SFIT/IQAC/SE-CMPN/2025-26/Rev0
Date: 08/03/2025

St. Francis Institute of Technology

(Engineering College)

(An Autonomous Institute, Affiliated to University of Mumbai)

S.V.P. Road, Borivli (W), Mumbai

Bachelor of Engineering in

Computer Engineering

Second Year Scheme and Syllabus

w.e.f. Academic Year 2025 – 2026

Contents

Preamble

Engineering education plays a pivotal role in today's world by equipping individuals with the knowledge, skills, and mindset needed to drive technological advancements, tackle complex global challenges, and foster societal progress.

St. Francis Institute of Technology (SFIT) in Borivali, Mumbai, stands as a renowned engineering institute offering both undergraduate and postgraduate degree programs in engineering. Acknowledging its commitment to quality education, SFIT has earned autonomous status from the UGC with institute vide letter no. F.2-10/2023 (AC-Policy) dated 24th April 2024 with effect from the academic year 2024-25. In light of this achievement, SFIT is unveiling a distinctive new curriculum for its undergraduate engineering degree program. Aligned with SFIT's vision, this curriculum aims to nurture bright young minds into technological entrepreneurs and innovative leaders of tomorrow's world, while upholding the Franciscan values of integrity, peace, and love.

Quality assurance in higher education primarily relies on accreditation, focusing on evaluating program outcomes. The introduction of the newly developed autonomy curriculum for undergraduate engineering degrees enhances quality assurance through several measures. These include well-defined learning outcomes for each course, rigorous assessment methodologies, feedback mechanisms to monitor student progress and program effectiveness and adherence to the Outcome-based education (OBE) framework, emphasizing critical thinking and holistic skill development.

Reflecting the transformative vision of the National Education Policy (NEP) 2020, the updated curriculum prioritizes multidisciplinary learning, flexibility, research, and innovation, integrating soft skills cultivation and ethical principles while leveraging technology for enhanced learning experiences.

The revised curriculum adopts a Choice Based Credit and grading system, promoting continuous evaluation, and enabling credit transferability. Skill-based laboratories and mini projects are integral components, fostering experiential learning across engineering disciplines.

The undergraduate degree program will consist of a total of **175 c**redits. Course credits are allocated based on a 15-week teaching-learning process, with course content delivered over 13 weeks, allowing the remaining 2 weeks for revision, guest lectures, and coverage of additional content beyond the syllabus. The overall credit distribution and curriculum approach in this revision align with the AICTE model curriculum.

Second year syllabus focuses on fundamental and core computer engineering courses along with the other multifaceted attributes like vocational skill courses, ability enhancement courses, multidisciplinary aspect and Co-curricular courses. It introduces the some EEM courses which can be learned on NPTEL/MOOC courses to develop the self- learning approach among students. Field project and course mini projects have been introduced to imbibe the problem identification and problem-solving skills among students.

This curriculum will be implemented sequentially for First Year Engineering from the academic year 2024-25, followed by subsequent years until the academic year 2027-28, aligning with the AICTE model curriculum.

Abbreviations

AEC	Ability Enhancement Courses
AIML	Artificial Intelligence and Machine Learning Engineering
BE	Fourth Year Engineering
BEE	Basic Electrical and Electronics Engineering
BSC	Basic Science Courses
CA	Continuous Assessment
CC	Co-curricular Courses
CEP	Community engagement project:
CMPN/CE	Computer Engineering
DAIML	Department of Artificial Intelligence and Machine Learning
DCMPN	Department of Computer Engineering
DECS	Department of Electronics and Computer Science
DEE	Department of Electrical Engineering
DEXTC	Department of Electronics and Telecommunication Engineering
DINFT	Department of Information Technology
DME	Department of Mechanical Engineering
ECS	Electronics and Computer Science
EE	Electrical Engineering
EEM	Entrepreneurship/Economics/Management
ELC	Experiential Learning Courses
ESC	Engineering Science Courses
ESE	End Semester Examination
EXTC	Electronics and Telecommunication Engineering
FBT	First Year B.Tech.
FP	Field Projects
HSSM	Humanities Social Sciences and Management
IKS	Indian Knowledge System
INFT	Information Technology
ISE	In Semester Evaluation
LLC	Liberal Learning Courses
MDC	Multidisciplinary Courses
MDM	Multidisciplinary Minor
ME	Mechanical Engineering
MSE	Mid Semester Examination
OE	Generic/ Open Electives (other than a particular program)
OrE	Oral Examination
OEC	Open Elective Courses

1 Course Structure and Curriculum

1.1 Definition of Credit

Table 1.1 Credit Allocation

Schedule	Score
1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
1 Hour Practical (P) per week	0.5 Credit
2 Hours Practical (P) per week	1 Credit

1.2 Range of Credits

Table 1.2 Options for 4 years Bachelor's Engg. / Tech. Degree

Level	Course Name	Total Credit Assigned
6	Bachelor's degree (B.E. / B.Tech.) in Computer Engineering	160-176
6	Bachelor's degree (B.E. / B.Tech.) in Computer Engineering with Honors	180-194
6	Bachelor's degree (B.E. / B.Tech.) in Computer Engineering with Honors with Research	180-194
6	Bachelor's degree (B.E. / B.Tech.) in Computer Engineering with Double Minor (Multidisciplinary and Specialization Minor)	180-194

1.3 Total Credits and Marks of B.E. / B.Tech. in CMPN Engineering

Table 1.3: Total Credits and Marks of Four-year CMPN Engineering Degree Program

S. No.	Academic Year	Total Credits	Total Marks
1	First Year	43	1400
2	Second Year	44	1450
3	Third Year (Tentative)	44	1425
4	Final Year (Tentative)	44	1375
	Total Credits of Program	**175**	**5750**

1.4 Semester-wise Credit Distribution Structure

Table 1.4 Credit distribution of verticals as per NEP-2020 in Second Year of B.Tech. in CMPN Engineering

Sr. No.	Course Type	Course Code	Courses	Credits	Total
Semester-III					
1	PCC	CE3PC_CR1	Discrete Mathematics	3	14
2		CE3PC_CR2	Operating System	3	
3		CE3PC_LR2	Operating System Lab	1	
4		CE3PC_CR3	Data Structures	3	
5		CE3PC_LR3	Data Structures Lab	1	
6		CE3PC_CR4	Software Engineering	2	
7		CE3PC_LR4	Software Engineering Lab	1	
8	VSEC	CE3VS_LR1	Object Oriented Programming (Java/Intro Advanced Java)	2	2
9	EEM	IL3HM_CR1	Innovation, Business Models and Entrepreneurship	2	2
10	AEC	ILSHM_CR1	Professional Communication and Soft Skills	1	1
11	AEC	ILSHM_LR1	Professional Communication and Soft Skills Lab	1	1
12	VEC	ILSHM_CR2	Human Values and Ethics	2	2
				Total	**22**
Semester-IV					
1	PCC	CE4PC_CR1	Sampling Theory and Quantitative Techniques	3	12
2		CE4PC_CR2	Database Management System	3	
3		CE4PC_LR2	Database Management System Lab	1	
4		CE4PC_CR3	Analysis of Algorithms	3	
5		CE4PC_LR3	Analysis of Algorithms Lab	1	
6		CE4PC_LR4	Fundamentals of Computer Organization and Architecture Lab	1	
7	EEM	IL4HM_CR1	Business Forecasting	2	2
8	FP	ILSEL_PR1	Field Project	2	2
9	MDM	-	MDM-1*	2	2
10	OEC	-	OEC-1[$]	2	2
11	VEC	ILSHM_CR3	Environment and Technology	2	2
				Total	**22**

C-Course, L-Laboratory, T-Tutorial, P-Project * Refer Table No. 1.5.2 [$]Refer Table No. 1.5.3

1.5 Second Year Scheme of the Syllabus

1.5.1 Contact Hours and Credit Distribution of Courses

Table 1.5.1: Contact Hours and Credit Distribution of Courses

Semester III											
Sr. No.	Course Code	Course	Contact Hours				Credits Assigned				
			Theory (C)	Practical (L)	Tutorial (T)	Project (P)	C	L	T	P	Total
1	CE3PC_CR1	Discrete Mathematics	2	-	1	-	2	-	1	-	3
2	CE3PC_CR2	Operating System	3	-	-	-	3	-	-	-	3
3	CE3PC_LR2	Operating System Lab	-	2	-	-	-	1	-	-	1
4	CE3PC_CR3	Data Structures	3	-	-	-	3	-	-	-	3
5	CE3PC_LR3	Data Structures Lab	-	2	-	-	-	1	-	-	1
6	CE3PC_CR4	Software Engineering	2	-	-	-	2	-	-	-	2
7	CE3PC_LR4	Software Engineering Lab	-	2	-	-	-	1	-	-	1
8	CE3VS_LR1	Object Oriented Programming (Java/Intro Advanced Java	-	4	-	-	-	2	-	-	2
9	IL3HM_CR1	Innovation, Business Models and Entrepreneurship	2	-	-	-	2	-	-	-	2
10	ILSHM_CR1	Professional Communication and Soft Skills	1	-	-	-	1	-	-	-	1
11	ILSHM_LR1	Professional Communication and Soft Skills Lab	-	2	-	-	-	1	-	-	1
12	ILSHM_CR2	Human Values and Ethics	2	-	-	-	2	-	-	-	2
		TOTAL	**15**	**12**	**1**	**-**	**15**	**6**	**1**	**-**	**22**
Semester IV											
Sr. No.	Course Code	Course	Contact Hours				Credits Assigned				
			Theory (C)	Practical (L)	Tutorial (T)	Project (P)	C	L	T	P	Total
1	CE4PC_CR1	Sampling Theory and Quantitative Techniques	3	-	-	-	3	-	-	-	3
2	CE4PC_CR2	Database Management System	3	-	-	-	3	-	-	-	3
3	CE4PC_LR2	Database Management System Lab	-	2	-	-	-	1	-	-	1
4	CE4PC_CR3	Analysis of Algorithms	3	-	-	-	3	-	-	-	3
5	CE4PC_LR3	Analysis of Algorithms Lab	-	2	-	-	-	1	-	-	1
6	CE4PC_LR4	Fundamentals of Computer Organization and Architecture Lab	-	2		-	-	1		-	1
7	IL4HM_CR1	Business Forecasting	2	-	-	-	2	-	-	-	2
8	ILSEL_PR1	Field Project	-	-	-	4	-	-	-	2	2
9	-	MDM-I *	2	-	-	-	2	-	-	-	2
10	-	OEC-I$	2	-	-	-	2	-	-	-	2
11	ILSHM_CR3	Environment and Technology	2	-	-	-	2	-	-	-	2
		Total	**17**	**6**	**-**	**4**	**17**	**3**	**-**	**2**	**22**

* Refer Table No. 1.5.2 $ Refer Table No. 1.5.3

1.5.2 Multi-Disciplinary Minor (MDM) Courses Offered in CMPN Program

Table 1.5.2: Semester-wise Credit Distribution of Multi-Disciplinary Minor Courses (MDM)

S. No.	Minor Title	Sem IV (2 credits)	Sem V (4 credits)		Sem VI (4 credits)		Sem VII (4 credits)
1	Image Processing and Computer Vision	Signals and Systems	Discrete Time Signal Processing	Discrete Time Signal Processing Lab	Image Processing and Machine Learning	Image Processing and Machine Learning Lab	Computer Vision and Machine Learning
	Course Codes	ET4MM_CX1	ET5MM_CX1	ET5MM_LX1	ET6MM_CX1	ET6MM_LX1	ET7MM_CX1
2	Embedded Systems	Digital System Design	Microprocessors and Microcontrollers	Microprocessors and Microcontrollers Lab	Advanced Microcontrollers and Interface Technology	Advanced Microcontrollers and Interface Technology Lab	Embedded Systems Applications
	Course Codes:	ET4MM_CX2	ET5MM_CX2	ET5MM_LX2	ET6MM_CX2	ET6MM_LX2	ET7MM_CX2
3	Electric Vehicles	Introduction to EV	EV System and Control	EV System and Control Lab	Energy Systems and Charging Infra	Energy Systems and Charging Infra Lab	Advanced Topic in EV
	Course Codes:	EE4MM_CX1	ET5MM_CX1	ET5MM_LX1	ET6MM_CX1	ET6MM_LX1	ET7MM_CX1
4	IoT	Introduction to IoT and Core Technologies	IoT Data Management, Cloud Integration, and Analytics	IoT Data Management, Cloud Integration, and Analytics Lab	IoT System Design Security	IoT System Design Security Lab	Advanced IoT Applications
	Course Codes:	EC4MM_CX1	EC5MM_CX1	EC5MM_LX1	EC6MM_CX1	EC6MM_LX1	EC7MM_CX1
5	Additive Manufacturing	Introduction to Additive Manufacturing	Introduction to CAD	CAD Lab	Applications of Additive Manufacturing	Additive Manufacturing Lab	3D Printing for Medical Tech
	Course Codes:	ME4MM_CX1	ME5MM_CX1	ME5MM_LX1	ME6MM_CX1	ME6MM_LX1	ME7MM_CX1
6	Robotics	Introduction to Robotics	Robot Kinematics and Dynamics	Robot Kinematics and Dynamics	Path planning and Control in Robotics	Path planning and Control in Robotics Lab	Industrial and Service Robots
	Course Codes:	ME4MM_CX2	ME5MM_CX2	ME5MM_CX2	ME6MM_CX2	ME6MM_LX2	ME7MM_CX1

1.5.3 Open Elective Courses-1 (OEC-1) Offered in Semester-IV

Table 1.5.3: List of Open Elective-1 Courses with Credits

Course Code	List of OEC-1 Courses
IL4OE_CX1	IPR and Patenting
IL4OE_CX2	Cyber security and Laws
IL4OE_CX3	Psychology
IL4OE_CX4	Personal Finance, Taxation and Investments
IL4OE_CX5	Adolescent Health and Well being
IL4OE_CX6	Essentials of Management
IL4OE_CX7	German Language
IL4OE_CX8	French Language

1.6 Evaluation and Examination Scheme of Second Year Syllabus

Table 1.6.1: Marks Distribution of Courses

Semester III							
S. No.	Course Code	Course	ISE		ESE		Total Marks
			CA	MSE	Theory	Practical	
1	CE3PC_CR1	Discrete Mathematics	15	15	45	-	75
2	CE3PC_CR2	Operating System	20	20	60	-	100
3	CE3PC_LR2	Operating System Lab	25	-	-	25	50
4	CE3PC_CR3	Data Structures	20	20	60	-	100
5	CE3PC_LR3	Data Structures Lab	25	-	-	25	50
6	CE3PC_CR4	Software Engineering	15	15	45	-	75
7	CE3PC_LR4	Software Engineering Lab	25	-	-	25	50
8	CE3VS_LR1	Object Oriented Programming (Java/Intro Advanced Java)	50	-	-	25	75
9	IL3HM_CR1	Innovation, Business Models and Entrepreneurship	50	-	-	-	50
10	ILSHM_CR1	Professional Communication and Soft Skills	25	-	-	-	25
11	ILSHM_LR1	Professional Communication and Soft Skills Lab	25	-	-	-	25
12	ILSHM_CR2	Human Values and Ethics	50	-	-	-	50
		Total	**345**	**70**	**210**	**100**	**725**
Semester IV							
S. No.	Course Code	Course	ISE		ESE		Total Marks
			CA	MSE	Theory	Practical	
1	CE4PC_CR1	Sampling Theory and Quantitative Techniques	20	20	60	-	100
2	CE4PC_CR2	Database Management System	20	20	60	-	100
3	CE4PC_LR2	Database Management System Lab	25	-	-	25	50
4	CE4PC_CR3	Analysis of Algorithms	20	20	60	-	100
5	CE4PC_LR3	Analysis of Algorithms Lab	25	-	-	25	50
6	CE4PC_LR4	Fundamentals of Computer Organization and Architecture	25	-	-	-	25
7	IL4HM_CR1	Business Forecasting	50	-	-	-	50
8	ILSEL_PR1	Field Project	25	-	-	25	50
9	-	MDM-I *	15	15	45	-	75
10	-	OEC-I$	15	15	45	-	75
11	ILSHM_CR3	Environment and Technology	50	-	-	-	50
		Total	**290**	**90**	**270**	**75**	**725**

* Refer Table No. 1.5.2 $ Refer Table No. 1.5.3

Evaluation Pattern:

Evaluations consist of the following –

1. **In Semester Evaluation (ISE)** which comprises of two components - Continuous assessment (CA) and Mid-Semester Examination (MSE)
   - CA - Includes home assignments, group assignments, quizzes, presentations, experiments, mock tests, tutorials, etc.
   - MSE - A written assessment covering up to 50% of the syllabus, conducted at mid-semester.
2. **End Semester Examination (ESE)** - A written assessment covering 100% of the syllabus, conducted at the end of the semester. Modules covered in the mid-semester exam will have a 30-40 % weightage, with the remaining 60 -70% weightage assigned to the rest of the modules.
3. **Practical Examination (PE), Oral Examination (OrE) and Project Examination (PrE)** – wherever applicable. These are conducted by a pair of internal and external examiner at the end of the semester.

Table 1.6.2: Components of evaluations with weightage

Components	Sub- Components	Weightage	Marks
Theory Course			
ISE	CA	20%[@]	20/15[*]
	MSE	20%	20/15[*]
ESE		60%	60/45[*]
Lab Course			
ISE	CA	60%[#]	15/30[&]
	Mock Test	40%	10/20[&]
ESE[$]	PE/OrE	100%	25/50[&]
Mini Project			
ISE	CA	100% • Internal mid Sem evaluation (includes partial demo[#]): 20% • Internal end Sem evaluation (full demo[#]): 40% • Report: 20% • Attendance: 20%	25/50[&]
ESE[$]	PrE	100%	25/50[&]

Note: Duration of MSE is 1 hour and ESE is 2.5/2 hours[*]

[@] Includes – (CA1 of 10 marks conducted before MSE) + (CA2 of 10 marks conducted after MSE)

[*] For 3 credit course/2 credit course

[&] For marks 25/50/100 as per scheme

[#] Rubrics can be defined by the faculty with approval from HOD

[$] Pair of internal and external examiner should conduct Practical/Oral/Project exams

1.7 Second Year Exit Courses

Certification after completion of Second Year exit courses: Diploma in Advance Programming for Modern Applications

Table 1.7.1: Contact Hours and Credit Distribution for Exit Courses after Second Year

Sr. No.	Course Code	Course	Contact Hours				Credits Assigned				Total
			Theory (C)	Practical (L)	Tutorial (T)	Project (P)	Theory (C)	Practical (L)	Tutorial (T)	Project (P)	
1	CE4EX_CR1	Advanced Java	-	-	2	-	-	-	2	-	2
	CE4EX_LR1	Advanced Java Lab	-	4	-	-	-	2	-	-	2
2	CE4EX_CR2	Advanced Python for Modern Application Development	-	-	2	-	-	-	2	-	2
	CE4EX_LR2	Advanced Python for Modern Application Development Lab	-	4	-	-	-	2	-	-	2
	OR										
	CE4EX_LR2	Internship/Product Development Using Python	-	-	-	8	-	-	-	4	4
										Total	8

Table 1.7.2: Marks Distribution of Exit Courses after Second Year

Sr. No.	Course Code	Course	ISE		ESE		Total Marks
			CA	MSE	Theory	Practical	
1	CE4EX_CR1	Advanced Java	15	15	45	-	75
	CE4EX_LR1	Advanced Java Lab	50	-	-	25	75
2	CE4EX_CR2	Advanced Python for Modern Application Development	15	15	45	-	75
	CE4EX_LR2	Advanced Python for Modern Application Development Lab	50	-	-	25	75
	OR						
	CE4EX_LR2	Internship/Product Development Using Python	50	-	-	100	150
Total							**300**

Guidelines for Exit:

- The NEP 2020 Four Year Multidisciplinary Engineering Curriculum Framework offers multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured.
- Multiple Exits: Students will have the flexibility to enter a programme in odd semesters and exit a programme after the successful completion of even semesters as per their future career needs.
- **Eligibility for Exit:**
    - Students exiting the Second Year Programme after securing minimum 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided they secure additional 8 credits in skill-based vocational courses (skill-based courses, internship, mini projects etc) offered during summer vacation after the second year.

- **Breakdown of the 8 Additional Credits:**
    - **Option 1**: Two 4-credit (2+2) courses from the PCC/VSEC category.
    - **Option 2**: One 4-credit (2+2) course from the PCC/VSEC category OR a certified industry internship worth 4 credits (minimum 60 hours).
- Exit options shall be provided with Diploma degree to the students exiting at the end of the fourth semester.
- **Re-entry or Lateral Entry**: Students, opting for exits at any level, will have the option to re-enter the programme from where they had left off, in the same or in a different higher education institution within four years of exit and complete the degree programme within the stipulated maximum period of eight years from the date of admission to first year UG. Re-entry at various levels for lateral entrants in academic programmes shall be based on the earned and valid credits as-deposited and accumulated in the Academic Bank of Credits (ABC) through Registered Higher & Technical Education Institutions (RHTEI) and proficiency test records. Lateral entry into the programme of study leading to the UG Diploma/ B. Vocational/ UG Bachelor's Degree with single minor/ UG Bachelor's Degree with Double Minor/ Honours /Research will be based on the validation of prior learning outcomes achieved and subject to availability based on intake capacity.

2 Semester-III Course Syllabus

2.1 Discrete Mathematics (CE3PC_CR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE3PC_CR1	Discrete Mathematics	03	03

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *develo*p the ability to reason logically and *understand* the notion of mathematical thinking
2	To *explain* the concept of relations and functions and its applications
3	To *teach* relations, functions, Diagraph, posets and Lattice
4	To *define* the use of groups and codes and its applications to basic Encoding-Decoding techniques
5	To *teach* concepts of graph theory and its applications in solving real world problems

Course Outcomes

The student will be able to	
CO1	*understand* the notion of mathematical thinking, mathematical proofs and *apply* them in problem solving
CO2	*analyse* the concept of relations and functions and solve problems
CO3	*solve* problems by identifying the appropriate structures of posets and lattices
CO4	*understand* binary operations on groups and rings and use it in coding
CO5	*analyse* the discrete structures mathematically and *apply* its principles to identify solutions

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisite		
	Introductory concepts from algebra and calculus.		
1.0	**Introduction to Logic**		**04**
	1.1	Propositional logic, Predicate logic, Laws of logic.	
	1.2	iQuantifiers, Normal forms, Mathematical induction.	
2.0	**Relations and Functions**		**05**

	2.1	Basic concepts of set theory, Inclusion-exclusions, Venn diagrams.	
	2.2	Relations: Definition, Types of relations, Representation of relations, Closures of relations, Warshall's algorithm, Equivalence relations and Equivalence classes.	
	2.3	Recursively defined functions. Functions: Definition, types of functions, Composition of functions, Identity and inverse function.	
3.0	**Posets and Lattice**		**06**
	3.1	Partial order relations, Poset, Hasse diagram.	
	3.2	Chain and anti-chains, Lattice, Types of lattice, Sub-lattice.	
4.0	**Algebraic Structures**		**05**
	4.1	Algebraic structures with one binary operation: Semi group.	
	4.2	Monoid groups, Subgroups, Abelian group, Cyclic group, Isomorphism; Algebraic structures with two binary operations: Ring.	
	4.3	Coding Theory: Coding, binary information and error detection, decoding and error correction.	
5.0	**Graph Theory**		**06**
	5.1	Types of graphs, Graph representation, Sub-graphs.	
	5.2	Operations on graphs, Walk, Path, Circuit, Connected-Disconnected graph, Components, Homomorphism and Isomorphism of graphs.	
	5.3	Euler and Hamiltonian Graphs, Planar graph, Cut-set, Cut vertex, Applications.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

2. Discrete Mathematical Structures, VII Ed., Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, Pearson Education, 2019.
3. Elements of Discrete Mathematics, A Computer Oriented Approach, IV Ed., D P Mohapatra, PHI Learning, 2014.
4. Elements of Discrete Mathematics, II Ed., C. L. Liu, McGraw- Hill Book Company, 2000.
5. Discrete Mathematics and Applications, V Ed., K. H. Rosen, Tata McGraw Hill Publication, 2003.

Reference Books

1. Discrete Mathematical Structures, II Ed., Y N Singh, Wiley India, 2017.
2. Discrete Mathematics for Computer Scientists and Mathematicians, II Ed., J. L. Mott, A. Kandel, T. P. Baker, Prentice Hall of India, 1986.
3. Discrete Mathematical Structures with Applications to Computer Science, I Ed., J. P. Trembley, R. Manohar, Tata McGraw Hill Education, 2001.

Web Resources

1. NPTEL course on Discrete Mathematical Structures, Prof. Kamala Krithivasan, IIT Madras.
   https://nptel.ac.in/courses/106/106/106106094/
2. Coursera course on Introduction to Discrete Mathematics for Computer Science Specialization, UC SanDiego.
   https://www.coursera.org/specializations/discrete-mathematics
3. Online Courses for discrete mathematics
   https://www.edx.org/learn/discrete-mathematics
4. Swayam Course on Distcrete mathematics
   https://swayam.gov.in/nd1_noc19_cs67/preview

2.2 Operating System (CE3PC_CR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE3PC_CR2	Operating System	03	03

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
20	Continuous	20	1	60	2.5	100

Course Objectives

S. No.	Objectives
1	To *introduce* basic concepts and functions of operating systems.
2	To *understand* the concept of process, thread and resource management.
3	To *understand* the concepts of process synchronization and deadlock.
4	To *discuss* different memory management techniques.
5	To *interpret* various I/O and file management techniques.

Course Outcomes

The student will be able to	
CO1	*discuss* the role of OS and demonstrate basic commands and various system calls.
CO2	*analyze* and *apply* the concept of processes, threads using shell script and evaluate performance of process scheduling algorithms and IPC.
CO3	*evaluate* process synchronization and deadlock handling.
CO4	*analyze* the concept of memory management techniques and evaluate performance of various algorithms.
CO5	*analyze* different techniques of file and I/O management.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites		
	Data Structures and Computer Architecture		
1.0	**Operating System Overview**		**05**
	1.1	Introduction, Objectives, Functions	
	1.2	Operating system structures: Layered, Monolithic and Microkernel	
	1.3	Linux Kernel, Shell and System Calls	
2.0	**Process and Process Scheduling**		**09**

	2.1	Concept of a Process, Process States, Process Description,, Context Switching.	
	2.2	Uniprocessor Scheduling-Types: Preemptive and Non-preemptive scheduling algorithms (FCFS, SJF, SRTN, Priority, RR)	
	2.3	Threads: Definition and Types	
3.0	**Process Synchronization and Deadlocks**		**09**
	3.1	Concurrency: Principles of Concurrency, Inter-Process Communication, Process Synchronization, Peterson's Solution	
	3.2	Mutual Exclusion: Requirements, Operating System Support (Semaphores), Producer and Consumer problem,	
	3.3	Principles of Deadlock: Conditions and Resource, Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker's Algorithm, Deadlock Detection, Dining Philosophers Problem.	
4.0	**Memory Management**		**09**
	4.1	Memory Management Requirements, Memory Partitioning: Fixed, Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit, Paging and Segmentation.	
	4.2	Virtual Memory: Demand Paging, Page Replacement Strategies: FIFO, Optimal, LRU	
5.0	**File and I/O Management**		**07**
	5.1	Overview, File Organization and Access, File directories, File Allocation Methods.	
	5.2	Disk Organization, I/O Management and Disk Scheduling: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK.	
		Total Hours	**39**

Suggested Learning Resources

Textbooks

1. Operating System: Internals and Design Principles, VIII Ed., William Stallings, Prentice Hall, 2014.
2. Operating System Concepts, IX Ed., Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, John Wiley & Sons, 2016.

Reference Books

1. Operating Systems, III Ed., Achyut Godbole and Atul Kahate, McGraw Hill Education.
2. Operating System Design and Implementation, III Ed., Andrew Tannenbaum, Pearson.
3. Principles of Operating System, I Ed., Oxford University Press.

Web Resources

1. Introduction to Operating Systems (NPTEL)
   https://swayam.gov.in/nd1_noc19_cs50/preview

2. Operating System Algorithms Animation
   https://www.binaryvisual.com/operating-systems

2.3 Operation System Lab (CE3PC_LR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE3PC_LR2	Operating System Lab	02	01

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	25	25	-	-	50

Course Objectives

S. No.	Objectives
1	To *study* features and basic commands of linux.
2	To *understand the use* of filters and design shell scripts in linux.
3	To *apply* the concepts of process scheduling and deadlock.
4	To *implement* various memory management strategies.
5	To *execute* various disk scheduling techniques.

Course Outcomes

The student will be able to	
CO1	*interpret* the features and file system of linux along with basic commands.
CO2	*analyze* and *apply* the concept of filters and shell scripts in linux.
CO3	*compare* various process scheduling algorithms and deadlock handling techniques.
CO4	*analyze* and *evaluate* the performance of various memory management algorithms.
CO5	*evaluate* different disk management algorithms based on performance parameters.

Suggested List of Experiments

S. No.	Suggested List of Experiments
1	To study of Linux features and file system
2	To explore the internal commands of Linux. **A.** Commands for creating files **B.** Commands for performing operations on files **C.** Directory related commands **D.** Miscellaneous commands
3	Understanding use of filters like sort, grep, awk , cut, head, tail
4	To write shell scripts to do following **A.** Display top 10 processes. **B.** Display current user and log name. **C.** Display current shell, home directory. **D.** Display OS type, current path, and current working directory. **E.** Display OS version, release number, kernel version

5	Write a program to implement FCFS and SJF CPU Scheduling algorithm
6	Write a program to implement Round Robin CPU Scheduling algorithm
7	Implementation of Banker's Algorithm
8	Implementation of dynamic memory allocation techniques(First Fit, Best Fit, Worst Fit)
9	Implementation of Page Replacement Algorithm (FIFO, OPT)
10	Implementation of Page Replacement Algorithm (LRU)
11	Implementation of Disk Scheduling Algorithm (FCFS, SCAN)
12	Implementation of Disk Scheduling Algorithm (SSTF, LOOK)

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list

Suggested Learning Resources

Textbooks

1. UNIX: Concepts and Applications, IV Ed., Sumitabha Das, McGraw Hill.
2. UNIX Shell Programming, I Ed., Yashwant Kanetkar, BPB Publications.

Reference Books

1. Operating Systems, III Ed., Achyut Godbole and Atul Kahate, McGraw Hill Education.
2. Operating System Design and Implementation, III Ed., Andrew Tannenbaum, Pearson.

Web Resources

1. Linux Commands
   https://ubuntu.com/tutorials/command-line-for-beginners#4-creating-folders-and-files
2. Operating System Algorithms Animation
   https://www.binaryvisual.com/operating-systems

2.4 Data Structures (CE3PC_CR3)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE3PC_CR3	Data Structures	03	03

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
20	Continuous	20	1	60	2.5	100

Course Objectives

S. No.	Objectives
1	To *understand* the need and significance of data structures as a computer professional.
2	To *teach* concept and implementation of linear and nonlinear data structures.
3	To *analyze* various data structures and *select* the appropriate one to solve a specific real- world problems.
4	To *introduce* various techniques for representation of the data in the real world.
5	To *teach* various sorting, searching and hashing techniques.

Course Outcomes

The student will be able to	
CO1	*implement* and *differentiate* between linear and non-linear data structures.
CO2	*demonstrate* a thorough understanding of the behavior of basic data structures like arrays and use it to implement stack and queue ADT.
CO3	*handle* operations like insertion, deletion, searching and traversing on linked list and develop applications using linked list
CO4	*solve* problems using the appropriate type of trees and will be able to apply the concept of graphs for the real time applications.
CO5	*implement* sorting algorithms and select the appropriate searching technique for a given problem.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisite		
	C Programming Language		
1.0	**Introduction to Data Structures and Abstract Data Types (ADT)**		**07**
	1.1	Introduction to Data Structures, Concept of ADT,	
	1.2	Types of Data Structures- Linear and Nonlinear, Primitive and Non-Primitive, Operations on Data Structures.	

2.0	**Stacks and Queues**		**08**
	2.1	Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Applications of Stack-Well formness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation, Applications of Stack: e.g., Recursion, Advantages and disadvantages of stack	
	2.2	Introduction, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Introduction of Double Ended Queue, Applications of Queue.	
3.0	**Linked List**		**08**
	3.1	Introduction, Representation of Linked List, Linked List v/s Array	
	3.2	Types of Linked List - Singly Linked List, Circular Linked List, Doubly Linked List, Operations on Singly Linked List and Doubly Linked List	
	3.3	Stack and Queue using Singly Linked List, Singly Linked List Application: Polynomial Representation and Addition	
4.0	**Trees and Graphs**		**09**
	4.1	Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, Applications of Binary Tree-Expression Tree, Huffman Encoding, Search Trees-AVL, rotations in AVL Tree, operations on AVL Tree, Introduction of B Tree, B+ Tree, Min Max Heap	
	4.2	Introduction, Graph Terminologies, Representation of Graph, Graph representation: Matrix and Adjacency list, Graph Traversals- Depth First Search (DFS) and Breadth First Search (BFS)	
5.0	**Sorting, Searching and Hashing**		**07**
	5.1	Basic Sorting Algorithms: Bubble Sort, Insertion and Selection Sort	
	5.2	Basic Searching Algorithms: Linear Search and Binary Search	
	5.3	Hashing-Concept, Hash Functions, Collision Resolution	
		Total Hours	**39**

Suggested Learning Resources

Textbooks

1. Data Structures Using C, II Ed., Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, Pearson Publication.
2. Data Structures using C, III Ed., Reema Thareja, Oxford Press.
3. Data Structures: A Pseudocode Approach with C, II Ed., Richard F. Gilberg, Behrouz A. Forouzan, CENGAGE Learning.

4. Introduction to Data Structure and Its Applications, I Ed., Jean Paul Tremblay, P. G. Sorenson, McGraw-Hill Higher Education.
5. Data Structures Using C, II Ed., ISRD Group, Tata McGraw-Hill.

Reference Books

1. C and Data Structures, I Ed., Prof. P. S. Deshpande, Prof. O. G. Kakde, DreamTech press.
2. Data Structure Using C, II Ed., E. Balagurusamy, Tata McGraw-Hill Education India.
3. Data Structures using C and C++, I Ed., Rajesh K Shukla, Wiley-India
4. Data Structures, I Ed., Schaum's Outlines.

Reference Books

1. Prof. P. S. Deshpande, Prof. O. G. Kakde, "C and Data Structures", 1st Edition, DreamTech press.
2. E. Balagurusamy, "Data Structure Using C", 2nd Edition, Tata McGraw-Hill Education India.
3. Rajesh K Shukla, "Data Structures using C and C++", 1st Edition, Wiley-India
4. GAV PAI, "Data Structures", 1st Edition, Schaum's Outlines.

Web Resources

1. Data Structures and Algorithms — NPTEL (IIT Delhi) https://nptel.ac.in/courses/106/102/106102064/
2. Data Structures and Algorithms Specialization — Coursera (offered by University of California San Diego) https://www.coursera.org/specializations/data-structures-algorithms
3. Data Structures Fundamentals — edX (University of California, San Diego) (MOOC/online course) https://www.edx.org/course/data-structures-fundamentals
4. Discrete Mathematics (IIT Ropar) (Swyam) https://swayam.gov.in/nd1_noc19_cs67/preview
5. Data Structure Visualizations — Algorithms Visualization Tool www.cs.usfca.edu/~galles/visualization/Algorithms.html

2.5 Data Structures Lab (CE3PC_LR3)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE3PC_LR3	Data Structures Lab	02	01

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	25	25	-	-	50

Course Objectives

S. No.	Objectives
1	To *understand* the fundamental concepts of data structures and their applications in problem-solving.
2	To *implement* and *manipulate* linear data structures such as stacks, queues, and linked lists.
3	To *apply* non-linear data structures like trees and graphs for efficient data organization and retrieval.
4	To implement searching, sorting, and hashing techniques to improve data processing efficiency.
5	To *apply* hashing techniques for fast and effective data storage and retrieval.

Course Outcomes

The student will be able to	
CO1	*implement* and *manipulate* linear data structures such as stacks, queues, and linked lists for solving computational problems.
CO2	*utilize* non-linear data structures, including trees and graphs, in various applications.
CO3	*implement* searching, sorting, and hashing techniques to efficiently organize and retrieve data.
CO4	*compare* and *select* appropriate data structures based on problem requirements.
CO5	*develop* structured and modular programs using data structures to solve real-world problems.

Suggested List of Experiments

S. No.	Suggested List of Experiments
1	Implement Stack ADT using array.
2	Convert an Infix expression to Postfix expression using stack ADT.
3	Evaluate Postfix Expression using Stack ADT.
4	Applications of Stack ADT.

5	Implement Linear Queue ADT using array.
6	Implement Circular Queue ADT using array.
7	Implement Priority Queue ADT using array.
8	Implement Singly Linked List ADT.
9	Implement Circular Linked List ADT.
10	Implement Stack / Linear Queue ADT using Linked List.
11	Implement Binary Search Tree ADT using Linked List.
12	Implement Graph Traversal techniques: Depth First Search
13	Implement Graph Traversal techniques: Breadth First Search
14	Implement Bubble Sort, Insertion Sort and/or Selection Sort
15	Implement Binary Search Technique

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list.

Suggested Learning Resources

Textbooks

1. Data Structures Using C, II Ed., Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, Pearson Publication.
2. Data Structures using C, III Ed., Reema Thareja, Oxford Press.
3. Data Structures: A Pseudocode Approach with C, II Ed., Richard F. Gilberg, Behrouz A. Forouzan, CENGAGE Learning.
4. Introduction to Data Structure and Its Applications, I Ed., Jean Paul Tremblay, P. G. Sorenson, McGraw-Hill Higher Education.

Reference Books

4. C and Data Structures, I Ed., Prof. P. S. Deshpande, Prof. O. G. Kakde, DreamTech press.
5. Data Structure Using C, II Ed., E. Balagurusamy, Tata McGraw-Hill Education India.
6. Data Structures using C and C++, I Ed., Rajesh K Shukla, Wiley-India
7. Data Structures and Program Design in C, II Ed., Robert Kruse, C. L. Tondo, Bruce Leung, Pearson Edition.

Web Resources

1. Data Structures and Algorithms Specialization — Coursera (offered by University of California San Diego) https://www.coursera.org/specializations/data-structures-algorithms
2. LeetCode – The World's Leading Online Programming Learning Platform www.leetcode.com
3. HackerRank – Online Coding & Technical Interview Platform www.hackerrank.com
4. CodeChef – Competitive Programming Platform www.codechef.com

2.6 Software Engineering (CE3PC_CR4)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE3PC_CR4	Software Engineering	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *understand* the significance of software engineering models and principles
2	To *identify* and *analyze* software requirements using analysis modelling
3	To *understand* various estimation, scheduling tracking tools and techniques
4	To *understand* software systems design concepts and principles
5	To *understand software testing and umbrella activities* for ensuring software quality

Course Outcomes

The student will be able to	
CO1	*identify* appropriate software engineering process models and principles to develop quality software products.
CO2	*develop their analytical* skills by preparing SRS/analysis models for real time problem statements
CO3	*develop* a project schedule using appropriate scheduling, and tracking tools.
CO4	*apply* appropriate *design* principles to *develop* effective software system
CO5	*apply* appropriate software engineering testing techniques along with umbrella activities

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisite		
	Object Oriented Programming with Java , Python Programming		
1.0	**Introduction To Software Engineering and Process Models**		**04**
	1.1	**Software Engineering-process framework**, the Capability Maturity Model (CMM), Advanced Trends in Software Engineering	
	1.2	**Prescriptive Process Models**: The Waterfall, Incremental	

		Process Models, Evolutionary Process Models: RAD & Spiral	
	1.3	**Agile process model**: Extreme Programming (XP), Scrum, Kanban	
2.0	**Software Requirements Analysis and Modeling**		**05**
	2.1	**Requirement Engineering**, Requirement Modeling, Data flow diagram, Scenario based model	
	2.2	Software Requirement Specification document format(IEEE)	
3.0	**Software Estimation Metrics**		**04**
	3.1	Software Metrics, Software Project Estimation (LOC, FP, COCOMO II)	
	3.2	Project Scheduling and & Tracking- Scheduling Principles and Timeline chart	
4.0	**Software Design**		**06**
	4.1	Design Principles & Concepts	
	4.2	Effective Modular Design, Cohesion and Coupling, Architectural design	
5.0	**Software Configuration Management, Quality Assurance and Maintenance**		**07**
	5.1	Basics of Software Testing Techniques and Strategies	
	5.2	Umbrella Activities Risk Analysis (RMMM), SQA, SCM : Quality Concepts and Software Quality assurance Metrics, Formal Technical Reviews, Risk mitigation, monitoring and management plan.	
	5.3	The Software Configuration Management (SCM) ,Version Control and Change Control	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Software Engineering: A Practitioner‘s Approach, IX Ed., Roger Pressman, McGraw-Hill Publications, 2019.
2. Software Engineering, IX Ed., Ian Sommerville, Pearson Education, 2011.

Reference Books

1. An integrated approach to Software Engineering, III Ed., Pankaj Jalote, Springer, 2005
2. Fundamentals of Software Engineering, V Ed., Rajib Mall, Prentice Hall India, 2014.

Web Resources

1. Prof. Rajib Mall Department of Computer science engineering. IIT Khadakpur https://onlinecourses.nptel.ac.in/noc19_cs69/preview

2.7 Software Engineering Lab (CE3PC_LR4)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE3PC_LR4	Software engineering Lab	02	01

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	25	25	-	-	50

Course Objectives

S. No.	Objectives
1	To *understand* and define complex real life problems by applying software engineering principles
2	To *develop* analytical and design thinking skills
3	To *choose a*ppropriate estimation and scheduling tools/techniques
4	To *understand* and choose suitable design principles for effective software design
5	To *understand* the applications of umbrella activities in SDLC

Course Outcomes

The student will be able to	
CO1	*choose* an appropriate process model and prepare SRS for the given problem statement.
CO2	*develop* analytical thinking through analysis modelling
CO3	*apply* software estimation techniques and Develop design skills for given problem statement.
CO4	*use* computer-aided software engineering (CASE) tools for umbrella activities
CO5	*apply and demonstrate* software testing techniques effectively

Suggested List of Experiments

S. No.	Suggested List of Experiments
1	**Identification and Analysis of Software requirements** Identification and Analysis of Software requirements a) Develop Software Requirement Specification (SRS) document in IEEE format for the project. Note: Decide Applicable Process Model(prescribed/agile)
2	**Demonstrate Functional modeling** Draw Use case / DFD-diagram to identify functional requirements
3	**Dynamic and behavioral Modelling** a)Identify Major USE CASES (from Use case Diagram) and write down the scenarios. b)For each scenario prepare the suitable UML diagram. (Note: UML:/sequence/collaboration
4	**Dynamic and behavioral Modelling** b)For each scenario prepare the suitable UML diagram. (Note: UML: Activity/state chart
5	**Software Project Estimation** Application of Size and Effort estimation tools and techniques for the project under study
6	**Project scheduling and tracking** a) Project scheduling using project scheduling tool b) Define task, milestone, CPM,PERT (Tools can be used like Hive,Asana)
7	**Software Architecture Design** a) Discuss different Architecture styles b) Select and draw suitable Architecture style for your product to be deployed
8	**Risk Mitigation and management** a) Identify potential risk for your project b) Prepare RIS and RMMM plan for high priority, potential risk from set of risks identified for selected problem statement.

Note: Lab course shall consist of minimum 8 experiments covering all the topics but not limited to the suggested list.

Suggested Learning Resources

Textbooks

1. The unified modeling language user, guide, II Ed., Grady Booch, James Rambaugh, Ivar Jacobson, Pearson Education, 2005.
2. Software Engineering: A Practitioner‘s Approach, IX Ed., Roger Pressman, McGraw Hill Publications, 2019.

Reference Books

1. Software Engineering for Self-Directed Learners – an online SE -Book with tutorials, guides, coding standards, tools & best practices, useful for lab preparation and self-study. se-education.org/se-book
2. Software Engineering Principles and Practice, Waman S.Jawadekar, Mc Graw Hill Education Education, 2004.

Web Resources

1. **Tiny Tool for FP calculation**
   http://groups.umd.umich.edu/cis/course.des/cis525/js/f00/harvey/FP_Calc.html
2. **COCOMO**
   a) http://softwarecost.org/tools/COCOMO/
   b) https://www.softstarsystems.com/
3. **Dia Tool or any open source tool for Design**
   http://dia-installer.de/
4. **Open-source Scheduling tool**
   a) https://sourceforge.net/projects/openproj/
   b) https://sourceforge.net/projects/ganttproject/
5. **Dev-ops tool for software configuration management**
   https://docs.ansible.com/ansible/latest/installation_guide/intro_installation.html

2.8 Object Oriented Programming (Java / Intro Advanced Java)(CE3VS_LR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE3VS_LR1	Object Oriented Programming (Java / Intro Advanced Java)	04	02

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	**50**	**-**	**-**	**25**	**75**

Course Objectives

S. No.	Objectives
1	To *learn* why Java is useful for the design of desktop and web applications.
2	To *learn* how to implement object-oriented designs with Java.
3	To *design* and program stand-alone Java applications.
4	To *learn* how to extend Java classes with inheritance and dynamic binding.
5	To *learn* how to use exception handling in Java applications, *understand* how to design GUI components with the Java Swing API.

Course Outcomes

The student will be able to	
CO1	*define* and *understand* Object oriented concepts using Java programming
CO2	*apply* the concept of Classes and Packages on real-time scenarios to *develop* structured and reusable Java applications.
CO3	*demonstrate* the concept of methods, arrays and strings.
CO4	*implement* the concept of inheritance, exception handling and multithreading
CO5	*design* and *develop* GUI based applications using Java or Python

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites		
	A brief introduction to the concept of C programming.		
1.0	**Introduction to Java and its basic building blocks**		**05**
	1.1	OOPs concepts in Java, Features of Java, Byte Code, JVM, JRE, The Java Language Specification, API, JDK and IDE, Writing a Simple Java Program. Creating, Compiling & Executing a Java Program	
	1.2	Identifiers, Variables, Data Types, Operators, Type	

		Compatibility and Casting, The String type, Reading Input using scanner Class, Displaying Output using System.out.println(), Command Line Arguments	
	1.3	Control Statements in Java: if... else, do... while Loop, while Loop, For loop, Nested Loops, Switch Statement, break Statement, continue Statement	
2.0	**Objects and Classes**		**05**
	2.1	Introduction, Defining Classes, Creating Objects, Construction of objects using constructors, Accessing objects via Reference Variables	
	2.2	Using Classes from Java Library, Static variables, Visibility Modifiers,	
3.0	**Methods, Arrays and Strings**		**05**
	3.1	Introduction, Java's Predefined Methods, Creating and Calling User-Defined Methods, Passing Objects to Methods Recursion, Method Overloading, Scope of variables.	
	3.2	Array Fundamentals - Declaration & Initialization, Array of Objects, Arrays and Methods - Passing Arrays to Methods and Returning an Array from a Method, Sorting Array, Searching an Array, Two-Dimensional array.	
	3.3	Strings: Creating Strings, String Class Methods, The String Buffer Class	
4.0	**Inheritance, Exception Handling and Multithreading**		**06**
	4.1	Types of inheritance, Method overriding, super, Abstract class and Abstract method, final, Multiple inheritance using interface, extends keyword.	
	4.2	Exception Handling Overview, Understanding techniques of Exception Handling, Exception Types, Rethrowing Exceptions, Creating Custom Exception Classes	
	4.3	Creating Thread – Different Methods, Using Thread Methods, Thread Exceptions, Priorities, Life Cycle of Thread Synchronization	
5.0	**Applets, Event-Driven Programming & Advanced Python Programming**		**05**
	5.1	Applet and applet life cycle, creating applets, graphics class functions, parameter passing to applet, Font and color class, Swing vs. AWT, Frames, Layout Managers, Common features of Swing GUI Components, Creating User Interfaces, Handling Mouse and Key Events, Introduction to JDBC connectivity	
	5.2	**Django**: Introduction to Django, Installation and Creating projects and app, Django Admin.	
		Total Hours	**26**

Module	Suggested List of Experiments
1	Program on command line arguments
2	Program on accepting input from keyboard
3	Programs on Basic programming constructs like branching and looping
4	Programs on class and objects (Include concept of constructors)
5	Program on method and constructor overloading.
6	Program on Packages
7	Program on Arrays and Vectors
8	Program on String Handling
9	Program on Inheritance
10	Program on Abstract classes
11	Program of Exception Handling
12	Program on Multithreading
13	Program on applet class
14	Program to create GUI application

Note: Lab course shall consist minimum of 10 - 12 experiments covering the syllabus of corresponding theory course but not limited to the suggested list. Mini Project based on the content of the syllabus (Group of 2-3 students)

Suggested Learning Resources

Textbooks

1. JAVA: The Complete Reference, VIII Ed., Herbert Schildt, Oracle Press.
2. Programming in JAVA, II Ed., Sachin Malhotra and Saurabh Chaudhary, Oxford University Press.
3. Programming with JAVA, A primer, IV Ed., E. Balaguruswamy, TATA McGrawHill Company.

Reference Books

1. JAVA: The Complete Reference, VII Ed., Herbert Schildt, Oracle Press.
2. Programming in JAVA, II Ed., Sachin Malhotra and Saurabh Chaudhary, Oxford University Press.
3. Programming with JAVA, A primer, IV Ed., E. Balaguruswamy, TATA McGrawHill Company.

Web Resources

1. Java Tutorial
   https://www.w3schools.com/java/
2. Learn Java: Tutorials for Beginners, Intermediate, and Advanced Programmers,
   https://stackify.com/java-tutorials/
3. Java Tutorial
   https://www.javatpoint.com/java-tutorial
4. Java Tutorial
   https://www.tutorialspoint.com/java/index.htm

2.9 Innovation, Business Models and Entrepreneurship (IL3HM_CR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL3HM_CR1	Innovation, Business Models and Entrepreneurship	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
50	Continuous	-	-	-	-	50

Course Objectives

S. No.	Objectives
1	To *introduce* key innovation concepts, *understand* types of innovation, and *explore* the importance of creativity in business.
2	To *learn* about the challenges and steps in managing innovation, and *understand* divergent/convergent thinking and design thinking.
3	To *explore* experimentation in innovation, foster idea champions, and *understand* co-creation and *prototyping* in product development.
4	To *understand* business models, entrepreneurship, and strategies like Blue Ocean Strategy, and *learn* to address business model failures.
5	To *learn* about technological innovation management, sustainability in entrepreneurship, and the role of intellectual property (IPR).

Course Outcomes

The student will be able to	
CO1	*define* and *analyze* types of innovation and *assess* their impact on businesses.
CO2	*understand* innovation processes, *apply* creative thinking methods, and *use* design thinking to solve problems.
CO3	*implement* experiments, promote collaboration, and *create/test* prototypes for innovation.
CO4	*design* business models, *apply* differentiation strategies, and *identify* reasons for business model failure.
CO5	*analyze* technological innovations, incorporate sustainability, and *handle* IPR effectively.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Universal Human Values/ General Knowledge		
1.0	**Foundations of Innovation and Creativity**		**07**
	Analyzing the Current Business Scenario, Innovation and Creativity: An Introduction, Innovation in the Current Environment, Types of Innovation, School of Innovation.		
2.0	**Innovation Management and Design Thinking**		**05**
	Challenges of Innovation, Steps of Innovation Management, Idea Management System, Divergent vs. Convergent Thinking, Design Thinking and Entrepreneurship.		
3.0	**Experimentation, Co-Creation, and Prototyping**		**05**
	Experimentation in Innovation Management, Idea Championship, Participation for Innovation, Co-Creation for Innovation, Prototyping to Incubation.		
4.0	**Business Models, Entrepreneurship, and Strategies**		**05**
	What is a Business Model?, Who is an Entrepreneur?, Social Entrepreneurship, Blue Ocean Strategy I & II, Business Models and Value Proposition, Business Model Failure: Reasons and Remedies		
5.0	**Technological Innovation, Sustainability, and Intellectual Property**		**04**
	Marketing of Innovation, Technology Innovation Process, Technological Innovation Management Planning & Strategies, Technology Forecasting, Sustainability Innovation and Entrepreneurship, Innovation Sustainable Conditions, SMEs' Strategic Involvement in Sustainable Development, Creation and Management of IPR, Patents and Copyrights, Patents in India		
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. 8 Steps to Innovation: Going from Jugaad To Excellence, I Ed., Rishikesha T. Krishnan, Vinay Dabholkar, HarperCollins, 2015.
2. Innovation and Entrepreneurship: Practice and Principles, I Ed., Peter Drucker, Routledge Classics, 2015.

Reference Books

1. HBS series on Innovation and Entrepreneurship, IV Ed., John R. Bessant, Joe Tidd, Wiley, 2024.

Web Resources

1. NPTEL course on Innovation, Business Models and Entrepreneurship, Prof. Rajat Agrawal, Prof. Vinay Sharma, IIT Roorkee.
   https://onlinecourses.nptel.ac.in/noc21_mg63/preview

2.10 Professional Communication and Soft Skills (ILSHM_CR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ILSHM_CR1	Professional Communication and Soft Skills	01	01

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
25	Continuous	-	-	-	-	25

Course Objectives

S. No.	Objectives
1	To *equip* students with the skills required for verbal aptitude tests and competitive exams
2	To *learn* advanced technical writing, focusing on clear, concise and well-structured reports.
3	To *develop* key employability skills necessary for securing a job and excelling in professional environments.
4	To *enhance* the ability to *design* and *deliver* professional presentations with a foucs on clarity, engagement and impactful delivery
5	To *introduce* students to AI tools and ethical approach that can enhance their technical and professional skills

Course Outcomes

The student will be able to	
CO1	*develop* and *implement* preparation strategy for competitive exams.
CO2	*write* a well-structured technical report with proper citations and data presentation.
CO3	*prepare* for and *participate* in interviews, group discussions, and conflict resolution exercises.
CO4	*design* and *deliver* a professional presentation using advanced tools.
CO5	*apply* AI tools to enhance their research, writing, and data analysis skills, and demonstrate practical application.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Basic knowledge of communication skills and minimal language proficiency		

1.0	**Aptitude Tests and Competitive Exams**		**03**
	1.1	Logical Reasoning: Puzzles, Analogies and Verbal Reasoning: Reading Comprehension, Sentence Completion	
	1.2	GRE, TOEFL, IELTS and GATE, Exam pattern and syllabus breakdown	
	1.3	Time management strategies for exam preparation.	
2.0	**Advanced Technical Writing and Reports**		**03**
	2.1	Structure of technical documents: Executive summaries, introduction, methodology, findings, conclusions, and recommendations. Language and tone for technical communication.	
	2.2	Use of graphs, tables and data visualization.	
	2.3	Research-based writing and citations (using LaTex).	
3.0	**Employability Skills**		**03**
	3.1	Types of Interviews: Telephonic, face-to-face and video. STAR method for answering behavioral questions. Preparing for interviews: Resume writing, platforms for checking resume efficiency, company and profile research, documents and conduct.	
	3.2	Group discussions. Leadership, listening skills and body language. Structuring arguments and building consensus.	
	3.3	Emotional intelligence, conflict resolution and building professional relationships.	
4.0	**Advanced Presentation Skills**		**02**
	4.1	Structuring a presentation: Introduction, body and conclusion.	
	4.2	Visual design: Effective use of slides, SmartArt, charts and animation. Presentations using Canva, Prezi and other creative tools.	
	4.3	Voice modulation, body language and eye contact. Handling audience questions and managing feedback.	
5.0	**Use of AI Tools Supporting Professional Growth**		**02**
	5.1	AI-powered research assistants and writing tools (e.g., ChatGPT, Grammarly etc.).	
	5.2	Using AI for plagiarism detection and content generation.	
	5.3	Tools for automated data analysis (e.g., Tableau, Power BI, Python-based AI tools).	
		Total Hours	**13**

Suggested Learning Resources

Textbooks

1. Soft Skills, IV Ed., Dr. K. Alex, S. Chand Publishing, 2021.
2. Business Communication, XII Ed., Leslikar, Flatley, Rentz and Pande, Cengage Learning, 2021.

Reference Books

1. The IUP Journal of Soft Skills, IUP Publications
2. Soft Skills, Dr. K. Alex (Revised Edition)
3. Business Communication, Leslikar, Flatley, Rentz and Pande
4. Managing Soft Skills for Personality Development, B. N. Ghosh
5. Soft Skills and Employability Skills, Sabina Pillai and Agna Fernandez

Web Resources

1. Business Communication
   http://www.ndl.gov.in/he_document/swayam_ugc_moocs/swayam_ugc_moocs/IN__S_U_M__1_U_C__17_B_C__133_134
2. English for Competitive Exams
   http://www.ndl.gov.in/he_document/dishtvo/dishtavo/D_D_I_S_F_H_T_A_V_O_B_O_A_E_F_C_E_E_1573464798?e=0|Competitive%20exams|||
3. Advanced Presentation Skills
   http://www.ndl.gov.in/he_document/openstax_cnx/openstax/IN__O__1_W_S_a_S__1006_C_07_A_P_S__2725_2726
4. Latex Documents
   https://www.ndl.gov.in/he_search?key=Latex%20documents

2.11 Professional Communication and Soft Skills Lab (ILSHM_LR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ILSHM_LR1	Professional Communication and Soft Skills Lab	02	01

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	25	-	-	-	25

Course Objectives

S. No.	Objectives
1	To *practice* solving quantitative and logical reasoning problems efficiently.
2	To *write* clear and well-formatted technical reports with proper citations.
3	To *develop* skills in resume writing, group discussions, and mock interviews.
4	To *deliver* clear and engaging presentations on technical topics.
5	To *use* AI tools for data analysis, visualization, and resume improvement.

Course Outcomes

The student will be able to	
CO1	*solve* aptitude and reasoning problems accurately within set time limits.
CO2	*create* structured technical reports on engineering topics with correct citations and formatting.
CO3	*draft* a professional resume, participate in group discussions, and *perform* in mock interviews.
CO4	present technical topics confidently using visual aids and effective communication.
CO5	*apply* AI tools for automated data analysis, visualization, and resume optimization.

Course Contents

S. No.	Suggestive List of Activities
1	Time bound practice session of quantitative and logical reasoning problems.
2	Write a technical report on a specific engineering topic with proper citations and formatting.
3	Participate in a mock group discussion, demonstrating leadership, communication, and problem-solving skills.
4	Appear for a mock interview showcasing the techniques learnt.
5	Deliver a live presentation on the topic chosen/ technical report prepared.
6	Draft an effective resume, check the efficiency percentage of the resume and showcase the report along with analysis of how to improve.

7	Workshop/ Hands on session on tools for automated data analysis
8	Report of the above workshop/hands on session along with plagiarism check analysis of the same.
9	Role play focusing on conflict resolution and maintaining professional conduct and challenging scenario.
10	Create a data visualization report using the tool learnt in the workshop incorporating AI assisted insights.

Note: Lab course shall consist minimum of 05 activities covering the syllabus of corresponding theory course but not limited to the suggested list.

Suggested Learning Resources

Textbooks

1. Soft Skills, IV Ed., Dr. K. Alex, S. Chand Publishing, 2021.
2. Business Communication, XII Ed., Leslikar, Flatley, Rentz and Pande, Cengage Learning, 2021.

Reference Books

1. Soft Skills, IV Ed., Dr. K. Alex, S. Chand Publishing, 2021.
2. Business Communication, XII Ed., Leslikar, Flatley, Rentz and Pande, Cengage Learning, 2021.
3. The IUP Journal of Soft Skills, IUP Publications.
4. Managing Soft Skills for Personality Development, I Ed., B. N. Ghosh, IUP Publications, 2023.
5. Soft Skills and Employability Skills, I Ed., Sabina Pillai, Agna Fernandez, IUP Publications, 2023.

Web Resources

1. Business Communication
   http://www.ndl.gov.in/he_document/swayam_ugc_moocs/swayam_ugc_moocs/IN__S_U_M__1_U_C__17_B_C__133_134
2. English for Competitive Exams
   http://www.ndl.gov.in/he_document/dishtvo/dishtavo/D_D_I_S_F_H_T_A_V_O_B_O_A_E_F_C_E_E_1573464798?e=0|Competitive%20exams|||
3. Advanced Presentation Skills
   http://www.ndl.gov.in/he_document/openstax_cnx/openstax/IN__O__1_W_S_a_S__1006_C_07_A_P_S__2725_2726
4. Latex Documents
   https://www.ndl.gov.in/he_search?key=Latex%20documents

2.12 Human Values and Ethics (ILSHM_CR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ILSHM_CR2	Human Values and Ethics	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
50	Continuous	-	-	-	-	50

Course Objectives

S. No.	Objectives
1	To *introduce* and *define* core universal human values and aid understanding of their role in individual and social harmony.
2	To *explore* the principles of trust, respect, and justice in relationships.
3	To *understand* the interconnectedness of humans and nature and the importance of developing sustainable practices.
4	To *learn* about ethical decision-making frameworks in professional settings.
5	To *integrate* intellectual, emotional, physical, and spiritual growth into personal development.

Course Outcomes

The student will be able to	
CO1	*identify* and *explain* the core universal values.
CO2	*demonstrate* the ability to resolve a real-life familial and societal conflict by applying principles of trust, respect and justice.
CO3	*conduct* an environmental audit of a local project or practice and *propose* sustainable changes.
CO4	*evaluate* an ethical dilemma in a professional context and *present* a solution based on ethical decision-making frameworks.
CO5	*create* and *implement* a personal development plan that integrates intellectual, emotional, physical, and spiritual growth goals.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
1.0	**Introduction to Universal Human Values (UHV)**		**05**
	1.1	Concept and importance of human values.	
	1.2	Harmony in the individual (Understanding Self: I and Body).	

	1.3	Perspective on human values: Right understanding, relationships and physical facility.	
2.0	**Harmony in Family and Society**		**05**
	2.1	Understanding relationships: Trust and respect.	
	2.2	Family as a basic unit of society.	
	2.3	Case studies on ethical issues in family and social settings.	
3.0	**Harmony with Nature and Sustainability**		**05**
	3.1	Interconnectedness of humans and nature.	
	3.2	Insights on living in harmony with nature.	
	3.3	Professional practices, environmental responsibility and sustainability.	
4.0	**Ethics in Professional Life**		**06**
	4.1	Defining professional ethics: Integrity, accountability and transparency.	
	4.2	Ethical decision-making models, Code of ethics for engineers.	
	4.3	Dealing with workplace challenges: Bias, corruption, and competition.	
5.0	**Holistic Development through Universal Values**		**05**
	5.1	Integrating intellectual, emotional, physical, and spiritual growth.	
	5.2	The role of meditation and reflection in personal development.	
	5.3	Professional excellence with ethical foundations.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. A Foundation Course on Human Values and Professional Ethics, III Ed., R. R. Gaur, R. Asthana, G. P. Bagaria, PHI, 2023.

Reference Books

1. Human Values and Professional Ethics, III Ed., R.S. Naagarazan, New Age International Publishers, 2023.
2. Ethics in Engineering, IV Ed., Mike W. Martin, Roland Schinzinger, McGraw Hill Education, 2020.
3. Harmony with Nature: An Anthology, II Ed., A. K. Sharma, Vikas Publishing House, 2021.

Web Resources

1. Coursera course on The Science of Well-Being, Yale University https://www.coursera.org/lecture/the-science-of-well-being/start-a-new-journey-swBKu
2. NPTEL course on Introduction to Human Values and Professional Ethics, https://archive.nptel.ac.in/content/storage2/courses/109104068/lecture36/36_2.html
3. AICTE aided materials on UHV https://fdp-si.aicte-india.org/SIPTeachMaterialM1.php

4. Free courses on Sustainability by Harvard University
   https://pll.harvard.edu/climate-sustainability

3 Semester-IV Course Syllabus

3.1 Sampling Theory and Quantitative Techniques (CE4PC_CR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE4PC_CR1	Sampling Theory & Quantitative Techniques	03	03

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
20	Continuous	20	1	60	2.5	100

Course Objectives

S. No.	Objectives
1	To *teach* basic concept of data collection & sampling methods
2	To *teach* concepts of hypothesis testing
3	To *develop* the basic concepts of Linear and Non-linear programming problems of optimization.
4	To *draw* interference using Statistical inference methods.
5	To *introduce* techniques for summarizing and data analysis.

Course Outcomes

The student will be able to	
CO1	*understand* the need of Statistics and Quantitative Analysis and identify and use data collection & sampling methods
CO2	*perform* hypothesis testing and interpret results
CO3	*solve* optimization engineering problems.
CO4	*formulate* Statistical inference drawing methods.
CO5	*apply* hypothesis testing and find errors

Course Contents

Module	Unit	Detailed Contents	Hours
	Pre-requisite		
	Matrices, Random variables and probability distributions.		
1.0	**Data Collection & Sampling Methods**		**05**
	1.1	Functions – Importance – Uses and Limitations of Statistics. Statistical data–	

		Classification & representation	
	1.2	Sources & methods of data collection	
2.0	**Sampling Theory**		**08**
	2.1	Basics of sampling theory: Introduction, test of hypothesis, level of significance, critical region	
	2.2	one-tailed and two-tailed tests, degree of freedom	
	2.3	Application based problem on Test statistics as z-test, t-test, chi-square test	
3.0	**Linear & Non-linear Programming**		**10**
	3.1	LPP formulation, Standard and canonical LPP, Types of LPP solutions, Solution of LPP using Simplex method	
	3.2	Problems involving slack and surplus variables, Concepts of Duality and Dual of LPPs, Convex and non-convex functions	
	3.3	Unconstrained solutions: Gradient Descent method, Constrained solutions: Lagrange multipliers, Application of Gradient Descent method in Machine Learning (Backward Propagation)	
4.0	**Statistical inference**		**07**
	4.1	Random sample -Parametric point estimation	
	4.2	Unbiasedness and consistence- method of moments and method of maximum likelihood	
	4.3	Application in GMM, Logistic Regression using Maximum likelihood.	
5.0	**Tests of hypotheses**		**09**
	5.1	Null and Alternative hypotheses, Types of errors	
	5.2	Application in Sampling and Hypothesis Testing in A/B Testing of Software Systems, Machine learning model evaluation.	
	5.3	Case study on quality check in industry and testing network congestion	
		Total Hours	**39**

Suggested Learning Resources

Textbooks

1. Statistics for Engineers and Scientists, IX Ed., William Navidi, McGraw Hill.
2. Probability, Statistics and Random Processes, IV Ed., T. Veerarajan, McGraw Hill.
3. Basic Statistics, Agarwal, B.L. (2006), Wiley Eastern Ltd., New Delhi.
4. Statistical Methods, Gupta, S. P. (2011), Sultanchand&Sons, New Delhi

Reference Books

1. An Introduction to Statistical Learning: With Applications in R., Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, Springer.
2. Engineering Optimization: Theory and Practice, V Ed., S. S. Rao, Wiley-Blackwell,2019.

3. Comprehensive Statistical Methods, Iv Ed., Arora, P.N., Sumeet Arora, S. Arora, Sultan
4. Chand, New Delhi, 2007.
5. Introduction to the theory of statistics, III Ed., Mood AM, Graybill FA, and Boes, D.C.(1985), McGrawhill Book Company, New Delhi.

Web Resources

1. NPTEL Course on Introduction to Statistics. https://onlinecourses.nptel.ac.in/noc24_ma30/preview
2. NPTEL Course on Sampling Theory https://nptel.ac.in/courses/111104073
3. NPTEL https://archive.nptel.ac.in/courses/111/105/111105100/

3.2 Database Management System (CE4PC_CR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE4PC_CR2	Database Management System	03	03

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
20	Continuous	20	1	60	2.5	100

Course Objectives

S. No.	Objectives
1	To *understand* the fundamentals of a database systems
2	To *develop* entity relationship data model and its mapping to relational model
3	To *understand* relational algebra and *formulate* SQL queries.
4	To *apply* normalization techniques to normalize the database
5	To *understand* concept of transaction, concurrency control and recovery techniques

Course Outcomes

The student will be able to	
CO1	*define* fundamental database concepts and *prepare* data models using ER/EER diagrams for real-world scenarios.
CO2	*apply* the steps to convert Data model to relational model and *formulate* relational algebra queries.
CO3	*construct* SQL queries for database operations.
CO4	*analyze* and apply concepts of normalization to relational database design.
CO5	*describe* the concept of transaction, concurrency and recovery.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Discrete Structures, Data Structures		
1.0	**Introduction to Database and Data Modelling**		**08**
	1.1	Introduction: Characteristics of databases, ACID properties, File system v/s Database system, Data abstraction, DBMS system architecture, Database Administrator	
	1.2	The Entity-Relationship (ER) Model: Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Keys,	

		Relationship constraints: Cardinality and Participation, Extended Entity-Relationship (EER) Model: Generalization, Specialization and Aggregation	
2.0	**Relational Model and relational Algebra**		**07**
	2.1	Introduction to the Relational Model, relational schema and concept of keys. Mapping the ER and EER Model to the Relational Model	
	2.2	Relational Algebra-operators (Selection, Projection, Union, Difference, Cartesian Product, Join, Intersection, Rename), Relational Algebra Queries.	
3.0	**Structured Query Language (SQL**		**09**
	3.1	Overview of SQL, Data Definition Commands, Integrity constraints: key constraints, Domain Constraints, Referential integrity, check constraints, Data Manipulation commands, Data Control commands, Transaction Control Commands	
	3.2	Aggregate function-group by, having, order by, joins, Nested and complex queries, Views in SQL, Set and string operations, Triggers	
	3.3	Introduction to Pl/SQL Block Structure	
4.0	**Database Normalization**		**06**
	4.1	Pitfalls in relational database designs, Concept of normalization, Function Dependencies	
	4.2	First Normal Form, 2NF, 3NF, BCNF, 4NF	
5.0	**Transactions Management**		**09**
	5.1	Transaction concept, Transaction states,Concurrent Executions, Serializability-Conflict and View	
	5.2	Concurrency Control: Lock-based, Timestamp-based protocols	
	5.3	Recovery System: log-based recovery, Introduction to Deadlock handling	
		Total Hours	**39**

Suggested Learning Resources

Textbooks

1. Fundamentals of Database Systems, V Ed., Elmasri and Navathe, Pearson Education.
2. Database System Concepts, VI Ed., Korth, Slberchatz, Sudarshan, McGraw Hill.

Reference Books

1. Database Systems Design, Implementation and Management, V Ed., Peter Rob and Carlos Coronel, Thomson Learning.
2. Database Management Systems, III Ed., Raghu Ramkrishnan and Johannes Gehrke, TMH.

Web Resources

NPTEL Lecture Series:

1. Database Management system By Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay, IIT Kharagpur
   https://nptel.ac.in/courses/106105175
2. Introduction to Database Systems By Prof. Sreenivasa Kumar, IIT Madras
   https://onlinecourses.nptel.ac.in/noc25_cs40/preview

3.3 Database Management System Lab (CE4PC_LR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE4PC_LR2	Database Management System Lab	02	01

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	25	25	-	-	50

Course Objectives

S. No.	Objectives
1	To *understand* and *define* the fundamentals of a DBMS.
2	To *design* entity relationship data model and relational model.
3	To *understand* usage of various of SQL commands (DDL,DML,DCL,TCL)
4	To *identify* and *apply* SQL commands to solve user queries
5	To *understand* the usage of transaction management.

Course Outcomes

The student will be able to	
CO1	*design* data model using ER/EER diagrams for real-world scenarios.
CO2	*decide* and *apply* steps to map Data model to relational model .
CO3	*design* databases and construct Simple SQL queries for data definition, manipulation, and retrieval
CO4	*construct* complex SQL queries
CO5	*apply* transaction management in DBMS

Course Contents

S. No.	Suggestive List of Experiments
1	Select a real-world case study, develop a detailed problem description, and design the corresponding ER/EER model.
2	Mapping ER/EER to Relational schema model.
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified system.
4	Perform DML Commands for the specified system.
5	Perform Simple queries, string manipulation operations and aggregate functions.
6	Implement various Join operations.
7	Perform Nested and Complex queries
8	Perform DCL and TCL commands.
9	Implement procedure and functions.
10	Implementation of Views and Triggers.

11	Implementation and demonstration of Transaction and Concurrency control techniques using locks.
12	Mini project (Design simple GUI and Backend Connectivity)/Field project

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list.

Suggested Learning Resources

Textbooks

1. Fundamentals of Database Systems, V Ed., Elmasri and Navathe, Pearson Education.
2. Database System Concepts, VI Ed., Korth, Slberchatz, Sudarshan, McGraw Hill.
3. Database Management Systems, III Ed., Raghu Ramkrishnan and Johannes Gehrke, TMH.

Reference Books

1. Database Systems Design, Implementation and Management, V Ed., Peter Rob and Carlos Coronel, Thomson Learning.
2. SQL and PL/SQL for Oracle 10g, Black Book, Dr. P.S. Deshpande, Dreamtech Press, ISBN-13: 978-8177227109

Web Resources

1. NPTEL Lecture Series: Database Management system By Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay, IIT Kharagpur
   https://nptel.ac.in/courses/106105175
2. Oracle Database SQL Reference
   https://docs.oracle.com/cd/B12037_01/server.101/b10759.pdf

3.4 Analysis of Algorithms (CE4PC_CR3)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE4PC_CR3	Analysis of Algorithms	03	03

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
20	Continuous	20	1	60	2.5	100

Course Objectives

S. No.	Objectives
1	To *understand* the concept of algorithm running time and performance analysis using asymptotic notations.
2	To *analyze* and compare the efficiency of algorithms based on time and space complexity..
3	To *develop* the ability to design efficient algorithms for solving common engineering problems
4	To *apply* the greedy strategy to design optimal algorithms for suitable problem scenarios
5	To *design* and *analyze* algorithms using divide-and-conquer and dynamic programming approaches.

Course Outcomes

The student will be able to	
CO1	*analyze* the asymptotic performance of algorithms using techniques like substitution method, recursion tree method, and the master method. Derive and solve recurrences describing the performance of divide-and-conquer algorithms.
CO2	*identify and solve* optimization problems using the greedy approach.
CO3	*synthesize* dynamic-programming algorithms, and analyze them.
CO4	*identify* and *solve* problems using Branch and Bound techniques.
CO5	*explore* fundamental concepts in NP-completeness, approximation algorithms for tackling intractable problems, and efficient string-matching techniques like Rabin-Karp and Knuth-Morris-Pratt.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites		
	Data Structures and Discrete Structures.		
1.0	**Introduction and Divide and Conquer**		**07**
	1.1	Performance analysis, space and time complexity, Growth of function – Big –Oh, Omega, Theta notation, Mathematical background for algorithm analysis, Analysis of selection sort, insertion sort.	
	1.2	**Recurrences:** The substitution method, Recursion tree method, and Master method.	
	1.3	**Divide and Conquer Approach** – General Method, Analysis of Merge Sort, Analysis of Quick sort, Analysis of Binary search,	
2.0	**Greedy Approach**		**07**
	2.1	Greedy Approach: Basic strategy, application to job sequencing with deadlines problem, Knapsack Problem,	
	2.2	Single source shortest path: Dijkstra's Algorithm, Minimum cost spanning trees-Kruskal and Prim's algorithm.	
3.0	**Dynamic Programming**		**09**
	3.1	General Method: Single source shortest path: Bellman Ford Algorithm, All pair shortest path: Floyd Warshall Algorithm, Travelling Salesman Problem	
	3.2	0/1 Knapsack Problem, Longest Common Subsequence	
4.0	**Backtracking and Branch-and-bound:**		**07**
	4.1	Backtracking: General Method, 8 queen problem(N-queen problem), Sum of subsets, Graph coloring	
	4.2	Branch and Bound: General Method: 15 Puzzle Problem, TSP	
5.0	**NP-Complete problems, Approximation, and String-Matching algorithms**		**09**
	5.1	NP-Complete Problems: Basic concepts, non-deterministic Algorithms, NP-hard and NP-complete, decision and optimization problems,	
	5.2	Approximation algorithms: The vertex-cover problem, the traveling-salesman problem, the set covering problem, the clique problem (any other suggestions)	
	5.3	String Matching algorithms: The naïve string-matching Algorithms, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm	
		Total Hours	**39**

Suggested Learning Resources

Textbooks

1. Introduction to algorithms, III Ed., T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, PHI Publication 2009.
2. Fundamentals of computer algorithms, II Ed., Ellis Horowitz, Sartaj Sahni, S. Rajsekaran, University Press, 2010.

Reference Books

1. Algorithms, I Ed., Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, Tata McGraw-Hill.
2. Design Methods and Analysis of Algorithm. II Ed., S. K. Basu, PHI.

Web Resources

1. Design and Analysis of Algorithms — NPTEL
   https://nptel.ac.in/courses/106/106/106106131/
2. Problem Solving through Programming in C (SWAYAM NPTEL course)
   https://swayam.gov.in/nd1_noc19_cs47/preview
3. Algorithms Specialization — Coursera (University of California San Diego & National Research University Higher School of Economics)
   https://www.coursera.org/specializations/algorithms
4. MOOC-List: Algorithms Courses
   https://www.mooc-list.com/tags/algorithms

3.5 Analysis of Algorithms Lab (CE4PC_LR3)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE4PC_LR3	Analysis of Algorithms Lab	02	01

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	25	25	-	-	50

Course Objectives

S. No.	Objectives
1	To *compute* the running time of algorithms and *analyze* their performance using asymptotic analysis.
2	To *compare* and *evaluate* algorithms based on efficiency and resource usage.
3	To *develop* the ability to *design* efficient algorithms for common engineering challenges.
4	To *apply* the greedy strategy to solve suitable optimization problems.
5	To *design* and *implement* algorithms using divide-and-conquer and dynamic programming approaches.

Course Outcomes

The student will be able to	
CO1	*analyze* the asymptotic performance of algorithms using techniques like substitution method, recursion tree method, and the master method. Derive and solve recurrences describing the performance of divide-and-conquer algorithms.
CO2	to *identify* and *solve* optimization problems using the greedy approach.
CO3	*synthesize* dynamic-programming algorithms, and analyze them.
CO4	*identify* and *solve* problems using Branch and Bound techniques.
CO5	*explore* fundamental concepts in NP-completeness, approximation algorithms for tackling intractable problems, and efficient string-matching techniques like Rabin-Karp and Knuth-Morris-Pratt.

Course Contents

S. No.	Suggestive List of Experiments
1	Implement **Insertion sort** and **Selection sort** and derive its time complexity
2	Implement **Quick sort** and **Merge sort** and derive its time complexity
3	Write a program to find **Single Source Shortest Path** for a directed graph using **Greedy Technique**.
4	Implement **Prims** and **Kruskal's** algorithm for finding **Minimum Cost Spanning Tree** using **Greedy Method.**

5	Write a program to solve the **0/1 Knapsack** problem using **Dynamic Programming.**
6	Write a program to find **Longest Common Subsequence** for two sequences using **Dynamic Programming**
7	Write a program to find **All Pairs Shortest Path** for a directed graph using **dynamic programming**
8	Write a program to solve the **Graph Coloring** problem using **Backtracking.**
9	Write a program to solve the **Sum of Subsets** problem using **Backtracking.**
10	Write a program to perform **String matching** using **Rabin Karp Algorithm.**
11	Write a program to perform **String Matching** using **Knutt Morris Pratt Algorithm.**
12	Write a program to solve **Chain Matrix Multiplication** problem using Dynamic Programming
13	Implementation of an **Approximation Algorithm (Vertex-Cover, TSP, Set-Cover or Clique Approximation)**

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list. Few Experiments can also be from the Self Learning list.

Suggested Learning Resources

Textbooks

1. Introduction to algorithms, III Ed., T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, PHI Publication 2009.
2. Fundamentals of computer algorithms, II Ed., Ellis Horowitz, Sartaj Sahni, S. Rajsekaran, University Press, 2010.

Reference Books

1. Algorithms, I Ed., Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, Tata McGraw-Hill.
2. Design Methods and Analysis of Algorithm. II Ed., S. K. Basu, PHI.

Web Resources

1. Design and Analysis of Algorithms — NPTEL
   https://nptel.ac.in/courses/106/106/106106131/
2. Problem Solving through Programming in C (SWAYAM NPTEL course)
   https://swayam.gov.in/nd1_noc19_cs47/preview
3. Algorithms Specialization — Coursera (University of California San Diego & National Research University Higher School of Economics)
   https://www.coursera.org/specializations/algorithms
4. MOOC-List: Algorithms Courses
   https://www.mooc-list.com/tags/algorithms

3.6 Fundamentals of Computer Organization and Architecture Lab (CE4PC_LR4)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE4PC_LR4	Fundamentals of Computer Organization and Architecture Lab	02	1

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	25	-	-	-	25

Course Objectives

S. No.	Objectives
1	To *understand* and *verify* of Logic Gates and Boolean Expressions
2	To *simulate* and *implement* of Arithmetic and ALU Operations
3	To *understand* Processor Architectures and Floating-Point Representation
4	To *study* on to Microcontrollers and Peripheral Interfacing
5	To *study* of Computer Buses and Parallel Processing Techniques

Course Outcomes

The student will be able to	
CO1	*analyze* and study basics of various digital components.
CO2	*apply* correct data representation and implement the arithmetic algorithms for solving ALU operations and study basics of arithmetic unit
CO3	*describe* multicore architecture, pipelining and parallel processing
CO4	*understand* and simulate the basic functionality of microcontrollers by programming LED blinking and temperature sensor interfacing using 8051 or Arduino.
CO5	*understand* and *analyze* the architecture, functionality, and applications of different types of processors and peripherals, including microprocessors, microcontrollers, DSP processors, RISC vs. CISC, and multi-core processors.

Course Contents

Module	Suggested List of Experiments
1	Introduction to basic and universal Gates a. To study and verify the truth table of various logic gates and realize Boolean expressions using gates. b. To realize basic gates using universal gates.
2	Understanding and Simulation of arithmetic units (basic combinational circuits)

	a. Half adder b. Full adder
3	Understanding and implementation of multiplication and division algorithms in ALU a. To simulate the working of Booth's algorithm b. To simulate the working of Restoring division algorithm and non-restoring algorithm
4	Understanding concept of IEEE 754 Floating point representations. a. Single precision/ IEEE 32-bit format b. Double precision/IEEE 64-bit format
5	Introduction to pipeline and parallel processing a. Pipeline processors: case study b. Parallel processors SIMD, SISD, MISD, MIMD: case study
6	Introduction to various buses and bus contention system a. ISA, PCI, IDE, SCSI\ b. Daisy chain, Polling and Independent requests.
7	Topic: Introduction to Microcontrollers (8051/ Arduino) a. Simulate blinking of LEDs b. Simulate temperature sensor
8	Introduction to Processor programming and interfacing of peripheral of processor a. Basic Arithmetic/ logical operations on 8/16-bit numbers (Simulation in 8086 Emulator / TASM/DEBUG) b. Simulation of LED blinking using 8086 and 8255 PPI (Proteus)
9	Introduction of different types of processors (Any one case study in detail / or Comparative study of basic features) a. Microprocessors (Intel 8086, 8088, Pentium, Core i-series) b. DSP Processors (TMS320, SHARC) c. RISC vs. CISC Processors (ARM vs. x86) d. Multi-core Processors (Dual-core, Quad-core, Octa-core)
10	Introduction to Micro Controller (Any one case study in detail / or Comparative study of basic features) a. Microcontrollers (8051, PIC, AVR, ARM Cortex-M)

Note: **:** Lab course shall consist minimum of 8 experiments covering all the topics, it should cover any one subtopic from each of the above given suggested experiments.

Suggested Learning Resources

Textbooks

1. Computer Organization and architecture: Designing for performance, X Ed., Willam Stallings Pearson.
2. Modern Digital Electronics, IV Ed., R P Jain, Tata McGraw -Hill Education.
3. Structured Computer Organization, VI Ed., Andrew S. Tanenbaum, Pearson Publication.
4. Computer Architecture and Organization, II Ed., B. Govindarajalu, McGraw-Hill Publication.
5. Digital computer Electronics, III Ed., Malvino, McGraw-Hill Publication.

Reference Books

1. The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications, IV ed., Walter A. Triebel & Avtar Singh, Pearson Publisher.
2. Advanced Microprocessors and Peripherals, II Ed., A.K. Ray & K.M. Bhurchandi, Mc Graw Hill publication.
3. The Intel Microprocessors: Architecture, Programming, and Interfacing, II Ed., Barry B. Brey Merrill publisher.
4. The 8051 Microcontroller and Embedded Systems, II Ed., Muhammad Ali Mazidi, Janice Gillispie Mazidi & Rolin D. McKinlay.

Web Resources

1. Simulator Link
   https://cse.iitkgp.ac.in/~chitta/coldvl/
2. Digital Logic
   https://nptel.ac.in/courses/117105080
3. Microprocessor
   https://www.tutorialspoint.com/microprocessor/index.htm
4. Processors
   https://www.intel.com/content/www/us/en/developer/topic-technology/processors/overview.html
5. Arduino UNO Q from Blink to think
   https://www.arduino.cc/

3.7 Business Forecasting (IL4HM_CR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4HM_CR1	Business Forecasting	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
50	Continuous	-	-	-	-	50

Course Objectives

S. No.	Objectives
1	To *introduce* the fundamentals of business forecasting and data-driven decision-making.
2	To *learn* various methods of time series forecasting, including moving averages and exponential smoothing.
3	To *understand* and *apply* regression analysis and methods for handling seasonality in time series data.
4	To *introduce* advanced techniques such as ACF, PACF, and ARIMA models for time series analysis.
5	To *explore* the use of machine learning, Monte Carlo simulations, and predictive analytics tools for forecasting.

Course Outcomes

The student will be able to	
CO1	*understand* the role of forecasting in business and *differentiate* between qualitative and quantitative approaches.
CO2	*apply* moving average techniques and exponential smoothing for accurate time series forecasting.
CO3	*implement* regression models and seasonal indices to improve the accuracy of forecasts.
CO4	*use* ACF, PACF, and ARIMA models to *identify* patterns and forecast future trends in time series data.
CO5	*apply* machine learning techniques and Monte Carlo simulations to enhance forecasting accuracy and manage risk.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
1.0	**Introduction to Business Forecasting & Data Analytics**		**04**
	1.1	Introduction to Business Forecasting, Data-Driven Decision Making and Essentials of Predictive Analytics.	
	1.2	Types of Forecasting: Qualitative Approaches and Quantitative Approaches.	
2.0	**Time Series Analysis and Forecasting Techniques**		**05**
	2.1	Components of a Time Series and Measures of Forecast Accuracy	
	2.2	Moving Average Methods: Simple, Weighted, and Exponential Moving Average	
	2.3	Exponential Smoothing, Trend Projections and Holt Model.	
3.0	**Regression, Seasonality, and Decomposition Methods**		**06**
	3.1	Regression Analysis	
	3.2	Measure of Goodness and Standard Error	
	3.3	Seasonality: Seasonal Index, and Quarterly Average Method, Seasonality and Trend: Holt Winter Method. Decomposition Method	
4.0	**Advanced Forecasting and Time Series Models**		**05**
	4.1	ACF and PACF	
	4.2	ARIMA	
5.0	**Machine Learning, Risk Analytics, and Predictive Analytics**		**06**
	5.1	Introduction to Machine Learning, Logistic Regression; Human Judgement in Time Series Analysis	
	5.2	Monte Carlo Simulation and Risk Analytics	
	5.3	Predictive Analytics using @Risk software/Python	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Business Forecasting, IX Ed., John E Hanke, Dean Wichern, Pearson Education, 2008.,9th Edition.
2. Essentials of Business Analytics- Descriptive, Predictive and Prescriptive Analytics, II Ed., Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, Cengage Learning, 2016.

Reference Books

1. Business Analytics, (PART 4: Regressions Analysis and Time Series Forecasting), V Ed., Albright and Winston, Cengage Learning, 2015.
2. Forecasting Methods and Applications, III Ed., Spyros G. Makridakis, Steven C. Wheelwright, Rob J. Hyndman, John Willey and Sons, 1997.
3. An Introduction to Management Science: Quantitative Approaches to Decision Making, XIII

Ed., David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, Jeffrey D. Camm, and Kipp Martin, Cengage Learning, 2012.
4. Quantitative Analysis for Management, X Ed., Barry Render, Ralph M. Stair, Pearson Education, 2008.

Web Resources

1. NPTEL course on Business Forecasting, Prof. Pankaj Dutta, IIT Bombay
https://onlinecourses.nptel.ac.in/noc24_mg66/preview

3.8 Field Project (ILSEL_PR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ILSEL_PR1	Field Project	04	02

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	25	-	-	25	50

Course Objectives

S. No.	Objectives
1	To *enable* students to identify real-world problems in society and propose technology-based solutions.
2	To *develop* mini-projects focusing on social impact.
3	To *enhance* critical thinking, teamwork, and innovation
4	To *provide* exposure to interdisciplinary problem-solving.
5	To *improve* understanding of user-centric software/hardware development.

Course Outcomes

The student will be able to	
CO1	*identify* societal issues that can be addressed through technology.
CO2	*apply* engineering principles to design innovative solutions.
CO3	*develop* prototypes or working models for real-world applications.
CO4	*collaborate* effectively in teams to implement their ideas.
CO5	*present* their solutions in technical reports, presentations, and demonstrations

Course Contents

Module	Unit	Weekly Activities: Project Development Flow	Weeks
	Prerequisites: Programming Language, Software Engineering		
1.0	**Introduction to Technology for Social Good**		**1-2**
	1.1	Understanding societal challenges and the role of technology	
	1.2	Case studies of successful tech-driven social innovations	
	1.3	Brainstorming potential problem domains.	
2.0	**Problem Identification & Ideation**		**3-4**
	2.1	Conducting surveys and interviews to identify local problems	
	2.2	Defining project scope and objectives	
	2.3	Forming teams and selecting problem statements.	
3.0	**Solution Design & Technology Selection**		**5-6**
	3.1	Selecting appropriate technologies (e.g Web/App	

		Development, AI, IoT, Blockchain, etc.).	
	3.2	Designing a basic system architecture	
	3.3	Prototyping tools & methodologies	
4.0	**Development Phase – Prototyping & Implementation**		**7-10**
	4.1	Coding, testing, and debugging the mini-project.	
	4.2	Iterative development with feedback loops.	
	4.3	Conducting usability tests with real users (if possible).	
5.0	**Testing, Validation and Impact Analysis**		**11-12**
	5.1	Testing and Validating the solution.	
	5.2	Evaluating societal impact and write feedback in the same context	
6.0	**Module 6: Documentation & Presentation**		**13-14**
	6.1	Preparing a technical report.	
	6.2	Creating project presentations & demo sessions	

Suggested Learning Resources

Tools & Technologies (student are allowed to use any Technology they are comfortable with). Following are few Suggestions

- Programming Languages: Python, JavaScript, Java, C++
- Web & App Development: React, Flutter, Node.js
- AI & ML: TensorFlow, OpenCV
- IoT & Embedded Systems: Arduino, Raspberry Pi
- Cloud Computing: Firebase, AWS
- Databases: MySQL, MongoDB

Assessment Criteria

Component	Weightage
Problem Identification & Proposal	10%
Design & Planning	15%
Prototype Development & Implementation	40%
Deployment & Testing	20%
Presentation & Documentation	15%

Template for Mini Project Report:

Sr. no	Title
1.	**Cover Page** • Project Title • Team Members (Names & Roll Numbers) • Guide/Faculty Mentor Name • Institution Name & Logo • Submission Date
2	**Certificate Page** - Acknowledgment page: **Thanking faculty, institution, mentors, and contributors.** - Abstract (***Max 300 words)*** • Brief overview of the project. • Problem statement, proposed solution, and expected impact.
3	**Table of Contents**

	• List of sections and corresponding page numbers.
4	**1. Introduction** 1.1 Background of the Problem 1.2 Problem Statement 1.3 Objectives of the Project 1.4 Scope of the Project 1.5 Significance & Social Impact **2. Literature Survey / Existing Solutions** 2.1 Review of Existing Systems/Solutions 2.2 Gaps in Current Solutions 2.3 Proposed Solution Approach **3. System Design & Methodology** 3.1 System Architecture 3.2 Technology Stack Used 3.3 Flowcharts/Block Diagrams 3.4 Data Flow Diagrams (DFD) 3.5 Algorithms or Working Principles **4. Implementation & Development** 4.1 Tools and Platforms Used (Software/Hardware) 4.2 Database Design (if applicable) 4.3 System Modules and Functionalities 4.4 Screenshots of UI/Prototype (if applicable) 4.5 Challenges Faced & How They Were Addressed **5. Testing, Demonstration & Evaluation** 5.1 Testing Methodologies Used (Unit, Integration, System Testing) 5.2 Test Cases and Results 5.3 User Feedback & Performance Evaluation **6. Results & Discussion** 6.1 Final Output of the Project 6.2 Comparison with Existing Solutions 6.3 Key Observations and Findings **7. Conclusion & Future Scope** 7.1 Summary of the Work Done 7.2 Limitations of the Current Work 7.3 Future Enhancements **8. References** • Books, research papers, websites, or other sources used. **9. Appendices (If Any)** • Additional diagrams, code snippets, surveys, etc.

Suggested Mini-Project: Students can choose any domain relevant to society

(Not limited to….)
Sample Topics Healthcare & Accessibility

- Smart health monitoring using IoT
- AI chatbot for mental health support
- Wearable alert systems for elderly care

II. Education & Skill Development

- AI-based personalized learning assistant
- AR/VR-based interactive learning applications
- App for skill development & vocational training

III. **Environment & Sustainability**
   - Smart waste management systems
   - AI-driven energy-saving solutions
   - Real-time air quality monitoring app

IV. **Smart Cities & Infrastructure**
   - AI-powered traffic management systems
   - Emergency response alert systems
   - Digital solutions for urban planning

V. **Agriculture & Rural Development**
   - IoT-based smart irrigation systems
   - AI-driven crop disease detection
   - E-commerce platform for farmers

VI. **Security & Disaster Management**
   - AI-based crime prediction system
   - Disaster response and relief tracking apps
   - Women's safety mobile applications

VII. **Social Welfare & Inclusion**
   - Job portal for underprivileged communities
   - AI-based sign language translator
   - Mobile app for NGO donation & volunteering

3.9 Multidisciplinary Minor Courses

3.9.1 Signals and Systems (ET4MM_CX1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ET4MM_CX1	Signals and Systems	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *understand* fundamental concepts of signals and systems in both continuous-time (CT) and discrete-time (DT) domains.
2	To *analyze* linear time-invariant (LTI) systems using time-domain methods (convolution, differential/difference equations).
3	To *apply* transform techniques (Fourier, Laplace, Z-Transform) for system and signal analysis in frequency domain.
4	To *develop* the ability to model and characterize systems, understand their stability, causality, and response.
5	To *provide* a strong foundation for advanced courses in Digital Signal Processing, Communication Systems, and Control Systems.

Course Outcomes

The student will be able to	
CO1	*classify* and *analyze* signals and systems based on type, properties, and behavior (CT/DT, periodic/aperiodic, causal/non-causal, stable/unstable).
CO2	*analyze* continuous-time and discrete-time linear time-invariant systems in the time domain using impulse/step responses, convolution, system equations, and basic sampling concepts.
CO3	*represent* and *analyze* signals in frequency domain using Fourier Series and Fourier Transform.
CO4	*apply* Laplace and Z-transform techniques to analyze continuous-time and discrete-time systems and to solve differential and difference equations.
CO5	*analyze* discrete-time systems using Z-Transform, determine transfer function, stability, and design/realize FIR and IIR systems.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisite		
	Basic Engineering Mathematics, Basics of signal		
1.0	**Signals & Systems Basics**		05
	1.1	Definition of signals and systems, Continuous-Time (CT) and Discrete-Time (DT) signals, Periodic, Aperiodic signals, Signal classification: even, odd, energy, power, causal, non-causal, Deterministic, random signals, Elementary signals: step, impulse, ramp, exponential, sine, cosine,	
	1.2	System classification: linear, non-linear, time-invariant, time-variant, causal, non-causal, stable, unstable, LTI system properties: memory, invertibility.	
2.0	**Time-Domain Analysis of Linear Time-Invariant Systems**		05
	2.1	Introduction to Linear Time-Invariant (LTI) systems: concepts of linearity and time-invariance; classification of continuous-time (CT) and discrete-time (DT) systems. Impulse and step responses of CT and DT LTI systems. Convolution integral (CT) and convolution sum (DT) with simple illustrative examples. Differential (CT) and difference (DT) equation representation of LTI systems (basic form).	
	2.2	Introduction to sampling: concept of sampling, sampling of continuous-time signals, brief overview of ideal sampling. Concepts of system stability and causality.	
3.0	**Fourier Series and Fourier Transform – Basics and Properties**		05
	3.1	Continuous-Time Fourier Series (CTFS): formulation and basic properties. Discrete-Time Fourier Series (DTFS): formulation and basic properties.	
	3.2	Continuous-Time Fourier Transform (CTFT) and Discrete-Time Fourier Transform (DTFT): concept, formulation, magnitude and phase spectra. Important Fourier properties: linearity, time shifting, frequency shifting, and convolution property.	
	3.3	Energy and power of signals: Parseval's theorem, basic concept of energy and power spectral density (PSD) and their significance.	
4.0	**Laplace Transform & Continuous-Time System Analysis**		05
	4.1	Laplace Transform: Definition transform of standard signals, basic properties, inverse Laplace transform (partial fractions), solution of linear differential equations.	
	4.2	Z-Transform: Definition, transform of standard sequences, basic properties, inverse Z-transform (partial fractions), solution of linear difference equations.	
5.0	**Digital Structures for FIR and IIR Filters**		06
	5.1	Basic building blocks for digital filter realization: adders, multipliers, and delay elements. Introduction to FIR and IIR filter FIR filter structures: direct form, cascade form, and lattice realization; concept of linear-phase FIR filters.	

	5.2	IIR filter structures: direct form-I, direct form-II, cascade form, parallel form, and lattice realization (basic concept). Comparison of FIR and IIR filter structures in terms of stability, memory requirement, and computational complexity.	
		Total Hours	26

Suggested Learning Resources

Textbooks

1. Signals and Systems, II Ed., Simon Haykin, Barry Van Veen, Wiley, 2007.
2. Signals and Systems, II Ed., Alan V. Oppenhiem, Alan S. Willsky, S. Hamid Nawab, Prentice-Hall, 1996.
3. Linear Systems and Signals, II Ed., B. P. Lathi, Oxford University Press, 2005.
4. Schaum's Outline: Signals and Systems, II Ed., Hwei P. Hsu, McGraw-Hill, 2003.
5. Fundamentals of Signals and Systems, I Ed., Michel J. Robert, McGraw-Hill, 2008.

Reference Books

1. Digital Signal Processing, IV Ed., John G. Proakis, Dimitris Manolakis, Pearson, 2006.
2. Signals, Systems and Inference, I Ed., Hwei P. Hsu, 1st Edition, McGraw-Hill, 2003.
3. Introduction to Signal and Systems, I Ed., Mark A. Pinsky, Samuel Karlin, Dover, 2001.
4. Signals and Systems for Bioengineers, II Ed., John Semmlow, Academic Press, 2007.
5. Principles of Linear Systems and Signals, II Ed., B. P. Lathi, Oxford University Press, 2005.

Web Resources

1. NPTEL course on Principles of Signals and Systems, Prof. Aditya Jagannatham, IIT Kanpur
   https://nptel.ac.in/courses/108104100
2. Signals and Systems, Prof. V.M. Gadre, IIT Bombay
   https://nptel.ac.in/courses/117101055
3. MIT Open Courseware on Signals and Systems
   https://www.youtube.com/watch?v=FHm2pQmiSM&list=PLUl4u3cNGP61kdPAOC7CzFjJZ8f1eMUxs

3.9.2 Digital System Design (ET4MM_CX2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ET4MM_CX2	Digital System Design	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *understand* number system representations and their inter-conversions used in digital electronic circuits.
2	To *study* Boolean algebra, logic families (TTL, CMOS), and implementation of Boolean expression
3	To *analyze* digital logic processes and to implement logical operations using various combinational logic circuits and sequential logic circuits.
4	To *explore* the characteristics and classification of programmable devices like FPGAs and CPLD and also implement combinational and sequential circuits using VHDL.

Course Outcomes

The student will be able to	
CO1	*develop* digital logic concepts, apply binary arithmetic, and perform digital operations.
CO2	*classify* and analyze Boolean algebra laws, logic families (TTL, CMOS), and digital logic gates.
CO3	*analyze, design* and *implement* combinational logic circuits.
CO4	*analyze*, *design* and *implement* sequential logic circuits.
CO5	*classify* different types of PLDs and Simulate and implement basic combinational and sequential circuits using VHDL/Verilog.

Course Contents

Module	Unit	Detailed Contents	Hours
		Prerequisites	
		Basic Electrical Engineering	
1.0	**Number Systems and Codes**		**04**

	1.1	Review of Binary, Octal and Hexadecimal Number Systems, their inter-conversion, Gray code and BCD code, Binary Arithmetic, Addition, Subtraction using 1's and 2's Complement	
2.0	**Boolean algebra and Logic Family**		**05**
	2.1	Laws of Boolean algebra, Theorems of Boolean algebra and implementation of Boolean expressions using logic gates and Universal gates.	
	2.2	Difference between Analog and Digital signals, Logic levels, TTL and CMOS Logic families and their characteristics	
3.0	**Combinational Logic Circuits**		06
	3.1	SOP and POS representation, K-Map up to four variables and Quine-McClusky method for minimization of logic expressions	
	3.2	Design of Arithmetic Circuits using Combinational Logic: Half adder, Full adder, Half Subtractor, Full Subtractor, BCD adder, Magnitude Comparator.	
	3.3	Multiplexer and Demultiplexer: Multiplexer operations, cascading of Multiplexer, Boolean function implementation using MUX, DEMUX and basic gates, Encoder and Decoder, Applications of combinational logic circuits.	
4.0	**Sequential Logic Circuits**		**06**
	4.1	Flip flops: RS, JK, Master slave flip flops; T & D flip flops with various triggering methods, Conversion of flip flops, Registers: SISO, SIPO, PISO, PIPO, Universal Shift Register	
	4.2	Counters: Asynchronous and Synchronous counters with State transition diagram, Up/Down, MOD-N Counter, BCD Counter,Ring counter, Johnson counter	
5.0	**Programmable logic and Introduction to VHDL**		**05**
	5.1	Introduction: Programmable Logic Devices (PLD), Programmable Read Only Memories (PROMs), Programmable Logic Array (PLA), Programmable Array Logic (PAL), Design of multiple output circuits using PLDs.	
	5.2	Basics of VHDL/Verilog Programming, Design of combinational and sequential circuits using VHDL/Verilog: adder, subtractor, multiplexer, flip flop and counters.	
		Total	**26**

Suggested Learning Resources

Textbooks

1. Digital Design Principles and Practices, V Ed., John F. Warkerly, Pearson Education, 2018.
2. Digital Design, V Ed., Morris Mano, Michael D. Ciletti, Pearson Education, 2013.
3. Modern Digital Electronics, IV Ed., R. P. Jain, Tata McGraw Hill Education, 2010.
4. Fundamentals of Digital Circuits, IV Ed., A. Anand Kumar, PHI, 2016.
5. Digital Electronics and Design with VHDL, I Ed., Volnei A. Pedroni, Morgan Kaufmann Publisher, 2008.
6. Fundamentals of Digital Logic with Verilog Design, III Ed., Stephen Brown & Zvonko

Vranesic, MGH, 2014.

Reference Books

1. Digital Fundamentals, XI Global Ed., Thomas L. Floyd, Pearson Prentice Hall, 2015.
2. Digital Electronics Principles and Applications, I Ed., Mandal, McGraw Hill Education, 2010.
3. Digital Systems Principles and Applications, IX Ed., Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, PHI 2009.
4. Digital Principles and Applications, VIII Ed., Donald P. Leach , Albert Paul Malvino, Gautam Saha, The McGraw Hill, 2015.
5. Fundamentals of Digital Logic Design with VHDL, II Ed., Stephen Brown & Zvonko Vranesic, TMH, 2009.
6. A Verilog HDL Primer, III Ed., J. Bhasker, Star Galaxy Press, 1997.

Web Resources

1. Course: Digital Circuits By Prof. Santanu Chattopadhyay (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee70/preview

3.9.3 Introduction to Electric Vehicle (EE4MM_CX1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
EE4MM_CX1	Introduction to Electric Vehicle	02	02

Examination and Evaluation Scheme

rmative Assessment		Summative Assessment				Total Marks
ISE		MSE		ESE		
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *introduce* students to the history, evolution, and significance of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs).
2	To *familiarize* students with various drivetrain topologies and power flow analysis in EVs and HEVs.
3	To *impart* knowledge about different energy sources, storage systems, and propulsion technologies used in EVs.
4	To *provide* an overview of autonomous electric vehicles, their core technologies, and future trends.
5	To *analyze* Indian government policies, financial incentives, and case studies related to EV adoption.

Course Outcomes

The student will be able to	
CO1	*explain* the history, evolution, and importance of EVs and HEVs, including their impact on the environment.
CO2	*analyze* different drivetrain topologies, power flow control, and fuel efficiency in EVs and HEVs
CO3	*apply* knowledge of energy storage technologies and propulsion systems for EV applications.
CO4	*evaluate* the core technologies of autonomous electric vehicles, their challenges, and future trends.
CO5	*assess* Indian government policies, incentives, and case studies to determine their impact on EV adoption.

Course Contents

Module	Unit	Detailed Contents	Hours
1.0	**History and Evolution of Electric Vehicles**		**05**
	1.1	**History of EVs:** Basics of vehicles mechanisms, history of electric vehicles (EV) and hybrid electric vehicles (HEV), need and importance of EV and HEV,	
	1.2	**Need and Importance of EVs:** Power/Energy supplies	

		requirements for EV/HEV applications. State of the art and Indian and global scenario in EV/HEV. Electric Vehicle and environment.	
2.0	**Drive Train Topology**		**05**
	2.1	**Vehicle Transmission:** Configurations of Electric Vehicles and Various electric drive-train topologies**.**	
	2.2	**Hybrid Electric Vehicles**: Concept of Hybrid Electric Drivetrains system, various hybrid drive-train topologies. Power flow control in drive-train topologies, fuel efficiency analysis.	
3.0	**Energy Sources and Propulsion of EVs**		**06**
	3.1	**Peaking Power Sources and Energy Storage:** Requirements of energy supplies and storage in EV/HEV, Review of batteries, fuel cells, flywheels and ultra-capacitors as energy sources for EV/HEV.	
	3.2	**DC and AC Machines for Propulsion Applications:** Electric system components for EV/HEV, types and suitability of DC and AC machines for EV/HEV applications.	
4.0	**Overview of Autonomous Electric Vehicles**		**05**
	4.1	**Introduction to Autonomous Vehicles:** Autonomous Vehicles, Core Technologies Behind Autonomous Vehicles	
	4.2	**Synergy between Autonomous Systems and EVs**: Benefits of Autonomous Electric Vehicles, Challenges in Developing Autonomous Electric Vehicles, Current and Future Trends in Autonomous EVs.	
5.0	**Indian Government Policies for Electric Vehicles (EVs)**		**05**
	5.1	**Introduction to Electric Vehicle Policies in India:** Need for EV Policies in India, National-Level EV Policies- FAME Scheme and its phases, NITI Aayog involvement, National Electric Mobility Mission Plan (NEMMP), rate of deployment of EVs on-board chargers. Production-Linked Incentive (PLI) Scheme for Automobile and Auto Components.	
	5.2	Financial Incentives and Subsidies for EV Adoption, Case studies of popular EVs on road.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Electric and Hybrid Vehicles: Design Fundamentals, I Ed., Iqbal Hussein, CRC Press, 2003.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, III Ed., Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi, CRC Press, 2018.
3. Energy Management Strategies for Electric and Plug-in Hybrid Vehicles, I Ed., Sheldon S Williamson, Springer 2013.
4. Electric Vehicle Technology Explained, II Ed., J. Larminie, J. Lowry, Wiley, 2012.

Reference Books

1. Modern Power Electronics and AC Drives, I Ed., B. K Bose, Pearson Education 2002.
2. Hybrid Electrical Vehicle Principles and Application with Practical Perspectives, I Ed., C. Mi, M. Abul, D. W. Gao, Wiley, 2011.
3. Energy Storage, I Ed., Robert A. Huggins, Springer 2010.

Web Resources

1. NPTEL course on Introduction to Hybrid and Electric Vehicles, Prof. Praveen Kumar, Prof. S. Majhi, IIT Guwahati.
   https://nptel.ac.in/courses/108/103/108103009
2. NPTEL course on EV – Vehicle Dynamics and Electric Motor Drives, Prof. Amit Jain, Prof. Avanish Tripathi, IIT Delhi.
   https://onlinecourses.nptel.ac.in/noc24_ee30/preview
3. Electric Vehicles and Renewable Energy, Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha, Prof. L Kannan, IIT Madras.
   https://nptel.ac.in/courses/108106182

3.9.4 Introduction to IoT and Core Technologies (EC4MM_CX1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
EC4MM_CX1	Introduction to IoT and Core Technologies	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *understand* the fundamental concepts, components, and applications of IoT.
2	To *gain* practical knowledge of the hardware components used in IoT, including sensors, actuators, and microcontrollers.
3	To *learn* about key communication protocols used in IoT systems and their application in device communication.
4	To *explore* integration of IoT devices with cloud platforms for data storage and processing.
5	To *apprise* about the security challenges and best practices for securing IoT systems and protecting user data.

Course Outcomes

The student will be able to	
CO1	*describe* the architecture of an IoT system and identify common IoT applications in various industries.
CO2	*design* basic IoT circuits by interfacing sensors and actuators with microcontrollers.
CO3	*implement* communication between devices using protocols such as MQTT, HTTP, and CoAP.
CO4	*explain* connection of IoT devices to a cloud platform for visualization of sensor data in real time.
CO5	*explore* basic security measures like encryption and authentication in an IoT system.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
1.0	**Introduction to Internet of Things**		**05**
	1.1	Overview of IoT: Introduction, definition, history, and evolution, Characteristics of IoT, Challenges, Applications of IoT, M2M.	
	1.2	IoT Architecture: Conceptual Framework of IoT, Physical design of IoT, Logical design of IoT, IoT World Forum (IoTWF) Standardized Architecture: Layer 1-7.	

	1.3	Core IoT Components: Sensors, actuators, microcontrollers, communication technologies	
2.0	**IoT Hardware and Devices**		**05**
	2.1	Sensors and Actuators: Types of sensors and actuators, its interfacing with IoT devices	
	2.2	Microcontrollers: Introduction to Arduino, Raspberry Pi, and ESP32	
	2.3	Interfacing Sensors: Connecting and programming sensors with microcontrollers- GPIO, I2C, SPI, and other hardware protocols	
3.0	**IoT Communication Protocols**		**05**
	3.1	Wired vs. wireless communication; IoT Communication Protocols: MQTT, HTTP, CoAP	
	3.2	Wireless Communication Technologies: Wi-Fi, Bluetooth, Zigbee, LoRa, LPWAN, 5G	
	3.3	Networking in IoT: Overview of IoT networks, IP addressing, and protocols	
4.0	**Cloud Integration and Data Storage**		**06**
	4.1	Cloud Computing for IoT: Introduction to cloud platforms (AWS IoT, Google Cloud IoT, Azure IoT)	
	4.2	Edge Computing in IoT: Benefits, challenges, and use cases. Fog Computing. Hierarchy of Fog, Edge and Cloud Computing.	
	4.3	Data Management: Storing and processing IoT data (local vs cloud storage)	
5.0	**Security and Privacy in IoT**		**05**
	5.1	IoT Security: Security challenges, encryption, authentication, and data integrity.	
	5.2	Privacy Considerations in IoT: Protecting user data, Privacy concerns and regulations (GDPR, IoT security standards)	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Internet of Things: A Hands-On Approach, II Ed., Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015.
2. Internet of Things: Principles and Paradigms, I Ed., Rajkumar Buyya, Amir Vahid Dastjerdi, Morgan Kauffman, 2016.
3. Designing the Internet of Things, I Ed., Adrian McEwen, Hakim Cassimally, Wiley, 2013.
4. Practical Internet of Things Security, II Ed., Brian Russell, Drew Van Duren, Packt Publishing, 2018.
5. Internet of Things – Architecture and Design Principles, I Ed., Kamal, R., Mcgraw Hill,2017.

Reference Books

1. The Internet of Things: A Guide to the Connected World, II Ed., Samuel Greengard, The MIT Press, 2021.
2. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, I Ed., David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, Cisco Press, 2017.

Web Resources

1. NPTEL course on Introduction to IoT by Prof. Sudip Misra, IIT Kharagpur
   https://archive.nptel.ac.in/courses/106/105/106105166/

3.9.5 Introduction to Additive Manufacturing (ME4MM_CX1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ME4MM_CX1	Introduction to Additive Manufacturing	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *introduce* the fundamentals and classifications of Additive Manufacturing (AM) technologies.
2	To *provide* knowledge of various AM systems including liquid-based, solid-based, and powder-based processes.
3	To *develop* understanding of AM machine specifications, working principles, and process parameters.
4	To *familiarize* students with materials used in AM and their properties, limitations, and applications.

Course Outcomes

The student will be able to	
CO1	*explain* the fundamentals, classifications, advantages, and applications of different AM processes.
CO2	*describe* and *compare* various liquid-based AM systems (SLA) by analyzing their working principles and process parameters.
CO3	*analyze* solid-based AM systems (LOM, FDM) by evaluating their process sequences, machine specifications, applications, and performance characteristics.
CO4	*evaluate* powder-based AM technologies (SLS, 3DP, EBM) by examining process mechanisms and material behavior.
CO5	*select* suitable materials for different AM processes by examining their properties such as dimensional accuracy, stability, surface finish, machinability and environmental resistance.

Course Contents

Module	Unit	Detailed Contents	Hours
1.0	**Additive Manufacturing**		**05**
	1.1	Introduction to AM, Classification of AM Processes, Advantages & Disadvantages, AM Applications; in Design, Concept Models, Form & Fit Checking, Functional testing and CAD data verification.	

2.0	**Liquid-based systems**		**05**
	2.1	Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies.	
3.0	**Solid-based Systems**		**05**
	3.1	Laminated object manufacturing (LOM): Models and specifications, Process, Working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies.	
4.0	**Powder-Based Systems**		**05**
	4.1	Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Three-dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, case studies. Electron Beam Melting (EBM): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.	
5.0	**Materials for Additive Manufacturing**		**06**
	5.1	Types of material: polymers, metals, ceramics and composites, liquid-based materials, photo polymer development, solid-based materials, powder-based materials. Material properties: Colour, dimensional accuracy, stability, surface finish, machinability, environmental resistance, and operational properties.	
		Total	**26**

Suggested Learning Resources

Textbooks

1. Additive Manufacturing, I Ed., Dr R. B. Chaudary, Khanna Publishers, 2022.
2. Rapid Prototyping: Principles and Applications, II Ed., Chua Chee Kai, Kah Fai Leong, Tata McGraw-Hill, 2018.

Reference Books

1. Additive Manufacturing: Principles, Technologies and Applications, I Ed., C.P. Paul, A.N. Jinoop, McGraw-Hill India, 2021.
2. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W. Rosen, Brent Stucker, Springer, 2020.

Web Resources

1. SWAYAM course on Fundamentals of Additive Manufacturing Technologies, Dr. Sajan Kapil, IIT Guwahati
   https://onlinecourses.nptel.ac.in/noc25_me151/preview

3.9.6 Introduction to Robotics (ME4MM_CX2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ME4MM_CX2	Introduction to Robotics	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *introduce* the history, evolution, and fundamental concepts of robotics.
2	To *teach* about the types, working principles, roles and applications of sensors, actuators and end effectors in robotics.
3	To *explore* the classification of robots based on various criteria.
4	To *discuss* the ethical, social, and safety implications of robotics.

Course Outcomes

The student will be able to	
CO1	*explain* the history, evolution, and basic concepts of robotics.
CO2	*identify* different sensors and actuators and their integration in robotic systems.
CO3	*identify* appropriate end effectors for specific applications.
CO4	*classify* and *relate* between robots based on various criteria.
CO5	*discuss* the ethical, social, and safety implications of robotics.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Physics of Motion, Coordinate geometry		--
1.0	**History and Concepts in Robotics**		**05**
	1.1	Introduction to Robotics: Definition of robotics, Historical milestones in robotics, Asimov's laws of robotics, Basic types of robots (stationary, mobile, swarm), Overview of robot components, Block diagram of a robotic system.	
	1.2	Study Areas in Robotics: Basic concepts of motion (position, velocity, and acceleration), Forward and inverse kinematics, Robot dynamics, Motion planning, Motion and force control, Perception and enabling technologies.	
	1.3	Robot Applications: Applications of robots in industry and society, Famous robots (Stanford robot, Canada arm, ASIMO, Boston Dynamics robots, Mars rovers, etc.).	

2.0	**Sensors and Actuators**		**05**
	2.1	Introduction to Sensors: Types of sensors (proximity, vision, force, temperature, etc.), Working of sensors (ultrasonic, infrared, accelerometer, etc.), Role of sensors in robot perception and decision-making.	
	2.2	Introduction to Actuators: Types of actuators (electric motors, hydraulic, pneumatic, piezoelectric), Working of actuators (DC motors, stepper motors, servo motors), Role of actuators in robot movement and manipulation.	
	2.3	Sensor-Actuator Integration: How sensors and actuators work together in a robotic system, Interfacing with microcontrollers, Study of line-following and obstacle-avoidance robots.	
3.0	**Robot End Effectors**		**05**
	3.1	Introduction to End Effectors: Definition and role of end effectors in robotics, Major classes of end effectors (mechanical and non-mechanical).	
	3.2	End effectors Applications: Grippers (two-finger, multi-finger, parallel, magnetic), Tools (suction cups, welding guns, fastening tools, glue nozzles, etc.), Advanced end effectors, compliant end effectors, and end effectors for soft robotics. Factors to consider during end effector design and selection (payload, precision, application), Case studies (Robotic hands, surgical tools, and adaptive grippers).	
4.0	**Robot Classification**		**05**
	4.1	Classification based on Mobility: Fixed robots (industrial arms), Mobile robots (wheeled, legged, flying, underwater).	
	4.2	Classification based on Control: Autonomous and teleoperated robots.	
5.0	**Ethical and Safety Considerations in Robotics**		**06**
	5.1	Ethical Issues in Robotics: Ethical dilemmas, job displacement, and privacy concerns, Positive and negative impacts on society.	
	5.2	Safety Standards in Robotics: Safety protocols for industrial and service robots, Risk assessment and hazard mitigation, Designing robots for safe and effective interaction with humans.	
	5.3	Case Studies: Self-driving car accidents, robotic surgery errors, Collaborative robots (cobots) and social robots.	
		Total	**26**

Suggested Learning Resources

Textbooks

1. Robotics and Control, I Ed., R. K. Mittal, I. J. Nagrath, McGraw Hill Education, 2017.
2. Industrial Robotics-Technology, Programming and Applications, II Ed., Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel, Ashish Dutta, McGraw Hill Education, 2014.
3. Robotics, I Ed., Chikesh Ranjan, Kaushik Kumar, S. Chand, 2024.

Reference Books

1. Robotics Modelling, Planning and Control, I Ed., Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Springer, 2009.
2. Robotics, Vision and Control - Fundamental Algorithms in Python, III Ed., Peter Corke, Springer, 2023.
3. Introduction to Robotics, II Ed., S. K. Saha, McGraw Hill Education, 2014.

Web Resources

1. SWAYAM course on Experimental Robotics, Dr. Dilip Kumar Pratihar, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc24_ge31/preview
2. NPTEL Course, Robotics, Prof. Dk Pratihar, IIT Kharagpur
   https://nptel.ac.in/courses/112105249
3. NPTEL course on Introduction to Robotics, Dr. Krishna Vasudevan, Dr. T Asokan, Dr. Balaraman Ravindran, IIT Madras
   https://nptel.ac.in/courses/107106090

3.10 Open Elective Courses

3.10.1 IPR and Patenting (IL4OE_CX1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX1	IPR and Patenting	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *familiarize* the learners with the concept of intellectual property and the need to protect it.
2	To *explain* the process of patent filing and related issues to the learners.
3	To *teach* the learners the processes, laws and practical issues related to copyrights and trademarks.
4	To *teach* the learners the processes, laws and practical issues related to industrial designs and geographical indications.
5	To *teach* the learners the processes, laws and practical issues related to trade secrets and traditional knowledge.

Course Outcomes

The student will be able to	
CO1	*understand* the concepts of intellectual property rights.
CO2	*understand* the process of patent filing and analyze the related issues.
CO3	*analyze* the processes, laws and practical issues related to copyrights and trademarks.
CO4	*analyze* the processes, laws and practical issues related to industrial designs and geographical indications.
CO5	*analyze* the processes, laws and practical issues related to trade secrets and traditional knowledge.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
1.0	**Introduction to Intellectual Property Rights**		**05**
	1.1	Intellectual property: Definition, Intellectual property versus physical property, Origin of IP, Role of IP in economic and cultural development.	
	1.2	Categories of Intellectual Property: Patent, Copyrights, Trademarks, industrial Designs, Geographical Indications,	
	1.3	IP Governance: What is IP Governance?, Organizations involved in IP governance in India and abroad – DPIIT, TIFAC, NRDC, CIPAM, WIPO and their functions.	
2.0	**Fundamentals of Patent**		**05**
	2.1	Understanding patents: Conditions for granting of patent, non-patentable inventions, process versus product patents, Types of patent applications.	
	2.2	Processes: Granting of a patent, filing an e-patent, Precautions to be taken while filing a patent.	
	2.3	Temporal and spatial aspect, Opposition to grant of patent, Rights of patentee.	
3.0	**Copyrights and Trademarks**		**05**
	3.1	Copyright: Definition and classes of copyrights, Publication of copyright, The rights of the copyright owner, Terms of copyright, Registration of copyright.	
	3.2	Laws: Copyright infringement, The copyright (Amendment) act, 2012, The Information Technology Act, 2000.	
	3.3	Trademarks: Definition, Classification of trademark, Developing a trademark, Conditions for trademark registrations, Infringement and remedies for trademark registration.	
4.0	**Industrial Designs and Geographical Indications**		**06**
	4.1	Industrial Designs: Definition, Registration of designs, Copyright in registered designs, conditions for registered designs, Procedure for registration of industrial designs, Terms of industrial design, Infringement of industrial design and their remedies, Integrated Circuits (IC) layout design, grant of registration of IC design.	
	4.2	Geographical indications: Concept, Procedure and duration of registration.	
	4.3	Geographical indications: Registration process, examination of application, acceptance of application, opposition to registration of GI, Infringement of GI and remedies.	
5.0	**Trade Secrets and Traditional knowledge**		**05**

	5.1	Criteria for trade secret, registration and protection time of trade secrets, rights associated with trade secrets, enforcement of trade secrets.	
	5.2	Application for trade secrets, precautions to be taken by the organizations.	
	5.3	Traditional knowledge: Significance, agreement and protection.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Intellectual Property Rights, I Ed., Neeraj Pandey, Khusdeep Dharni, Prentice Hall India, 2014.
2. Intellectual Property Rights: Texts and Cases, I Ed., R. Radhakrishnan, S. Balasubramanian, Excel Books, 2008.

Reference Books

1. Fundamentals of Intellectual Property for Engineers, I Ed., Kompal Bansal, Parikshit Bansal, BS Publications, 2014.

Web Resources

1. Intellectual Property: A Primer for Academia, Rupinder Tewari, Mamta Bharadwai, Publication Bureau, Panjab University, 2021.
   https://tinyurl.com/mvsvvafj
2. NPTEL course on Intellectual Property Rights and Competition Law, Prof. K.D. Raju, Prof. Niharika Sahoo Bhattacharya, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc24_mg125/preview

3.10.2 Cyber Security and Laws (IL4OE_CX2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX2	Cyber Security and Laws	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *understand* and *identify* different types cybercrime and cyber law
2	To *recognize* Indian IT Act 2008 and its latest amendments
3	To *understand* the types of attacks and how to tackle the amount of risk involved.
4	To *discuss* the role of industry standards and legal requirements with respect to compliance.
5	To *create* awareness about Incident Management and its life cycle.

Course Outcomes

The student will be able to	
CO1	*understand* fundamental cyber threats and security principles.
CO2	*apply* cryptography techniques to secure digital assets.
CO3	*analyze* cybercrimes and perform basic forensic investigations.
CO4	*explain* key cyber laws and compliance frameworks.
CO5	*explore* cybersecurity applications in IoT, AI, and Blockchain.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites:		
	Basic Computer Science and Networking		
1.0	**Introduction to Cyber Security**		**06**
	1.1	Fundamentals of cyber security: Definition, Need and Importance, Evolution of Cyber Security, CIA Triad (Confidentiality, Integrity, Availability), Cyber Threats, Vulnerabilities, and Attacks.	
	1.2	Types of cyber-attack: Malware (Viruses, Worms, Trojans, Ransomware), Phishing and Social Engineering Attacks, Denial of Service (DoS) and Distributed DoS (DDoS), SQL Injection, Man-in-the-Middle (MITM) Attacks.	

	1.3	Cybersecurity Challenges & Trends: Zero-Day Attacks, Cloud Security Risks, AI in Cybersecurity.	
2.0	**Cyber Security Mechanisms**		**06**
	2.1	Cyber Defense Strategies: Encryption Techniques & Cryptography Basics, Firewalls, Intrusion Detection & Prevention Systems (IDS/IPS), Endpoint Security & Antivirus Software.	
	2.2	Authentication & Access Control: Multi-Factor Authentication (MFA), Role-Based Access Control (RBAC), Digital Signatures & Certificates.	
	2.3	Cyber Security Frameworks & Standards: NIST Cybersecurity Framework, ISO 27001 Standard, GDPR, HIPAA, and Compliance Requirements.	
3.0	**Ethical Hacking & Cyber Forensics**		**05**
	3.1	Ethical Hacking & Penetration Testing: Phases of Ethical Hacking, Common Hacking Techniques, Vulnerability Assessment & Exploitation.	
	3.2	Cyber Forensics & Incident Response: Digital Evidence Collection & Chain of Custody, Incident Handling & Recovery Strategies, Case Studies on Real-World Cybercrime Investigations.	
4.0	**Cyber Laws & Legal Framework**		**05**
	4.1	Overview of Cyber Laws: Importance of Cyber Laws, Cyber Crimes and Legal Challenges, International Perspectives on Cyber Laws.	
	4.2	IT Act, 2000 & Amendments: Key Provisions of the Information Technology (IT) Act, 2000, Important Sections Related to Cybercrime & Data Protection, Recent Amendments & Relevance in Today's Digital Era.	
	4.3	Global Cybersecurity Regulations & Compliance: General Data Protection Regulation (GDPR), California Consumer Privacy Act (CCPA), International Cyber Treaties & Agreements.	
5.0	**Case Studies & Practical Applications**		**04**
	5.1	Real-World Cybercrime Case Studies: Famous Cyber Attacks & Data Breaches, Lessons Learned from High-Profile Security Incidents.	
	5.2	Cybersecurity in Business & Government: Corporate Cybersecurity Strategies, Role of Governments in Cybersecurity Policies.	
	5.3	Future Trends in Cybersecurity & Law: Cyber Warfare & Nation-State Attacks, Artificial Intelligence in Cybersecurity Law Enforcement, Future of Data Privacy & Ethical Challenges.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Cyber Security, I Ed., Nina Godbole, Sunit Belapure, Wiley India, 2011.
2. The Indian Cyber Law, I Ed., Suresh T. Vishwanathan, Bharat Law House, 2004.
3. The Information Technology Act, 2000 (Bare Act), I Ed., Professional Book Publishers, 2000.
4. Cyber Law & Cyber Crimes, I Ed., Advocate Prashant Mali, Snow White Publications, 2012.
5. Information Systems Security, I Ed., Nina Godbole, Wiley India, 2012.
6. Cyber Security & Global Information Assurance, I Ed., Kennetch J. Knapp, Information Science Publishing, 2009.
7. Cryptography and Network Security, VII Ed., William Stallings, Pearson Education, 2017.

Reference Books

1. IT Systems Management: Designing, Implementing and Managing World - Class Infrastructures, II Ed., Rich-Schiesser, Prentice Hall, 2010.
2. COBIT 2019 Framework: Introduction and Methodology, I Ed., Dr. David Lanter, ISACA, 2019.
3. Open Source Security Testing Methodology Manual (OSSTMM) v3, III Ed., Pete Herzog, 2010.
4. Guide for Conducting Risk Assessments, NIST Special Publication, National Institute of Standards and Technology (NIST, 2012.

Web Resources

1. NPTEL Course on Introduction to Information Security – I, Prof. V. Kamakoti, IIT Madras
   https://archive.nptel.ac.in/courses/106/106/106106129/
2. Ultimate IT Security website
   https://www.ultimatewindowssecurity.com/securitylog/book/Default.aspx
3. American Library Association - Chapter 14: Standards, Guidelines, and Frameworks
   http://www.ala.org/acrl/resources/policies/chapter14
4. Advisera - ISO 27001
   https://advisera.com/27001academy/what-is-iso-27001/
   https://nvlpubs.nist.gov/nistpubs/legacy/sp/nistspecialpublication800-30r1.pdf
   http://www.diva-portal.org/smash/get/diva2:1117263/FULLTEXT01.pdf

3.10.3 Psychology (IL4OE_CX3)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX3	Psychology	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	*define* key concepts of psychology, including its definitions, history, and major milestones.
2	*understand* the various methods used in psychology and the differences between sensory mechanisms and perception theories.
3	*apply* learning theories such as classical conditioning, operant conditioning, and social learning to real-life situations.
4	*analyze* the different perspectives on personality, comparing theories from different schools of thought.
5	*evaluate* and *assess* the effectiveness of different memory theories and the techniques for improving memory retention.

Course Outcomes

The student will be able to	
CO1	*describe* and *explain* the various schools of thought in psychology and the core principles behind sensation, perception, and learning.
CO2	*demonstrate* a clear understanding of the major theories of learning and memory, including classical conditioning, operant conditioning, and cognitive learning theories.
CO3	*apply* psychological theories of personality, memory, and learning to real-world scenarios, demonstrating practical understanding
CO4	*analyze* and *compare* the effectiveness of different psychological approaches to personality assessment, as well as the role of culture in perception.
CO5	*create* a comprehensive evaluation of personality theories and suggest how modern psychological perspectives can be integrated into personality assessments.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
1.0	**Introduction to Psychology**		**05**
	1.1	Definition of Psychology, Psychology as a science, Major Milestones in Psychology, Methods in psychology.	
	1.2	Different schools of thought of Psychology, and modern perspectives of psychology, Scope and branches of psychology.	
2.0	**Sensation and Perception**		**06**
	2.1	Sensory Mechanisms, General Properties of Senses.	
	2.2	External Factors in Perception: Theory of Signal Detection, Gestalt Principles, Form Perception, Role of culture in perception.	
3.0	**Learning**		**05**
	3.1	Definition of learning, Basic concepts of learning.	
	3.2	Theories of learning: Classical conditioning, Operant conditioning, Cognitive Learning, Social Learning.	
4.0	**Memory**		**05**
	4.1	Meaning and nature of memory, Theories of memory: Information processing theories-sensory register, Short term memory, Storage and Retention.	
	4.2	Long term memory- organizations, semantic and episodic memory, encoding and storing long term memories, Forgetting- Motivated forgetting, Interference, Decay through disuse, Techniques of improving memory.	
5.0	**Personality**		**05**
	5.1	Various perspectives of Personality, Neo Freudian and Behaviourist Perspective, Humanistic Perspective.	
	5.2	Indian Perspective of Personality and assessment of Personality, Psychometric tests of Personality Assessment.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Introduction to Psychology, VII Ed., Morgan, C.T., King, R.A., Weisz, J.R., Amp; Schopler, J., Singapore: McGraw- Hill, 2007.
2. Psychology, V Ed., D.G. Myers, Worth Publishers-New York, 2004.
3. Psychology, V Ed., R.A. Baron, Prentice Hall, India, 2002.
4. Introduction To Psychology, VIII Ed. J. Kalat, Wordsworth Pub. Co., 2007.
5. Introduction To Psychology, XIV Ed., E.R. Hilgard, R. L. Atkinson, Wordsworth Pub. Co., 2013.

Reference Books

1. Understanding Psychology, VI Ed., R.S. Feldman, Tata McGraw Hill, New Delhi, 2006.
2. Psychology In Context, III Ed., S.M. Kosslyn, R.S. Rosenberg, Pearson Education Ltd., 2006

Web Resources

1. NPTEL Course on Introduction to Psychology, Dr. Braj Bhushan, IIT Kanpur
   https://archive.nptel.ac.in/courses/109/104/109104105/

3.10.4 Personal Finance, Taxation and Investments (IL4OE_CX4)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX4	Personal Finance, Taxation and Investments	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *introduce* personal finance, budgeting, debt management, savings, and insurance.
2	To *bring out* awareness of investment opportunities and *illustrate* the importance of wealth creation.
3	To *acquaint* with alternative investments and long-term retirement planning.
4	To *explain* Indian tax system, income tax structure, tax implications of investments and tax-saving strategies.
5	To *train* on comprehensive financial planning and tax filing/compliance.

Course Outcomes

The student will be able to	
CO1	*set* financial goals, track income and expenses, manage debt, and select appropriate insurance and savings plans.
CO2	*analyze* and *invest* in equities, fixed-income products, and use online platforms for investments.
CO3	*diversify* with alternative investments, and plan for retirement using various instruments.
CO4	*understand* the taxation system, calculate taxes based on income, and use tax-efficient strategies for minimizing liabilities.
CO5	*create* a financial plan and file taxes compliantly.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
1.0	**Foundations of Personal Finance**		**04**
	1.1	Introduction to Personal Finance- Setting financial goals and priorities, Budgeting, Tracking income and	

		expenses, Importance of emergency funds and financial discipline.	
	1.2	Managing Debt and Credit- Types of debt, understanding credit scores, Debt repayment strategies and managing EMIs, Credit card management and Personal loans.	
	1.3	Savings and Insurance Planning- Saving instruments: Fixed Deposits (FD), Recurring Deposits (RD), Public Provident Fund (PPF), Understanding insurance products: Life insurance, health insurance, and general insurance, Risk management strategies: Health, life, and property insurance.	
2.0	**Investment Basics and Opportunities**		**05**
	2.1	Introduction to Investments and Wealth Creation- Different investment instruments: Stocks, mutual funds, fixed-income, real estate, etc., Regulatory bodies and market overview: SEBI, RBI, NSE, BSE, Asset allocation and diversification strategies	
	2.2	Equity and Stock Market Investments- Overview of the Indian stock market (NSE, BSE, Sensex, Nifty), Understanding stocks, IPOs, mutual funds, and ETFs, Stock market analysis, How to invest in stocks using online trading platforms (Zerodha, Groww, etc.), Risks of investing in stock market.	
	2.3	Fixed-Income Investments- Understanding bonds and fixed-income securities (Government bonds, corporate bonds, etc.), role of CRISIL and ICRA bond ratings, tax treatment of fixed deposits and interest income.	
3.0	**Alternative Investments, and Retirement Planning**		**05**
	3.1	Alternative Investments- Investment in commodities: Gold, silver, and other precious metals, cryptocurrency and digital assets.	
	3.2	Retirement Planning- Understanding retirement planning and tax-saving options: National Pension Scheme (NPS), EPF, and PPF, creating a retirement corpus: The role of compounding.	
4.0	**Taxation**		**06**
	4.1	Introduction to the Indian Taxation System- Overview of the Indian taxation system: Direct vs. Indirect taxes, Income tax laws and the Income Tax Act, 1961, Types of taxes: Income tax, Goods and Services Tax (GST). Income tax structure for individuals (tax slabs, exemptions, deductions).	
	4.2	Taxation of Investments and Savings- Taxation of interest income from fixed deposits, PPF, and other	

		savings instruments, understanding capital gains tax: Short-term vs. long-term capital gains tax, Taxation of dividend income, rental income, and mutual funds, TDS (Tax Deducted at Source) in India and its relevance to investments.	
	4.3	Advanced Tax Planning Strategies- Tax-saving instruments under Section 80C (ELSS, PPF, NPS, etc.), Tax deductions under Section 80D, 80G, and other sections, Tax planning for salaried and self-employed individuals, Tax planning for NRIs (Non-Resident Indians).	
5.0	**Financial Planning and Compliance**		**06**
	5.1	Comprehensive Financial Planning in India- Developing a financial plan: Setting goals, budgeting, investing and risk management, Integrating tax planning, retirement planning and insurance into financial planning.	
	5.2	Tax filing, Compliance, and Investment strategies- Filing income tax returns (ITR forms, filing process, deadlines, understanding Form 16, Form 26AS, and their role in tax filing, using tax software and online portals for e-filing (e.g., NSDL, Income Tax Portal), Strategies for maximizing tax-efficient investments.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Let's Talk Money, II Ed., Monika Halan, HarperCollins India, 2023.
2. Retire Rich: Invest Wisely to A Secure Future, I Ed., P.V. Subramanyam, CNBC TV18, 2013.
3. Taxation of Individuals, Dr. Girish Ahuja, Ravi Gupta, Commercial Law Publishers, 2024.
4. Income Tax: Law and Practice, 65th Ed., Dr. H.C. Mehrotra, Dr. S.P. Goyal, Sahitya Bhawan Publications, 2024.
5. How to Save Taxes through Tax Planning, Amit Tiwari, Bharat Law House, 2024.

Reference Books

1. The Little Book of Common-Sense Investing, II Ed., John C. Bogle, John Wiley & Sons, 2017.
2. The Intelligent Investor, III Ed., Benjamin Graham, Harper Business, 2024.

Web Resources

1. Million Dollar Life Lessons- T. Harv Eker
   https://www.harveker.com/
2. Employee Provident Fund Organization portal
   https://www.epfindia.gov.in/site_en/index.php
3. Income Tax Department e-filing portal

https://eportal.incometax.gov.in/iec/foservices/#/login

4. National Pension Scheme portal
   https://enps.nsdl.com/eNPS/NationalPensionSystem.html
5. National Stock Exchange portal
   https://www.nseindia.com/
6. Bombay Stock Exchange portal
   https://www.bseindia.com/

3.10.5 Adolescent Health and Well being (IL4OE_CX5)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX5	Adolescent Health and Well being	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *provide* students with a fundamental understanding of nutrition, its role in health, and the importance of meal planning.
2	To *educate* students on the nutritional requirements and challenges specific to adolescence, including physiological and psychological aspects.
3	To *equip* students with knowledge about behavior modification, weight management, and national initiatives supporting adolescent well-being.

Course Outcomes

The student will be able to	
CO1	*develop* nutritionally balanced meal plans considering macronutrient and micronutrient requirements.
CO2	*analyze* the impact of macronutrients and micronutrients on adolescent growth and health.
CO3	*evaluate* the physiological, psychological, and nutritional needs of adolescents.
CO4	*apply* dietary counseling strategies to address adolescent nutritional challenges.
CO5	*implement* behavior modification techniques for weight management and holistic well-being in adolescents.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
1.0	**Basic Concepts in Nutrition**		**05**
	1.1	Food, Nutrition and Health	
	1.2	Macronutrients- 1, Macronutrients- 2, Carbohydrates and Water, Vitamin	
	1.3	Principles of Meal Planning, Meal planning for adults, Food Preservation and Other methods of maximization of Nutritional Benefit	

2.0	**Foundation of Nutrition and Wellbeing in Adolescence**		**06**
	2.1	Adolescent Health Statistics, Introduction to Nutrition and Dietetics	
	2.2	Role of Macronutrients, Role of Micronutrients	
	2.3	Basics of Adolescent Mental Health	
3.0	**Special Requirements during Adolescence**		**05**
	3.1	Physiological and Psychological changes during Adolescence	
	3.2	Special nutritional requirements during Adolescence, Malnutrition during Adolescence and their effects in later life	
	3.3	Adolescent Immunization, High risk behaviors in Adolescents	
4.0	**A Comprehensive Guide for Nutritional Support during Adolescence**		**05**
	4.1	Nutrition Care Process Dietary Counselling and Nutritional planning	
	4.2	Common Micronutrient Deficiency in Adolescents Eating-disorders in Adolescents	
	4.3	National Initiatives related to Adolescents	
5.0	**Behavior Modification for Weight Management and Wellbeing**		**05**
	5.1	Behavior modification for Weight management	
	5.2	Adolescents and Physical Activity	
	5.3	Combating Special Situations	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Dietary Guidelines for Indians. A manual by National Institute of Nutrition, ICMR.
2. Guidelines for Parents: Nutrition for Adolescents by IAP (Indian Academy of Paediatrics).
3. Implementing Adolescent Nutrition Guidelines by UNICEF.

Reference Books

1. Guideline: Implementing effective actions for improving adolescent nutrition by WHO.
2. National Health Programs of India, National Policies and legislations related to health by J. Kishore.
3. Fitness Protocols and Guidelines for 5-18 Years by Ministry of Youth Affairs & Sports.
4. Adolescence in India: Issues, Challenges and Possibilities by Swati Patra.

Web Resources

1. NPTEL course
   https://onlinecourses.nptel.ac.in/noc24_ge61/preview

3.10.6 Essentials of Management (IL4OE_CX6)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX6	Essentials of Management	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *equip* students with a comprehensive understanding of core management concepts, theories, and functions (planning, organizing, leading, and controlling)
2	To *encourage* students to think critically and analytically about decision-making processes in an organizational context.
3	To *promote* leadership development and team collaboration
4	To *prepare* students to apply management skills in technical roles and interdisciplinary projects.
5	To *help* students understand the importance of ethical decision-making while managing projects and teams.

Course Outcomes

The student will be able to	
CO1	*demonstrate* an understanding of core management concepts.
CO2	*use* analytical tools for strategic planning and decision-making.
CO3	*demonstrate* leadership skills, effectively manage teams, and communicate effectively in a professional environment.
CO4	*apply* management principles in engineering contexts.
CO5	*recognize* the importance of ethical decision-making and propose practical solutions to organizational challenges.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
1.0	**Fundamentals of Management and Organizational Structure**		**05**
	1.1	Introduction to Management: Definition, Nature, and Scope of Management, Levels and Functions of Management (Planning, Organizing, Leading, Controlling), Evolution of Management Thought	

		(Classical, Behavioral, Modern Theories)	
2.0	**Planning, Decision-Making, and Strategy**		**05**
	2.1	Principles of Planning: Types of Planning (Strategic, Tactical, Operational), Planning Tools: SWOT Analysis, PESTLE Analysis, Management by Objectives (MBO).	
	2.2	Decision-Making in Management: Types of Decisions (Programmed vs. Non-Programmed), Decision-Making Models and Techniques (Rational Model, Bounded Rationality, Heuristics), Risk and Uncertainty in Decision-Making.	
3.0	**Leadership, Motivation, and Team Management**		**06**
	3.1	Leadership in Management: Leadership Theories (Trait, Behavioral, Contingency), Styles of Leadership (Autocratic, Democratic, Laissez-Faire), Role of Engineers as Leaders in Organizations.	
	3.2	Motivation Theories and Practices: Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory, cGregor's Theory X & Y, Motivational Tools and Techniques in the Workplace Empowerment and Employee Engagement.	
	3.3	Team Management and Communication: Building and Managing Effective Teams, Communication Process, Barriers, and Channels in Management, Conflict Resolution and Negotiation Skills.	
4.0	**Financial and Operations Management**		**05**
	4.1	Basics of Financial Management: Understanding Financial Statements (Balance Sheet, Income Statement), Budgeting, Costing, and Break-Even Analysis, Basics of Capital Investment Decisions (NPV, IRR)	
	4.2	Operations and Project Management: Introduction to Operations Management in Engineering, Project Management Tools (Gantt Charts, PERT, CPM), Resource Allocation and Time Management.	
5.0	**Ethics and Sustainability in Management**		**05**
	5.1	Business Ethics and Corporate Governance: Ethical Issues in Management and Engineering, Corporate Social Responsibility (CSR) and Sustainability Practices, Legal and Regulatory Frameworks for Ethical Business Practices	
	5.2	Globalization and Contemporary Issues in Management: Global Business Environment and Cross-Cultural Management, The Role of Technology in Modern Management, Sustainable Development Goals (SDGs) and Management's Role	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Principles and Practice of Management, L. M. Prasad, S. Chand and Sons; 11th Standard Edition, 2024.
2. Business Organization and Management, C. B. Gupta, S. Chand and Sons, 2017.
3. Essentials of Management, Harold Koontz and Heinz Weihrich, McGraw Hill Education, 11th Edition, 2020

Reference Books

1. Human Management, Stephen P. Robbins, Pearson Education; 14th edition, 2019.

Web Resources

1. Principles of Management, by Prof. Susmita Mukhopadhyay, Prof. S. Srinivasan, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc21_mg88/preview

3.10.7 German Language (IL4OE_CX7)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX7	German Language	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *introduce* German language in a holistic manner.
2	To *develop* essential communication skills for greetings, introductions, and common conversational scenarios.
3	To *enhance* reading, comprehension, and writing abilities using different types of German texts.
4	To *gain* insights into German culture, family structures, work culture, and digital communication.
5	To *acquire* corporate communication skills such as writing emails, technical reports, and making presentations in German.

Course Outcomes

The student will be able to	
CO1	*demonstrate* understanding of basic German grammar, pronunciation, and expressions for effective communication.
CO2	*engage* in basic German conversations using greetings, self-introductions, numbers, dates, and everyday expressions.
CO3	*develop* reading, comprehension, and writing skills by interpreting German texts such as dialogs, monologs, and biodata.
CO4	*demonstrate* understanding of key aspects of German culture, family structures, work culture, and digital communication in a professional and social context.
CO5	*apply* corporate communication skills by drafting emails, technical reports, and delivering presentations in German.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
1.0	**Introduction to German Language**		**05**

	1.1	Basic grammar.	
	1.2	Pronunciation and basic expressions.	
2.0	**Communication**		**06**
	2.1	Greetings, beginning of conversation, Introduction of oneself, numbers, counting and dates.	
3.0	**Text Interpretation and Composition**		**04**
	3.1	Reading, Comprehension, and writing - (Type of Text).	
	3.2	Dialogs, Monologs, Biodata.	
4.0	**German Society, Work Culture, and Digital Communication**		**07**
	4.1	Family Structures, Culture.	
	4.2	Computer and Multimedia.	
	4.3	Work culture.	
5.0	**Corporate Communication**		**04**
	5.1	Emails, Technical Reports, Making presentations.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. German Conversation Demystified, I Ed., Ed Swick, Tata McGraw Hill Education, 2009.
2. German for Beginners, II Ed., Angela Wilkes, Usborne Publishing Ltd., 2001.

Reference Books

3. German Conversational Course - Level 1, I Ed., Pimsleur, Simon & Schuster Audio, 2005.
4. German Made Easy Level 1: An Easy Step-By-Step Approach to Learn German for Beginners, I Ed., Lingo Mastery, 2022.

Web Resources

1. NPTEL Course on German-I, Prof. Miling Brahme, IIT Madras
   https://onlinecourses.nptel.ac.in/noc21_hs30/preview

3.10.8 French Language (IL4OE_CX8)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX8	French Language	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *introduce* French in a holistic manner.
2	To *develop* essential communication skills for greetings, introductions, and common conversational scenarios.
3	To *enhance* reading, comprehension, and writing abilities using different types of French texts..
4	To *gain* insights into French culture, family structures, work culture, and digital communication.
5	To *acquire* corporate communication skills such as writing emails, technical reports, and making presentations in French.

Course Outcomes

The student will be able to	
CO1	*understand* basic grammar rules and pronunciation, enabling them to use fundamental expressions correctly
CO2	*introduce* themselves, *engage* in simple conversations, and use numbers, dates, and greetings appropriately.
CO3	*develop* French reading and writing skills, including comprehension of different text types such as dialogues, monologues, and biodata.
CO4	*gain insights* into French family structures, cultural aspects, and work environments while developing digital communication skills.
CO5	*compose* professional emails, draft technical reports, and deliver structured presentations in French, *demonstrating* appropriate linguistic accuracy and formal communication skills.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
1.0	**Introduction to French Language**		**06**
	1.1	Basic grammar.	
	1.2	Pronunciation and basic expressions.	
2.0	**Communication**		**06**
	2.1	Greetings, beginning of conversation, Introduction of oneself, numbers, counting and dates	
3.0	**Text Interpretation and Composition**		**04**
	3.1	Reading, Comprehension and writing - (Type of Text)	
	3.2	Dialogs, Monologs, Biodata	
4.0	**French Society, Work Culture, and Digital Communication**		**06**
	4.1	Family Structures, Culture	
	4.2	Computer and Multimedia	
	4.3	Work culture	
5.0	**Corporate Communication**		**04**
	5.1	Emails, Technical Reports, Making presentations	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. French Conversational Course - Level 1, I Ed., Pimsleur, Simon & Schuster Audio, 2005.
2. Easy French Step-by-Step, I Ed., Myrna Bell-Rochestor, Mc-Graw Hill Publications, 2008.

Reference Books

1. French Made Simple, II Ed., Pamela Rose Haze, Crown publishing Group, 2006.
2. French For Dummies, II Ed., Dodi-Katrin Schmidt, Michelle M. Williams, Dominique Wenzel, Wiley, 2011.

Web Resources

1. NPTEL Course on Foundations of French, Ramya Jagannathan, IIM Bangalore
   https://onlinecourses.swayam2.ac.in/imb25_mg88/preview

3.11 Environment and Technology (ILSHM_CR3)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ILSHM_CR3	Environment and Technology	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
50	CA	-	-	-	-	50

Course Objectives

S. No.	Objectives
1	To *understand* the interconnections between environmental science and technological advancements.
2	To *investigate* the role of sustainable technologies in mitigating environmental issues.
3	To *study* the concepts of renewable energy, waste management, pollution control, and conservation technologies, *analyze* and *interpret* environmental data using computational tools.

Course Outcomes

The student will be able to	
CO1	*describe* the fundamental principles of environmental science and its relationship with technology.
CO2	*design* and *develop* computer-based systems for environmental data collection, analysis and decision-making
CO3	*understand* waste management methods and pollution control technologies.
CO4	*identify* and *assess* renewable energy technologies and their potential for reducing carbon footprints
CO5	*develop* skills in problem-solving, critical thinking, and communication

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites:		
	Basic programming skills (Python), Introductory courses in environmental Science and mathematics.		

1	**Introduction to Environment and Technology**	**04**
	Environmental science & engineering and its significance, Definition and scope of technology in environmental contexts, Technological innovations in environmental protection and sustainability, History of environmental concerns and technological responses.	
2	**Technology Applications in Environment Monitoring and Modeling**	**06**
	Electronic sensors for environmental monitoring (temperature, humidity, air & water quality), Sensor networks and data acquisition IoT-based environmental monitoring systems, Concept of modeling, Water quantity/ water quality prediction, air pollution forecasting, using latest Technology.	
3	**Solid Waste Management and Pollution Control Technologies**	**06**
	Solid waste management technologies: recycling, composting, and waste-to-energy, Electronics waste and hazardous waste management technologies, Role of information technology in waste management systems.	
4	**Renewable Energy Technologies**	**05**
	Solar, wind, hydro, and geothermal energy technologies, Biomass and bioenergy as sustainable energy solutions, Energy storage technologies and their environmental implications, Technological innovations in energy efficiency.	
5	**Case Studies and Project Development**	**05**
	Real-world case studies of technology applications in environmental engineering, Group project.	
	Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Computer Modeling Applications for Environmental Engineer, II Ed., Kindle Edition, Isam Mohammed Abdel-Magid Ahmed, Mohammed Isam Mohammed Abdel-Magid.
2. Introduction to Environmental Engineering and Science, III Ed., Gilbert M. Masters, Wendell P. Ela., Pearson India, 2015.
3. Environmental Science and Technology: Concepts and Applications Second Edition, Frank
4. R. Spellman, Nancy E. Whiting, 2006.
5. Waste Management Practices: Municipal, Hazardous, and Industrial, John Pichtel.
6. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle.

Reference Books

1. Online Journals: Environmental Science & Technology, Journal of Cleaner Production, Renewable and Sustainable Energy Reviews.
2. "Environmental Engineering and Computer Application", Kennis Chan, CRC Press, 2015.
3. "Information Technologies in Environmental Engineering - New Trends and Challenges", Paulina Golinska, Marek Fertsch, Jorge Marx-Gómez, Springer, 2011.
4. Information Technology in Environmental Engineering: Selected Contributions to the Sixth International Conference on Information Technologies in Environmental Science and Engineering, 2016.

Web Resources

1. Ministry of Environment, Forest and Climate Change
   https://moef.gov.in/
2. U.S. Environmental Protection Agency
   https://www.epa.gov/
3. United Nations Environment Programme (UNEP)
   https://www.unep.org/
4. International Energy Agency (IEA)
   https://www.iea.org/
5. World Resources Institute (WRI).
   https://www.wri.org/

4. Exit Courses

4.1 Advanced Java (CE4EX_CR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE4EX_CR1	Advanced Java	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *understand* core Java networking concepts, including sockets, HTTP communication, and database integration.
2	To *develop* client-server applications using Java's networking APIs and multithreading.
3	To *implement* secure and efficient web-based networking with session tracking and HTTP request handling.
4	To *apply* best practices and exception handling techniques for robust Java networking applications.
5	To *understand* and *implement* the core concepts of MVC framework, including JavaBeans properties, and JSON integration, with practical examples and configuration techniques.

Course Outcomes

The student will be able to	
CO1	*design* and *develop* interactive GUI applications using AWT and Swing components while effectively handling user events and layout management.
CO2	*understand* and *implement* Java Collections Framework to efficiently store, manipulate, and retrieve data using Lists, Sets, and Maps.
CO3	*create* dynamic web pages, using Servlets and JSP
CO4	*develop* network-based applications using Java networking classes, HTTP requests, and session tracking. Implement Swing controls, JDBC operations, and exception handling for robust application development.
CO5	*understand* and *apply* JavaBeans, Struts 2 MVC framework, and JSON for efficient application development and data handling.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
	Recap of OOP principles (Classes, Objects, Inheritance, Polymorphism, Encapsulation), and Scope in Java		
1.0	**Basic Graphics and Event Driven Programming:**		
	1.1	Components and Containers, AWT and Swing, Windows & frames, Layout managers, Panels, Component and JComponent, Buttons, Labels, TextFields, TextAreas, Dialog Boxes, Mouse Events, Checkboxes and RadioButtons, Menus, Scroll Bars, Sliders, Designing Event Listener Classes	**08**
2.0	**Java Collections Framework**		
	2.1	ArrayList, LinkedList, List Interface, HashSet, Map Interface, HashMap, Set	**08**
3.0	**Servlets**		
	3.1	Introduction to Servlets (Life cycle of servlets, Java Servlets Development Kit, creating, Compiling and running servlet). The servlet API: javax. servlet package. Reading the servlet Parameters, Reading Initialization parameter. The javax.servlet.http.	
	3.2	**Java Server Pages**: Configuring Tomcat JSP/Servlet server. Brief Introduction to J2EE Architecture. Advantage of JSP technology. JSP Architecture, JSP Access Model. JSP Syntax Basic (Directions, Declarations, Expression, Scriplets, Comments) JSP Implicit Object (Out, HttpServlet Request, Http Servlet Response, Exception Handling, Session Management.	**10**
4.0	**Networking with JAVA**		
	4.1	Introduction to Java Networking- Java Networking API Overview, Working with **InetAddress** (IP Address handling), Socket Programming in Java, URL and HTTP Communication - Working with URL, URL Connection, HttpURLConnection, Sending HTTP GET and POST requests, Handling responses and reading data from a server, HTTP Request and Response Handling, **Session Tracking using Cookies & HttpSession,** Building a basic web application that interacts with a database, Handling networking errors and exceptions, Best practices in Java networking applications	**07**
5.0	**Java Beans**		
	5.1	Introduction, JavaBeans Properties, Examples Struts 2: Basic MVC Architecture, Struts 2 framework features, Struts 2 MVC pattern, Request life cycle, Examples, Configuration Files, Actions, Interceptors, Results & Result	**06**

		Types, Value Stack/OGNL JSON: Overview, Syntax, DataTypes, Objects, Schema, Comparison with XML, JSON with Java	
		Total Hours	**39**

Suggested Learning Resources

Textbooks

Textbooks

1. Core Java™ Volume II–Advanced Features, XIII Ed., Cay S. Horstmann, Gary Cornell.
2. Java2: The Complete Reference, V Ed., Herbert Schildt, Prentice Hall PTR, Tata McGraw-Hill.

Reference Books

1. Introduction to Java Programming, VII Ed., Y. Daniel Liang, Pearson.
2. Java Programming from the Ground Up, Ralph Bravaco, Shai Simonson, TATA McGRAW-HIL, ISBN-13 978-1259025631

Web Resources

1. Advanced Java Tutorial
   https://www.geeksforgeeks.org
2. Advanced Java Tutorial
   https://www.w3schools.com/

4.2 Advanced Java Lab (CE4EX_LR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE4EX_LR1	Advanced Java Lab	4	2

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	50	-	-	25	75

Course Objectives

S. No.	Objectives
1	To *implement* Java socket programming and HTTP communication for client-server applications.
2	To *develop* multithreaded networking applications using Java's APIs, ensuring efficient resource handling and concurrency.
3	To *build* and *secure* web-based applications with proper session management, HTTP request handling, and user authentication.
4	To *apply* exception handling techniques and best practices to *ensure* the stability and reliability of Java networking applications.
5	To *integrate* Java networking applications with databases to *enable* data storage, retrieval, and real-time interaction in client-server models.

Course Outcomes

The student will be able to	
CO1	*develop* interactive GUI applications using AWT and Swing focusing on effective event handling and layout management techniques.
CO2	*utilize* Java Collections Framework to analyze and apply appropriate data structures (Lists, Sets, Maps) for efficient data storage, manipulation, and retrieval in real-world applications.
CO3	*design* and *implement* dynamic web applications using Servlets and JSP, with a focus on request-response handling, session management
CO4	*create* networked applications leveraging Java's networking classes, HTTP communication, session tracking, and JDBC for database interaction in distributed systems.
CO5	*integrate* JavaBeans, Struts 2 MVC framework, and JSON to build scalable, maintainable applications

Course Contents

S. No.	Suggested list of Experiments
1	Develop a GUI application using AWT and Swing components.
2	Implement and compare different layout managers in a GUI.
3	Implement Java Collections Framework: lists and Sets
4	Build a simple servlet-based web application.

5	Build a simple JSP-based web application.
6	Create a basic client-server application using sockets.
7	Create an application that uses the JavaBean to manage user input or settings.
8	Build a simple Struts 2 application following the MVC pattern.

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list. (Note: with minimum five Experiments -Mini Project can be developed)

Suggested Learning Resources

Textbooks

1. Core Java™ Volume II–Advanced Features, XIII Ed., Cay S. Horstmann, Gary Cornell.
2. Java2: The Complete Reference, V Ed., Herbert Schildt, Prentice Hall PTR, Tata McGraw-Hill.

Reference Books

1. Introduction to Java Programming, VII Ed., Y. Daniel Liang, Pearson.
2. Java Programming from the Ground Up, Ralph Bravaco, Shai Simonson, TATA McGRAW-HIL, ISBN-13 978-1259025631

Web Resources

1. Advanced Java Tutoria
   https://www.geeksforgeeks.org
2. Advanced Java Tutorial
   https://www.w3schools.com/

4.3 Advanced Python for Modern Application Development (CE4EX_CR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE4EX_CR2	Advanced Python for Modern Application Development	02	02

Examination and Evaluation Scheme

ISE				ESE		Total Marks
CA		MSE				
Marks	Duration	Marks	Duration (Hrs.)	Marks	Duration (Hrs.)	
15	Continuous	15	1	45	2	75

Course Objectives

S. No.	Objectives
1	To *master* advanced Python programming concepts for scalable and efficient application development.
2	To *explore* design patterns, best practices, and performance optimization techniques.
3	To *integrate* databases, APIs, and asynchronous programming for modern web and cloud applications.
4	To *understand* Python's role in DevOps, automation, and cloud computing
5	To *implement* security, testing, and deployment strategies for production-ready applications.

Course Outcomes

The student will be able to	
CO1	*apply* advanced Python programming techniques for modern application development
CO2	*utilize* object-oriented and functional programming paradigms effectively.
CO3	*design* scalable, modular, and efficient Python applications
CO4	*implement* asynchronous programming, parallel processing, and threading
CO5	*develop* secure and high-performance APIs using Python frameworks.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
	Fundamentals of Python		
1.0	**Advanced Data Structures**		**06**
	1.1	Advanced list operations: list comprehensions, nested lists, slicing, lambda functions	
	1.2	Tuples and Sets: set operations, set comprehensions	

	1.3	Dictionaries: default dict, Counter, OrderedDict	
	1.4	Stacks and Queues: deque, custom stack and queue implementations	
2.0	**Advanced Python Techniques**		**06**
	2.1	Concurrency and Parallelism: threading, multiprocessing, GIL	
	2.2	basic concurrency concepts, Asynchronous Programming.	
	2.3	Regular Expressions: Using re module for pattern matching	
3.0	**Web Development with Django**		**09**
	3.1	Introduction to Django - Setting up a Django project and app, URL routing and views in Django	
	3.2	Templates in Django, Database models and migrations	
	3.3	Django ORM: Querying the database, User authentication and sessions	
4.0	**Web Development with Flask**		**10**
	4.1	Introduction to Flask - Setting up a Flask project, Routing and URL handling- Templates and static files, Form handling and request methods	
	4.2	Flask Sessions and Cookies - Introduction to Flask RESTful APIs, Integrating Django/Flask with databases	
5.0	**Web Scraping and Automation**		**08**
	5.1	Introduction to Web Scraping, Web scraping with Beautiful Soup and scrappy, Handling Anti scraping Mechanism, Automation with Selenium	
	5.2	Automation use cases	
		Total Hours	**39**

Suggested Learning Resources

Textbooks

1. The Hitchhiker's Guide to Python: Best Practices for Development" ,Kenneth Reitz, Tanya Schlusse
2. Ultimate Django for Web App Development Using Python: Build Modern, Reliable and Scalable Production-Grade Web Applications with Django and Python" , Leonardo Luis Lazzaro
3. "Flask Web Development: Developing Web Applications with Python, Second Edition", Miguel Grinberg
4. "Website Scraping with Python: Using BeautifulSoup and Scrapy" ,Gábor László Hajba.
5. "Test-Driven Development with Python: Obey the Testing Goat: Using Django, Selenium, and JavaScript" , Harry Percival

Reference Books

1. "Web Development with Django" , Ben Shaw
2. "Python: The Complete Reference", by Martin C. Brown

Web Resources

1. Udemy Course on Python RestAPI Programming with Flask and Django
   https://www.udemy.com/course/python-restapi-programming-with-flask-and- django/
2. Glocal Academy of Skills Course on Advanced Python
   https://glocalafterschool.com/product/core-and-advance-python-django-flask/

4.4 Advanced Python for Modern Application Development Lab (CE4EX_LR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE4EX_LR2	Advanced Python for Modern Application Development Lab	02	2

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	50	25	-	-	75

Course Objectives

S. No.	Objectives
1	To *enhance* Python programming skills by applying list comprehensions, nested lists, slicing, lambda functions, and regular expressions for effective data manipulation and processing.
2	To *understand* and implement core data structures such as stacks and queues using Python lists and deque, and analyze their performance differences.
3	To *develop* practical skills in web application development using Django and Flask, including project setup, routing, templates, models, forms, and database interactions.
4	To *design* and *implement* RESTful APIs using Flask, enabling CRUD operations on databases and handling HTTP requests effectively.
5	To *gain* hands-on experience in web data extraction and automation using BeautifulSoup and Selenium, including handling dynamic web content and automating browser interactions.

Course Outcomes

The student will be able to	
CO1	*develop* proficiency in manipulating data using Python through list operations, lambda functions, and regular expressions for pattern matching and text processing.
CO2	*implement* stack and queue structures in Python and *analyze* the performance of various implementations.
CO3	*acquire* competence in designing web apps with Django and Flask, including content rendering, database operations, and authentication.
CO4	*develop* the ability to build RESTful APIs that enable seamless communication between applications and databases.
CO5	*acquire* proficiency in automating web tasks and scraping content using BeautifulSoup and Selenium safely and efficiently.

Course Contents

S. No.	Suggested list of Experiments
1	Implement and demonstrate list comprehensions, nested lists, slicing, and using lambda functions to filter and manipulate lists.
2	Implement a custom stack and queue using Python lists and deque. Compare the performance of list-based and deque-based implementations.
3	Practice using Python's re module to perform pattern matching, search, replace, and validate text with regular expressions.
4	Set up a basic Django project and create a simple app. Implement URL routing and views to display content dynamically.
5	Implement a Django template, create a simple model, and run database migrations to store and display data.
6	Django's ORM to query the database with filtering, ordering, and aggregating data. Implement user authentication and manage sessions.
7	Set up a basic Flask project and create routes for handling URLs and rendering templates. Implement form handling and process POST requests.
8	Build a simple RESTful API using Flask, allowing the user to interact with a database via HTTP methods (GET, POST, PUT, DELETE).
9	Scrape web pages using BeautifulSoup to extract data like titles, paragraphs, or links. Learn how to handle HTML parsing and traversal.
10	Use Selenium to automate browser actions for scraping dynamic content and handle anti-scraping mechanisms (like CAPTCHA or JavaScript rendering). Automate a login process or form submission.

Suggested Assignments/Projects

1. To create a project focused on recycling and up cycling plastic waste into useful products.
2. To create a battery using saltwater as the electrolyte and analyze its performance.
3. To construct a basic fuel cell and study its operation and efficiency.
4. To investigate how e-waste is currently managed in your local area and suggest improvements.
5. Analyze the lifecycle of a common electronic devices and understand the environmental impact at each stage.

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list.

Suggested Learning Resources

Textbooks

1. "The Hitchhiker's Guide to Python: Best Practices for Development" ,Kenneth Reitz, Tanya Schlusse
2. "Ultimate Django for Web App Development Using Python: Build Modern, Reliable and Scalable Production-Grade Web Applications with Django and Python", Leonardo Luis Lazzaro

3. “Flask Web Development: Developing Web Applications with Python”, II Ed., Miguel Grinberg
4. “Website Scraping with Python: Using BeautifulSoup and Scrapy“ ,Gábor László Hajba
5. “Test-Driven Development with Python: Obey the Testing Goat: Using Django, Selenium, and JavaScript“, Harry Percival

Web Resources

1. Udemy Course on Python RestAPI Programming with Flask and Django https://www.udemy.com/course/python-restapi-programming-with-flask-and- django/
2. Glocal Academy Of Skills Course on Advaced Python https://glocalafterschool.com/product/core-and-advance-python-django-flask/

4.5 Internship (CE4EX_LR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
CE4EX_PR1	Internship	08	04

Examination and Evaluation Scheme

Evaluation	ISE	ESE			Total Marks
	CA	PE	OrE	PrE	
Marks	50	-	-	100	150

Course Objectives

S. No.	Objectives
1	To *gain* hands-on experience in a professional work environment and understand the industry dynamics.
2	To *apply* theoretical knowledge gained to real-world projects in the industry.
3	To *acquire* a deeper understanding of workplace culture and ethics.
4	To *improve* communication, teamwork, and interpersonal skills.

Course Outcomes

The student will be able to	
CO1	*apply* academic knowledge in practical settings.
CO2	*develop* specific technical skills.
CO3	*achieve* a better understanding of career paths within the chosen field.
CO4	*develop* personal attributes like accountability, work ethic, and adaptability.

Guidelines

A. Process of internship identification for exit program

- The student shall approach industry for internship opportunities. The industry and the role/profile need to be approved by HoD/Dean Academics. The student may also take guidance from TPO/ IIC/IIIC for identification of a suitable opportunity.
- The internship taken up by the student should result in either being converted to job or job-ready for a similar role.

B. Continuous Monitoring and Assessment

- A mentor is to be appointed at the department level to guide the student.
- The mentor should assess the progress of the students on a weekly basis and record their observations in the logbook. Preferably, the mentors should interact with the industry mentor and may also visit the company to assess his/her progress.
- Mentors need to visit the industry minimum once in a semester if required.
- ISE mark to be given based on continuous evaluation and recommendation from industry mentor.

C. End Semester Examination

- A report to be prepared and submitted by the student.

- A presentation summarizing the work done in the industry needs to be done. The external examiner should preferably be from the industry.

Mark distribution for internship for exit program after second year of Engineering

Assessment Tool	Components	Marks
CA	Logbook	25
	Approval presentation and mid sem presentation	25
	TOTAL	**50**
ESE	Report	50
	Final Presentation	50
	Total	**100**