Programmable logic Controller: Programming methods and Applications By John R Hackworth and Frederick D. Hackworth Jr. PEARSON Edition: 1st Edition, 2006

Course Title	Computational Photography
Course Code (Credit)	EC28001 (L-T-P-Cr: 0-0-2-1)

Course Objective:

Computational photography (CP) is the fusion of computer graphics, computer vision, optics and imaging. The role of CP is to overcome the limitations of traditional cameras by combining imaging and computing to enable new and improved ways to capture, represent and interact with the physical world. The course provides and overview of elements photography, which includes digital image capturing mechanisms, lighting controls, effect of focal length and aperture and various lossy and lossless image storage mechanisms. Objective is to briefly explain computational methods used to enhance photographs.

Course Contents
UNIT I
Introduction to Computational Photography:
History of Photography and Computational Photography, Digital Representation of Images, Cameras, Difference between Full frame, APSC and Medium format sensors, scaling, crop sensor advantages/disadvantages

UNIT II
Digital photography:
Principle of Operation of DSLR camera, Aperture, ISO, Shutterspeed and Angle Control, Camera Calibration and Tethering, Computational Cameras,

Image Storage formats: Compressed vs uncompressed formats, Basics of Lenses: Wide angle, Telephoto, Prime lenses, Macro lenses. Difference in angle, Depth of field control

UNIT III

Computational Techniques:

Concept of Color, color models, noise, its types, image histogram, Image Processing software: Licensed and Open Source

UNIT IV

Training on Computational Photography:

Shooting with wide angle lenses, Shooting with Telephoto lens, zooming, changes in angle, Shooting with Prime lenses and constant aperture lenses, Shooting with Macro lenses, microscopic photography

UNIT V

Training on Digital Imaging-I:

Photography Genres, Scene Composition, Dynamic Range improvement, Portraits, Photographing scenes, crowd and people, Shooting Portraits, group photos and events

Training on Digital Imaging-II:

Long exposure, Brenizer's Method, Sports High Shutter speed, Burst, fisheye, architecture photography, Macro, Basics of Long exposures, using polarizing filters Shooting panorama, Brenizer's method and other photographing techniques Shooting sports, high shutter speed

Training on Digital Imaging-III:

Use of lights, soft box and flashes, guide number etc. , product photography, computational photography,E-commerce photography, Use of Lights, Flash, wireless flash, Basics of product photography, photography for e-commerce and computational photography

Training on Post Processing-I:

RAW image processing, Basic adjustments and correction, Lens Distortion and color correction using Adobe Photoshop, Monochrome image processing, color image processing batch processing using Light-room

Training on Post Processing-II:

Image enhancement operations, noise removal, Artistic filtering, cosmetic filtering, and other post processing methods. Post Processing III: Background removal, artificial coloring.

Training on Post Processing-III:

Open Source and free software for image post processing and computational photography, their usage and capabilities.

Photography Ethics:

Photography ethics: empathy, consent, integrity, ethical decision making, privacy

Course Outcomes:
Upon completion of this course, the students will be able to:
CO 1: Appreciate concept of photography, and digital camera technology
CO 2: Uunderstand types of cameras and their mechanisms
CO 3: Demonstrate computational image processing
CO 4: Apply computational photography methods for photo composition and panoramic
CO5: Apply computational image processing for photography quality enhancement
CO 6: Explain various image filtering techniques

Textbooks:

1. Computer Vision: Algorithms and Applications, 2nd ed by by Richard Szeliski

Reference Books:

1. Computational Imaging Book, by AyushBansai, AchutaKadambi, and Ramesh Raskar.
2. Multiple View Geometry in Computer Vision, by Richard Hartley and Andrew Zisserman.
3. Computer Vision: A Modern Approach, by David Forsyth and Jean Ponce.
4. Foundations of 3D Computer Graphics, by Steven Gortler.
5. Digital Image Processing, by Rafael Gonzalez and Richard Woods.
6. Photography, by Barbara London and John Upton

Course Title	**Sound Engineering**
Course Code (Credit)	**CE28003 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

It elaborately covers in various aspects of sound (physical and mechanical behavior), equipment used for recording/ reproducing and basic idea for the preparation of final sound track in film or television production.

Course Contents:

1. Introduction to technology of sound
2. Analysis of prerecorded speech, music and effects
3. Observation of the installation of PA System in a large auditorium
4. Study and analysis of different microphones
5. Study the feature of 2 channel digital sound recorder
6. Study about the effect of loudness in relation with the distance from source to the listener
7. Sound recording and reproduction practice by using recorder in PA system chain
8. Study of sound in different environmental situation
9. Study and analysis on Modulated Radio wave AM and FM in Live streaming radio stations
10. Study the effect of Bass and Treble (Concept of Equalization)

Course Outcomes:

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

CO1: Recognize, define, and explain the principles of sound engineering related to signal flow, microphones, recording, mixing, production, and mastering.

CO2: Demonstrate practical, imaginative understanding and fluency on sound engineering technologies and procedures.

CO3: Solve problems independently, imaginatively, and creatively in the field of sound engineering will be demonstrated by students.

CO4: Learn how to conduct research and have a critical comprehension of sound engineering and its related fields.

CO5: Understand the basic techniques of sound recording.

CO6: Understand the working of different types microphone and loudspeakers and their applications in industry.

Textbooks:

1. Sound Recording and Reproduction – Glyn Alkin

Reference Book:

1. Sound Assistance – Michael Talbot Smit

Course Title	**Sensors For Automation**
Course Code (Credit)	**EC28005 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

Sensors and automation are revolutionizing the technology in the areas like consumer electronics, automotive industry, healthcare, and in other settings. The course will provide an opportunity for students to learn different sensors and its application in real world problems. It will empower the students to develop their knowledge regarding operation, application and integration of sensors to enable the design and realization a complete systems.

Course Contents:

1. Introduction to microcontroller, platform of operations with basic programming techniques
2. Interfacing of serial and parallel device with microcontroller
3. Interfacing of microcontroller with display devices
4. Use of ADC to interface various analog sensors with microcontroller
5. Introduction to sensor, measurement of physical parameters like temperature and humidity
6. Application of ultrasonic and proximity sensor
7. Application of gas and pressure sensor
8. Application of IR sensor and RFID
9. Interfacing actuators to drive DC motor (application of touch switch as actuators)
10. Implement sensor in final products for real time solution

Course Outcomes:

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

CO1: Learn about the microcontroller, its hardware interfacing and programming

CO2: Understand the working principle and characteristics of different types of sensor

CO3: Interface various sensor interfacing with microcontroller and display devices

CO4: Understand the basic principles of analog to digital conversion and its application with different sensors

CO5: Gain knowledge about various types of automation system

CO6: Develop and implement sensor for final products in real time applications

Textbooks:

1. T. Karvinen, and K. Karvinen, Getting started with sensors, Shroff Publishers, Kindle, Edition, 2014.

Reference Books:

1. J. S. Katre, Sensors in Automation, TechKnowledge Publications, 1st Edition, 2023
2. D. Patranabis, Sensors and Transducers, PHI Learning, 2nd Edition, 2003.

Course Title	**Pcb Design**
Course Code (Credit)	**EC28007 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

Over the years, printed circuit board manufacturing has continued to grow in order to keep up with the increasing demands of newer, faster, and more complex electronic circuitry. This course will familiarize students to design, simulate electronics circuit and fabricate PCB for prototyping using CAD tool. This program is designed to provide a balanced foundation of theoretical knowledge and practical skills in printed circuit board design.

Course Contents:

UNIT I

Description of different Electronics Component and their Identification: Passive and active components, component identification, Color code for resistor and disc capacitors, Inductor and their types, simple air core and iron core inductor design.

UNIT I

Circuit Design and Simulation using CAD tool (OrCAD): Design of a simple electronics circuit using data sheet and circuit schematic and simulation.

UNIT II

Schematic to PCB transfer and routing:

Schematic to PCB transfer (assigning foot prints to various components, transfer to PCB), routing, DRC, ERC, EMC

UNIT III

Screen Printing Procedure:

Preparation of screen, mask transfer

UNIT IV

PCB preparation and Checking of Routing:

transfer of layout to PCB using screen printing methods, etching, cleaning, error checking of routing, component mounting, soldering

UNIT V

Testing and Verification:

Testing the circuit with the help of multi-meter and CRO

Course Outcomes:

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

CO1: understand and evaluate different electronics components.

CO2: create schematic and simulate the circuit using OrCAD or any other CAD tools.
CO3: understand single- and double-layer PCB.
CO4: create and fabricate PCB and analyze the PCB using screen printing method.
CO5: understand assembly of electronics component by soldering.
CO6: analyze and test the circuit for any error.

Textbooks:

1. Chris Robertson, Printed Circuit Board, PHI, 2003
2. Elaine Rhodes, Developing Printed Circuit Assemblies: From Specifications to Mass Production, 2008, ISBN: 978-1435718760.

Reference Books:

1. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, PHI, 2003.
2. Kraig Mitzner, Complete PCB Design Using OrCAD Capture and PCB Editor, Newnes, 2009

Open source EDA Tool KiCad Tutorial : http://kicad-pcb.org/help/tutorials/

Course Title	**Additive Manufacturing (3D Printing)**
Course Code (Credit)	**ME28011 (L-T-P-Cr: 0-0-2-1)**

Course Objective:
Additive Manufacturing (AM) is a modern manufacturing technology also known as 3D printing process, will provide a clear understanding about the process, acceptability and usability in various field. AM technologies classified on the basis material types will be focused with its real life applications with advantages and disadvantages. Different types of errors associated with AM and CAD technology will be discussed with suitable error minimization processes. Various reverse engineering process will be discussed and practically implemented with its real life applications.

Course Contents:
UNIT I
Introduction to Additive Manufacturing Technologies:
Need & Development of AM systems, AM process chain, Impact of AM and Tooling on Product Development, Benefits, Applications, Digital prototyping, Virtual prototyping.
Model Preparation using Solid Modelling Software.

UNIT II

Classification of Additive Manufacturing Technologies:
Classification of AM technologies on the basis of Materials types. Discussion on various AM processes based solid, liquid and semi solid type of materials along with its application, advantages and disadvantages.

Hands on practice for model creation and saving on particular file format.

UNIT III

Data Processing for AM Technologies:
Process planning for AM, CAD model preparation, data requirements & geometric modelling techniques: Wire frame, surface and solid modelling data formats.
Hands on practice for the fabrication of Single components and Assembly components.

UNIT IV

Rapid Tooling:
Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect, Fabrication processes, Applications, Rapid tooling techniques such as laminated metallic tooling, direct metallaser sintering, vacuum casting.

Hands on practice for the fabrication of pattern and mould preparation.

UNIT V

Reverse Engineering Processes:
Introduction to reverse engineering, Integration of reverse engineering with AM technology.

Hands on practice to generate model data in revere engineering process integrated with AM process

Course Outcomes:
Upon completion of this course, the students will be able:
CO1: To understand the concept of additive manufacturing, its benefits and applications in various field.
CO2: To know the various liquid, powder and solid material based technologies in Rapid Prototyping and Rapid Tooling process.
CO3: To know the application of AM process in the field of Biomedical.
CO4: To design solid models and converting it to 3D printing readable file format required for part fabrication.
CO5: To focus on the various types errors in the RP parts and errors during CAD file conversion.
CO6: To apply reverse engineering process to generate data for fabrication RP part.

Reference Books:

1. Rapid Prototyping: Principle and Applications, Rafiq I Noorani, Wiley & Sons, 2006.
2. Rapid prototyping: Principles and applications, Chua C.K., Leong K.F., and Lim C.S., Yes Dee Publishing Pvt. Ltd, Third edition, 2010.
3. Rapid Prototyping and Engineering Applications, Frank W. Liou, CRC Press, Special Indian Edition, 2007.
4. Additive manufacturing, R.B. Choudhary, Khanna Publication, 2022

Course Title	**Die development by CNC milling**
Course Code (Credit)	**ME28013 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

The objective of the course is to provide basic knowledge on various tools and precision instruments used during CNC milling operation. It helps in understanding the usage of various machining cycles to reduce the manufacturing lead time. Moreover, it explains the usage of various standards and programming methods to be followed during CNC machining operation. Finally, the students can develop/generate the programs used to produce the geometries with complex contours using CNC milling machine.

Course content:

UNIT I

Tools and Safety: List of tools used on Milling Machine to perform various operations.

Safety: Introduction to safety equipment and their uses.

UNIT II

Measuring instruments:

Vernier caliper, Micrometer, Bevel protractor, Coordinate measuring machine (CMM): Construction, principle graduation and reading, least count.

UNIT III

Introduction to CNC:

Introduction to CNC technology, Conventional Vs. CNC machine tool, CNC clamping system. Implementation of JH for CNC.

UNIT IV

CNC programming:

Introduction to CNC programming, Introduction and demonstration of line programs milling machine using ISO codes into the CNC simulator. Part programming methods, Cutting process parameter selection, Process planning issues and path planning, G & M Codes, Interpolations, Tool compensations.

UNIT V

CNC Programming-Milling:

Calculations of parameters like speed feed, depth of cut etc. and set a references for the various operations. Prepare & set CNC Milling operations and dry run on the machine. Execute program and inspect simple geometrical forms / standard parts.

Course Outcomes:

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

Understand the usage of different tools and precautions to be followed during machining.

- CO1: Know the principle and operation of precision instruments.
- CO2: Understand the technological advancements in NC and aimed to achieve JH pillar.
- CO3: Understanding the programming methods and programming in simulators
- CO4: Planning for optimized CNC programming by estimating suitable process parameters
- CO5: Programming of die contours and executing on CNC milling machine.

Reference Books:

1. Computer Control of Manufacturing Systems, Mc Graw Hill Publication, By Yoram Koren.
2. CAD/CAM ByMikell P. Groover
3. A Textbooks: of Manufacturing Technology-II By P C Sharma
4. Engineering Metrology, Khanna Publishers, By R K Jain

Course Title	**Concept Car Manufacturing**
Course Code (Credit)	**ME28015 (L-T-P-Cr: 0-0-2-2)**

Course Contents:

UNIT I

Car Development:

Constraints And Specifications – Performance, Handling, Structure; Driver Accommodation and Safety

Tyres: Adjustable Features, Preliminary Design And Analysis; Driver-Vehicle Relationship. Desirable Vehicle Characteristics, Fundamentals of Track and Lap

UNIT II

Racing Car Aerodynamics:

Aerodynamic Force and Moment, Race Car Drag; Spoilers, Dams, Wings - Effectiveness Of Wings In SteadyState Cornering

UNIT III

Chassis Design:

Conditions For Traversing a 90° Corner, Effects Of High Speed Braking, Cornering, Combined Braking Cornering; Steady State Cornering, Throttle Behaviour, Steering Wheel Force And Kick Back; Moving CG Position, Roll Centre Position Changing

UNIT IV

Suspension System:

Front Suspension- General Design Issues, Camber Effects; SLA Suspension, McPherson Struts; Independent Rear Suspension- Trailing Arm Types, Instant Axis Concept; Suspension Springs- Torsion Springs, Coil Springs.

Course Outcomes:

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

CO1. Remember the fundamentals of concept car characteristics.

CO2. Understand the aerodynamic requirements in racing vehicles.

CO3. Use the concepts of chassis behaviour of concept car

CO4. Illustrate the suspension characteristics of the concept car.

CO5. Understand the problems faced in drives and braking systems in motorsports.

CO6. Build a concept car body

Textbooks:

1. Advanced Race Car Chassis Technology HP1562: Winning Chassis Design and Setup for Circle Track and Road Race Cars Bob Bolles, HP Books; Revised, Updated ed. edition 2010

Reference Books:

1. Race car vehicle dynamics, William F. Milliken and Douglas L. Milliken, 11th edition, SAE, 1995.
2. Formula 1Technology, Peter Wright, Sae Intl; 1st edition 2001.

Course Title	**Development of Autonomous Wheeled Robots**
Course Code (Credit)	**ME28017 (L-T-P-Cr: 0-0-2-2)**

Course Objective:

Nowadays, robotics is playing a vital role in industry 4.0, and autonomous wheeled robots are being applied to minimize human efforts and to improve the production rate. This course gives fundamental knowledge about wheeled robotics and its different hardware and software components. Moreover, the subject discusses kinematics equations, which will be implemented to control the motion of wheeled robots through the actuators. Further, the present course also describes the integration of various sensors and their programming, which will be used to make an autonomous control system for a robot.

Course Contents:

UNIT I
About Locomotion for Wheeled Robot:
Key issues for locomotion, wheeled mobile robot's locomotion, Legged wheeled robots.

UNIT II
Wheeled Robots Kinematics:
Kinematic models and constraints, Representing robot position, Forward kinematic models, Wheel kinematic constraints, Degree of freedom.

UNIT III
Sensors for Autonomous Wheeled Robots:
Various sensors for wheeled robots, Sensor classification, Ultrasonic sensor, Infrared sensor, Vision sensor, Inertial measurement unit (IMU).

UNIT IV
Actuators for Autonomous Wheeled Robots:
Various actuators for wheeled robots, DC motor, Servo motor, Stepper motor, Motor controller.

UNIT V
Wheeled Robots Programming:
Robot programming language features, Computer control and robot software (monitor mode, run mode and editor mode), Arduino microcontroller programming, Raspberry Pi programming, Complete design of an autonomous wheeled robot.

Course Outcomes: Course Outcomes:
Upon completion of this course, the students will be able to:
CO1: Understand the fundamentals of wheeled robotics and its different components.
CO2: Apply locomotion constraint features to travel the wheeled robots in different surface conditions.
CO3: Apply various sensors integration on wheeled robots for autonomous navigation.
CO4: Analyze the kinematics of wheeled robots.
CO5: Create a robot programming to make an autonomous sensor-actuator control system.
CO6: Design of automation solutions using wheeled robots.

Reference Books:

1. R. Siegwart, I.R. Nourbakhsh, D. Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, 2011.
2. S.G. Tzafestas, Introduction to Mobile Robot Control, Elsevier Science, 2013.
3. G. Dudek, M. Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, 2010.
4. T. Bräunl, Embedded Robotics Mobile Robot Design and Applications with Embedded Systems, Springer Berlin Heidelberg, 2013.

5. U. Nehmzow, Mobile Robotics A Practical Introduction, Springer London, 2012.

Course Title	Modeling of Micro-Wind turbine by 3D CAD Design
Course Code (Credit)	**ME28019 (L-T-P-Cr: 0-0-2-2)**

Course Objective:
Introduce computer-based solid, parametric, and assembly modeling as a tool for engineering design; enhance critical thinking and design skills. This course introduces the technology and economics of converting wind energy to electricity and other kinds of energy. Both utility scale horizontal axis wind turbines and small-scale horizontalare addressed, as well as the economical and environmental issues associated with wind energy.

Course Contents:
UNIT I
Introduction to Wind Energy, Wind Power, State of the art technology:
Introduction to renewable sources, Wind energy, Types of wind turbines, State of the art technology in wind energy.

UNIT II
Design and development of small wind turbines:
Small wind technology, blade element momentum theory, design of tail fin, Wind turbine tower structure design stiffness and strength consideration, Aerodynamics of wind turbine rotor blade design, angle of attack, profile.

UNIT III
3D modelling of wind turbine using CAD tools (SOLIDOWRKS):
Introduction to 3D modeling, Parametric modeling, feature-based modeling, Design Intent; Solid modeling commands: Sketching, Extrusion, Revolve, fillet, pattern.; Solid Modeling: reference geometry, Sweeps and Lofts;

UNIT IV
Assembling of the 3D model of the Wind turbine:
Assembly modeling; Top-down and bottom-up, Mates in assembly, exploded view,

UNIT V
Creation of 2D drawings for production/manufacturing processes.
Extract 2D orthographic views from the 3D model for fabrication by specifying the proper dimensions, according to industry standards, for parts to be fabricated and to extract section and auxiliary views, Dimensioning standards and conventions. 3D assembly drawing of the wind turbine, exploded view of the tower, 3D drawings of all 3D printed parts.

UNIT VI

Simulation of wind turbine using SOLIDWORKS using CAD tools (SOLIDOWRKS and ANSYS):
Engineering analysis with SolidWorks, Stress and deflection of the wind turbine tower, Simulation of wind turbine using SolidWorks

Course Outcomes:
Upon completion of this course, the students will be able to:
CO1: To learn about the basic concepts of wind energy conversion system.
CO2: To understand the engineering design process and the implementation of different design phases.
CO3: To create a 3D solid model with high degree of confidence.
CO4: To develop the ability to extract 2D orthographic views from the 3D model for fabrication.
CO5: To learn the basics of assembly and associative constraints.
CO6: To understand the importance of standalone, grid-connected, and hybrid operation in renewable energy systems.

Reference Books:

1. Wind Energy Explained: Theory, Design, and Application, By James F. Manwell, Jon G. McGowan, and Anthony L. Rogers, Wiley (2010).
2. Wind Power Plants: Fundamentals, Design, Construction and Operation, Gasch, Robert, Twele, Jochen (Eds.) Springer-Verlag Berlin Heidelberg; 2nd edition (2012).
3. Open source SOLIDWORKS Tutorial : https://my.solidworks.com/training/video/40d7a678-3293-4d7b-ba18-2113ff114b2a

K-Xplore

(Practice Oriented Open Elective – I)

The B. Tech. curriculum provides for a 1-Credit practice-oriented Open Elective K-Xplore in Semester V to make our undergraduate engineering programme holistic, multidisciplinary, skill-based, and balanced. This course allows the students to explore the opportunity that the KIIT University offers to them to sharpen their skills in areas which excite them the most.

Offered in a self-learning mode, this subject allows the students to hone their skills in areas they are passionate about which they select from a wide spectrum of subjects in art, literature, technology, community engagement and service, health, and environment and sustainability. In addition, the students develop soft skills that are important for them in their professional life. This course, thus, allows students to explore and grow in areas outside of core academics and provides a channel for complementing the lessons learned in the classroom, offering them the opportunity to apply academic skills in a real-world context and providing a truly well-rounded education.

This course is designed on the basis of the guiding philosophy of student-centered learning where the students define problems, evaluate alternatives, design solutions, and self-learn by performing certain assigned activities with limited guidance from faculty facilitators.

Each student selects an area of his (or her) choice from a specified list of areas. All the students with choice in a particular area are assigned to one or more faculty facilitators. Faculty facilitators assign the activities and tasks necessary for the course to the students and decide the desired mode of skills training. They may decide to make small groups of students of varying group sizes to carry out the assigned activities and tasks. They also make the required facilities available to the students to enable them to carry out the assigned activities and tasks.

The timetable will earmark specific hours for the subject. But the students are expected to use their spare time (including holidays and after-lecture hours on working days) to learn the required skills and use these skills to accomplish the assigned activities and tasks. The students, however, have to meet the faculty supervisors on the specified hours every week to appraise them of their progress, clear their doubts, if any, and chart their future plan.

The Head of KIIT Student Activity Centre (KSAC) will coordinate offering of the course.

Course Outcomes:

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

CO1 :Develop the needed technical skills in their chosen fields of interest,
CO2 :Develop higher levels of self-confidence and soft skills such as communication, writing, discussion and debate, time-management, and leadership skills
CO3 : Apply the learned skills to give shape to their passionate ideas,
CO4 : Develop Innovation and entrepreneurial mindset,
CO5 : Analyze and judge a problem situation for deploying the learnt knowledge and skills and develop problem solving strategies,and
CO6 : Build new products and services using the learned knowledge and skills.

Course Title	**Robotic**
Course Code	**SA38001 (L-T-P-Cr: 0-0-2-1)**

Course Objective

To assist students develop the knowledge of robotics and circuitry, build circuits, bots and robots, and participate in different Robotics events such as Robo Wars.

Course Title	Web Designing
Course Code (Credit)	SA38003 (L-T-P-Cr: 0-0-2-1)

Course Objective:

To help a student learn and develop front-end and back-end web development skills and create websites.

Course Title	Civil-Tech
Course Code (Credit)	SA38005 (L-T-P-Cr: 0-0-2-1)

Course Objective:

To make a student ready to plan and design selected aspects of real life construction projects with relation to environment, transport & connectivity, water resource engineering & soil exploration and gain pre-, present-, and post- construction experience.

Course Title	Circuit Design & Control
Course Code (Credit)	SA38007 (L-T-P-Cr: 0-0-2-1)

Course Objective:

To let the students learn the required skills to design and develop electrical circuits and implement controllers for use in robotics, automation, voice recognition, gesture recognition, etc.

Course Title	Indian Classical, Folk & Bollywood Dance
Course Code (Credit)	SA38009 (L-T-P-Cr: 0-0-2-1)

Course Objective:

To encourage and boost the confidence of the students to choreograph and perform in classical, semi classical / folk and bollywood dance forms.

Course Title	Indian Classical & Western Music
Course Code (Credit)	SA38011 (L-T-P-Cr: 0-0-2-1)

Course Objective

To give confidence to the students to participate and perform as a vocalist and/or instrumentalist in different forms of Indian classical and western music.

Course Title	Graphic Designing & Editing

Course Code (Credit)	**SA38013 (L-T-P-Cr: 0-0-2-1)**

Course Objective

To nurture the students’ skills in creative designing, photo and video editing activities, and digital sketching and painting, using Designing & Editing software such as Photoshop, Illustrator and video editing software.

Course Title	**Art & Craft**
Course Code (Credit)	**SA38015 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

To endow the students with the skills to do various types of painting such as portrait painting, landscape painting, abstract painting, pencil sketching, and doodling and craft, using various Painting and Sketching tools.

Course Title	**Theatre & Street Pla**
Course Code (Credit)	**SA38017 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

To give students the confidence to perform in Theatres, Nukkad, Mono Acts and skits based on written scripts.

Course Title	**Film Making**
Course Code (Credit)	**SA38019 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

To impart skills for film making in areas such as cinematography, script writing, audio recording, and editing.

Course Title	**Debating, Public Speaking & Anchoring**
Course Code (Credit)	**SA38021 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

To develop the students’ skills for performing oratory activities such as extempore speech, debate, poetry reading, open topic speech, public speaking, interviewing, open dialogue, anchoring, and presentation.

Course Title	**Creative Writing**
Course Code (Credit)	**SA38023 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

To develop the students' skills in creative writing, content writing, article writing, and poem composition.

Course Title	**Photography & Videography**
Course Code (Credit)	**SA38025 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

To provide the technical knowledge required to create photos and videos that tell a story or capture a real-world occurrence.

Course Title	**Fashion Styling**
Course Code (Credit)	**SA38027 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

To impart the basic skills of costume design, styling, grooming, and presentation relevant to a specified theme.

Course Title	**Culinary Arts**
Course Code (Credit)	**SA38029 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

To help the students learn the skills of cooking, knowing ingredients, and preparing cuisines of Pan India and 65 countries

Course Title	**Quiz Activity**
Course Code (Credit)	**SA38031 (L-T-P-Cr: 0-0-2-1)**

Course Objective:

To give the students the confidence to participate in, and conduct, various forms of quiz, such as Technical Quiz and Business Quiz.

Course Title	**Social Outreach**

Course Code (Credit)	SA38033 (L-T-P-Cr: 0-0-2-1)

Course Objective:

To sensitize the students on the social issues and giving them an opportunity to connect with the community and the environment through outreach activities, community projects, and volunteering.

Course Title	Health & Emergency Care
Course Code (Credit)	SA38035 (L-T-P-Cr: 0-0-2-1)

Course Objective:

To let the students learn about health issues, basic Life-saving skills and participate in health awareness and sensitization programs.

Summary sheet for all courses in the B.Tech. Syllabus for all Programs of School of Computer Engineering

Course Title	CSE	IT	CSSE	CSCE
Scientific and Technical Writing	EX20003	EX20003	EX20003	EX20003
Probability & Statistics	MA 21001	MA 21001	MA 21001	MA 21001
Industry 4.0 Technologies	EX20001	EX20001	EX20001	EX20001
Data Structures	CS21001	CS21001	CS21001	CS21001
Digital Systems Design	EC20005		EC20005	EC20005
Automata Theory and Formal Languages	CS21003			
Communication Engineering		EC20008		EC20008
Principle of Signal Systems			EC20006	
Data Structures Laboratory	CS29001	CS29001	CS29001	CS29001
Digital Systems Design Laboratory	EC29005		EC29005	EC29005

Communication Engineering Laboratory		EC 29002		EC 29002
Discrete Structures	MA21002	MA21002	MA21002	MA21002
Operating Systems	CS20002	CS20002	CS20002	CS20002
Object Oriented Programming using Java	CS20004	CS20004	CS20004	CS20004
Database Management Systems	CS20006	CS20006	CS20006	CS20006
Computer Organization and Architecture	CS21002	CS21002	CS21002	
Information Theory and Coding		CS20008		
Information Security		CS20010		CS20010
Operating Systems Laboratory	CS29002	CS29002	CS29002	CS29002
Java Programming Laboratory	CS29004	CS29004	CS29004	CS29004
Database Management Systems Laboratory	CS29006	CS29006	CS29006	CS29006
Design and Analysis of Algorithms	CS30001	CS30001	CS30001	CS30001
Software Engineering	CS31001	CS31001	CS31001	CS31001
Computer Networks	CS30003	CS30003	CS30003	CS30003
Algorithms Laboratory	CS39001	CS39001	CS39001	CS39001
Engineering Professional practice	EX40003	EX40003	EX40003	EX40003
Computer Networks Laboratory	CS39003	CS39003	CS39003	CS39003
Machine Learning	CS31002	CS31002		
Artificial Intelligence	CS30002			
Data Science and Analytics		CS30004		
Compilers			CS30006	

ARM and Advanced Microprocessors			EC30007	
Cloud Computing				CS30008
Wireless Mobile Communication				EC30002
Universal Human Values	HS30401	HS30401	HS30401	HS30401
Artificial Intelligence Laboratory	CS39002			
Applications Development Laboratory	CS33002			
Data Analytics Laboratory		CS39004		
Advance Programming Laboratory		CS39006	CS39006	CS39006
ARM Laboratory			EC39006	
Wireless Communication & Networking Laboratory				EC39002
Mini Project	CS37001	CS37001	CS37001	CS37001
Project- I	CS47001	CS47001	CS47001	CS47001
Internship	CS48001	CS48001	CS48001	CS48001
Research Methods and Ethics	EX40001	EX40001	EX40001	EX40001
Project- II	CS47002	CS47002	CS47002	CS47002

PROFESIONAL ELECTIVE COURSES (PE)

Course Title	CSE	IT	CSSE	CSCE
High Performance Computing	CS30005		CS30005	
ARM and Advanced Microprocessors	EC30007			
Multi-Core Programming	CS30007			
Distributed Operating Systems	CS30009		CS30009	
Computational Intelligence	CS30011	CS30011	CS30011	CS30011

Compiler	CS30006			
Data Mining and Data Warehousing	CS30013		CS30013	
Image Processing and Applications	CS30015	CS30015	CS30015	CS30015
Cloud Computing	CS30010	CS30010		CS30010
Computer Vision	CS30026		CS30026	CS30026
IOT and Applications	CS40004			CS40004
Time Series Forecasting	CS30014	CS30014		
Natural Language Processing	CS30016			
Deep Learning Techniques	CS40001	CS40001	CS40001	CS40001
Software Testing and Automation	CS40003	CS40003	CS40003	CS40003
Human Computer Interaction	CS40005	CS40005	CS40005	CS40005
Computer Graphics and Multimedia Systems	CS40007		CS40007	CS40007
Principles of Cryptography	CS40009	CS40009		
Nature Inspired Computing	CS40002	CS40002	CS40002	CS40002
Software Project Management	CS30012	CS30012		CS30012
Agile Software Development	CS40006	CS40006	CS40006	CS40006
Social Network Analysis	CS40008	CS40008	CS40008	CS40008
Augmented and Virtual Reality	CS40010	CS40010	CS40010	CS40010
Artificial Intelligence	CS30002	CS30002	CS30002	
Big Data		CS30017		
Automata Theory and Formal Languages		CS21003		
Information Security		CS20010		
Web Technology and Applications		CS30019		

Real Time Systems		CS30021		
Software Defined Networking		CS30023		
Mobile Computing		CS40011		CS40011
Block Chain		CS40012		CS40012
Game Theory		CS40014		
Modeling and Simulation			CS30025	
Machine Learning			CS31002	
VLSI Circuits & Systems			EC30005	
Robotics and Application			CS30027	
Embedded System			EC30024	
Data Science and Analytics		CS30004	CS30004	CS30004
Information Theory and Coding				CS20008
Digital Signal Processing				EC30023
Fiber Optics Communication Systems & Networks				EC30025
Smart Antennas				EC40018
Satellite Communication System				EC30022
Multimedia Systems				CS40013
K-Explore (Open Elective I)	Yes	Yes	Yes	Yes
Social Science Elective II	Yes	Yes	Yes	Yes
Social Science Elective III	Yes	Yes	Yes	Yes
Vocational Electives	Yes	Yes	Yes	Yes

Mapping of Course Outcomes with Programme Outcomes

Data Structures:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√													
CO2	√		√										√		
CO3		√	√	√									√		
CO4			√	√								√	√		√
CO5		√	√									√			√
CO6		√	√	√									√		√

Automata Theory and Formal Languages:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√		√										√		
CO2	√		√								√	√	√		
CO3			√	√											√
CO4		√		√							√			√	√
CO5			√	√								√	√		√
CO6		√	√	√									√		√

Data Structures Laboratory:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√													
CO2	√		√		√								√		
CO3		√	√	√	√								√	√	
CO4			√	√	√							√	√	√	
CO5		√	√									√		√	√
CO6		√	√	√									√		√

Operating Systems:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√		√		√		√						√		
CO2	√		√				√						√		
CO3	√		√									√	√		

CO4	√		√									√		√	√
CO5	√	√			√							√		√	√
CO6		√	√	√											

Object Oriented Programming using Java:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√													
CO2	√				√								√		√
CO3		√		√	√		√		√				√	√	
CO4			√	√	√			√	√			√	√		
CO5		√	√					√				√			√
CO6		√	√	√									√		√

Database Management Systems:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√	√										√		
CO2	√		√	√					√		√		√		√
CO3	√				√				√		√		√	√	
CO4			√			√						√			√

Computer Organization and Architecture:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√	√								√				
CO2	√	√			√		√			√	√		√		√
CO3	√	√	√			√					√		√		
CO4	√		√	√								√	√	√	√
CO5		√	√	√									√	√	
CO6			√	√											

Operating Systems Laboratory:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√	√		√										
CO2	√				√				√		√		√		√

CO3	√	√	√												√
CO4		√	√	√									√	√	
CO5			√	√									√	√	
CO6		√	√	√											

Java Programming Laboratory:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√			√						√				
CO2	√	√		√	√						√		√		√
CO3	√	√		√	√			√					√	√	
CO4			√			√								√	√
CO5			√	√		√			√			√			
CO6		√	√			√		√		√	√				√

Database Management Systems Laboratory:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√									√				
CO2	√				√	√							√		√
CO3		√			√	√	√				√		√		√
CO4	√		√		√	√	√	√						√	√
CO5	√	√	√	√		√		√		√				√	
CO6			√	√	√		√					√			

Design and Analysis of Algorithms:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√													
CO2	√	√										√	√		
CO3	√	√		√							√		√		√
CO4			√									√	√	√	√
CO5			√	√							√			√	
CO6		√	√	√											

Software Engineering:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1		√													
CO2								√	√				√		√

CO3		√	√		√					√	√	√		√	
CO4	√		√	√	√			√		√	√		√		√
CO5			√	√			√			√		√	√		√
CO6			√	√		√			√					√	√

Computer Networks:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√								√						
CO2	√		√		√				√		√		√		√
CO3		√		√		√					√	√	√	√	
CO4			√		√	√					√				√
CO5		√								√		√	√	√	
CO6			√	√	√						√				√

High Performance Computing:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√	√												
CO2	√											√			
CO3	√	√		√			√						√		√
CO4	√		√	√				√			√	√	√		
CO5		√	√			√								√	√
CO6			√	√								√			√

Multi-Core Programming:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√		√		√										√
CO2		√		√									√	√	
CO3		√				√						√			
CO4		√		√	√						√	√	√	√	√
CO5			√									√			
CO6			√	√		√									

Distributed Operating Systems:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√		√		√										
CO2		√		√										√	
CO3		√	√			√									

CO4		√		√	√						√		√	√	√
CO5			√									√			
CO6			√			√						√	√		

Computational Intelligence:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√		√		√										
CO2		√		√										√	
CO3		√	√									√			
CO4	√	√		√	√						√		√		
CO5			√												√
CO6		√	√	√								√	√		

Compiler:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√		√			√						√			
CO2	√		√	√											
CO3	√		√					√					√	√	
CO4		√		√		√		√				√			√
CO5	√	√				√	√						√	√	√
CO6			√	√									√		

Data Mining and Data Warehousing:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√											√			
CO2	√			√									√		
CO3													√	√	
CO4		√	√	√		√						√			√
CO5		√	√			√							√	√	√
CO6			√	√									√		

Image Processing and Applications:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√				√									
CO2	√		√		√				√			√			√
CO3		√	√		√				√				√		√
CO4		√				√							√	√	
CO5			√	√		√						√		√	

CO6			√	√								√			

Algorithms Laboratory:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√						√				√			
CO2	√	√				√			√				√		
CO3	√		√		√	√						√	√		√
CO4		√	√						√					√	√
CO5		√	√		√				√			√		√	
CO6					√							√			

Computer Networks Laboratory:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√			√		√								
CO2		√	√		√	√						√	√		
CO3	√	√			√	√		√		√			√	√	
CO4	√							√		√	√	√		√	
CO5			√										√		√
CO6			√												√

Machine Learning:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√		√		√				√		√				
CO2	√			√							√				
CO3			√								√	√	√		√
CO4		√	√	√						√	√		√	√	√
CO5		√										√	√		
CO6			√	√											

Artificial Intelligence:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√		√		√				√						
CO2	√			√											

CO3												√			√
CO4		√	√	√						√	√		√	√	
CO5		√	√									√	√		√
CO6			√	√									√		

Cloud Computing:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√	√			√					√	√			
CO2					√						√		√		
CO3	√	√	√											√	
CO4	√		√				√				√	√	√		√
CO5			√	√											
CO6			√	√		√									

Computer Vision:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√	√			√						√			
CO2					√										
CO3	√	√		√										√	
CO4	√						√				√	√	√		√
CO5			√	√									√		
CO6			√	√		√									

Software Project Management:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√														
CO2	√	√	√		√							√		√	√
CO3					√			√	√	√	√				
CO4			√			√					√	√			√
CO5			√	√		√		√			√		√		
CO6				√	√								√		

Time Series Forecasting:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√														
CO2		√												√	
CO3	√			√									√		
CO4			√									√			√
CO5	√		√										√		
CO6			√												

Natural Language Processing:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√		√		√	√			√		√			√	
CO2		√			√				√	√			√		
CO3	√		√			√						√			√
CO4		√	√		√				√		√				
CO5	√	√			√	√			√			√			
CO6			√	√											

Universal Human Values:

Artificial Intelligence Laboratory:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1					√										
CO2					√						√				
CO3	√		√					√						√	√
CO4	√		√			√		√					√		√
CO5	√		√	√					√	√		√	√		
CO6	√	√	√			√		√		√	√				

Applications Development Laboratory:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1					√			√			√				
CO2					√			√			√			√	
CO3	√		√					√							
CO4	√					√		√		√			√		
CO5	√		√	√		√			√	√		√	√		√
CO6	√	√	√			√		√		√	√				

MINI PROJECT:

Deep Learning Techniques:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1		√				√					√				
CO2	√	√							√		√				√
CO3	√		√			√						√	√		
CO4	√			√		√				√	√		√		
CO5			√											√	√
CO6			√												

Software Testing and Automation:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1			√	√											
CO2	√				√										
CO3					√	√		√					√		
CO4	√							√			√			√	
CO5	√	√		√							√			√	
CO6	√				√			√			√	√			√

Human Computer Interaction:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√		√		√	√						√			
CO2	√		√			√					√			√	
CO3					√							√	√		√
CO4		√	√			√					√				
CO5			√	√			√						√		√
CO6				√	√	√									

Computer Graphics and Multimedia Systems:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1							√								
CO2	√	√							√		√		√		√
CO3	√	√	√	√		√			√		√	√	√		
CO4				√		√					√			√	
CO5			√												
CO6			√												

Principles of Cryptography:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√						√								

CO2	√	√													√
CO3		√	√	√		√			√			√			
CO4				√		√								√	
CO5			√										√		
CO6			√												

Nature Inspired Computing:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√					√								
CO2	√	√													√
CO3		√	√	√		√			√			√			
CO4			√	√		√									
CO5												√	√		
CO6			√												

IOT and Applications:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√		√								√				
CO2		√		√					√		√			√	
CO3	√		√			√		√			√		√		
CO4	√		√	√		√				√					√
CO5	√		√		√	√		√			√		√		
CO6			√		√										

Agile Software Development:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1		√								√	√				
CO2						√				√	√			√	
CO3	√		√								√		√		
CO4		√	√		√						√		√		√
CO5				√	√										√
CO6			√		√										

Social Network Analysis:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1			√												
CO2	√								√						

CO3		√						√							
CO4			√			√					√		√		
CO5		√				√						√			√
CO6			√	√											

Augmented and Virtual Reality:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1		√	√												
CO2	√		√												
CO3	√		√		√	√	√			√	√				
CO4															√
CO5		√		√		√							√		
CO6		√		√									√		

Project – II/ Research Project-II:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1															
CO2															
CO3															
CO4															
CO5															
CO6															

Software Engineering Fundamentals:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√													
CO2								√	√				√		√
CO3		√									√	√		√	
CO4	√							√			√		√		
CO5			√	√			√			√		√	√		
CO6			√	√		√			√					√	√

Essentials of Computer Science:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1		√						√		√	√				
CO2	√		√		√	√		√				√			
CO3	√			√		√						√	√		
CO4		√		√		√	√					√		√	
CO5	√		√				√	√							√
CO6			√	√											

Object Oriented Programming:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√												√		
CO2	√				√								√		
CO3	√	√		√											
CO4		√		√								√		√	
CO5			√												√
CO6			√	√											

Fundamentals of Data Structures:

PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	√	√													
CO2	√		√										√		
CO3		√	√	√									√		
CO4			√	√								√	√		√
CO5		√	√									√			√
CO6		√	√	√									√		√

INFORMATION TECHNOLOGY

Course Title	**Communication Engineering**
Course Code (Credit)	**EC20008 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**EC20001**

Course Objective:

The Objective of the course is to learn the concepts of various analog and digital communication systems. Also students will be able to analyze and develop the problem solving abilities related to communication Engineering.

Course Contents:

UNIT I

Introduction:

To communication system, Signals in time and frequency domain, Fourier transform and Series, properties of FT and FS, Various Signal functions, Brief Idea of Probability, Cumulative Distributive Function, Probability Distributive Function, Gaussian and Rayleigh PDF. Concept of Signal to Noise Ratio

(This module introduces readers to basic mathematics and probability required for communication system analysis. Derivation/Proof are not required, students may be encouraged to self-study regarding the derivation and proofs for better understanding)

UNIT II

Amplitude Modulation Techniques:

Need of Modulation, Frequency Translation, Principle of AM, side bands, Power Relationship, Assignable Frequency spectrum, Side band Transmission, DSB, SSB, VSB, AM modulators and Demodulators, AM Radio Receiver, Super hetero-dyne Principle.

UNIT III

Frequency Modulation Techniques:

Principle of FM, Frequency Deviation, Spectrum of FM wave, Power in Modulated wave, Narrow band FM, Pre-emphasis and De-emphasis, Block Diagram of FM Transmitter, FM Detector, Block Diagram of FM Receiver,

UNIT IV

Pulse Modulation Techniques:

Analog vs Digital modulation, Sampling Process, Pulse Amplitude Modulation, Pulse Width Modulation,Pulse Position Modulation,Time Division Multiplexing, Frequency Division Multiplexing, The Quantization Process, Pulse Code Modulation, Bandwidth vs SNR trade-off in PCM.

UNIT V

Digital Modulation:
Data Form, Principles involved in ASK, PSK (BPSK, QPSK, π/4 QPSK), FSK.

UNIT VI
Different Communication Systems:
Introduction to Modems, Brief concept of satellite communication, Fiber optic communication and Mobile communication.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: Comprehend the basics of signals and systems like Fourier series, Fourier transform and their properties, random variable, random process, power spectral density of a signal etc.
CO2: Identify the need of communication and analyze different Amplitude Modulation based communication systems and their functions.
CO3: Comprehend, analyze and design Angle Modulation based communication systems and their functions.
CO4: Comprehend, analyze and Compare different Pulse Modulation based communication systems and their functions.
CO5; Comprehend and analyze various Digital communication techniques and Systems.
CO6: Gain broad Knowledge about Wireless, Satellite and Optical Communication.

Textbooks:
1. Modern Digital and Analog Communications Systems -B.P. Lathi - Hardcover, Oxford Univ Press, 4^{th} Edition.
2. Introduction to Analog & Digital Communication System – Simon Haykins, Wiley Student edition 2011 – John Wiley.

Reference Book:
1. Principles of Communication System – H. Taub & D.L.Schilling – TMH, 3rd Edition

Course Title	**Information Theory and Coding**
Course Code (Credit)	**CS20008 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**MA21002**

Course Objectives
- To define and apply the basic concepts of information theory (entropy, channel capacity etc.)
- To learn the principles and applications of information theory in communication systems

- To study various data compression methods and describe the most common such methods
- To understand the theoretical framework upon which error-control codes

Course Content:

UNIT-I:

Information theory: Concept of amount of information, Information units Entropy: marginal, Conditional, joint and relative entropies, Relation among entropies Mutual information, Information rate, Channel capacity, Redundancy and efficiency of channels Discrete channels, Symmetric channels, Binary Symmetric Channel, Binary Erasure Channel, Noise-Free Channel, Channel with independent I/O, Cascaded channels, Repetition of symbols, Binary asymmetric channel, Shannon theorem

UNIT-II:

Source coding, Encoding techniques, Purpose of encoding, Instantaneous codes, Construction of instantaneous codes, Kraft's inequality, Coding efficiency and redundancy, Source coding theorem. Construction of basic source codes, Shannon Fano coding, Shannon Fano Elias coding, Huffman coding, Minimum variance Huffman coding, Adaptive Huffman coding, Arithmetic coding, Dictionary coding, Lempel Ziv coding, Channel coding theorem for DMC

UNIT-III:

Codes for error detection and correction, Parity check coding, Linear block codes, Error detecting and correcting capabilities, Generator and Parity check matrices, Standard array and Syndrome decoding, Probability of an undetected error for Linear Codes over a BSC, Hamming codes, Applications of Block codes for Error control in data storage system

UNIT-IV:

Cyclic codes, Generator polynomial, Generator and Parity check matrices, Encoding of cyclic codes, Syndrome computation and error detection, Decoding of cyclic codes, BCH codes, RS codes, Burst error correction, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes.

UNIT-V:

Convolutional codes, Encoding and State, Tree and Trellis diagrams, Maximum likelihood decoding of convolutional codes, Viterbi algorithm, Sequential decoding, Stack algorithm. Interleaving techniques, Block and convolutional interleaving, Coding and interleaving applied to CD digital audio system, CIRC encoding and decoding, Interpolation and muting.

Course Outcomes:

Upon completion of this course, the students will be able to:
CO1: Solve problems on measurement of information and errors.
CO2: Explain the significance of quantitative measure of information in the communications systems
CO3: Design various source codes and channel codes
CO4: Differentiate between lossy and lossless compression techniques
CO5: Model encoders and decoders for block and cyclic codes
CO6: Discuss the significance of codes in various applications

Textbooks:

1. T. M. Cover, J. A. Thomas, "Elements of Information Theory", 2^{nd} Edition, Wiley.
2. Ranjan. Bose, *Information Theory Coding and Cryptography*, Third Edition, McGraw Hill.

Course Title	**Data Science and Analytics**
Course Code (Credit)	**CS30004 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**MA21002**

Course Objectives:

- To understand the concepts of Data science
- To explore the big data technologies and tools
- To become familiar with statistical concepts
- To apply the different data analytics techniques

Course Contents:

UNIT I
Introduction to Data Science:
Introduction to Data, Data Science, Challenges of Traditional Systems, Evolution of Analytic Scalability, Types of Computing (Distributed, Parallel, Grid), Data Analytics Lifecycle, Introduction to Big Data (Characteristics) and Hadoop (Hadoop Ecosystem, MapReduce, Hbase, Pig, Hive, Sqoop, NOSQL), Visualizations

UNIT II
Statistical Concepts:
Data Exploration: Distribution of a single variable, Basic Concepts (populations and samples, Data sets, Variables, and observations, Types of data), Descriptive measures for categorical variables, Descriptive measures

for numerical variables, Outliers and Missing values. Finding relationships among variables: Categorical variables, Numerical variables, Categorical variables and a Numerical variable. Sampling and distributions: Terminology, Estimation, Confidence Interval estimation, Sampling distributions, Confidence interval, Hypothesis testing, Chi-square test for independence

UNIT III
Data Analytics:
Introduction, Types of Data Analytics, Importance of Data Analytics, Data Analytics Applications, Regression Modelling Techniques: Linear Regression, Multiple Linear Regression, Non Linear Regression, Logistic Regression, Time Series Analysis, Performance analysis (RMSE, MAPE).

UNIT IV
Frequent Itemsets and Association:
Introduction to Frequent Itemsets, Market-Basket Model, Algorithm for Finding Frequent, Itemsets, Association Rule Mining, Apriori Algorithm and Correlations.

UNIT V
Classification & Clustering:
Introduction to classification and clustering, Distance-Based Algorithms: K Nearest Neighbour (KNN), Decision Tree-Based Algorithms: Decision Tree (ID3 Algorithm), Support Vector Machines (Linear), Naves Bayes. Overview of Clustering Techniques, Hierarchical Clustering, Partitioning Methods, K-Means Algorithm.

UNIT VI
Data Streams:
Introduction to Mining Data Streams, Data Stream Management Systems, Data Stream Mining, Examples of Data Stream Applications, Stream Queries, Issues in Data Stream Query, Processing, Sampling in Data Streams, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments.

Course Outcome:

Upon completion of the course, the students will be able to:
- CO1: Make use of data science concepts to handle big data.
- CO2: Examine the statistical concepts for finding relationships among variables and estimate data samplings.
- CO3: Select the data analytics techniques & models for both data prediction and performance analysis.
- CO4: Develop rules using frequent item sets and association mining.

CO5: Solve real-time problems using classification and clustering techniques.

CO6: Apply the mining techniques for data streams.

Textbooks:

1. Radha Shankarmani, M. Vijayalaxmi, “Big Data Analytics”, Second Edition, Wiley

Reference Books:

1. Business Analytics: Data Analysis & Decision Making by S. Christian Albright and Wayne L. Winston. 7th Edition. Published by Cengage Learning. (ISBN: 9781305947542)
2. Data Mining: Concepts and Techniques by Jiawei Han, Micheline Kamber, and Jian Pei. 3rd Edition. Published by Morgan Kaufmann. (ISBN: 9780123814791)
3. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services (Editor), Wiley, 2014
4. Big Data, Black Book, DT Editorial Services, Dreamtech Press, 2015

Course Title	**Automata Theory and Formal Languages**
Course Code (Credit)	**CS21003 (L-T-P-Cr: 3-1-0-4)**

Course Objectives

- To know about Chomsky hierarchy for organizing languages
- To introduce concepts in automata theory and theory of computation
- To identify different formal language classes and their relationships
- To design grammars and recognizers for different formal languages
- To understand undecidability and decide on languages that are undecidable

Course Contents:

UNIT I

Finite Automata:

Alphabets, Strings and Languages, Automata and Grammars, Deterministic Finite Automata (DFA), Formal Definition, Simplified notation: State transition graph, Transition table. Language of DFA, Non-deterministic Finite Automata (NFA), NFA with epsilon transition, Language of NFA, Equivalence of NFA and DFA, Minimization of Finite Automata, Distinguishing one string from other, Myhill Nerode Theorem.

UNIT II

Regular Expression (RE):

Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions, Kleen's Theorem, Regular expression to FA, DFA to Regular expression, Arden Theorem, Non Regular Languages, Pumping Lemma for regular Languages. Application of Pumping Lemma, Closure properties of Regular Languages, Decision properties of Regular Languages, FA with output: Moore and Mealy machine, Equivalence of Moore and Mealy Machine, Applications and Limitation of FA.

UNIT III

Context Free Grammar (CFG) and Context Free Languages:

Definition, Examples, Derivation, Derivation trees, Ambiguity in Grammar, Inherent ambiguity, Ambiguous to Unambiguous CFG, Useless symbols, Simplification of CFGs, Normal forms for CFGs: CNF and GNF, Closure properties of CFLs, Decision Properties of CFLs: Emptiness, Finiteness and Membership, Pumping lemma for CFLs.

UNIT IV

Push Down Automata (PDA):

Description and definition, Instantaneous Description, Language of PDA, Acceptance by Final state, Acceptance by empty stack, Deterministic PDA, Equivalence of acceptance by empty stack and final state, Conversion of CFG to PDA and PDA to CFG.UNIT V

UNIT V

Turing Machines (TM) and Undecidability:

Basic model, definition and representation, Instantaneous Description, Language acceptance by TM, Variants of Turing Machine, TM as Computer of Integer functions, Universal TM, Church's Thesis, Recursive and recursively enumerable languages, Halting problem, Introduction to Undecidability, Undecidable problems about TMs, Post correspondence problem (PCP), Modified PCP and undecidable nature of post correspondence problem, Introduction to recursive function theory.

Course Outcomes:

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

CO1: Acquire a fundamental understanding of the core concepts in automata theory and formal languages

CO2: Design finite automata or regular expression for any tokenization task

CO3: Construct a context free grammar for parsing any language

CO4: Design Turing machine for any language

CO5: Conclude the decidable / undecidable nature of any language

CO6: Apply mathematical and formal techniques for solving real-world problems

Textbooks:

1. John Hopcroft, Rajeev Motwani, and Jeffrey Ullman, "Introduction to Automata Theory, Languages and Computation", Third Edition, Pearson Education, 2014.

Reference Books:

5. John Hopcroft, Jeffrey Ullman, "Introduction to Automata Theory, Languages and Computation", Nineteenth Reprint, Narosa Publishing House, 2002.
6. Martin J. C., "Introduction to Languages and Theory of Computations", Fourth Edition, TMH, 2010.
7. Peter Linz, "An Introduction to Formal Language and Automata", Jones and Bertlett, 2011.
8. Papadimitriou C., Lewis C. L., "Elements of the Theory of Computation", Pearson, 1997.

Course Title	**Web Technology and Applications**
Course Code (Credit)	**CS30019 (L-T-P-Cr: 3-0-0-3**

Course Objectives:

- To understand the basics of Web Designing using HTML, DHTML, and CSS
- To learn the basics about Client side scripts and Server side scripts

Course Contents:

UNIT I:

HTML, Introduction, HTML Formatting, Hyper-Links, Lists, Tables, Images, Forms, Frames, Cascading Style sheets, Types, XML, Document type definition, XML Schemas, Document Object model.*

UNIT II:

Introduction to Client Side scripting, JavaScript, Control statements, Functions, Arrays, Objects, Events, Dynamic HTML with Java Script, AJAX: Ajax Client Server Architecture, XML Http Request Object, Call Back Methods.

UNIT III:

NodeJS and Express, Introduction to AngularJS and Fundamentals of ReactJS, Web servers, IIS (XAMPP, LAMPP) and Tomcat Servers, Server Side Scripting, Java Servlets, Java Server Pages, Java Server Faces, JSF Components, Session Tracking, Cookies.

UNIT IV:

PHP, Basic Syntax, Defining variable and constant, PHP Data types, Operator and Expression, Operator Precedence, Decisions and Loop, Functions & Recursion, String Processing and Regular Expressions, Form Processing, Working with file and Directories, Cookies

UNIT V:
Database Connectivity with MySQL, Servlets, JSP, PHP, MongoDB, NOSQL Database*, Fundamentals of JQuery and Bootstrap

Course Outcomes:
Upon completion of the course, the students will be able to:

CO1: Describe and interpret standard web technologies
CO2: Apply the basics of Web Designing using HTML, DHTML, and CSS
CO3: Build real world applications using client side and server side scripting languages
CO4: Design and develop applications using web technologies
CO5: Create the database connectivities
CO6: Suggest appropriate web technologies for any application

Textbooks:

1. Paul J. Deitel, Harvey M. Deitel, Abbey Deitel, "Internet & World Wide Web How to Program", Fifth Edition, Deitel Series, 2012.
2. Jason Gilmore, "Beginning PHP and MySQL from Novice to Professional", Fourth Edition, Apress Publications, 2010.
3. Brown, Ethan, "Web Development with Node and Express: Leveraging the JavaScript Stack",Second Edition O'Reilly Media,.
4. Anthony, Accomazzo, Murray Nathaniel, Lerner Ari, "Fullstack React: The Complete Guide to React JS and Friends", Fullstack.io, 2017.

Reference Books:
1. Robert W. Sebesta, "Programming with World Wide Web", Eighth Edition, Pearson, 2008.
2. David William Barron, "The World of Scripting Languages", John Wiley & Sons Publications, 2000.
3. Dayley B., "Node.js, MongoDB, and AngularJS Web Development", Addison-Wesley Professional, 2014.

Course Title	**Big Data**
Course Code (Credit)	**CS30017 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS20006**

Course Objectives:
- To understand the concepts of big data

- To know the big data technology foundations
- To know the hardtop ecosystem
- To become aware of storing data in databases and data warehouses
- To know the insights of data through data analytics

Course Contents:

UNIT I

Getting an Overview of Big Data:

What is Big Data, History of Data Management – Evolution of Big Data, Structuring Big Data, Elements of Big Data, Big Data Analytics, Future of Big Data, Use of Big Data in Social Networking, Use of Big Data in Preventing Fraudulent Activities, Use of Big Data in Detecting Fraudulent Activities in Insurance Sector, Use of Big Data in Retail Industry.

UNIT II

Understanding Big Data Technology Foundations:

Exploring the Big Data Stack, Data Sources Layer, Ingestion Layer, Storage Layer, Physical Infrastructure Layer, Platform Management Layer, Security Layer, Monitoring Layer, Analytics Engine, Visualization Layer, Virtualization and Big Data, Virtualization Approaches, Distributed and Parallel Computing for Big Data, Introducing Hadoop, Cloud Computing and Big Data, In-Memory Computing Technology for Big Data.

UNIT III

Understanding Hadoop Ecosystem:

Hadoop Ecosystem, Hadoop Distributed File System, MapReduce, Hadoop YARN, Introducing HBase, Combining HBase and HDFS, Hive, Pig and Pig Latin, Sqoop, ZooKeeper, Flume, Oozie, The MapReduce Framework, Techniques to Optimize MapReduce Jobs, Uses of MapReduce, Role of HBase in Big Data Processing.

UNIT IV

Storing Data in Databases and Data Warehouses:

RDBMS and Big Data, Non-Relational Database, Polyglot Persistence, Integrating Big Data with Traditional Data Warehouses, Big Data Analysis and Data Warehouse, Changing Deployment Models in Big Data Era. Introduction to NoSQL, Types of NoSQL Data Models, Schema-Less Databases, Materialized Views, Distribution Models, Sharding.

UNIT V

Understanding Analytics and Big Data:

Comparing Reporting and Analysis, Types of Analytics, Points to Consider during Analysis, Developing an Analytic Team, Understanding Text Analytics, Introducing Social Media Introducing Key Elements of Social Media, Introducing Text Mining, Understanding Text Mining Process, Sentiment Analysis, Performing Social Media Analytics and Opinion Mining on Tweets.

Course outcome:

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

CO1. Formulate the concept of data management and evolution of Big Data.

CO2. Implement and understand various big data technology foundations.

CO3. Apply the fundamentals of Hadoop ecosystem and its components for data analysis.

CO4. Analyze the optimization and storage of data in data bases.

CO5. Explore the understanding of analytics and big data.

CO6. Implement deep learning approches in real life application.

Textbooks:

1. Big Data, Black Book, DT Editorial Services, Dreamtech Press, 2015
2. Seema Acharya, Subhashini Chellappan ,"Big Data and Analytics", Wiley India, Second Edition, 2015

Reference Books:

1. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analytics, John Wiley & sons, 2012.(Foreign books)
2. Glenn J. Myatt, Making Sense of Data, Wiley-Inter Science, 2007
3. Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman "Big Data For Dummies", Wiley 2013

Course Title	**Real Time Systems**
Course Code (Credit)	**CS30021 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To study issues related to the design and analysis of systems with real-time constraints
- To learn the features of Real time OS
- To study the various Uniprocessor and Multiprocessor scheduling mechanisms
- To learn about various real time communication protocols
- To study the difference between traditional and real time

databases

Course Contents:

UNIT I

Introduction to Real-time systems:

Introduction to real time computing, Concepts, Example of real-time applications, Structure of a real time system, Characterization of real time systems and tasks, Hard and Soft timing constraints, Design Challenges, Performance metrics, Prediction of Execution Time: Source code analysis, Micro–architecture level analysis, Cache and pipeline issues, Programming Languages for Real-Time Systems.*

UNIT II

Task Assignment and Scheduling:

Real time OS, Threads and Tasks, Structure of Microkernel, Time services, Scheduling Mechanisms, Communication and Synchronization, Event Notification and Software interrupt, Uniprocessor scheduling algorithms, Task assignment, Mode changes, Fault tolerant scheduling.*

UNIT III

Real–Time Communication:

Network topologies and architecture issues, Protocols, Contention-based, token–based, Polled bus, Fault tolerant routing.*

UNIT IV

Real–Time Databases:

Transaction priorities and aborts, Concurrency control issues, Scheduling algorithms, Two-phase approach to improve predictability.*

UNIT V

Programming Languages and Tools:

Hierarchical decomposition, Run–time error handling, Overloading, Timing specification, Recent trends and developments.*

*Programming Assignments are mandatory.

Course Outcomes:

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

CO1: Classify the features of Real time OS

CO2: Identify issues related to the design and analysis of systems with real-time constraints

CO3: Analyze scheduling problems

CO4: Appreciate and apply Real–time programming environment tasks for solving practical problems

CO5: Develop real time systems.

CO6: Compare basic multi-task scheduling algorithms

Textbooks:

1. Jane Liu, “Real–Time Systems”, First Edition, Pearson, 2002

Reference Books:

1. Rajib Mall, “Real–Time Systems: Theory and Practice”, First Edition, Pearson Education, 2012.

Course Title	**Software Defined Networking**
Course Code (Credit)	**CS30023 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS30003**

Course Objectives:

- Analyze reduced Complexity of Network Operation
- Describe and understand the concepts of minimize Layer and maximize Network Resources
- Evaluate and understand the Faster Time to Revenue for New Applications
- Memorize Data center and its usage
- Illustrate about Big data

Course Contents:

UNIT I

Introduction:

Introduction, Control Plane, Data Plane, Distributed Control Planes, IP and MPLS, Creating the IP Underlay, Convergence Time, Load Balancing High Availability, Creating the MPLS Overlay, Replication, Centralized Control Planes, Logical Versus Litera, ATM/LANE, Route Servers, Wire Protocol, FAWG, Config and Extensibility, Architecture, Hybrid Approaches, Ships in the Night, Dual Function Switches.*

UNIT II

Interface:

VMWare, Nicira, Mininet, NOX/POX, Trema, Ryu, Big Switch Networks/Floodlight, Layer 3 Centric, L3VPN, Path Computation Element Server, Plexxi Affinity, Cisco OnePK, Management Interface, Network Divide, Modern Programmatic Interfaces, Modern Orchestration.*

UNIT III

Data Center:

Multitenant Data Center, Virtualized Multitenant Data Center, SDN Solutions for Data Center Network, VLANs, EVPN, VxLan, NVGRE, Virtualization and Data Plane I/O, Services Engineered Path, Service Locations and Chaining, NEV at ETSI, Non-ETSI NEV Work.*

UNIT IV

Topology:

Network Topology, Traditional Methods, LLDP, BGP-TE/LS, ALTO, I2RS, Build Code First, The Juniper SDN Framework(s), Open Daylight Controller/Framework, Policy.*

UNIT V

Technology:

Bandwidth Scheduling, Manipulation, Calendaring, Bandwidth Calendaring, Big Data and Application Hyper, Virtualization for Instant CSPF, Expanding Technology, Use Cases for Data Center Overlays, Big Data, Network Function Virtualization, Data Center Orchestration, Puppet, Network Function Virtualization, Optimized Big Data, Firewall as Service, Network Access Control Replacement, Virtual Firewall, Feed Back and Optimization, Intrusion Detection/Threat Mitigation.*

*Programming Assignments are mandatory

Course Outcomes:

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

CO1: Comprehend Software Defined Networks

CO2: Analyze reduced Complexity of Network Operation

CO3: Compare and analyze the advantages of SDN over traditional network

CO4: Design and implement software defined network

CO5: Design algorithm for virtualization

CO6: Design algorithm for big data analytics

Textbooks:

1. Thomas D. Nandeau, Ken Gray, “Software Defined Networks”, First Edition, O’ Reilly Media Inc., 2013.
2. FEI HU, “Network Innovation through OpenFlow and SDN: Principles and Design”, CRC Press, 2014.

Reference Books:

1. Azodolmolky, Siamak, “Software Defined Networking with OpenFlow”, Packt Publishing Ltd., 2013.
2. Nadeau, Thomas D., Ken Gray, “SDN: Software Defined Networks: An Authoritative Review of Network Programmability Technologies”, O'Reilly Media Inc., 2013.
3. Dillinger, Markus, Kambiz Madani, Nancy Alonistioti, “Software Defined Radio: Architectures, Systems and Functions”, John Wiley & Sons, 2005.
4. Goransson, Paul, Chuck Black, Timothy Culver, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann, 2016.

Course Title	Information Security
Course Code (Credit)	**CS20010 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS30003**

Course Objectives

- To understand the basics of Information Security
- To know the legal, ethical and professional issues in Information Security
- To know the aspects of risk management
- To become aware of various standards in this area
- To know the technological aspects of Information Security

Course Contents:

UNIT I

Introduction:
Information Security, Critical Characteristics of Information, NSTISSC Security Model, Components of an Information System, Securing the Components, Balancing Security and Access, The SDLC, The Security SDLC.

UNIT II
Security Investigation:
Need for Security, Business Needs, Threats, Attacks, Legal, Ethical and Professional Issues, An Overview of Computer Security, Access Control Matrix, Policy, Security policies, Confidentiality policies, Integrity policies and Hybrid policies.

UNIT III
Security Analysis:
Risk Management, Identifying and Assessing Risk, Assessing and Controlling Risk, Systems: Access Control Mechanisms, Information Flow and Confinement Problem.

UNIT IV
Logical Design:
Blueprint for Security, Information Security Policy, Standards and Practices, ISO 17799/BS 7799, NIST Models, VISA, International Security Model, Design of Security Architecture, Planning for Continuity.

UNIT V
Physical Design:
Security Technology, IDS, Scanning and Analysis Tools, Cryptography, Access Control Devices, Physical Security, Security and Personnel

Course Outcomes

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

CO1: Identify goals of Information Security

CO2: Discuss the basics of information security

CO3: Illustrate the legal, ethical and professional issues in information security

CO4: Demonstrate the aspects of risk management

CO5: Become aware of various standards in the Information Security System

CO6: Design and implementation of Security Techniques

Textbooks:

1. Michael E. Whitman, Herbert J Mattord, "Principles of Information Security", Cengage, Sixth Edition, 2018.

Reference Books:

1. Micki Krause, Harold F. Tipton, "Handbook of Information Security Management", Vol. 1-3, CRC Press LLC, 2004.
2. Stuart McClure, Joel Scrambray, George Kurtz, "Hacking Exposed", Tata McGraw Hill, 2003.
3. Matt Bishop, "Computer Security Art and Science", Addison-Wesley Professional, 2002

Course Title	**Mobile Computing**
Course Code (Credit)	**CS40011 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To understand the fundamentals of mobile communication
- To understand the architecture of various Wireless Communication Networks
- To understand the significance of different layers in mobile system

Course Contents:

UNIT I:

Introduction to Wireless Networks, Applications, History, Simplified Reference Model, Wireless transmission, Frequencies, Signals, Antennas, Signal propagation, Multiplexing, Modulation, Spread spectrum, Cellular Systems: Frequency Management and Channel Assignment, Types of hand-off and their characteristics.*

UNIT II:

MAC, Motivation, SDMA, FDMA, TDMA, CDMA, Telecommunication

Systems, GSM: Architecture- Location tracking and call setup, Mobility management, Handover, Security, GSM, SMS, International roaming for GSM, Call recording functions, Subscriber and service data management, DECT, TETRA, UMTS, IMT-2000.*

UNIT III:
Wireless LAN, Infrared vs. Radio transmission, Infrastructure, Adhoc Network, IEEE 802.11WLAN Standards, Architecture, Services, HIPERLAN, Bluetooth Architecture & protocols.*

UNIT IV:
Mobile Network Layer, Mobile IP, Dynamic Host Configuration Protocol, Mobile Transport Layer, Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/Fast recovery, Transmission/Time-out freezing, Selective retransmission, Transaction Oriented TCP.*

UNIT V:
WAP Model, Mobile Location based services, WAP Gateway, WAP protocols, WAP user agent profile caching model, Wireless bearers for WAP, WML, WML Scripts – WTA – iMode, SyncML.*
*Programming assignments are mandatory.

Course Outcomes:
Upon completion of the course, the students will be able to:
CO1: Perceive the fundamentals of mobile communication
CO2: Describe the architecture of various Wireless Communication Network
CO3: Recognize different layers in mobile system
CO4: Develop a strong grounding in the fundamentals of mobile Networks
CO5: Apply knowledge in MAC, Network, and Transport Layer protocols of Wireless Network
CO6: Comprehend and develop a lightweight network stack

Textbooks:

1. Jochen Schiller, “Mobile Communication”, Second Edition, Pearson Education, 2008.
2. Theodore, S. Rappaport, “Wireless Communications, Principles, Practice”, Second Edition, Pearson, 2023.

Reference Books:

1. C. Siva Ram Murthy, B. S. Manoj, “Adhoc Wireless Networks: Architectures and Protocols”, Second Edition, Pearson Education, 2008.
2. Vijay. K. Garg, “Wireless Communication and Networking”, Morgan Kaufmann Publishers, 2007.

Course Title	**Block Chain**
Course Code (Credit)	**CS40012 (L- T- P-Cr: 3-0-0-3)**

Course Objectives

- To understand the design principles Block Chain
- To describe differences between proof-of-work and proof-of-stake consensus
- To understand building a distributed application
- To understand Bitcoin's consensus mechanism

Course Contents:

Unit I
Blockchain Fundamentals:
Fundamental of Blockchain Technology and its Importance, Electronic Systems and Trust, Distributed Versus Centralized Versus Decentralized, Bitcoin Predecessors, DigiCash, E-Gold, Cryptographic hash functions, Properties of a hash function-Hash pointer and Merkle tree, digital signatures, B-Money, Evolution of the Blockchain Technology, Storing Data in a Chain of Blocks, Compelling Components, Achieving Consensus

Unit II
Cryptocurrency Fundamentals:
Basic cryptocurrency system, Public and Private Keys in Cryptocurrency Systems, The UTXO Model, Transactions, Signing and Validating Transactions, Bitcoin Transaction Security, Wallet Types: Custodial Versus Noncustodial, Lightweight wallets, Hierarchical deterministic wallets, Permissioned and Permissionless Consensus, Proof-of-Work, Proof-of-Stake, Proof of Burn, Proof of Elapsed Time, Bitcoin Miner, Mining Difficulty

Unit III
Distributed Consensus:
Permissioned Blockchain: Design issues for Permissioned blockchains, Execute contracts, State machine replication, Overview of Consensus models for permissioned blockchain- Distributed consensus in closed environment, Paxos, RAFT Consensus Algorithm, Practical Byzantine Fault Tolerance (PBFT), Lamport-Shostak-Pease BFT Algorithm.

Unit IV
Forks and Altchains:

Understanding Forks, Contentious Hard Forks, The Bitcoin Cash Fork, Altcoins, Litecoin, Privacy-Focused Cryptocurrencies, Segregated witness, Validation and Analysis of Smart Contracts, Evolution of Ethereum, The Ethereum Classic Fork, Comparison among Bitcoin, Ethereum, Stellar, Monero, ZCash, Quorum and Hyperledger fabric. Enterprise, Healthcare and transportation application of Blockchain

Course Outcomes:

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

CO1: Explain the design principles of Bitcoin and Ethereum.

CO2: List and describe differences between proof-of-work and proof-of-stake consensus.

CO3: Interact with a blockchain system by sending and reading transactions

CO4: Design, build and deploy a distributed application.

CO5: Apply the concept of Bitcoin's consensus mechanism and the interaction between Bitcoin and Altcoins

CO6: Familiarize with Ethereum, smart contracts and related technologies, and solidity language

Textbooks:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.
2. Lorne Lantz & Daniel Cawrey, Mastering Blockchain Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, O'REILLY Publications

Reference Books:

1. Bina Ramamurthy, Blockchain in Action, MANNING Publication.
2. Bikramaditya Singhal, Gautam Dhameja, and PriyansuSekhra Panda, Beginning Blockchain, Apress Publication.
3. Draft version of "S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, "Blockchain Technology: Cryptocurrency and Applications", World cientific, 2020.
4. Josh Thompson, "Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing Platform, 2017.

Course Title	**Game Theory**
Course Code (Credit)	**CS40014 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To explain and predict how individuals behave in a specific strategic situation, and therefore help improve decision making
- To explain in depth the standard equilibrium concepts in Game Theory
- To illustrate the concepts, real-world examples and case studies
- To design Repeated Games with public information
- To design static and Dynamic games with incomplete information

Course Contents:
UNIT I
Introduction to Game Theory:
Games and solutions, Game theory and mechanism design, Examples from networks, Strategic form games, Matrix and continuous games, Iterated strict dominance, Rationalizability, Nash Equilibrium, existence and uniqueness, Mixed and correlated equilibrium, Super modular games, Potential/congestion games, Existence and Properties of Nash Equilibria.

UNIT II
Extensive-Form Games:
Definition, Strategies and Equilibria in Extensive Form Games, Backward Induction and Subgame Perfection and its Critiques

UNIT III
Repeated Games:
Infinitely/finitely repeated games, Pareto Perfection and Renegotiation, Proofness in Repeated Games, Repeated Games with incomplete Public Information, Trigger strategies, Fork Theorem with Imperfect Public Information

UNIT IV
Static Games with incomplete information:
Mixed and Behavioral strategies, Bayesian Nash equilibrium, Applications in auctions, Different auction formats, Revenue and efficiency properties of different auctions, Bayesian Games and Mechanism Design Principle, Single Agent, Several Agents, Further topics in Mechanism Design.

Unit V
Dynamic Games with incomplete information:
Introduction, Perfect Bayesian Equilibrium in Multi-stage games, Extensive-Form and Strategic-Form Refinements, Reputation Effects, Sequential Bargaining under Incomplete Information

Course Outcomes:

Upon completion of this course, the students will be able to:
CO1: Identify strategic situations and represent them as games
CO2: Solve simple games using various techniques
CO3: Recommend and prescribe which strategies to implement
CO4: Develop Static and Dynamic Games
CO5: Develop Repeated Games
CO6: Design Repeated Games with public information

Textbooks:

1. Fudenberg, Drew, Jean Tirole, "Game Theory", Cambridge, MA: MIT Press, 1991.

Reference Books:

1. Nisan, Noam, Tim Roughgarden, Eva Tardos, Vijay V. Vazirani, "Algorithmic Game Theory", Cambridge, UK: Cambridge University Press, 2007.
2. Fudenberg, Drew, David Levine, "Theory of Learning in Games", Cambridge, MA: The MIT Press, 1998.

PROGRAMME LABORATORY COURSES

Course Title	**Communication Engineering Laboratory**
Course Code (Credit)	**EC29002 (L-T-P-Cr: 0-0-2-1)**
Pre-requisites	**EC20001/EC21001**

Course Objective:

This lab aims to make students practice the fundamental theories of analog and digital communication systems. Students will use computer simulation tools such as P-SPICE or Matlab to carry out design experiments. Students will design, and build and examining trade-offs in different modulation systems. Perform experiments in converting analog information into digital data via sampling, quantization, and coding.

Course Outcomes:

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

CO 1: Understand the principle of different types of Amplitude Modulation(AM) and demodulation. Also gain knowledge on the principle of Superheterodyne receivers.

CO 2: Generate Frequency Modulated (FM) signals using IC XR2206 with its principle of operation and apply the FM signal to PLL IC 565 circuit for demodulation process.

CO 3: Analyze the process of sampling and quantization with different Pulse modulation techniques and Waveform Coding techniques. Also acquire some knowledge on multiplexing scheme.

CO 4: Understand the operating principles of different digital modulation techniques with respective waveforms representation.

CO 5: Design and implementation of Modulator and Demodulator circuits using discrete components.
CO 6: Simulate the modulated signals using Matlab programs. Formulate design and real life engineering problems for executing minor projects.

Course Title	**Data Analytics Laboratory**
Course Code (Credit)	**CS39004 (L-T-P-Cr: 0-0-2-1)**

Course Objectives:

- To explore the fundamental concepts of data analytics.
- To understand the various search methods and visualization techniques.
- To apply various machine learning techniques for data analysis.

LIST OF EXPERIEMENTS:

1. R AS CALCULATOR APPLICATION

a. Using with and without R objects on console

b. Using mathematical functions on console

c. Write an R script, to create R objects for calculator application and save in a specified location in disk

2. DESCRIPTIVE STATISTICS IN R

a. Write an R script to find basic descriptive statistics using summary

b. Write an R script to find subset of dataset by using subset ()

3. READING AND WRITING DIFFERENT TYPES OF DATASETS

a. Reading different types of data sets (.txt, .csv) from web and disk and writing in file in specific disk location.

b. Reading Excel data sheet in R

c. Reading XML dataset in R

4. VISUALIZATIONS

a. Find the data distributions using box and scatter plot.

b. Find the outliers using plot.

c. Plot the histogram, bar chart and pie chart on sample data

5. CORRELATION AND COVARIANCE

a. Find the correlation matrix.

b. Plot the correlation plot on dataset and visualize giving an overview of relationships among data on iris data.

c. Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data

6. REGRESSION MODEL

Import a data from web storage. Name the dataset and now do Logistic Regression to find out relation between variables that are affecting the admission of a student in a institute based on his or her GRE score, GPA obtained and rank of the student. Also check the model is fit or not. require (foreign), require(MASS).

7. MULTIPLE REGRESSION MODEL

Apply multiple regressions, if data have a continuous independent variable. Apply on above dataset.

Week-8: REGRESSION MODEL FOR PREDICTION

Apply regression Model techniques to predict the data on above dataset.

9. CLASSIFICATION MODEL

a. Install relevant package for classification.

b. Choose classifier for classification problem.

c. Evaluate the performance of classifier.

10. CLUSTERING MODEL

a. Clustering algorithms for unsupervised classification.

b. Plot the cluster data using R visualizations.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: Install different Data Analytics tools

CO2: Examine the basics of data analytics using concepts of statistics and probability.
CO3: Apply various inferential statistical analysis techniques to describe data sets and withdraw useful conclusions from acquired data set.
CO4: Explore the data analytics techniques using various tools
CO5: Apply data science concept and methods to solve problems in real world context
CO6: Select advanced techniques to conduct thorough and insightful analysis and interpret the results

Reference Book :

1. Yanchang Zhao, “R and Data Mining: Examples and Case Studies”, Academic Press, Elsevier, 1st Edition, 2013

Web References:

1.http://www.r-bloggers.com/how-to-perform-a-logistic-regression-in-r/
2.http://www.ats.ucla.edu/stat/r/dae/rreg.htm
3.http://www.coastal.edu/kingw/statistics/R-tutorials/logistic.html 4. http://www.ats.ucla.edu/stat/r/data/binary.csv

Course Title	**Advance Programming Laboratory**
Course Code (Credit)	**CS39006 (L-T-P-Cr: 2-0-0-2)**

Course Objectives:

- Explore and understand how to use the R documentation
- Expand R by installing R packages
- Read Structured Data into R from various sources
- Understand the different data types and structures in R
- Using R for mathematical operations
- Use of vectorized and matrix calculations
- Write user-defined and looping constructs R functions
- Reshape data to support different analyses

LIST OF EXPERIEMENTS:

1. Download and install R-Programming environment and install basic packages using install.packages() command in R.
2. Learn all the basics of R-Programming (Data types, Variables, Operators etc.)

3. Implement R-Loops with different examples.
4. Learn the basics of functions in R and implement with examples.
5. Implement data frames in R.
6. Implement different String Manipulation functions in R.
7. Implement different data structures in R (Vectors, Lists, Data Frames)
8. Write a program to read a csv file and analyze the data in the file in R
9. Create pie charts and bar charts using R.
10. Create a data set and do statistical analysis on the data using R.

Course Outcomes

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

CO1: Install, configure and install different packages in R.

CO2: Import and export files.

CO3: Make use of different data structures.

Perform mathematical operations.

Perform operations for different data types.

Perform analysis of data in different perspective.

Reference Book:

1. Jared P. Lander, R for Everyone: Advanced Analytics and Graphics, Second Edition, Pearson Education, 2018.

Web References:

1. https://www.r-project.org/
2. https://www.tutorialspoint.com/r/index.htm

COMPUTER SCIENCE & COMMUNICATION ENGINEERING

Detailed Syllabus

Course Title	**Wireless Mobile Communication**
Course Code (Credit)	**EC30002 (L- T- P-Cr: 3-0-0-3)**
Pre-requisites	**EC21002/ EC20008**

Course Objective:
The course intends to make the students learn the Cellular Concept, RF signal propagation through a wireless channel, Various fading scenarios, Equalization and diversity techniques, multiple access techniques, and various signal degradation factors associated with wireless communication and to study numerous wireless standards and current technological trends in this domain.

Course Contents:
UNIT I
Channel Coding:
Error Correction Codes – Introduction to Galois fields, polynomial arithmetic, linear block codes for error correction – Generator matrix, Encoding, Parity Check matrix, Decoding – Standard array decoding and Syndrome decoding. Cyclic Codes – Generation of codes, encoding and syndrome decoding, Introduction to Convolutional codes

UNIT II
Cellular Communication System:
Cellular Concept,System Architecture, Spectrum Allocation, Frequency Reuse Channel Assignment Strategies, Co-channel Interference & System Capacity. Hand off, Hand off structure, Practical Hand off consideration, Prioritizing Hand off, Power Control, Near – Far Problem,System capacity, Improvement Techniques : Cell splitting, Sectoring, Micro cell Zone concept

UNIT III
RF Propagation and Fading:
Free space propagation model, propagation mechanism
Large Scale fading, Diffraction & Scattering by high – raise structures, shadowing and path loss. Small Scale Fading, Doppler and time-delay

spread, coherence Bandwidth and coherence-Time, Types of Small – Scale Fading

UNIT IV
Equalization and Diversity principles
Fundamentals of Equalization, Adaptive equalizer. Concept of diversity, Types of diversity (space, time, frequency, polarization, Rake receiver

UNIT V
Different Multiple access Techniques and Spread Spectrum modulation
Multiplexing and multiple access, TDD and FDD techniques, Description of FDMA, TDMA, CDMA systems. Architecture and special features of GSM. Spread Spectrum Modulation and principle, PN sequence and its properties. Direct sequence SS and frequency – hopped SS (DS – SS and FH – SS), TH – SS.

UNIT VI
OFDM and Multi-carrier Communication
Data transmission using multiple carriers, multi carrier modulation with overlapping sub channels, mitigation of sub carrier fading. Discrete Implementation of multi carrier modulation, DFT and its properties, OFDM Principle, The Cyclic Prefix. Matrix representation of OFDM, Multi-carrier Communication with OFDM

UNIT V
Technological Trends in Wireless and Mobile Communication
Concept of Multi input multi output Antenna system, Narrow band MIMO model. MIMO channel capacity, MIMO Diversity gain, Space time Modulation & Coding, LTE and LTE Advanced support technologies, Cognitive radio, mobility management, IEEE 802.11, Bluetooth.

Course Outcomes:

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

CO1: Comprehend the significance of terminology associated with cellular architecture and determine the performance parameters of cell splitting, sectoring, and microcell zone techniques.

CO2: Solve problems associated with basic propagation models like two ray reflection model, Knife edge propagation model etc and able to analyze signal degradation in wireless out door propagation models.

CO3: Analyse the concepts and solve problems on various modulation schemes like QPSK, Off set QPSK, π/4 QPSK, MSK, GMSK, QAM used in present day mobile communication.

CO4: Comprehend and analyse the concepts of channel equalization and various diversity techniques.
CO5: Comprehend and analyse the concepts of Spread Spectrum and its applications along with different types of multiple access techniques and able to solve related numerical associated with this.
CO6: Comprehend and analyse the concepts of MC-CDMA and OFDMA modulation and the concepts of MIMO antenna systems along with different technological trends in wireless and mobile communication

Textbooks:

1. Wireless Communication – T.S.Rappaport – Pearson Education
2. Wireless Communication – Andrea Goldsmith – Cambridge Press

Reference Books: :

1. Wireless and Cellular Communication – C. Y. Lee – McGraw Hill
2. Mobile Communication – Schillar – Pearson Education
3. LTE for UMTS, Evolution to LTE Advanced-Harri Holma,Antti Toskala-Wiley

Course Title	**Information Theory and Coding**
Course Code (Credit)	**CS20008 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**MA21002**

Course Objectives

- To define and apply the basic concepts of information theory (entropy, channel capacity etc.)
- To learn the principles and applications of information theory in communication systems
- To study various data compression methods and describe the most common such methods
- To understand the theoretical framework upon which error-control codes

Course Content:

UNIT-I:

Information theory: Concept of amount of information, Information units Entropy: marginal, Conditional, joint and relative entropies, Relation among entropies Mutual information, Information rate, Channel capacity, Redundancy and efficiency of channels Discrete channels, Symmetric channels, Binary Symmetric Channel, Binary Erasure Channel, Noise-Free

Channel, Channel with independent I/O, Cascaded channels, Repetition of symbols, Binary asymmetric channel, Shannon theorem

UNIT-II:

Source coding, Encoding techniques, Purpose of encoding, Instantaneous codes, Construction of instantaneous codes, Kraft's inequality, Coding efficiency and redundancy, Source coding theorem. Construction of basic source codes, Shannon Fano coding, Shannon Fano Elias coding, Huffman coding, Minimum variance Huffman coding, Adaptive Huffman coding, Arithmetic coding, Dictionary coding, Lempel Ziv coding, Channel coding theorem for DMC

UNIT-III:

Codes for error detection and correction, Parity check coding, Linear block codes, Error detecting and correcting capabilities, Generator and Parity check matrices, Standard array and Syndrome decoding, Probability of an undetected error for Linear Codes over a BSC, Hamming codes, Applications of Block codes for Error control in data storage system

UNIT-IV:

Cyclic codes, Generator polynomial, Generator and Parity check matrices, Encoding of cyclic codes, Syndrome computation and error detection, Decoding of cyclic codes, BCH codes, RS codes, Burst error correction, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes.

UNIT-V:

Convolutional codes, Encoding and State, Tree and Trellis diagrams, Maximum likelihood decoding of convolutional codes, Viterbi algorithm, Sequential decoding, Stack algorithm. Interleaving techniques, Block and convolutional interleaving, Coding and interleaving applied to CD digital audio system, CIRC encoding and decoding, Interpolation and muting.

Course Outcomes:

Upon completion of this course, the students will be able to:
CO1: Solve problems on measurement of information and errors.
CO2: Explain the significance of quantitative measure of information in the communications systems
CO3: Design various source codes and channel codes
CO4: Differentiate between lossy and lossless compression techniques
CO5: Model encoders and decoders for block and cyclic codes
CO6: Discuss the significance of codes in various applications

Textbooks:

3. T. M. Cover, J. A. Thomas, "Elements of Information Theory", 2^{nd} Edition, Wiley.
4. Ranjan. Bose, *Information Theory Coding and Cryptography*, Third Edition, McGraw Hill.

Course Title	**Digital Signal Processing**
Course Code (Credit)	**EC30023 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**EC20006**

Course Objective:

This course will begin with an introduction to analog and digital signal processing, then elaborates on various transformation techniques to signal, and finally presents an idea about actual implementations of these techniques in today's hardware using software systems. The course begins with a discussion on discrete-time signals and systems. This will be followed by introducing the Z transform, DFT, and its properties and system theoretic implications. Later, the concepts and foundations of digital filter design and its realization are built up for FIR and IIR filters.

Course Contents:

UNIT I
Introduction:
Brief idea about analog and digital signals, Definition of signal and systems, Signal Processing (ASP and DSP), Advantages and Disadvantages of DSP, Application of DSP.

UNIT II
Discrete time Signals & Systems:
Discrete Time Signals and its classification, Discrete Time Systems and its classification, Operation on Discrete Time Signals, LTI systems Linear convolution sum and de-convolution, Properties of convolution, Applications of convolution, Interconnection of LTI systems, Correlation of two sequences & its Properties

UNIT III
Fourier Transform, DTFT, DFT, IDFT and FFT: Introduction to Fourier Transform, Discrete Time Fourier Transform, DTFT of discrete time signal and its properties, Discrete Fourier Transform and its Properties, Inverse Discrete Fourier Transform, Circular convolution and its properties, Long duration sequences by digital filter method (Over-lap save and Over-lap add method), Fast Fourier Transform and its properties.

UNIT IV

Z-Transform:

Introduction to Z-Transform, Definition of Z-Transform, ROC of the Z-Transform, Properties of ROC, Properties of Z-Transform, Inverse Z-Transform, Long division method, Partial Fraction Expansion Method, Stability analysis of Discrete Time Systems.

UNIT V

Digital filters (IIR & FIR FILTERS):

Introduction to Digital Filter, Design of IIR filter using Design of IIR filter using impulse invariance technique, Design of IIR filter using Bilinear transformation, Design of FIR Filter using Rectangular, Hamming Window, Blackmann window, Kaiser window, and Bartlett window.

Course Outcomes:

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

CO1: Classification of analog and discrete time signals; perform different operations on discrete time signals.

CO2. Analysis of discrete time systems in time domain.

CO3. Analyze characteristics of signals and systems in frequency domain using Fourier analysis and its properties.

CO4: Comprehend the properties of z-transform; perform z-transform and its inverse; analysis of discrete time systems using z-transform.

CO5: Design IIR filter with given specifications using impulse invariance and bilinear transformation techniques.

CO6: Design of FIR filter with given specifications using different windowing techniques.

Textbooks:

1. Digital Signal Processing- J.G. Proakis & D. G. Manolakes, 4^{th} Edition-PHI.
2. Signals & Systems – Alan V Oppeinhem, Alan S Willsky– 2nd/ 2011–PHI.

Reference Books:

1. Principle of Signal Processing and Linear System: B.P. Lathi, First Edition, Oxford University Press.
2. Digital Signal Processing: P. Ramesh Babu: Scitech,2nd Edition.
3. Digital Signal Processing - Computer Based Approach: S. K . Mitra, Second Edition, MGH.

Course Title	**Smart Antennas**
Course Code (Credit)	**EC40018 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**EC20003**

Course Objective:
This course focuses on advanced topics in design of smart antennas systems, including antenna array principles and smart antenna algorithms such as angle of arrival estimation and antenna beam forming. The course provides the student with the basic principles of smart antenna systems, which is an adaptive antenna array consisting of multiple antennas. Objective is to use intelligent algorithms to calculate the optimal antenna combination to make optimal use of beamforming and antenna array technologies, thereby reaping better benefits.

Course Contents:
UNIT I
Introduction:
Analysis of linear and circular antenna arrays, and phased array antenna. Array synthesis methods. Adaptive antennas and smart antennas, adaptive processing using minimum variance distortionless technique.

UNIT II
Direct Data Domain Least Square Approaches to Adaptive Processing:
Direct data domain least square procedures, eigenvalue method, forward method, backward method, forward-backward method, main beam construction for prevention of signal cancellation.

UNIT III
Mutual Coupling in Adaptive Smart Antennas:
Mutual coupling among an array of dipoles (qualitative), compensation using open-circuit voltages and minimum norm formulation, effect of mutual coupling for constant jammers and constant signals, compensation for mutual coupling for constant jammers and constant signals.

UNIT IV
Direction of Arrival (DOA) Estimation and Adaptive Signal Processing for Smart Antennas:
Problem formulation, transformation matrix to compensate undesired electromagnetic effects, DOA estimation for a semicircular array, adaptive processing using a single snapshot from a non-uniformly spaced array in presence of mutual coupling and near-field scatterers, DOA estimation using a phased array on a conformal hemispherical surface, DOA estimation using cyclostationarity, Optimization of base station location for indoor wireless communication.

Course Outcomes:

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

CO1: analyze linear and circular antenna arrays.
CO2: classify adaptive processing for smart antenna using different methods.
CO3: solve design problems on smart antenna in presence of mutual coupling between the antennas.
CO4: compensate mutual coupling in presence of jammers.
CO5: solve design problems on smart antenna by estimating direction of arrival (DOA) of signal.
CO6. investigate different types of DOA estimation methods.

Textbooks:

1. Smart Antennas – T. K. Sarkar, M. C. Wicks, M. Salazar-Palma and R. J. Bonneau, Wiley-Interscience, 1st Ed., 2003.

Reference Books: :

2. Smart Antenna Engineering - Ahmed El-Zooghby, Artech House, 1st Ed., 2005.
3. Smart Antennas for Wireless Communication: With MATLAB- F. Gross, McGraw Hill, 1st Ed., 2005.

Course Title	**Satellite Communication Systems**
Course Code (Credit)	**EC30022 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**EC20003/ EC20008**

Course Objective:

The course offers the students to the basic concept regarding satellite communication. Satellite communication systems carry much of the world's communication traffic, especially over oceans, and are extensively used for television distribution and navigation. Satellites are also being involved for data relay and personal communication systems. This course will help the students to know how to place a satellite in orbit and about the earth & space segment. The satellite services like broadcasting, GPS, VSAT with multiple access techniques are also introduced.

Course Contents:

UNIT I

Introduction to Satellite Communication:

Frequency spectrum for satellite communication, Types of orbits, Kepler's Laws of planetary motion, Orbital perturbations, Geostationary orbit, Satellite launching, General satellite communication, Block diagram uplink, Downlink frequencies, Types of modulation techniques, Satellite launch vehicles - Arian, SLV space shuttle.

UNIT II

Losses/Attenuation:

Signal loss on transmission through earth's atmosphere, Atmospheric losses, Ionospheric effects, Rain attenuation,

UNIT III

Module 3(Satellite link design):

Link equation, uplink/downlink design, Transmission losses, Interference, System noise temperature, Link power budget.

UNIT IV

Satellite sub-system:

Antenna sub-systems, Altitude and orbit control sub-system, Power sub-system, Communication sub-system, TTC&M sub-systems.

UNIT V

Satellite Application:

Satellite application in TV, Internet, Mobile telephony, Receive only home TV, Master Antenna :TV, Low earth orbit satellite systems and use, GPS, INMARSAT, VSAT.

UNIT VI

Satellite Access techniques:

Multiple access techniques - FDMA, TDMA, CDMA, SS-TDMA, Interference in FDMA systems, Random access techniques.

Course Outcomes:

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

CO1: comprehend the basic parameters for satellite communication.

CO2: know the satellite launching methods and orbital control mechanisms.

CO3: comprehend the different types of losses in satellite link and satellite link design.

CO4: learn different types of noises and interferences associated with satellite link.

CO5: evaluate the stability of a satellite in orbit and different satellite sub-systems.

CO6: learn the different multiple access techniques used for digital satellite communication.

Course Title	**Agile Software Development**
Course Code (Credit)	**CS40006 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To develop an understanding on agile software development
- To learn about the principles, planning and requirement in agile software development
- To understand the testing methodologies in agile software development
- To explore the metrics and measurement in agile software development

Course Contents:

UNIT I

Introduction:

Agile Software Development: Basics and Fundamentals of Agile Process Methods, Values of Agile, Principles of Agile, Stakeholders, Challenges Lean Approach: Waste Management, Kaizen and Kanban, Add process and products add value, Roles related to the lifecycle, Differences between Agile and traditional plans, Differences between Agile plans at different lifecycle phases, Testing plan links between testing, Roles and key techniques, principles, Understand as a means of assessing the initial status of a project/ How Agile helps to build quality.

UNIT II

Principles:

Agile and Scrum Principles: Agile Manifesto, Twelve Practices of XP, Scrum Practices, Applying Scrum, Need of scrum, Working of scrum, Advanced Scrum Applications, Scrum and the Organization, Scrum values.

UNIT III

Planning and Product Management:

Agile Product Management: Communication, Planning, Estimation, Managing the Agile approach, Monitoring progress, Targeting and motivating the team, Managing business involvement, Escalating issue, Quality, Risk, Metrics and Measurements.

UNIT IV

Requirements and Testing:

Agile Requirements: User Stories, Backlog Management, Agile Architecture: Feature Driven Development, Agile Risk Management: Risk and Quality Assurance, Agile Tools, Agile Testing: Agile Testing Techniques, Test- Driven Development, User Acceptance Test, Agile Review: Agile Metrics and Measurements, The Agile approach to estimating and project variables.

UNIT V

Measurement:

Agile Measurement, Agile Control, Control parameters, Agile approach to Risk, The Agile approach to Configuration Management, The Atern Principles, Atern Philosophy, Rationale for using Atern, Refactoring, Continuous integration, Automated Build Tools, Scaling Agile for large projects: Scrum of Scrums, Team collaborations, Scrum, Estimate a Scrum Project, Track Scrum Projects, Communication in Scrum Projects, Best Practices to Manage Scrum.

Course Outcomes:

CO1: Assess principles, planning and requirement in agile software development

CO2: Distinguish between agile software development and traditional software development

CO3: Identify Agile Requirements

CO4: Suggest agile software development approaches for any real-time problem

CO5: Provide measurement, metrics necessary for problems involving agile software development

CO6: Inference best practices of traditional and agile software development and use in real-time problem solving

Textbooks:

3. Robert C. Martin, “Agile Software Development, Principles, Patterns, and Practices”, First Edition, Pearson Education India, 2002.
4. Mike Cohn “Succeeding with Agile: Software Development Using Scrum”, Pearson Education, 2010.

Reference Book

2. Robert C Martin, Micah Martin, “Agile Principles, Patterns and Practices in C#”, Pearson Education, 2007.

Course Title	**Multimedia Systems**
Course Code (Credit)	**CS40013 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

To understand the different media and design issues in multimedia systems·
To understand Multimedia security and data hiding for image/video

Course Contents:

UNIT I

Multimedia Elements:

Introduction, Definitions, Applications. Elements. Text, Image/Graphics Audio, Video, Animation.*

UNIT II

Data and File Formats:

J Compression Techniques, Lossless, Lossy JPEG, MPEG, TIFF, RIFF-H.261, H.J262, H.263 -File formats-Display Technologies.*

UNIT III

Multimedia Networks:

Protocol - QOS Issues - RTP, RTCP, RTSP, SIP - Media on demand –ITV - STB Broadcast Schemes for VoD Buffer Management- Multimedia over wireless networks.*

UNIT IV

Multimedia Security and Forensics:

Multimedia encryption, Digital Watermarking Security Attacks, Digital Forensics taxonomy, goals/requirements, Forensic Data Acquisition, Forensics Analysis and Validation.*

UNIT V

Multimedia Data Hiding:

Overview, Data hiding framework, Key elements, Basic embedding mechanisms, Techniques for Embedding multiple bits-Quantitative model for Uneven embedding Capacity, CER-VER, Data Hiding in Binary image, Multilevel embedding-Multilevel image and video data hiding.*

*Programming assignments are mandatory.

Course Outcomes:

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

CO1: Ability to design multimedia components efficiently

CO2: Ability to develop integrated, collaborative multimedia systems

CO3: Ability to develop data hiding algorithms for the specialized applications

Textbooks: ::

1. K. Andleigh, Kiran Thakrar , Multimedia Systems Design, Pearson Education, 2015
2. ZeNian Li, S. Drew, “Fundamentals of Multimedia”, Springer, 2021

Reference Books::

1. Ralf Steinmetz and Klara, “Multimedia Computing, Communications and Applications”, Pearson Education, 2009
2. Min Wu, Bede Liu, “Multimedia Data Hiding”, Springer-Verlag, 2002

Cox, M. Miller, and J. Bloom, "Digital Watermarking", Morgan Kaufman Publishers, 2001

3. Chun-Shien Lu, “Multimedia Security : Steganography and Digital Watermarking techniques for Protection of Intellectual Property”, Springer Inc 2007
4. Wenjun Zeng, Heather Yu and Ching, Yung Lin, “Multimedia Security technologies for Digital rights Management”, Elsevier Inc 2006

Course Title	**Computer Vision**
Course Code (Credit)	**CS30026 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS40007**

Course Objective:

- To understand image formation and camera calibration
- To understand stereo vision and stereo camera geometry
- To be able to know structures from motions
- To know machine learning for computer vision

Course Contents:

UNIT I

Image formation and camera calibration:

Introduction to computer vision, Geometric camera models, Orthographic and perspective projections, Weak perspective projection, Intrinsic and extrinsic camera parameters, Linear and nonlinear approaches of camera calibration.

UNIT II

Feature detection and matching:

Edge detection, Interest points and corners, Local image features, Feature matching and Hough transform, Model fitting and RANSAC, Scale invariant feature matching.

UNIT III

Stereo Vision:

Stereo camera geometry and epipolar constraints, Essential and fundamental matrix, Image rectification, Local methods for stereo matching: Correlation and multi-scale approaches, Global methods for stereo matching: Order constraints and dynamic programming, Smoothness and graph-based energy minimization, Optical flow.

UNIT IV

Shape from Shading:

Modeling pixel brightness, Reflection at surfaces, The Lambertian and specular model, Area sources, Photometric stereo: Shape from multiple shaded images, Modeling inter-reflection, Shape from one shaded image.

UNIT V:
Structure from motion:
Camera self-calibration, Euclidean structure and motion from two images, Euclidean structure and motion from multiple images, Structure and motion from weak-perspective and multiple cameras.

UNIT VI:
Machine Learning for Computer Vision:
Introduction to Machine Learning, Image Classification, Object Detection, Semantic Segmentation, Case study on computer vision and machine learning for applied research.

Course Outcome:

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

CO1: Categorizing of image formation and camera calibration
CO2: Apply the concepts of feature detection, Feature reduction, and matching.
CO3: Analyze the concepts of stereo vision and stereo camera geometry.
CO4: Design the concepts of generating shapes from shading.
CO5: Identifying the concepts of structures from motions.
CO6: Determine the concepts of machine learning for computer vision for applied research.

Textbooks:

2. Forsyth, D. A. and Ponce, J., "Computer Vision: A Modern Approach", 2nd Ed., Pearson Education.

Reference Books:

2. Hartley, R. and Zisserman, A., "Multiple View Geometry in Computer Vision", Cambridge University Press.

PROGRAMME LABORATORY COURSES

Course Title	**Wireless Communication & Networking Lab**
Course Code (Credit)	**EC39002 (L-T-P-Cr: 0-0-2-1)**
Pre-requisites	**EC21002**

Course Objective:

The laboratory course introduces readers to the various aspects of wireless & cellular communication and computer networks. The experiments are performed using open-source and industry-accepted simulators such as

NS2 and Cisco packet tracer, and software tools like Qualnet, etc. Furthermore, wireless communication-related experiments are performed on the Virtual Labs platforms.

Course Outcomes:

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

CO1: design, simulate and evaluate the performance of different wired network topologies using NS-2.
CO2: evaluate the performance of contention window size in IEEE 802.11 wireless Local Area Network (LAN) using NS-2.
CO3: analyze the effects of different physical, MAC and network layer parameters for an adhoc network using Qualnet 5.2.
CO4: analyze the effects of different physical, MAC and network layer parameters for an infrastructure network using Qualnet 5.2.
CO5: analyze and comprehend effect of shadowing on path-loss formula using Virtual platforms
CO6: design, simulate and evaluate the performance of virtual LANs (VLANs) under wired, wireless (heterogeneous) network configurations using CISCO® Packet Tracer.

OPEN ELECTIVE COURSES (OE)

Course Title	**Software Engineering Fundamentals**
Course Code (Credit)	**CS30018 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To know software process models
- To understand application of software process models
- To be able to know requirements of the software projects
- To apply the basic project management practices in real life projects.
- To be able to distinguish different testing methodologies

Course Contents:
Unit I
Software Process Models:
Software product, Software crisis, Handling complexity through Abstraction and Decomposition, Overview of software development activities. Process Models: Classical waterfall model, Iterative waterfall model, Prototyping

model, Evolutionary model, Spiral model, RAD model. Agile models: Extreme programming and Scrum. Software Requirement Engineering

Unit II
Software Requirement Engineering:
Requirement Gathering and analysis, Functional and non functional requirements, Software Requirement Specification(SRS) , IEEE 830 guidelines, Decision tables and trees.

Unit III
Software Project Management:
Responsibilities of a Software project manager, Project planning, Metrics for project size estimation, Project estimation techniques, Empirical estimation techniques, COCOMO models, Scheduling, Organization & team structure, Staffing, Risk management, Software configuration management.

Unit IV
Structural Analysis & Design:
Overview of design process: High level and detailed design, Cohesion & coupling, Modularity and layering, Function–Oriented software design: Structural Analysis, Structural Design (DFD and Structured Chart), Object Oriented Analysis & Design, Command language, menu and iconic interfaces.

Unit V
Testing Strategies:
Coding, Code Review, Documentation, Testing:, Unit testing, Black-box Testing, White-box testing, Cyclomatic complexity measure, Coverage analysis, Debugging, Integration testing, System testing, Regression testing.

Course Outcome:

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

CO1: Elaborate on different software process models
CO2: Evaluate the requirements of the software projects.
CO3: Apply the basic project management practices in real life projects.
CO4: Translate the baseline requirement specifications into design process.
CO5: Distinguish different testing methodologies.
CO6: Work ethically in a team on software projects

Textbooks:

2. Fundamentals of Software Engineering, Rajib Mall , PHI, Latest edition.

Reference books:

3. Software Engineering: A Practitioner's Approach, Roger S. Pressman, Eighth edition, MGH.
4. Software Engineering, Ian Sommerville, Tenth Edition, Pearson Education.

Course Title	**Essentials of Computer Science**
Course Code (Credit)	**CS30020 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To make the student understand the basic building blocks of a computing system
- To make the student understand the flow of Concept- Program-Input-Processing-Output
- To introduce low level language, translators, operating system

Course Contents:

UNIT I

Concept, Program, Input, Processing – Output:

Demo of simple high level language program to low level machine level language program, Tracing their execution from high level to circuit level/ gate level, Overview of the Hardware Description Language (HDL), Designing a set of elementary logic gates from primitive NAND gates. Design of binary adders, Culminating in the construction of a simple ALU (Arithmetic–Logic Unit) using logic gates, Design of memory hierarchy from elementary flip–flop gates to registers and RAM units of arbitrary sizes using logic gates.

UNIT II

Introduction to Low Level Language:

Introducing an instruction set in both binary and assembly (symbolic) versions, Writing some low-level assembly programs, Other details of computer architecture, Basic language translation techniques: parsing, symbol table, macro, assembly

UNIT III

Introduction to Virtual Machine:

The role of virtual machines in modern software architectures like Java and .NET, Introduction of a typical VM language, Focusing on stack–based arithmetic, Logical and memory access operations, VM abstraction and implementation, Focusing on stack-based flow-of-control and subroutine call-and-return techniques.

UNIT IV
Introduction to Compilers:
Context-free grammars and recursive parsing algorithms, Building a syntax analyzer (tokenizer and parser), The syntax analyzer to generate XML code reflecting the structure of the translated program, Code generation, Low- level handling of arrays and objects.

UNIT V
Introduction to OS:
Discussion of OS/hardware and OS/software design trade–offs, and time/space efficiency considerations, Design and implementation of OS, memory management, string processing, I/O handling algorithms.

Course Outcomes:

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

CO1: Trace the fundamentals of digital logic design

CO2: Classify programming languages

CO3: Explore the use of compiler

CO4: Generate low level code for simple programs

CO5: Understand functionality of an operating systems

CO6: Design simple arithmetic and memory units

Textbooks:

2. Noam Nisan, Shimon Schocken, “The Elements of Computing System: Building a Modern Computer from First Principles”, MIT Press, 2005.

Course Title	**Object Oriented Programming**
Course Code (Credit)	**CS30022 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**C Programming**

Course Objectives

- To understand the difference between structure-oriented and object-oriented programming
- To know various object-oriented features
- To know exception handling and generic programming
- To test and debug solutions in C++

Course Contents:
UNIT I
Introduction to Object Oriented Programming:

Object oriented programming concepts: Objects, Classes, Encapsulation and abstraction, Inheritance, Polymorphism, Dynamic binding, Message passing; C++ Programming basics: Character set, Keyword, Constant, Variable, Data types, Operator & expression, Control structure (branching & looping), typecasting, Array & strings, Streams based I/O, Type conversions and casting, Name space, Scope resolution operator (::); Function: Parameter passing (i) by value, (ii) by address, (iii) by reference, Inline function, Function overloading, Default arguments.

UNIT II

Class and Object:

Class and Object: Defining class with functions and data members, Creating & deleting objects by using new and delete operators respectively, Array of Objects, Objects as function argument, Static Data members and member functions, Function with default arguments, Function overloading; Constructor and Destructors: Definition of constructors and its uses, Types of constructors: Default constructor, Parameterized constructor, Copy constructor, Constructor with dynamic allocation, Dynamic Constructors, Constructor Overloading, Destructors.

UNIT III

Inheritance:

Concept of inheritance: Defining derived and base classes, Class hierarchies, public, private, and protected derivations; Types of Inheritance: Single Inheritance, Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Hybrid Inheritance, Virtual base class: Function overriding, Constructors/Destructors in derived classes: Constructors invocation and data members initialization in derived classes, Member classes: classes within classes.

UNIT IV

Polymorphism:

Operator overloading: Overloading unary operators, Binary operators, overloading binary operators using friend function and member function, Rules for overloading operators; Polymorphism: Introduction to pointers: Pointers to objects, Pointer to derived class object, This pointer, Compile time polymorphism: Review of Function Overloading and Operator overloading; Run time polymorphism: Virtual functions, Pure virtual functions, Abstract class, Virtual constructors and destructors

UNIT V

Exception Handling, Templates, Files and Streams:

Exception Handling: Basics of Exception Handling, Exception Handling Mechanism: The keyword try, Throw and catch. Templates: Need of template, Class Templates: Definition, Class Template with multiple parameters, Function Templates: Definition, Function Template with multiple parameters. Files and Streams: Introduction to file handling: text file Vs. binary file, Hierarchy of file stream classes: Functions of File Stream classes, Steps to process a File in a program. Different functions used in file, File modes(Sequential and random), File pointers and their Manipulations, Error handling during file operation

Course Outcome:

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

CO1: Compare the features between structure-oriented and object-oriented programming
CO2: Develop object-oriented programming language like C++ and associated libraries to develop object-oriented programs.
CO3: Apply various object-oriented features like class, object, inheritance, data abstraction, encapsulation polymorphism to solve various computing problems
CO4: Design application using operator-overloading, contracture and destructor
CO5: Apply exception handling and use built-in classes from STL
CO6: Implement, test and debug solutions in C++.

Textbooks:

3. Object Oriented Programming with C++, Reema Thareja, OXFORD University Press, Revised First Edition, 2018.
4. Object Oriented Programming with C++, E.Balaguruswamy, McGraw Hill Education; Seventh edition 2017.

Reference Books :

4. C++ completes reference, Herbert Schildt, MGH, 10th Edition, 2002
5. C++ How to Program, Deitel and Deitel, Pearson Education, 10th Edition, 2011.
6. Programming in C++ Ashok N Kamthane, Pearson Education, 2nd Edition, 2003

Course Title	**Fundamentals of Data Structures**
Course Code (Credit)	**CS30024 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To find the Time Complexity and Space Complexity for algorithm
- To understand the various techniques of sorting and searching
- To design and implement arrays, stacks, queues, and linked lists

- To understand the complex data structures such as trees and graphs
- To solve real life problems

Course Contents:
UNIT I
Introduction:
Development of Algorithms, Notations and analysis, Storage structures for arrays, Sparse matrices, Stacks and Queues: Representations and applications.

UNIT II
Linked List, Stacks, and Queues:
Linked Lists, Linked stacks and queues, Operations on polynomials, Doubly linked lists, Circularly linked lists, Dynamic storage management, Garbage collection and compaction.

UNIT III
Trees:
Tree representation, Binary Trees, Binary search trees, Tree traversal, Expression manipulation, Symbol table construction, Height balanced trees, AVL trees.

UNIT IV
Graphs:
Graphs, Representation of graphs, BFS, DFS, Topological sort, String representation and manipulations, Pattern matching.

Course Outcomes:

Upon completion of this course, the students will be able to:
CO1: Use the concepts of data structure, data type and abstract data type to develop solutions for engineering problems.
CO2: Develop programs to implement linear data structures such as stacks, queues, linked lists, etc.
CO3: Apply the concept of trees and graph data structures in real world scenarios
CO4: Comprehend the implementation of sorting and searching algorithms
CO5: Compare Time Complexity and Space Complexity for algorithm
CO6: Effectively choose the data structure that efficiently models the information in a problem.

Textbooks:

4. J. P. Tremblay, P. G. Sorenson, “An Introduction to Data Structures with Applications”, Second Edition, Tata McGraw Hill, 1981.

5. M. Tenenbaum, Augestien, “Data Structures using C”, Third Edition, Pearson Education, 2007.
6. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Third Edition, Pearson Publishers, 2006.

Reference Book:

2. Sartaj Sahni, “Data Structures, Algorithms and Applications in C++”, Universities Press (I) Pvt. Ltd., 2008.

COMPUTER SCIENCE & SYSTEM ENGINEERING

Course Title	Principle of Signals & Systems
Course Code (Credit)	**EC20006 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

This course will begin with an introduction to analog and digital signal processing, then elaborates on various transformation techniques to signals, and finally presents an idea about actual implementations of these methods in today's hardware and software systems. The course begins with a discussion on analog-time, discrete-time signals and, systems. The syllabus revisits the continuous time transform methods like Fourier and Laplace. This will be followed by discrete time transform methods like the Z transform, DFT, and its properties and system theoretic implications. Later, the concepts and foundations of digital filter design and its realization are built up for FIR and IIR filters.

Course Contents:

UNIT I

Introduction to signals and System:

Representation of continuous and discrete time signals, Basic operations Sampling Theorem, Linear convolution, Correlation.

UNIT II

Revision of Fourier and Laplace analysis:

Significance of Fourier series in LTI system, continuous time Fourier series formula. Dirichlet conditions & properties, S-plane mapping, ROC properties, and examples, Relationship between Fourier and Laplace Transform, Pole-zero Plot,

Discrete time Fourier Transforms: Discrete Time Fourier Transform, Conditions and properties of DTFT, Discrete Fourier Transform, Properties of DFT, Inverse Discrete Fourier Transform.
Z-Transform: - Z-transform, ROC and it's properties, Stability analysis

Digital FIR filters: Introduction to Digital Filter: FIR, IIR and their

Course Outcomes:
Upon completion of this course, the students will be able to:
CO1: Analyze and plot continuous and discrete signals, understand sampling process, determine respective characteristics
CO2: Classify various types of systems and analyze system characteristics in time domain
CO3: Determine and understand appropriate continuous time transformation technique for signal analysis.
CO4: Analyze the signal and its properties in its frequency domain using discrete time transformation techniques.
CO5: Apply transforms and analyze system stability.
CO6: Understand the use of digital filter and their application.

Textbooks:
3. Digital Signal Processing- J.G. Proakis & D. G. Manolakes, 4th Edition-PHI
4. Signals & Systems – Alan V Oppeinhem, Alan S Willsky– 2nd/ 2011–PHI

Reference Books:
1. Principle of Signal Processing and Linear System: B.P. Lathi, First Edition, Oxford University Press.
2. Digital Signal Processing: P. Ramesh Babu: Scitech,2nd Edition.
3. Digital Signal Processing - Computer Based Approach: S. K . Mitra, Second Edition, MGH.

Course Title	**Design and Analysis of Algorithms**
Course Code (Credit)	**CS30001 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS21001**

Course Objectives:
- To understand the importance of algorithm
- To analyze the complexity of an algorithm in terms of time and space complexities
- To understand various problem solving techniques
- To learn about amortized analysis of algorithms
- To design and implement various programming paradigms and its complexity

Course Contents:

UNIT I
Introduction:
Concepts in algorithm analysis & design motivation, Space and Time Complexity of algorithm, Asymptotic Notations (Big Oh, Omega, Theta), Analysis of time complexity of Insertion Sort by step count method, Solving recurrences using Iterative, Substitution, Recurrence Tree, Master theorem

UNIT II
Divide & Conquer and Greedy Approaches:
Divide and Conquer method, Greedy method, Huffman code, Minimum spanning trees, Dijkstra algorithm, Knapsack problem, Job sequencing with deadlines.

UNIT III
Dynamic Programming Approaches:
Dynamic Programming, Knapsack problem, Matrix Chain Multiplication, longest common subsequence Multistage graphs, All pair's shortest paths, Optimal binary search trees, Travelling salesman problem.

UNIT IV
Amortization:
Randomized Algorithms and Amortized Analysis, Las Vegas and Monte Carlo types, Randomized quick sort and its analysis, Min-Cut algorithm.

UNIT V
NP Problems:
NP-Hard and NP-complete problems, Basic concepts, Reducibility, Vertex cover, 3CNF_SAT, clique, Hamiltonian cycle, TSP, Approximation algorithms, Vertex cover, TSP.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: Analyze the time and space complexity for any algorithm

CO2: Compare and contrast different algorithm techniques

CO3: Apply the design techniques of algorithm in solving real world problems

CO4: Perform amortize analysis for any algorithm

CO5: Modify existing algorithms to apply in common engineering design situations

CO6: Use NP class of problems to propose approximation algorithms

Textbooks:
1. T. Cormen, C. Lieserson, R. Rivest, C. Stein, "Introductions to

Algorithms", Third Edition, Prentice-Hall/India, 2009.

Reference Books:

3. A. M. Tenenbaum, Y. Langsam, M. J. Augestien, "Data Structures using C", First Edition, Pearson Education, 2007.
4. E. Harowitz, S. Sahni, S. Rajsekaran, "Fundamentals of Computer Algorithms", Universities press.

Course Title	**Compiler**
Course Code (Credit)	**CS30006 (L- T- P-Cr: 3-0-0-3)**
Pre-requisites	**CS21001**

Course Objectives:

- To introduce the major concept areas in compiler design and know the various phases of the compiler
- To understand the various parsing algorithms and comparison of the same
- To provide practical programming skills necessary for designing a compiler
- To gain knowledge about the various code generation principles
- To understand the necessity for code optimization

Course Contents:
UNIT I

Introduction to Compilation:

Compilers, Analysis of the source program, Phases of a compiler, Cousins of the Compiler, Grouping of Phases, Compiler construction tools, Lexical Analysis, Role of Lexical Analyzer, Input Buffering, Specification ofTokens.
Lab Component: Tutorial on LEX / FLEX tool, Tokenization exercises using LEX.

UNIT II
Syntax Analysis:
Role of the parser, Writing Grammars, Context, Free Grammars, Top Down parsing, Recursive Descent Parsing, Predictive Parsing, Bottom-up parsing, Shift Reduce Parsing, Operator Precedent Parsing, LR Parsers, SLR Parser, Canonical LR Parser, LALR Parser.
Lab Component: Tutorial on YACC tool, Parsing exercises using YACC tool.

UNIT III

Intermediate Code Generation:
Intermediate languages, Declarations, Assignment Statements, Boolean Expressions, Case Statements, Back patching, Procedure calls.
Lab Component: A sample language like C-lite is to be chosen. Intermediate code generation exercises for assignment statements, loops, conditional statements using LEX/YACC.

UNIT IV
Code Optimization and Run Time Environments:
Introduction, Principal Sources of Optimization, Optimization of basic Blocks, DAG representation of Basic Blocks, Introduction to Global Data Flow Analysis, Runtime Environments, Source Language issues, Storage Organization, Storage Allocation strategies, Access to non-local names, Parameter Passing, Error detection and recovery.
Lab Component: Local optimization to be implemented using LEX/YACC for the sample language.

UNIT V
Code Generation:
Issues in the design of code generator, The target machine, Runtime Storage management, Basic Blocks and Flow Graphs, Next-use Information, A simple Code generator, DAG based code generation, Peephole Optimization. Lab Component: DAG construction, Simple Code Generator implementation, DAG based code generation using LEX/YACC for the sample language.
Course Outcomes:
Upon completion of this course, the students will be able to:
- CO1: Identify the phases of a compiler to translate from source code to executable code
- CO2: Apply the knowledge of LEX & YACC tool to develop a scanner and parser
- CO2: Design and develop software system for backend of the compiler
- CO3: Suggest the necessity for appropriate code optimization techniques
- CO4: Conclude the appropriate code generator algorithm for a given source language
- CO5: Identify the effectiveness of optimization and learn various machine independent and machine dependent optimization techniques.
- CO6: Design a compiler for any programming language

Textbooks:
3. Alfred V. Aho, Jeffrey D Ullman, "Compilers: Principles, Techniques and Tools", Second Edition,Pearson Education ,2014.
4. Jean Paul Tremblay, Paul G Serenson, "The Theory and Practice of Compiler Writing", BS Publications, 2005.

Reference Books:
1. Allen I. Holub, "Compiler Design in C", Prentice Hall of India, 2003.
2. C. N. Fischer, R. J. LeBlanc, "Crafting a compiler with C", Benjamin

Cummings, 2003.
3. Kenneth C. Louden, “Compiler Construction: Principles and Practice”, Thompson Learning, 2003.

Course Title	ARM and Advanced Microprocessors
Course Code (Credit)	EC30007 (L-T-P-Cr: 3-0-0-3)

Course Objective:

The objective of this course is to teach the higher-level concepts of Advanced Microprocessors (like 80286, 80386 and Pentium) and ARM to the students. The students learn about Multitasking, Virtual memory, Memory management, Paging, TLB, RISC features, Pipelining and Branch Prediction like concepts. They develop skills for writing programs on ARM to solve simple problems as well as some real time applications.

Course Contents:

Introduction:

Overview of Intel higher level Processors, Concept of Multitasking, Virtual memory & Memory management.

Intel 80286 & 80386:

Brief outline of Processor Architecture, Mode of operation, Segment descriptor, Privilege level & protection and Task switching in 80286, Virtual 86 mode, Paging and TLB in 80386

Pentium Processor:

Features of RISC processors & Implementation of RISC features in Pentium, Pipelining, Superscalar execution & Branch prediction Technique

ARM & Interfacing:

ARM design, ARM Processor fundamentals: Registers, CPSR, Memory map, Pipelines, Exceptions, Interrupt Vector Table, Introduction to ARM Instruction set and Thumb instructions, Interfacing – LCD, ADC, DAC, Stepper motor, UART

Course Outcomes

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

CO1: understand the concepts implemented in higher level Processors like Multitasking, Virtual Memory, Memory Management etc.

CO2: examine the mode of Operation of 80286, Concept of program invisible registers, Segment Descriptors etc.
CO3: analyze Segment Descriptors, Privilege level and Protection, Virtual '86 Mode and Paging in 80386, enhanced features incorporated in 80486
CO4: analyze the RISC features implemented in the design of Pentium Processors, Parallel processing through U & V Pipelines / Superscalar Execution and Branch Prediction Techniques
CO5: acquire the knowledge of a 32-bit ARM Processor, its RISC features, Registers, Pipelining and Interrupts
CO6: examine the 32-bit ARM instruction set, 16-bit Thumb instructions and Interfacing

Textbooks:

1. Advanced Microprocessor and Peripherals - Architecture, Programming and Interfacing by A. K. Ray and K. M. Bhurchandi - McGraw Hill Eduction Pvt Ltd - 3rd Edition

2. ARM Assembly Language Programming & Architecture - M A Mazidi & others, Micro Digital Ed, ISBN: 9780997925906.

Reference Books:

1. The Intel Microprocessors 8086/8088, 80186/80188, 80386, 80486, Pentium and Pentium Pro - Processor by B. B. Brey - PHI - 8th Edition

2. Microprocessors & Interfacing, Programming & Hardware by D. V. Hall - TMH - 3rd Edition.

3. ARM Assembly Language: Fundamentals and Techniques by William Hohl

4. ARM System Developers Guide Design & Optimizing System Software – Andrew N. Sloss & others - Elsevier.

Course Title	**Modeling and Simulation**
Course Code (Credit)	**CS30025 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To define important terminologies and classify systems/models
- To understand continuous and discrete modelling of computer systems
- To understand the analytical modelling of computer systems

- To enable the students to develop new queueing analysis for both simple and complex systems
- To appreciate the use of smart scheduling and introduce the students to analytical techniques for evaluating scheduling policies

Course Contents:
UNIT I
Simulation:
Inventory Concept: The technique of Simulation, Major application areas, concept of a System, Continuous and discrete systems, Systems modeling, types of models, Progress of a Simulation Study, Monte Carlo Method, Comparison of Simulation and Analytical Methods.

UNIT II
Applications:
Discrete-Time Markov Chains, Ergodicity Theory, Real World Examples, Google, Aloha, Transition to Continuous-Time Markov Chain, M/M/1 and PASTA.

UNIT III
Queueing Analysis:
Server Farms: M/M/k and M/M/k/k, Capacity Provisioning for Server Farms, Time Reversibility and Burke's Theorem, Networks of Queues and Jackson Product Form, Classed and Closed Networks of Queues.

UNIT IV
Matrix Analytic Methods:
Case Study of Real-world Workloads, Phase-Type Distributions and Matrix-Analytic Methods, Networks with Time-Sharing Servers, M/G/1 Queue and the Inspection Paradox, Task Assignment Policies for Server Farms.

UNIT V
Scheduling Policies:
Performance Metrics, Scheduling, Non-Preemptive and Preemptive Non-Size-Based Policies, Scheduling Non- Preemptive and Preemptive Size-Based Policies, Scheduling, SRPT and Fairness.

Course Outcomes:
Upon completion of this course, the students will be able to:
CO1: Identify the technique for discrete and continuous models
CO2: Discuss open and closed queueing networks
CO3: Apply the operational laws to open and closed systems
CO4: Use discrete-time and continuous-time Markov chains to model real world systems
CO5: Develop analytical techniques for evaluating scheduling policies

CO6: Analyze the performance metrics of scheduling policies

Textbooks:

1. Mor Harchol-Balter, “Performance Modeling and Design of Computer Systems–Queueing Theory in Action”, Cambridge University Press, 2013

Reference Books:

1. Lieven Eeckhout, “Computer Architecture Performance Evaluation Methods”, Springer, 2010
2. A. M. Law, W. D. Kelton, “Simulation Modelling and Analysis”, Fifth Edition, McGraw Hill, 2014

Course Title	**High Performance Computing**
Course Code (Credit)	**CS30005 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS21002**

Course Objectives:

- To understand the concept of advanced pipelining techniques
- To understand the current state of art in memory system design
- To know the working principle of I/O devices
- To understand the memory management techniques

Course Contents:

UNIT I:
Introduction, Classes of computers, Defining Computer Architecture, Trends in Technology, Trends in Power and Energy in Integrated Circuits, Trends in Cost, Dependability, Measuring, Reporting and Summarizing Performance, Quantitative Principles of Computer Design

UNIT II:
Basic and Intermediate pipelining Concepts, The Major Hurdle of Pipelining, Pipeline Hazards, Pipelining Implementation, Implementation issues that makes Pipelining hard, Extending the MIPS Pipeline to Handle Multicycle Operations, The MIPS R4000 Pipeline.

UNIT III:
Instruction, Level Parallelism: Concepts and Challenges, Basic Compiler Techniques for Exposing ILP, Reducing Branch Costs with Prediction, Overcoming Data Hazards with Dynamic Scheduling, Dynamic Scheduling, Hardware, Based Speculation, Exploiting ILP Using Multiple Issue and Static Scheduling, Exploiting ILP, Advanced Techniques for Instruction Delivery and Speculation, Studies of the Limitations of ILP.

UNIT IV:

Vector Architecture, SIMD Instruction Set Extensions for Multimedia, Graphics Processing Units, Detecting and Enhancing Loop-Level Parallelism, Centralized Shared-Memory Architectures, Performance of Shared-Memory Multiprocessors, Distributed Shared Memory, Models of Memory Consistency, Multicore Processors and their Performance.

UNIT V:
Review of Memory Hierarchy Design, Cache Performance, Basic Cache Optimizations, Virtual Memory, Protection and Examples of Virtual Memory, Advanced Optimizations of Cache Performance, Memory Technology and Optimizations, Protection: Virtual Memory and Virtual Machines, Crosscutting Issues: The Design of Memory Hierarchies, Case Studies / Lab Exercises.

Course Outcomes:
Upon completion of the course, the students will be able to:
CO1 : Choose performance metrics to find the performance of systems
CO2 : Identify the program block that requires parallelism for any program
CO3: Comprehend the concept of different types of hazards along with theistructural implementation and applications.
CO4: Elaborate the criteria to enhance the performance of the pipelined processors.
CO5: Design algorithms for memory management techniques for multiprocessor system
CO6: Identify various parallel architecture like centralized anddistributed memory architecture require for real life application

Textbooks:

2. David. A. Patterson, John L. Hennessy, “Computer Architecture: A Quantitative approach”, Sixth Edition, Morgan Kaufmann, 2012.

Reference Books:

3. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, “Computer Organization and Embedded Systems”, Sixth Edition, McGraw Hill Inc, 2022.
4. William Stallings “Computer Organization and Architecture”, Eleventh Edition, Pearson Education, 2006.

Course Title	Machine Learning
Course Code (Credit)	**CS31002 (L-T-P-Cr: 3-1-0-4)**

Course Objectives:

- To provide a broad survey of different machine learning approaches and techniques
- To understand the principles and concepts of machine learning

- To understand neural networks concepts
- To learn regression and reinforcement learning
- To develop programming skills that helps to build real world applications based on machine learning

Course Contents:
UNIT I
Introduction:
Introduction: Machine learning: What and why? Types of Machine Learning, Supervised Learning, Unsupervised Learning, The Curse of dimensionality, Over and under fitting, Model selection, Error analysis and validation, Parametric vs. non-parametric models.

UNIT II
Machine Learning:
Types of Machine Learning, Supervised Learning, Classification models, Naïve Bayes Classifier, Decision trees, Support Vector Machines, KNN model, Dimensionality reduction, PCA.

UNIT III
Clustering:
Clustering approaches, Mean Shift clustering, Clustering data points and features, Bi-clustering, Multi-view clustering, K-Means clustering, K-medians clustering, Expectation Maximization (EM).

UNIT IV
Neural Networks:
Neural networks, Biological motivation for Neural Network, Neural network Representation, Perceptron, Feed forward networks, Multilayer Networks and Back Propagation Algorithms, Hidden layer representation, Application of neural network.

UNIT V
Applications and Tools:
Linear models for regression, Reinforcement Learning, Machine Learning Tools, Engineering applications.

Course Outcomes:
Upon completion of the course, the students will be able to:

CO1: Solve typical machine learning problems
CO2: Compare and contrast different data representation to facilitate learning
CO3: Apply the concept of regression methods, classification methods and clustering methods.
CO4: Suggest supervised /unsupervised machine learning approaches for any application

CO5: Implement algorithms using machine learning tools

CO6: Design and implement various machine learning algorithms in a range of real-world applications.

Textbooks:

3. Kevin P. Murphy, “Probabilistic Machine Learning”, The MIT Press, 2023.
4. Ethem Alpaydin, “Introduction to Machine Learning”, Fourth Edition, MIT Press, 2010.

Reference Books:

4. Laurene Fausett, “Fundamentals of Neural Networks, Architectures, Algorithms and Applications”, Pearson Education, 2008.
5. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.
6. Simon Haykin, “Neural Networks and Learning Machines”, Pearson 2008.

Course Title	**Distributed Operating Systems**
Course Code (Credit)	**CS30009 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS20002**

Course Objectives:

- To understand the fundamentals of distributed system
- To be able to know the basic concepts of shared memory architecture
- To be able to understand various implementation difficulties of distributed operating systems
- To be able to understand transparency in distributed operating systems

Course Contents:

UNIT-I

Fundamentals of Distributed Systems:

Introduction to distributed systems, Goals of Distributed Systems, Hardware Concepts, Software Concepts, Design Issues, Network Operating Systems, True Distributed System and Time sharing Multiprocessor Operating System, System Architectures.

UNIT-II

Communication in Distributed Systems:

Basics of Communication Systems, Layered Protocols, ATM Models, Client Server Model, Blocking Primitives and Non Blocking Primitives, Buffered Primitives and Unbuffered Primitives, Reliable and Unreliable primitives, Message Passing, Remote Procedure Call.

UNIT-III

Synchronization and Processes:

Clock Synchronization, Mutual Exclusion, Election Algorithm, Atomic Transactions, Deadlock in Distributed Systems, Process and Threads, System Models, Processor Allocation, Process Scheduling.

UNIT-IV

Consistency, Replication and Fault Tolerance:

Data Centric Consistency Models, Client-Centric Consistency Models, Replica Management, Consistency protocols, Fault Tolerance, Process Resilience, Distributed Commit, Reliable Client Server Communication, Reliable Client Server Communication.

UNIT-V

Overview of shared memory:

Architecture, Algorithm, Protocols, Design Issues, consistency model, Page based Distributed Shared Memory, Shared variable Distributed shared Memory, and Object based Distributed Shared Memory.

Course Outcomes:

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

CO1: Assess the concept of Distributed Operating Systems

CO2: Enlist the communication techniques in Distributed Operating Systems

CO3: Determine the clock synchronous concepts and algorithms

CO4: Examine the distributed system that fulfills requirements with regards to key distributed systems properties

CO5: Discuss distributed shared memory architectures and algorithms

CO6: Analyze the distributed files systems

Textbooks:

2. Andrew S. Tanenbaum, "Distributed Operating Systems", Pearson Education, 1995.

Reference Books:

3. G. Coulouris, J. Dollimore, and T. Kindberg, "Distributed Systems: Concepts & Design", Pearson Publication, 4th Edition,2005.
4. Pradeep K. Sinha, "Distributed Operating Systems Concepts and Design", PHI, 1998.

Course Title	**VLSI Circuits and System**
Course Code (Credit)	**EC30005 (L-T-P-Cr:3-0-03)**

Course Objective:

The VLSI design course aims for students to learn fundamental theories and techniques of digital VLSI Circuits & Systems using CMOS technology, and layout, about the digital integrated circuits domain. In addition, the course aims to enable students to analyze and design different VLSI architectures using the fundamental concepts of digital VLSI systems.

Course Contents:

UNIT I

Introduction to VLSI:

VLSI Design Methodology, VLSI Design Flow, VLSI Design Hierarchy, VLSI Design Styles.

UNIT II

MOSFET:

Two terminal MOS Structure, MOS Structure under external Bias Condition, Derivation of Threshold Voltage and its components, MOSFET structure and its Qualitative Analysis, MOSFET Current-Voltage Relationship and its Characteristics, MOSFET Scaling and short geometry effects (only qualitative)

UNIT III

Inverter DC & Switching Characteristics:

Inverter Noise Margin, CMOS Inverter DC Characteristics and its analysis, Delay time definitions, derivation of pHL, pLH for CMOS Inverter, super buffer ,Power dissipations in CMOS, Interconnect Parameters- Resistance, Capacitance, Inductance, Lumped RC Model, Distributed RC Model.

UNIT IV

CMOS Combinational circuits:

CMOS NAND and NOR Gate and their qualitative analysis with sizing, CMOS Complex Logic Circuit, , logical efforts, NMOS and PMOS as Pass transistor, PTL and CMOS Transmission Gate based logic circuit, Stick Diagram and layout of Inverter & Complex logic Circuit

UNIT V

High performance CMOS logic and Sequential logic Circuits:

Dynamic Logic Concept, Synchronous Dynamic Logic Circuits (Domino and NOR logic Circuit), Bistable Circuit, SR Latch, Clocked Latch and Flip Flop Circuits.

VLSI Subsystem:
Approach to digital system design, Adder(CMOS, TG,PTL based) Multiplier, SRAM (6T) 5.

Course Outcomes:
Upon completion of this course, the students will be able to:

CO1: understand VLSI design flow, design strategy and role of different methods for chip design
CO2: apply knowledge to estimate different parameters of MOS transistor.
CO3: analyze different performance metrics of CMOS inverter circuit
CO4: create combinational circuits for different logic design expressions using CMOS style
CO5: analyze different CMOS sequential circuits.
CO6: create different VLSI sub-systems like adder, multiplier, etc.

Textbooks:
1. CMOS digital integrated circuits by Sung –Mo KANG Y. Lebeleci, 4th edition, Mc-Graw Hill publications.
2. CMOS VLSI Design : A Circuits And Systems Perspective by Neil Weste, David Harris, Pearson, 2023

Reference Books:
1. CMOS Circuit Design, Layout, Simulation R. Jacob baker, Harry W. Li, David E Boyce,4th edition, Wiley publications.
2. VLSI Design Methodology Development by Thomas Dillinger, Pearson, 2020

Course Title	**Data Mining and Data Warehousing**
Course Code (Credit)	**CS30013 (L-T-P-Cr: 3-0-0-3)**
Pre-requisites	**CS20006**

Course Objective:
- To understand the basic principles, concepts, applications of data mining and data mining tools.
- To know the kinds of patterns discovered by association rule mining algorithms
- To understand various classification and prediction algorithms
- To be able to apply data mining techniques on web, spatial, temporal, text and multimedia data mining.

Course Content:

UNIT I

Introduction to Data Mining Systems:

Knowledge Discovery Process, Data Mining Techniques, Issues, applications, Data Objects and attribute types, Statistical description of data.

Data Preprocessing: Cleaning, Integration, Reduction, Transformation and discretization, Data Visualization, Data similarity and dissimilarity measures

UNIT II

Data Warehousing and Online Analytical Processing:

Basic Concepts, Data Warehousing Architecture, Multidimensional Data Model, Data Warehouse Schemas for Decision Support, Building a Data Warehouse , Concept Hierarchies, Characteristics of OLAP Systems, Typical OLAP Operations, OLAP and OLTP.

UNIT III

Frequent Pattern Analysis:

Mining Frequent Patterns, Market Basket Analysis: The Apriori Algorithm: Finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiently of Apriori, Mining Frequent Itemsets without Candidate Generation, Measuring the Quality of Rules, Association Mining to Correlation Analysis.

UNIT IV

Classification and Prediction:

Issues Regarding Classification and Prediction, Classification by Decision Tree Introduction, Naïve Bayesian Classification, Rule Based Classification, Classification by Back propagation, Support Vector Machines, Lazy Learners, Other Classification Methods, Prediction: Simple linear regression, Accuracy and Error Measures, Evaluating the Accuracy of a Classifier or Predictor.

UNIT V

Clustering:

Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Partitioning Methods: K-Means, K-medoids, Hierarchical methods: Agglomerative and Divisive Hierarchical Clustering, Density, Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Clustering High, Dimensional Data.

Course Outcome:

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

CO1: Compile the basic principles, concepts, applications of data mining and familiar with mathematical foundations of data mining tools.
CO2: Interpret the fundamental concepts, benefits, operations associated with data warehousing and develop data warehousing models.
CO3: Evaluate the kinds of patterns discovered by association rule mining algorithms.
CO4: Analyze various classification and prediction algorithms for model designing.
CO5: Apply various clustering algorithms to solve the real problems.
CO6: Adapt various data mining techniques on web, spatial, temporal, text and multimedia data mining.

Textbooks:

2. J. Han and M. Kamber, "Data Mining: Concepts and Techniques", 4th Edition, Morgan Kaufman, 2015.

Reference Books:

4. M. H. Dunham, "Data Mining: Introductory and Advanced Topics", Pearson Education, 2006.
5. I. H. Witten and E. Frank, "Data Mining: Practical Machine Learning Tools and Techniques," Morgan Kaufmann, 2000.
6. D. Hand, H. Mannila and P. Smyth. Principles of Data Mining. The MIT Press. 2001.

Course Title	**Robotics and Applications**
Course Code (Credit)	**CS30027 (L-T-P-Cr: 3-0-0-3)**

Course Objective:

- To provide an introduction to robotics including robot classification, design and selection, analysis and applications in industry.
- To provide information on various types of actuators and sensors
- To provide the details of operations of kinematics and to gain knowledge on programming of robots
- To perform the navigation of robots through map path planning-cell decomposition

Course Contents:

UNIT I

Basic Concepts:

Introduction, Brief history, Components of robotics, Classifications of Robot, workspace, Work-envelop, Motion of robotic arm, End-effectors and its types, service robot, Laws of Robotics.

UNIT II

Actuators and sensors:

Types of actuators, Stepper, DC, Servo and brushless motors model of DC servo motor, Types of transmissions, Purpose of sensor, Internal and external sensor, common sensors, Encoders tachometers, Strain gauge based force torque sensor-proximity and distance measuring sensors.

UNIT III

Kinematics of robots:

Mathematical representation of Robots, position and orientation, Representation of joints and frames, Frames transformation, Homogeneous matrix, Denavit Hattenberg parameters, Forward and inverse kinematics: two link planar (RR) and spherical robot (RRP). Mobile robot Kinematics: Differential wheel mobile robot.

UNIT IV

Planning and Navigation:

Introduction, path planning, Overview, Road map path planning, Cell decomposition path planning, Potential field path planning, Obstacle avoidance-case studies

UNIT V

Vision System:

Robotic vision systems, Image representation, Object recognition and categorization, Depth measurement, Image data compression, Visual inspection, Software considerations

UNIT VI

Applications:

Ariel robots, Collision avoidance robots for agriculture, Mining, Exploration, underwater, Civilian, and military applications, Nuclear applications, Space applications, Industrial robots, Artificial intelligence in robots, Application of robots in material handling, Continuous arc welding, Spot welding, Spray painting, Assembly operation, Cleaning, etc.

Course Outcomes:

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

CO1: Explain the basic working concepts of robots

CO2: Analyze the function of sensor in robot and design the robotic arm with various tools

CO3: Program the robot for typical application and path planning of robot using robotic vision

CO4: Make use of the various robot programming languages
CO5: Conduct and design the experiments for various robot operations
CO6: Use the advanced techniques for robot processing

Textbooks:

1. Robotic Engineering and Integrated Approach by RicharedD.Klafter. Thomas A. Chmielewski and MickaelNegin, Prentice Hall India, New Delhi, 2001
2. Saeed B.Nikku, "Introduction to Robotics, Analysis, Control and Applications", Third edition, Wiley, 2019

Reference Books:

1. Industrial robotic technology-programming and application by M.P.Groover et.al, McGraw Hill, 2nd edition, 2017.
2. Robotics technology and flexible automation by S.R.Deb, Sankha Deb,McGraw Hill, 2nd edition, 2017.

Course Title	**Embedded System**
Course Code (Credit)	**EC30024 (L-T-P-Cr: 3-0-0-3)**

Course Objective:
To introduce students to the modern embedded systems and programming skills to develop embedded system using PIC.

Course Contents:
UNIT I
Overview of Embedded System: Embedded Processor in System, Components of Embedded System, Brief introduction to Embedded software in system, Design Process in Embedded System, Programming methods for Embedded System case study.

UNIT II
Embedded Hardware: Real world interfacing, Parallelism in instruction level, Processor and memory selection, Memory organization, I/O Types: Serial and Parallel communication Ports, Serial bus Communication Protocols- I2C, CAN

UNIT III
Introduction to advanced Processor Architectures -Introduction to PIC microcontroller (PIC18F), PIC architecture and assembly programming,

Branch, call and delay loop, IO port programming, PIC arithmetic and logic instructions, Interfacing with LCD, ADC, sensors, stepper motor, key board, DAC

UNIT IV

RTOS(Real time operating System)- OS overview, Process, Interrupt and memory management, RTOS overview, Basic Design rule using RTOS, Task scheduling using Priority based scheduling, cyclic scheduling and round robin scheduling, Case Study- RTOS μCOS-II

Course Outcomes:

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

- CO1: Apply different design constraints for embedded systems.
- CO2: Analyse criteria for selection of processors, memory and IO system for embedded system design.
- CO3: Apply standard communication protocols for embedded system.
- CO4: Utilize programming skills to develop software for different hardware requirements.
- CO5: Develop PIC based system using Assembly/Embedded C coding.
- CO6: Apply RTOS Concepts in Embedded System

Textbooks:-

1. PIC Microcontrollers and Embedded Systems using ALP and C for PIC18F by M. A. Mazidi, R. D. McKinlay, D. Causey, Pearson, 2021.
2. Embedded Systems: Architecture, Programming & Design, Raj Kamal, TMH, 2011

Reference Book:

1. Embedded System Design: A unified Hardware/ Software Introduction, by Frank Vahid, Willey, 2011.
2. Design with PIC Microcontrollers , J. B. Peatman, Pearson India,2008

OPEN ELECTIVE COURSES (OE)

Course Title	**Software Engineering Fundamentals**
Course Code (Credit)	**CS30018 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To know software process models
- To understand application of software process models
- To be able to know requirements of the software projects
- To apply the basic project management practices in real life projects.
- To be able to distinguish different testing methodologies

Course Contents:

Unit I

Software Process Models:

Software product, Software crisis, Handling complexity through Abstraction and Decomposition, Overview of software development activities. Process Models: Classical waterfall model, Iterative waterfall model, Prototyping model, Evolutionary model, Spiral model, RAD model. Agile models: Extreme programming and Scrum. Software Requirement Engineering

Unit II

Software Requirement Engineering:

Requirement Gathering and analysis, Functional and non functional requirements, Software Requirement Specification(SRS) , IEEE 830 guidelines, Decision tables and trees.

Unit III

Software Project Management:

Responsibilities of a Software project manager, Project planning, Metrics for project size estimation, Project estimation techniques, Empirical estimation techniques, COCOMO models, Scheduling, Organization & team structure, Staffing, Risk management, Software configuration management.

Unit IV

Structural Analysis & Design:

Overview of design process: High level and detailed design, Cohesion & coupling, Modularity and layering, Function–Oriented software design: Structural Analysis, Structural Design (DFD and Structured Chart), Object Oriented Analysis & Design, Command language, menu and iconic interfaces.

Unit V
Testing Strategies:
Coding, Code Review, Documentation, Testing:, Unit testing, Black-box Testing, White-box testing, Cyclomatic complexity measure, Coverage analysis, Debugging, Integration testing, System testing, Regression testing.

Course Outcome:

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

CO1: Elaborate on different software process models
CO2: Evaluate the requirements of the software projects.
CO3: Apply the basic project management practices in real life projects.
CO4: Translate the baseline requirement specifications into design process.
CO5: Distinguish different testing methodologies.
CO6: Work ethically in a team on software projects

Textbooks:
3. Fundamentals of Software Engineering, Rajib Mall, PHI, Latest edition.

Reference books:
5. Software Engineering: A Practitioner's Approach, Roger S. Pressman, Eighth edition, MGH.
6. Software Engineering, Ian Sommerville, Tenth Edition, Pearson Education.

Course Title	**Essentials of Computer Science**
Course Code (Credit)	**CS30020 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:
- To make the student understand the basic building blocks of a computing system
- To make the student understand the flow of Concept- Program-Input-Processing-Output
- To introduce low level language, translators, operating system

Course Contents:
UNIT I
Concept, Program, Input, Processing – Output:
Demo of simple high level language program to low level machine level language program, Tracing their execution from high level to circuit level/ gate level, Overview of the Hardware Description Language (HDL), Designing a set of elementary logic gates from primitive NAND gates. Design of binary adders, Culminating in the construction of a simple ALU

(Arithmetic–Logic Unit) using logic gates, Design of memory hierarchy from elementary flip–flop gates to registers and RAM units of arbitrary sizes using logic gates.

UNIT II
Introduction to Low Level Language:
Introducing an instruction set in both binary and assembly (symbolic) versions, Writing some low-level assembly programs, Other details of computer architecture, Basic language translation techniques: parsing, symbol table, macro, assembly

UNIT III
Introduction to Virtual Machine:
The role of virtual machines in modern software architectures like Java and .NET, Introduction of a typical VM language, Focusing on stack–based arithmetic, Logical and memory access operations, VM abstraction and implementation, Focusing on stack-based flow-of-control and subroutine call-and-return techniques.

UNIT IV
Introduction to Compilers:
Context-free grammars and recursive parsing algorithms, Building a syntax analyzer (tokenizer and parser), The syntax analyzer to generate XML code reflecting the structure of the translated program, Code generation, Low- level handling of arrays and objects.

UNIT V
Introduction to OS:
Discussion of OS/hardware and OS/software design trade–offs, and time/space efficiency considerations, Design and implementation of OS, memory management, string processing, I/O handling algorithms.

Course Outcomes:

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

CO1: Trace the fundamentals of digital logic design

CO2: Classify programming languages

CO3: Explore the use of compiler

CO4: Generate low level code for simple programs

CO5: Understand functionality of an operating systems

CO6: Design simple arithmetic and memory units

Textbooks:

3. Noam Nisan, Shimon Schocken, “The Elements of Computing System: Building a Modern Computer from First Principles”, MIT Press, 2005.

Course Title	Object Oriented Programming
Course Code (Credit)	CS30022 (L-T-P-Cr: 3-0-0-3)
Pre-requisites	CS13001

Course Objectives

- To understand the difference between structure-oriented and object-oriented programming
- To know various object-oriented features
- To know exception handling and generic programming
- To test and debug solutions in C++

Course Contents:
Unit I
Introduction to Object Oriented Programming:
Object oriented programming concepts: Objects, Classes, Encapsulation and abstraction, Inheritance, Polymorphism, Dynamic binding, Message passing; C++ Programming basics: Character set, Keyword, Constant, Variable, Data types, Operator & expression, Control structure (branching & looping), typecasting, Array & strings, Streams based I/O, Type conversions and casting, Name space, Scope resolution operator (::); Function: Parameter passing (i) by value, (ii) by address, (iii) by reference, Inline function, Function overloading, Default arguments.

Unit II
Class and Object:
Class and Object: Defining class with functions and data members, Creating & deleting objects by using new and delete operators respectively, Array of Objects, Objects as function argument, Static Data members and member functions, Function with default arguments, Function overloading; Constructor and Destructors: Definition of constructors and its uses, Types of constructors: Default constructor, Parameterized constructor, Copy constructor, Constructor with dynamic allocation, Dynamic Constructors, Constructor Overloading, Destructors.

Unit III
Inheritance:
Concept of inheritance: Defining derived and base classes, Class hierarchies, public, private, and protected derivations; Types of Inheritance: Single Inheritance, Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Hybrid Inheritance, Virtual base class: Function overriding,

Constructors/Destructors in derived classes: Constructors invocation and data members initialization in derived classes, Member classes: classes within classes.

Unit IV
Polymorphism:
Operator overloading: Overloading unary operators, Binary operators, overloading binary operators using friend function and member function, Rules for overloading operators; Polymorphism: Introduction to pointers: Pointers to objects, Pointer to derived class object, This pointer, Compile time polymorphism: Review of Function Overloading and Operator overloading; Run time polymorphism: Virtual functions, Pure virtual functions, Abstract class, Virtual constructors and destructors

Unit V
Exception Handling, Templates, Files and Streams:
Exception Handling: Basics of Exception Handling, Exception Handling Mechanism: The keyword try, Throw and catch. Templates: Need of template, Class Templates: Definition, Class Template with multiple parameters, Function Templates: Definition, Function Template with multiple parameters. Files and Streams: Introduction to file handling: text file Vs. binary file, Hierarchy of file stream classes: Functions of File Stream classes, Steps to process a File in a program. Different functions used in file, File modes(Sequential and random), File pointers and their Manipulations, Error handling during file operation

Course Outcome:

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

CO1: Compare the features between structure-oriented and object-oriented programming
CO2: Develop object-oriented programming language like C++ and associated libraries to develop object-oriented programs.
CO3: Apply various object-oriented features like class, object, inheritance, data abstraction, encapsulation polymorphism to solve various computing problems
CO4: Design application using operator-overloading, contracture and destructor
CO5: Apply exception handling and use built-in classes from STL
CO6: Implement, test and debug solutions in C++.

Textbooks:

5. Object Oriented Programming with C++, Reema Thareja, OXFORD University Press, Revised First Edition, 2018.

6. Object Oriented Programming with C++, E.Balaguruswamy, McGraw Hill Education; Seventh edition 2017.

Reference Books :

7. C++ completes reference, Herbert Schildt, MGH, 10th Edition, 2002
8. C++ How to Program, Deitel and Deitel, Pearson Education, 10th Edition, 2011.
9. Programming in C++ Ashok N Kamthane, Pearson Education, 2nd Edition, 2003

Course Title	**Fundamentals of Data Structures**
Course Code (Credit)	**CS30024 (L-T-P-Cr: 3-0-0-3)**

Course Objectives:

- To find the Time Complexity and Space Complexity for algorithm
- To understand the various techniques of sorting and searching
- To design and implement arrays, stacks, queues, and linked lists
- To understand the complex data structures such as trees and graphs
- To solve real life problems

Course Contents:

UNIT I

Introduction:

Development of Algorithms, Notations and analysis, Storage structures for arrays, Sparse matrices, Stacks and Queues: Representations and applications.

UNIT II

Linked List, Stacks, and Queues:

Linked Lists, Linked stacks and queues, Operations on polynomials, Doubly linked lists, Circularly linked lists, Dynamic storage management, Garbage collection and compaction.

UNIT III

Trees:

Tree representation, Binary Trees, Binary search trees, Tree traversal, Expression manipulation, Symbol table construction, Height balanced trees, AVL trees.

UNIT IV

Graphs:

Graphs, Representation of graphs, BFS, DFS, Topological sort, String representation and manipulations, Pattern matching.

Course Outcomes

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

CO1: Use the concepts of data structure, data type and abstract data type to develop solutions for engineering problems.

CO2: Develop programs to implement linear data structures such as stacks, queues, linked lists, etc.

CO3: Apply the concept of trees and graph data structures in real world scenarios

CO4: Comprehend the implementation of sorting and searching algorithms

CO5: Compare Time Complexity and Space Complexity for algorithm

CO6: Effectively choose the data structure that efficiently models the information in a problem.

Textbooks:

7. J. P. Tremblay, P. G. Sorenson, “An Introduction to Data Structures with Applications”, Second Edition, Tata McGraw Hill, 1981.
8. M. Tenenbaum, Augestien, “Data Structures using C”, Third Edition, Pearson Education, 2007.
9. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Third Edition, Pearson Publishers, 2006.

Reference Book:

3. Sartaj Sahni, “Data Structures, Algorithms and Applications in C++”, Universities Press (I) Pvt. Ltd., 2008.

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