SFIT/IQAC/SE-AIML/2025-26/Rev0
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St. Francis Institute of Technology

(Engineering College)

(An Autonomous Institute, Affiliated to University of Mumbai)

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

Bachelor of Engineering

in

Artificial Intelligence and Machine Learning

Second Year Scheme and Syllabus

w.e.f. Academic Year 2025 – 2026

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Preamble

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, UGC has conferred an autonomous status to the 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 presenting a distinctive new curriculum for its undergraduate engineering degree program adhering to National Education Policy (NEP) 2020 credit framework as per Government Directive dated 4th July 2023. In line 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.

The SFIT curriculum prioritizes multidisciplinary learning, flexibility, research, and innovation, integrating soft skills cultivation and ethical principles while leveraging technology for enhanced learning experiences. The undergraduate degree program consists of a total of 160-176 credits. The overall credit distribution and curriculum approach in this revision align with the AICTE model curriculum.

The second-year syllabus for Artificial Intelligence and Machine Learning (AIML) is designed to build upon the foundational knowledge acquired in the first year, while introducing core concepts essential to AI and ML. The curriculum emphasizes a balanced approach between theory and hands-on learning, focusing on key areas such as data structures and algorithms, probability and statistics, database management, and machine learning fundamentals. It fosters critical thinking, problem-solving, and model-building skills through practical sessions, mini-projects, and exposure to real-world datasets. The teaching-learning process encourages self-directed learning through platforms like NPTEL, SWAYAM, and Kaggle. The objective is to prepare students with a strong analytical and computational mindset, enabling them to tackle contemporary challenges in AI and contribute to emerging technological solutions.

We extend our sincere gratitude to the Board of Studies (BoS) members for their valuable insights, guidance, and contributions in the design and revision of the second-year AIML syllabus. Their academic expertise and industry perspectives have been instrumental in shaping a curriculum that is both contemporary and aligned with the evolving demands of the field of Artificial Intelligence and Machine Learning.

AIML BoS Members:

1. Dr. Mahesh Shirole
2. Dr. Parikshit Mahalle
3. Dr. Sandeep Thorat
4. Dr. Santosh Chapaneri
5. Dr. Amiya Kumar Tripathy
6. Mr. Harsh Jalan
7. Dr. Joanne Gomes

Abbreviations

AEC	Ability Enhancement Courses
AIML	Artificial Intelligence and Machine Learning Engineering
BE	Fourth Year Engineering
BSC	Basic Science Courses
CA	Continuous Assessment
CEP	Community Engagement Project:
CMPN	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
FP	Field Project
HSSM	Humanities Social Sciences and Management
INFT	Information Technology
ISE	In Semester Evaluation
MDC	Multidisciplinary Courses
MDM	Multidisciplinary Minor
ME	Mechanical Engineering
MSE	Mid Semester Examination
OrE	Oral Examination
OEC	Open Elective Courses
PCC	Program Core Courses
PE	Practical Examination
PrE	Project Examination
SE	Second Year Engineering
VEC	Value Education Courses
VSEC	Vocational and Skill Enhancement Course

1 Course Structure and Curriculum

1.1 Definition of Credit

Table 1-1: Credit allocation

Schedule	Score
1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. 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 degree (B.E.) in AIML (As per NEP 2020)

Level	Course name	Total Credit
6	Bachelor's degree (B.E.) in Artificial Intelligence and Machine Learning	160-176
6	Bachelor's degree (B.E.) in Artificial Intelligence and Machine Learning with Honors and Multidisciplinary Minor ##	180-194
6	Bachelor's degree ((B.E.) in Artificial Intelligence and Machine Learning Honors with Research and Multidisciplinary Minor ##	180-194
6	Bachelor's degree (B.E.) in Artificial Intelligence and Machine Learning Major Engineering Discipline with Double Minors (Multidisciplinary and Specialization Minors)	180-194

1.3 Total Credits and Marks (tentative) of B.E. in AIML:

Table 1.3: Total credits and marks of four-year AIML degree program

S.N.	Academic Year	Total Credits	Total Marks
1	First Year	42	1450
2	Second Year	44	1450
3	Third Year	41	1450
4	Final Year	40	1200
	Total Credits of Program	**167**	**5550**

1.4 Semester-wise Credit Distribution Structure

Table 1.4: Credit distribution in Second Year of B.E. in AIML

S. No.	Course Type	Course Code	Courses	Credits	Total
Semester-III					
1	PCC	AI3PC_CR1	Mathematics for Intelligent Systems	3	16
2		AI3PC_LR1	Mathematics for Intelligent Systems Lab	1	
3		AI3PC_CR2	Data Structures and Algorithm	3	
4		AI3PC_LR2	Data Structures and Algorithm Lab	1	
5		AI3PC_CR3	Introduction to Artificial Intelligence	3	
6		AI3PC_LR3	Artificial Intelligence Lab	1	
7		AI3PC_CR4	Computer Fundamentals and Operating System	3	
8		AI3PC_LR4	Operating System Lab	1	
9	EEM	IL3HM_CR1	Innovation, Business Models and Entrepreneurship[#]	2	2
10	FP	ILSEL_PR1	Field Project	2	2
11	VEC	ILSHM_CR3	Environment & Technology	2	2
				Total	**22**
Semester-IV					
1	PCC	AI4PC_CR1	Applied Statistics for Data Science	2	10
2		AI4PC_LR1	Applied Statistics Lab	1	
3		AI4PC_CR2	Database Management Systems	2	
4		AI4PC_LR2	Database Management Systems Lab	1	
5		AI4PC_CR3	Machine Learning	3	
6		AI4PC_LR3	Machine Learning Lab	1	
7	VSEC	AI4VS_LR4	Web Programming Lab	2	2
8	EEM	IL4HM_CR1	Business Forecasting[#]	2	2
9	MDM		MDM-I*	2	2
10	OEC		OEC-I $	2	2
11	AEC	ILSHM_CR1	Professional Communication and Soft Skills	1	1
12		ILSHM_LR1	Professional Communication and Soft Skills Lab	1	1
13	VEC	ILSHM_CR2	Human Values and Ethics	2	2
				Total	**22**

C-Course, L-Laboratory *Refer to Table 1.5.2 [$]Refer to Table 1.5.3 # NPTEL Course

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

S. N.	Course Code	Course	Contact Hours				Credits Assigned				
			Theory (C)	Practical (L)	Tutorial (T)	Project (P)	C	L	T	P	Total
	Semester III										
1	AI3PC_CR1	Mathematics for Intelligent Systems	3	-	-	-	3	-	-		3
2	AI3PC_LR1	Mathematics for Intelligent Systems Lab	-	2	-	-	-	1	-		1
3	AI3PC_CR2	Data Structures and Algorithms	3	-	-	-	3	-	-		3
4	AI3PC_LR2	Data Structures and Algorithms Lab	-	2	-	-	-	1	-		1
5	AI3PC_CR3	Introduction to Artificial Intelligence	3	-	-	-	3	-	-		3
6	AI3PC_LR3	Artificial Intelligence Lab	-	2	-	-	-	1	-		1
7	AI3PC_CR4	Computer Fundamentals and Operating System	3	-	-	-	3	-	-		3
8	AI3PC_LR4	Operating System Lab	-	2	-	-	3	1	-		1
9	IL3HM_CR1	Innovation, Business Models & Entrepreneurship	2	-	-	-	2	-	-		2
10	ILSEL_PR1	Field Project	-	-	-	4	-	-	-	2	2
11	ILSHM_CR3	Environment & Technology	2	-	-	-	2	-	-		2
		Total	**16**	**8**	**0**	**4**	**16**	**4**	**0**	**2**	**22**
	Semester IV										
1	AI4PC_CR1	Applied Statistics for Data Science	2	-	-	-	2	-	-		2
2	AI4PC_LR1	Applied Statistics Lab	-	2	-	-	-	1	-		1
3	AI4PC_CR2	Database Management Systems	2	-	-	-	2	-	-		2
4	AI4PC_LR2	Database Management Systems Lab	-	2	-	-	-	1	-		1
5	AI4PC_CR3	Machine Learning	3	-	-	-	3	-	-		3
6	AI4PC_LR3	Machine Learning Lab	-	2	-	-	-	1	-		1
7	AI4VS_LR4	Web Programming Lab	-	4	-	-	-	2	-		2
8	IL4HM_CR1	Business Forecasting	2	-	-	-	2	-	-		2
9		MDM-I*	2	-	-	-	2	-	-		2
10		OEC-I $	2	-	-	-	2	-	-		2
11	ILSHM_CR1	Professional Communication and Soft Skills	1	-	-	-	1	-	-		1
12	ILSHM_LR1	Professional Communication and Soft Skills Lab	-	2	-	-	-	1	-		1
13	ILSHM_CR2	Human Values & Ethics	2	-	-	-	2	-	-		2
		Total	**16**	**12**	**0**	**0**	**16**	**6**	**0**		**22**

*Refer to Table 1.5.2 $Refer to Table 1.5.3

1.5.2. Multi-Disciplinary Minor Courses Offered in AIML Program

Table 1.5.2: Semester wise credit distribution of Multi-Disciplinary Minor courses

S. No.	Offering Departments	Minor Title	Sem IV (2 credits)	Sem V (4 credits)	Sem VI (4 credits)	Sem VII (4 credits)
1	EXTC	**Embedded Systems**	Digital System Design	Microprocessor (MP) Microcontroller (MC)	Adv MC and Interface Tech	Embedded Systems Application
		Course Codes:	ET4MM_CX2	ET5MM_CX2	ET6MM_CX2	ET7MM_CX2
3	ELEC	**Electric Vehicles (EV)**	Introduction to EV	EV Converters & Drives	Energy Storage & Charging Infrastructure	Auxiliary Systems & Advancement in EV System
		EE4MM_CX1	EE5MM_CX1	EE6MM_CX1	EE7MM_CX1	EE4MM_CX1
4	MECH	**Additive Manufacturing**	Introduction to Additive Manufacturing	Introduction to Computer-Aided Design (CAD)	Applications of Additive Manufacturing	3D Printing for Medical Techchnology
		Course Codes	ME4MM_CX1	ME5MM_CX1	ME6MM_CX1	ME7MM_CX1
5		**Robotics**	Introduction to Robotics	Robot Kinematics and Dynamics	Path planning and Control in Robotics	Industrial and Service Robots
		Course Codes	ME4MM_CX2	ME5MM_CX2	ME6MM_CX2	ME7MM_CX2
6	ECS	**Internet of Things (IoT)**	Introduction to IoT and Core Technologies	IoT Data Management, Cloud Integration, and Analytics	IoT System Design Security	Advanced IoT Applications
		Course Code	EC4MM_CX1	EC5MM_CX1	EC6MM_CX1	EC7MM_CX1

Note: Student will choose any one MDM stream during four-year degree program.

1.5.3 Open Elective-1 Courses Offered in Semester-IV

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

Course Code	Course Name	Credits
IL4OE_CX1	IPR and Patenting	2
IL4OE_CX2	Cybersecurity and Laws	2
IL4OE_CX3	Psychology	2
IL4OE_CX4	Personal Finance, Taxation and Investments	2
IL4OE_CX5	Adolescent Health and Well being	2
IL4OE_CX6	Essentials of Management	2
IL4OE_CX7	German Language	2
IL4OE_CX8	French Language	2

Note: Student will choose any one OEC course during Semester-IV

1.6 Evaluation and Examination Scheme of Second Year

Table 1.6: Marks distribution of courses

S.N.	Course Code	Course	ISE		ESE		Total
			CA	MSE	Theory	Practical	
Semester III							
1	AI4PC_CR1	Mathematics for Intelligent Systems	20	20	60	-	100
2	AI4PC_LR1	Mathematics for Intelligent Systems Lab	25	-	-	-	25
3	AI4PC_CR2	Data Structures and Algorithms	20	20	60	-	100
4	AI4PC_LR2	Data Structures and Algorithms Lab	25	-	-	25	50
5	AI4PC_CR3	Introduction to Artificial Intelligence	20	20	60	-	100
6	AI4PC_LR3	Artificial Intelligence Lab	25	-	-	25	50
7	AI4PC_CR4	Computer Fundamentals and Operating System	20	20	60	-	100
8	AI4PC_LR4	Operating System Lab	25	-	-	25	50
9	IL3HM_CR1	Innovation, Business Models and Entrepreneurship	50	-	-	-	50
10	ILSEL_PR1	Field Project	25	-	-	25	50
11	ILSHM_CR3	Environment & Technology	50	-	-	-	50
		Total	305	80	240	100	**725**
Semester IV							
1	AI4PC_CR1	Applied Statistics for Data Science	15	15	45	-	75
2	AI4PC_LR1	Applied Statistics Lab	25	-	-	-	25
3	AI4PC_CR2	Database Management Systems	15	15	45	-	75
4	AI4PC_LR2	Database Management Systems Lab	25	-	-	25	50
5	AI4PC_CR3	Machine Learning	20	20	60	-	100
6	AI4PC_LR3	Machine Learning Lab	25	-	-	25	50
7	AI4VS_LR4	Web Programming Lab	25	-	-	25	50
8	IL4HM_CR1	Business Forecasting (NPTEL)	50	-	-	-	50
9		MDM-I*	15	15	45	-	75
10		OEC-I $	15	15	45	-	75
11	ILSHM_CR1	Professional Communication and Soft Skills	25	-	-	-	25
12	ILSHM_LR1	Professional Communication and Soft Skills Lab	25	-	-	-	25
13	ILSHM_CR2	Human Values and Ethics	50	-	-	-	50
		Total	330	80	240	75	**725**

*Refer to Table 1.5.2 $Refer to Table 1.5.3

Evaluation Pattern:

Note:

Evaluations consist of the following –

1. **In Semester Evaluation (ISE)** which comprises of two components - Continuous Assessment (CA) and Mid-Semester Examination (MSE)
   - Continuous Assessment (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.

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 will be of 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 Data Science

Table 1.7.1: Contact hours and credit distribution for exit courses after **Second Year**

S. N.	Course Code	Course	Contact Hours				Credits Assigned				
			Theory (C)	Practical (L)	Tutorial (T)	Project (P)	C	L	T	P	Total
1	AI4EX_CR1	Data Science for Engineers	3	-	-	-	3	-	-		3
2	AI4EX_LR1	Data Science Lab	-	2	-	-	-	1	-		1
3	AI4EX_PR1	Internship	-	-	-	16	-	-	-	4	4
		OR									
3	AI4EX_PR2	Project on Data Science	-	-	-	8	-	-	-	4	4
		Total							-		**8**

Table 1.7.2: Marks distribution of exit courses after **Second Year**

S.N.	Course Code	Course	ISE		ESE		Total
			CA	MSE	Theory	Practical	
1	AI4EX_CR1	Data Science for Engineers	20	20	60	-	100
2	AI4EX_LR1	Data Science Lab	25		-	25	50
3	AI4EX_PR1	Internship	50		-	100	150
		OR					
3	AI4EX_PR2	Project on Data Science	50		-	100	150
		Total					**300**

Guidelines for Exit:

- As per NEP 2020 Four Year Multidisciplinary Engineering Curriculum Framework, SFIT 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 after second year:**
  - 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 (3+1) courses.
    - **Option 2:** One 4-credit (3+1) course OR a certified industry internship worth 4 credits (minimum 60 hours).
  - Exit options shall be provided with Diploma to the students at the end of the fourth semester, in the four-year degree programme.

Semester-III Course Details

Table 2: Semester-III Credits and Evaluation Scheme

S. N.	Course Code	Course	Credits Assigned					Marks Distribution				
			C	L	T	P	Total	ISE		ESE		Total
								CA	MSE	The	Pra	
Semester III												
1	AI4PC_CR1	Mathematics for Intelligent Systems	3	-	-	-	3	20	20	60	-	100
2	AI4PC_LR1	Mathematics for Intelligent Systems Lab	-	1	-	-	1	25	-	-	-	25
3	AI4PC_CR2	Data Structures and Algorithms	3	-	-	-	3	20	20	60	-	100
4	AI4PC_LR2	Data Structures and Algorithms Lab	-	1	-	-	1	25	-	-	25	50
5	AI4PC_CR3	Introduction to Artificial Intelligence	3	-	-	-	3	20	20	60	-	100
6	AI4PC_LR3	Artificial Intelligence Lab	-	1	-	-	1	25	-	-	25	50
7	AI4PC_CR4	Computer Fundamentals and Operating System	3	-	-	-	3	20	20	60	-	100
8	AI4PC_LR4	Operating System Lab	-	1	-	-	1	25	-	-	25	50
9	IL3HM_CR1	Innovation, Business Models & Entrepreneurship	2	-	-	-	2	50	-	-	-	50
10	ILSEL_PR1	Field Project	-		-	2	2	25	-	-	25	50
11	ILSHM_CR3	Environment & Technology	2	-	-	-	2	50	-	-	-	50
		Total	16	4	0	2	**22**	305	80	240	100	**725**

.

2 Semester-III Course Syllabus

2.1 Mathematics for Intelligent Systems (AI3PC_CR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI3PC_CR1	Mathematics for Intelligent Systems	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 enable students to understand and apply fundamental mathematical concepts such as linear algebra, and calculus in AI/ML context.
2	To provide students with the skills to apply linear algebra and calculus concepts in real life AI systems.
3	To equip students with the knowledge of partial, gradients and directional derivatives.
4	To introduce students with the concepts of Definite and Indefinite Integrals
5	To explain students, differential equations concepts in AI/ML context.

Course Outcomes

The student will be able to:	
CO1	demonstrate an understanding and use of core linear algebra concepts such as vectors, and matrices.
CO2	facilitate an understanding and use of advanced linear algebra concepts such as eigenvalues, and eigenvectors to represent and manipulate data structures commonly used in AI and ML.
CO3	apply partial derivatives, gradients and directional derivatives to identify the rate and direction of change in multivariable systems.
CO4	demonstrate proficiency in definite and indefinite integrals and apply them to compute areas and cumulative data trends.
CO5	solve and apply differential equations to model dynamic systems and understand their role in AI applications.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites		
		Introductory concepts from linear algebra and calculus	
1.0	**Fundamentals of Linear Algebra**		**08**
	1.1	Introduction to vector spaces: Basis and dimension of a vector space. Definition of vector spaces and subspaces. Span, and linear independence. basis and dimensions	
	1.2	Linear transformations and their matrix representation: definition of	

		linear maps. Matrix representation of linear maps. Geometric interpretation of transformations: scaling, rotation, and reflection. Null spaces, Range space, rank-nullity, theorem (without proof) with applications,	
	1.3	Solving Systems of Equations: Techniques for solving systems of linear equations, Gaussian elimination, back-substitution and Matrix inversion method for solving linear systems. Unique, infinite, and no solutions.	
2.0	**Advanced Linear Algebra**		08
	2.1	Eigenvalues, Eigenvectors and Diagonalization: Eigenvalues and eigenvectors of linear operators, Definition and properties of eigenvalues and eigenvectors. Computation and geometric interpretation. Matrix diagonalization, examples of inner product spaces and normed space, Gram Schmidt orthogonalization process.	
	2.2	Principal Component Analysis (PCA): Dimensionality reduction techniques. Norms and Metrics in Vector Spaces: Vector norms (L1, L2, and ∞ norms). Distance metrics (Euclidean, Manhattan, and cosine similarity).	
	2.3	Numerical Linear Algebra: LU factorization, Singular value decomposition (SVD), SVD in image processing, solving least squares using SVD.	
3.0	**Multivariate Calculus-1**		**08**
	3.1	Functions of Several Variables: Concept of multivariate functions. Visualizing functions of two or three variables (e.g., 3D plots). Explain partial derivatives and their interpretation.	
	3.2	Partial Derivatives: Concept and geometric interpretation.	
	3.3	Gradient and Directional Derivatives: Gradient as a vector of partial derivatives: The gradient points in the direction of the steepest ascent. Directional derivatives and their geometric interpretation: Derivative of a function in a given direction. Relationship between the gradient and steepest ascent/descent.	
4.0	**Multivariate Calculus-2**		**07**
	4.1	Introduction to Definite and Indefinite Integrals Basics of integration: Understanding the area under a curve. Applications of Definite Integrals: Computing areas between curves.	
	4.2	Techniques of Integration Basic integration techniques: Substitution and integration by parts.	
5.0	**Differential Equations and Fourier Series**		**08**
	5.1	First-Order Differential Equations: Definition and classification of differential equations. Solving exact, non-exact and linear first-order equations. Interpretation of solutions.	
	5.2	Higher-Order Differential Equations: Introduction to second-order & higher-order linear equations with constant coefficients. Homogeneous and non-homogeneous equations. Numerical Methods for Solving Differential Equations: Euler's method for approximating solutions. Runge-Kutta method.	
	5.3	Fourier Series: Basics of Fourier series: periodic function representation. Applications in signal analysis.	
		Total Hours	**39**

Suggested Learning Resources

1. Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, Cambridge University Press, First Ed, 2020.
2. Higher Engineering Mathematics, B V Ramana, Tata McGraw Hill, First Ed, 2017
3. Schaum's Outline Series Theory And Problems of Advanced Calculus, Robert Wrede and Murray Spiegel,

McGraw-Hill, Third Ed, 2010.

Reference Books

1. Linear Algebra and Its Applications by Gilbert Strang, New York, Academic Press, Fourth Ed, 2006.
2. Advanced Engineering Mathematics by Erwin, New York: Wiley, Fifth Ed, 1983
3. Calculus and Analytic Geometry, Thomas, Finney Addison-Wesley Publishing Company, Nineth Edition, 1996.

Web Resources

4. NPTEL, https://onlinecourses.nptel.ac.in/noc24_ma61/preview
5. NPTEL, https://onlinecourses.nptel.ac.in/noc21_ma38/preview

2.2 Mathematics for Intelligent Systems Lab (AI3PC_LR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI3PC_LR1	Mathematics for Intelligent Systems 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 enable students to understand and apply fundamental mathematical concepts such as linear algebra, and calculus in AI/ML context.
2	To provide students with the skills to apply linear algebra and calculus concepts in real life AI systems.
3	To equip students with the knowledge of partial, gradients and directional derivatives.
4	To introduce students with the concepts of Definite and Indefinite Integrals
5	To explain students, differential equations concepts in AI/ML context.

Course Outcomes

The student will be able to:	
CO1	demonstrate an understanding and use of core linear algebra concepts such as vectors, and matrices.
CO2	facilitate an understanding and use of advanced linear algebra concepts such as eigenvalues, and eigenvectors to represent and manipulate data structures commonly used in AI and ML.
CO3	apply partial derivatives, gradients and directional derivatives to identify the rate and direction of change in multivariable systems.
CO4	demonstrate proficiency in definite and indefinite integrals and apply them to compute areas and cumulative data trends.
CO5	solve and apply differential equations to model dynamic systems and understand their role in AI applications.

Course Contents

Module	Suggested List of Experiments /Tutorials /Assignments
1	1. Given a set of data points, determine whether they form a vector space or subspace. 2. Represent a simple linear transformation (e.g., a scaling transformation) as a matrix. 3. Solve a system of linear equations using matrix methods.
2	1. Solve problems on finding eigenvalues, eigenvectors, and matrix diagonalization. 2. Calculate different norms (L1, L2) for given vectors. 3. SVD and its application in dimensionality reduction and explain the

	decomposition. 4. Implement a distance metric function for KNN.
3	1. Solve partial derivatives for real-world functions. 2. Visualize partial derivatives using online tools like Desmos. 3. Visualize the gradient of a simple 2D function. 4. Practice calculating the gradient and directional derivatives at various points. 5. Solve examples involving gradient, divergence, and curl. 6. Identify and classify critical points (minima, maxima, saddle points) for 2D functions. 7. Visualize optimization processes using software like GeoGebra.
5	1. Solve and interpret simple first-order differential equations (e.g., exponential growth). 2. Solve second-order linear equations with constant coefficients (e.g., simple harmonic motion). 3. Apply Euler's method to approximate a solution for a given differential equation. 4. Solve a basic PDE using the separation of variables method. 5. Expand a periodic function using Fourier series. 6. Derive the solution to a cooling system model using first-order equations. 7. Write a short report on practical examples of PDEs in image smoothing (basic insights). 8. Perform Fourier series analysis.

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. Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, Cambridge University Press, First Ed, 2020.
2. Schaum's Outline of Linear Algebra, Marc Lipson and Seymour Lipschutz, Tata McGraw Hill, Sixth Ed, 2017

Reference Books

1. Linear Algebra and Its Applications by Gilbert Strang, New York, Academic Press, Fourth Ed, 1976.
2. Advanced Engineering Mathematics by Erwin, New York: Wiley, Fifth Ed, 1983

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc24_ma61/preview
2. NPTEL, https://onlinecourses.nptel.ac.in/noc21_ma38/preview

2.3 Data Structures and Algorithms (AI3PC_CR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI3PC_CR2	Data Structures and 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 develop the ability to perform algorithm analysis to evaluate the efficiency of algorithms and data structures based on time and space complexity.
2	To equip students with knowledge of searching and sorting algorithms.
3	To gain understanding of fundamental data structures and algorithms, learning to select and implement the most efficient data structures for specific problem-solving tasks.
4	To provide students with knowledge of linear and non-linear data structures.
5	To acquire the knowledge of data structures and algorithms to solve practical problems in computer science, with a focus on AI/ML applications and real-world scenarios.

Course Outcomes

The student will be able to:	
CO1	analyze the time and space complexity of algorithms and apply basic algorithm design techniques.
CO2	implement and compare various searching and sorting algorithms, understanding their time and space complexity, and select appropriate algorithms for different scenarios.
CO3	implement linear data structures and compare their use cases and performance characteristics.
CO4	implement and traverse non-linear data structures and apply these structures to solve real-world problems. (BL3)
CO5	demonstrate the practical applications of recursion, trees, and graphs in solving problems such as polynomial operations, encoding, decision trees, and graph-based problems.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites		
		Basic Programming Skills: using Python, C or Java	
1.0	**Algorithm Basics**		**08**
	1.1	Introduction to Algorithms: Definition, importance, and basic concepts. Algorithm Specifications: Expressing algorithms with pseudocode. Characteristics of a Good Algorithm: Correctness, efficiency, and clarity. Performance Analysis: Time complexity: Big-O, Big-Θ, Big-Ω notations with examples, Space complexity: Memory usage and trade-	

		offs. Case Analysis: Best case, worst case, and average case complexities with practical examples.	
	1.2	Algorithm Design Techniques: Divide and Conquer: Breaking a problem into subproblems (examples: Binary Search, Merge Sort).	
	1.3	Greedy Algorithms: Making locally optimal choices (Fractional Knapsack). Dynamic Programming: Concept of solving overlapping subproblems (0/1 Knapsack – concept only).	
2.0	**Searching and Sorting**		**08**
	2.1	Searching: Linear and binary search.	
	2.2	Hashing: Introduction to hashing. Hash functions division & mid-square, Collision resolution techniques: open addressing, chaining.	
	2.3	Basic Sorting Algorithms: Insertion sort, and selection sort. Advanced sorting: merge sort and quick sort	
3.0	**Linear Data Structures-I**		**08**
	3.1	Data Structures Overview: Abstract data types, difference between Linear and Nonlinear data structures. Arrays: Static vs. Dynamic arrays, memory representation (1D & 2D). Basic Array Operations: Insertion, deletion, traversal, and search. Applications of Arrays: Example use case.	
	3.2	Stack Operations: Push, pop, peek, isEmpty. Implementation of Stack using Array. Applications of Stacks: Expression evaluation (postfix evaluation). Function call stack (brief mention).	
	3.3	Queue Operations: Enqueue, dequeue, isEmpty, isFull. Array Implementation of Queue. Types of Queues: Simple Queue. Circular Queue: Explanation and advantages. Double-ended Queue (Deque). Priority Queue: Concept and example. Applications: Scheduling problems (e.g., Round Robin CPU scheduling).	
4.0	**Linear Data Structures-II**		**07**
	4.1	Singly linked lists: Basic operations, Insertion, deletion, update and copy. Applications: Dynamic memory allocation.	
	4.2	Implementation of Stack & Queue using Singly Linked List.	
	4.3	Doubly linked lists: Operations- Insertion, deletion, traversal. and Comparison: Array-based vs. Linked list-based implementation. Applications of Linked Lists: Polynomial addition and multiplication.	
5.0	**Non-Linear Data Structures**		**08**
	5.1	Trees: Basic concepts of binary trees and their representations (Array & Linked List). Binary Search Trees (BST): Insertion, deletion, and traversal. Binary Tree Traversals: Recursive methods: In-order, Pre-order, Post-order. Non-recursive (stack-based) methods: Iterative In-order, Iterative Pre-order, Iterative Post-order traversal using an explicit stack. Applications of Binary Trees: Heap tree and Huffman encoding.	
	5.2	Recursion: Concept and applications (e.g., Tower of Hanoi). Graphs: Representation (adjacency matrix, adjacency list), Graph Traversals: BFS and DFS. Graph Application: Minimum Spanning Tree (MST) and shortest path algorithms.	
		Total Hours	**39**

Suggested Learning Resources

Textbooks

1. Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia and Michael H. Goldwasser, VP & Publisher, First Ed, 2013.

2. Data Structures and Algorithms in C, Mark Allen Weiss, Second Ed, Addison-Wesley, Second Ed, 1997.
3. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, MIT Press, Fourth Ed, 2022
4. Cracking The Coding Interview, Gayle Laakman N, 189 Programming Questions and Solutions, MCDOWELL, Sixth Ed, 2015.

Reference Books

1. Algorithms, Robert Sedgewick and Kevin Wayne, Pearson Education, Fourth Ed, 2011.
2. Data Structures and Algorithms Made Easy, Narasimha Karumanchi. WWW.Careermonk.com, First Ed, 2011.
3. Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss Advanced Engineering Mathematics by Erwin, New York: Wiley, Fourth Ed, 2013.

Web Resources

1. NPTEL, https://nptel.ac.in/courses/106102064
2. NPTEL, https://archive.nptel.ac.in/courses/106/106/106106131/
3. NPTEL, https://onlinecourses.nptel.ac.in/noc22_cs26/preview

2.4 Data Structures & Algorithms Lab. (AI3PC_LR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI3PC_LR2	Data Structures & 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 develop the ability to perform algorithm analysis to evaluate the efficiency of algorithms and data structures based on time and space complexity.
2	To equip students with knowledge of searching and sorting algorithms.
3	To gain understanding of fundamental data structures and algorithms, learning to select and implement the most efficient data structures for specific problem-solving tasks.
4	To provide students with knowledge of linear and non-linear data structures.
5	To acquire the knowledge of data structures and algorithms to solve practical problems in computer science, with a focus on AI/ML applications and real-world scenarios.

Course Outcomes

The student will be able to:	
CO1	analyze the time and space complexity of algorithms and apply basic algorithm design techniques.
CO2	implement and compare various searching and sorting algorithms, understanding their time and space complexity, and select appropriate algorithms for different scenarios.
CO3	implement linear data structures and compare their use cases and performance characteristics.
CO4	implement and traverse non-linear data structures and apply these structures to solve real-world problems. (BL3)
CO5	demonstrate the practical applications of recursion, trees, and graphs in solving problems such as polynomial operations, encoding, decision trees, and graph-based problems.

Course Contents

Module	Suggested List of Experiments /Tutorials /Assignments
1	Exp1: For binary search tree, 1. discuss the time complexity of BST operations in the best case (O(log n)) and worst case (O(n)). Compare the efficiency of searching in a BST with Linear Search. 2. Illustrate the best-case and worst-case scenarios of a BST (balanced vs. skewed trees).
2	Expt2: To implement and perform basic operations on a binary search tree. A) Implement insert, delete, and search operations for BST. B) Perform in-order, pre-order, and post-order traversal. C) Implement a function to find the minimum and maximum elements in a BST.

	D) Discuss the time complexity of BST operations in the best case (O(log n)) and worst case (O(n)). Compare the efficiency of searching in a BST with Linear Search. E) Illustrate the best-case and worst-case scenarios of a BST (balanced vs. skewed trees). Expt3: To implement and compare sorting algorithms. A) Implement insertion sort, and selection sort. B) Analyze and compare the performance (time complexity) of each sorting algorithm. C) Test sorting algorithms on random datasets of various sizes. D) Performance Analysis: Compare time complexity for best, average, and worst cases for each sorting algorithm. Explain space complexity differences between Merge Sort (O(n)) and Quick Sort (O(log n)). E) Case Analysis: Provide examples demonstrating best-case and worst-case sorting scenarios. F) Graph Visualization: Plot execution times of sorting algorithms for various input sizes. Expt4: To implement hashing with different collision resolution techniques. A) Implement a hash table with open addressing and separate chaining. B) Test the performance of different collision resolution techniques. C) Implement and test a simple hashing function (e.g., division method).
3	Expt5: To Implement and demonstrate basic operations on arrays such as insertion, deletion, and searching. A) Implement an array and perform operations like insertion, deletion, and traversal. B) Implement linear search and binary search algorithms. C) Analyze the performance of both search algorithms. Expt6: To Implement a stack using arrays and linked lists and perform basic operations. A) Implement push, pop, and peek operations for stack. B) Use both array-based and linked list-based implementations. C) Implement a stack for expression evaluation (e.g., infix to postfix conversion). Expt7: To implement different types of queues (simple, circular) and their basic operations. A) Implement simple queue using arrays and linked lists. B) Implement circular queue using arrays. C) Implement priority queue and demonstrate with an example (e.g., process scheduling).
4	Expt8: To implement a singly linked list and perform basic operations. A) Implement insert, delete, and search operations for a singly linked list. B) Traverse the list and display its elements. C) Implement an algorithm to reverse the list. Expt9: To implement a doubly linked list and perform basic operations. A) Implement insert, delete, and search operations for a doubly linked list. B) Implement traversal in both directions (from head to tail and tail to head).

	C) Demonstrate use of doubly linked list with a real-life example (e.g., browser history). Expected Outcome: Understanding of doubly linked list operations and memory management.
5	Expt10: To implement graph representation (adjacency matrix, adjacency list) and graph traversal algorithms. A) Implement a graph using both adjacency matrix and adjacency list. B) Implement breadth-first search (BFS) and depth-first search (DFS) traversal. C) Apply BFS/DFS to solve simple problems like finding a path between two nodes. pt11: To implement and solve problems using backtracking. A) Solve the N-Queen problem using backtracking. B) Implement a solution to the sum of subsets problem using backtracking. C) Explore the potential of backtracking for solving graph coloring problems.

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 and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia and Michael H. Goldwasser, VP & Publisher, First Ed, 2013.
2. Data Structures and Algorithms in C, Mark Allen Weiss, Second Ed, Addison-Wesley, Second Ed, 1997.
3. Cracking The Coding Interview, Gayle Laakman N, 189 Programming Questions and Solutions, MCDOWELL, Sixth Ed, 2015.

Reference Books

1. Algorithms, Robert Sedgewick and Kevin Wayne, Pearson Education, Fourth Ed, 2011.
2. Data Structures and Algorithms Made Easy, Narasimha Karumanchi. WWW.Careermonk.com, First Ed, 2011.
3. Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss Advanced Engineering Mathematics by Erwin, New York: Wiley, Fourth Ed, 2013.

Web Resources

1. NPTEL, https://nptel.ac.in/courses/106102064
2. NPTEL, https://archive.nptel.ac.in/courses/106/106/106106131/

2.5 Introduction to Artificial Intelligence (AI3PC_CR3)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI3PC_CR3	Introduction to Artificial Intelligence (IAI)	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 foundational concepts of AI.
2	To learn to apply AI methodologies to analyze and solve complex problems in real life effectively.
3	To acquire hands-on experience in developing intelligent systems through practical implementation of AI models.
4	To understand decision-making strategies in various domains.
5	To solve AI problems involving uncertainty.

Course Outcomes

The student will be able to:	
CO1	identify and describe the fundamental concepts, history, and applications of Artificial Intelligence, including intelligent agents and problem representation.
CO2	apply various search algorithms, including uninformed and informed search, to solve AI problems effectively.
CO3	represent knowledge using logical approaches, including propositional and first-order logic, and solve optimization problems using programming techniques.
CO4	implement decision-making strategies using planning techniques, and game theory to develop intelligent systems.
CO5	model and solve AI problems involving uncertainty using probabilistic reasoning, and Bayesian networks.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites		
		Python programming, basic data structures, and mathematics (linear algebra, and probability)	
1.0	**Fundamentals of Artificial Intelligence**		**07**
	1.1	Introduction to AI: Definition, history, Types of AI and key applications, Turing Test.	
	1.2	Agents and Environment: Definition, PEAS (Performance measure, Environment, Actuators, Sensors). Defining rational agents and criteria	

		for evaluation. Types of agents (reflex, goal-based, utility-based) and environment types.	
	1.3	Agents and Environment: Definition, PEAS (Performance measure, Environment, Actuators, Sensors). Defining rational agents and criteria for evaluation. Types of agents (reflex, goal-based, utility-based) and environment types.	
2.0	**Problem-Solving Techniques in AI**		08
	2.1	Uninformed Search: Depth-First Search and Breadth-First Search. Uniform Cost Search, Depth-Limited Search.	
	2.2	Informed Search: Heuristic Functions, A* Search.	
	2.3	Constraint Satisfaction Problems: Backtracking, Problems like Map Coloring and N-Queens.	
3.0	**Knowledge Representation and Reasoning**		08
	3.1	Knowledge Representation Basics: Propositional Logic Syntax, semantics, and solving simple logical problems. Logical Agents	
	3.2	First-order logic, inferences in first-order logic. Forward chaining, backward chaining, resolution.	
4.0	**Planning in AI**		08
	4.1	Planning as a Search Problem, State-Space Planning: Forward and backward state-space search	
	4.2	Linear and nonlinear planning, Planning Graph Representation	
5.0	**Reasoning Under Uncertainty**		08
	5.1	Introduction to Uncertainty in AI: probability and Bayes' theorem	
	5.2	Bayes Nets: Representation and Independence, Bayes Nets: Inference, Naïve Bayes models.	
	5.3	Applications of Probabilistic Reasoning: Examples like spam filtering or medical diagnosis.	
		Total Hours	39

Suggested Learning Resources

Textbooks

1. Artificial Intelligence A Modern Approach, Stuart Russell and Peter Norvig, PEARSON Education, Third Ed, 2003.
2. Artificial Intelligence and Intelligent Systems, N.P. Padhy, OXFORD publication, First Ed, 2005.

Reference Books

1. Artificial Intelligence: Foundations of Computational Agents, David L. Poole and Alan K. Mackworth, Cambridge English, Second Ed, 2017.
2. Python Machine Learning, Sebastian Raschka and Vahid Mirjalili, Packt Publishing, Second Ed, 2017.
3. Probabilistic Graphical Models: Principles and Techniques, Daphne Koller and Nir Friedman, The MIT Press, First Ed, 2009.

Web Resources

1. "CS50's Introduction to Artificial Intelligence with Python" (Harvard Online free)
3. AI For Everyone by Andrew Ng (Coursera)
4. https://nptel.ac.in/courses/106102220

2.6 Artificial Intelligence Lab. (AI3PC_LR3)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI3PC_LR3	Artificial Intelligence 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 foundational concepts of AI.
2	To learn to apply AI methodologies to analyze and solve complex problems in real life.
3	To acquire hands-on experience in developing intelligent systems through practical implementation of AI models.
4	To understand decision-making strategies in various domains.
5	To solve AI problems involving uncertainty.

Course Outcomes

The student will be able to:	
CO1	identify and describe the fundamental concepts, history, and applications of Artificial Intelligence, including intelligent agents and problem representation.
CO2	apply various search algorithms, including uninformed and informed search, to solve AI problems effectively.
CO3	represent knowledge using logical approaches, including propositional and first-order logic, and solve optimization problems using programming techniques.
CO4	implement decision-making strategies using planning techniques, and game theory to develop intelligent systems.
CO5	model and solve AI problems involving uncertainty using probabilistic reasoning, and Bayesian networks.

Course Contents

Module	Suggested List of Experiments /Tutorials /Assignments
1	Expt1: To get familiarize with Python libraries like NumPy, Pandas, Matplotlib, and AI-focused libraries such as scikit-learn and TensorFlow. Expt2**:** To represent a simple problem (e.g., water jug problem or tic-tac-toe) using state space representation and graph visualization.
2	Expt3: To implement Depth-First Search (DFS) and Breadth-First Search (BFS). Expt4: To implement A* Search. Expt5: To solve problems like N-Queens or Sudoku using backtracking and constraints.
3	Expt6: To develop programs to demonstrate inference using propositional logic (e.g., implementing modus ponens).
4	Expt7: Implement forward chaining, backward chaining, and resolution strategies.

5	Expt8: Build naïve Bayes models. Expt9: To design a Bayesian network for a real-world problem (e.g., medical diagnosis) and perform inference using tools or programming. Expt10: Mini-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. Artificial Intelligence A Modern Approach, Stuart Russell and Peter Norvig, PEARSON Education, Third Ed, 2003.

Reference Books

1. Artificial Intelligence and Intelligent Systems, N.P. Padhy, OXFORD publication, First Ed, 2005.
2. Artificial Intelligence: Foundations of Computational Agents, David L. Poole and Alan K. Mackworth, Cambridge English, Second Ed, 2017.
3. Python Machine Learning, Sebastian Raschka and Vahid Mirjalili, Packt Publishing, Second Ed, 2017.
4. Probabilistic Graphical Models: Principles and Techniques, Daphne Koller and Nir Friedman, The MIT Press, First Ed, 2009.

Web Resources

1. "CS50's Introduction to Artificial Intelligence with Python" (Harvard Online free)
2. AI For Everyone by Andrew Ng (Coursera)
3. https://nptel.ac.in/courses/106102220

2.7 Computer Fundamentals and Operating System (AI3PC_CR4)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI3PC_CR4	Computer Fundamentals and 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 understand the fundamental concepts of computer architecture and operating systems laying the foundation for further study in AI and ML applications.
2	To develop the ability to implement and analyze operating system functionalities such as process and memory management.
3	To provide students with the knowledge of memory and IO organization in a computer system.
4	To empower students with the knowledge of scheduling algorithms using programming techniques
5	To understand the fundamental concepts memory management and file systems.

Course Outcomes

The student will be able to:	
CO1	explain the principles of the binary number system, perform conversions between different number systems (binary, decimal, octal, hexadecimal), and apply Boolean algebra and logic gates to design and analyze simple digital circuits.
CO2	identify and describe the components and functions of computer architecture.
CO3	explain memory and IO organization in a computer system.
CO4	compare and contrast various CPU scheduling algorithms.
CO5	perform memory and file management operations.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites		
		Programming Language C, Binary number system.	
1.0	**Fundamentals of Logic Design**		**08**
	1.1	Number systems: Introduction to Number systems, Binary Number systems, Signed Binary Numbers, Binary, Octal, Decimal and Hexadecimal number and their conversions, 1's and 2's complement. Combinational Circuits: NOT, AND, OR, NAND, NOR, EX-OR, EX-NOR Gates. Design of Half & Full Adder and subtractor,	
	1.2	Reduction of Boolean functions using K-map method (2,3,4 Variable),	

	1.3	Introduction to Multiplexers and Demultiplexers, Encoders & Decoders. Sequential Circuits: Introduction to Flip Flops: SR, JK, D, T, master slave flip flop, Truth Table.	
2.0	**Overview of Computer Architecture & Organization**		**08**
	2.1	Introduction of Computer Organization and Architecture. Basic organization of computer and block level description of the functional units. Evolution of Computers, Von Neumann model. Performance measure of Computer Architecture,	
	2.2	Architecture of 8086 Family, Instruction Set, Addressing Modes, Assembler Directives, Mixed-Language Programming, Stack, Procedure, Macro	
	2.3	Basics of floating-point representation IEEE 754 floating point (Single & double precision) number representation.	
3.0	**Processor and Memory Organization**		**07**
	3.1	Basic organization of computer: Components. CPU Organization, registers, and execution cycle, Concept of Low-level, high-level programming.	
	3.2	Memory Hierarchy: Cache, primary memory, secondary storage.	
	3.3	I/O Organization. Basic concepts of buses, interrupts, and DMA.	
4.0	**Operating System fundamentals**		**08**
	4.1	Role of operating systems and compilers, Introduction to Operating Systems; Operating System Structure and Operations; Functions of Operating Systems; Types: types (Batch, Multitasking, Real-Time, Distributed, and Embedded OS). Basics of Linux & Shell Scripting, Operating System Services and Interface; System Calls and its Types; System Boot.	
	4.2	Process Creation & Management: Basic Concepts of Process; Operation on Process; Process State Model and Transition, Process Control Block; Context Switching, Inter-process communication. Thread Synchronization: Introduction to Threads; Types of Threads, Thread Models; multithreaded applications. Mutex Locks for thread synchronization	
	4.3	CPU Scheduling Algorithms: Basic Concepts of Scheduling; Types of Schedulers; Scheduling Criteria; Scheduling Algorithms: FCFS, SJF, Priority, and Round Robin, Numerical on FCFS scheduling.	
5.0	**Memory and File system Management**		**08**
	5.1	Basic Concepts of Memory Management; Swapping; Contiguous Memory Allocation.	
	5.2	Paging; Structure of Page Table. Segmentation; Basic Concepts of Virtual Memory.	
	5.3	Basic Concepts of File System; File Access Methods; Directory Structure. File Allocation Methods; Free Space Management; Overview of Mass Storage Structure, Disk Structure. Introduction to Device Management: I/O devices and device drivers.	
		Total Hours	**39**

Suggested Learning Resources

Textbooks

1. Digital Electronics-An introduction to theory and practice, W. H. Gothman, Pearson Education,1982.
2. Computer Organization and Embedded Systems, Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, McGraw Hill Education, Sixth Ed, 2023.
3. Computer Organization and Design: The Hardware/Software Interface by David A. Patterson and John L. Hennessy, Morgan Kaufmann, Fifth Ed ,2013.

4. Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne, Wiley, Tenth Ed, 2021
5. Computer Networking: A Top-Down Approach, James F. Kurose and Keith W. Ross, Pearson, Seventh Ed, 2016.
6. Cloud Computing: Concepts, Technology & Architecture", Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, Prentice Hall, First Ed, 2013.

Reference Books

1. Modern Operating Systems by Andrew S. Tanenbaum and Herbert Bos, published by Pearson, Fifth Ed, 2024.
2. Computer Networks by Andrew S. Tanenbaum and David J. Wetherall, published by Pearson, Fifth Ed, 2010.
3. Data Communications and Networking by Behrouz A. Forouzan, published by McGraw-Hill Education, Fourth Ed, 2017.

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc21_cs61/preview
2. NPTEL, https://archive.nptel.ac.in/courses/106/105/106105183/
3. NPTEL, https://archive.nptel.ac.in/courses/106/105/106105214/

2.8 Operating System Lab. (AI3PC_LR4)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI3PC_LR4	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 understand the fundamental concepts of computer architecture and operating systems laying the foundation for further study in AI and ML applications.
2	To develop the ability to implement and analyze operating system functionalities such as process and memory management.
3	To provide students with the knowledge of memory and IO organization in a computer system.
4	To empower students with the knowledge of scheduling algorithms using programming techniques
5	To understand the fundamental concepts memory management and file systems.

Course Outcomes

The student will be able to:	
CO1	explain the principles of the binary number system, perform conversions between different number systems (binary, decimal, octal, hexadecimal), and apply Boolean algebra and logic gates to design and analyze simple digital circuits.
CO2	identify and describe the components and functions of computer architecture.
CO3	explain memory and IO organization in a computer system.
CO4	compare and contrast various CPU scheduling algorithms.
CO5	perform memory and file management operations.

Course Contents

Suggested List of Experiments /Tutorials /Assignments
Expt1: To perform binary addition and subtraction and simulate basic logic gates using software tools (e.g., Logisim). Expt2: To write and execute simple assembly language programs (e.g., adding two numbers) using a simulator like MASM or Keil.
Basics of Linux & Shell Scripting Expt3: Execute file handling, process management, and networking commands. Expt4: Write a shell script for basic automation (e.g., file backup, CPU monitoring). Process Creation & Management Expt5: Write a C program to create child processes using fork().

Expt6: Implement parent-child process synchronization using wait(). CPU Scheduling Algorithms Expt7: To implement First-Come-First-Serve (FCFS) and Round Robin scheduling algorithms using a simple Python or C program and compare turnaround time and waiting time for different algorithms. Thread Synchronization Expt8: Create a multi-threaded C/Python program using pthread.
Memory Management: Paging & Segmentation Expt9: Implement a program to show page replacement algorithms (FIFO, LRU). Expt10: Simulate segmentation using linked lists. File System Implementation Expt11: To perform basic file operations (create, read, write, delete) in a Linux environment using shell commands.

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. Computer Organization and Embedded Systems, Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, McGraw Hill Education, Sixth Ed, 2023.
2. Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne, Wiley, Tenth Ed, 2021
3. Computer Networking: A Top-Down Approach, James F. Kurose and Keith W. Ross, Pearson, Seventh Ed, 2016.
4. Cloud Computing: Concepts, Technology & Architecture", Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, Prentice Hall, First Ed, 2013.

Reference Books

1. Modern Operating Systems by Andrew S. Tanenbaum and Herbert Bos, published by Pearson, Fifth Ed, 2024.
2. Computer Networks by Andrew S. Tanenbaum and David J. Wetherall, published by Pearson, Fifth Ed, 2010.
3. Data Communications and Networking by Behrouz A. Forouzan, published by McGraw-Hill Education, Fourth Ed, 2017.

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc21_cs61/preview
2. NPTEL, https://archive.nptel.ac.in/courses/106/105/106105183/
3. NPTEL, https://archive.nptel.ac.in/courses/106/105/106105214/

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 (NPTEL)	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: Nil		
1.0	**Foundations of Innovation and Creativity**		**06**
	1.1	Analyzing the Current Business Scenario, Innovation and Creativity- An Introduction, Innovation in Current Environment.	
	1.2	Types of Innovation, School of Innovation.	
2.0	**Innovation Management and Design Thinking**		**05**

	2.1	Challenges of Innovation, Steps of Innovation Management, Idea Management System, Divergent V/s Convergent Thinking,	
	2.2	Design Thinking and Entrepreneurship.	
3.0	**Experimentation, Co-Creation, and Prototyping**		**05**
	3.1	Experimentation in Innovation Management, Idea Championship, Participation for Innovation, Co-creation for Innovation.	
	3.2	Proto typing to Incubation.	
4.0	**Business Models, Entrepreneurship, and Strategies**		**05**
	4.1	What is a Business Model? Who is an entrepreneur? Social Entrepreneurship.	
	4.2	Blue Ocean Strategy I & II, Business Models and Value Proposition, Business Model Failure: Reasons and Remedies	
5.0	**Technological Innovation, Sustainability, and Intellectual Property**		**05**
	5.1	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, Rishikesha T. Krishnan, Vinay Dabholkar, HarperCollins, First Ed,2015.

2. Innovation and Entrepreneurship: Practice and Principles, I Ed., Peter Drucker, Routledge Classics, First Ed, 2015

Reference Books

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

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc21_mg63/preview

2.10 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 identify real-world problems in society through observations and interaction with the community.
2	To propose technology-based solutions to societal issues.
3	To provide exposure to interdisciplinary problem-solving and promote teamwork.
4	To enhance communication skills.
5	To inculcate ethical awareness and social responsibility while applying engineering knowledge for societal benefit.

Course Outcomes

The student will be able to:	
CO1	interact with society at large and identify socio-economic issues prevalent in the society.
CO2	relate theoretical knowledge for generation of technological solutions to real-life problems.
CO3	collaborate and contribute effectively in a team-based activity.
CO4	present their solutions in technical reports, presentations, and demonstrations.
CO5	recognise the need for lifelong learning in the broad context of technological change.

Guidelines

A. Process of field project/community engagement projects identification

- A coordinator to be appointed at the department level to guide students in field project/community engagement projects.
- Students should form a group of 3-4 students. A faculty mentor to be assigned to each group.
- Collaborate with NSS Cell to arrange visits/trips to explore community/society based issues and/or for data/sample collection. Engage with local communities or stakeholders to gather information and insights. Preferably, the mentors should also accompany the students.
- Topic approval presentaion must be carried out for finalization of the topic.
- The approach should be to identify a community/society based real-life problem and to propose a technological solution to solve the problem.

B. Continuous Monitoring and Assessment (ISE)

- The mentor should assess the progress of the students on a weekly basis and record their observations in the logbook.

C. End Semester Examination

- A report (max. 25 pages) to be prepared by each group.
- A presentation summarizing the objectives, methodology, findings, and community impact to be carried out. The external examiner should preferably be from the industry.

Assessment Tool	Components	Marks
CA	Weekly progress of the group	10
	Logbook	10
	Attendance	5
	TOTAL	**25**
ESE	Report	10
	Presentation	15
	Total	**25**

2.11 Environment & Technology (ILSHM_CR3)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ILSHM_CR2	Environment & Technology	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 *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.		
1.0	**Introduction to Environment and Technology**		**05**
	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.		
2.0	**Technology Applications in Environment Monitoring and Modeling**		**05**
	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.	
3.0	**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.	
4.0	**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.	
5.0	**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, Isam Mohammed Abdel-Magid Ahmed, Mohammed Isam Mohammed Abdel-Magid. Kindle Edition, Second Ed, 2017
2. Introduction to Environmental Engineering and Science, , Gilbert M. Masters, Wendell P. Ela., Pearson India, Second Ed.2015.
3. Environmental Science and Technology: Concepts and Applications, Frank R. Spellman, Nancy E. Whiting, Second Ed, 2006.
4. Waste Management Practices: Municipal, Hazardous, and Industrial, John P., CRC Press, Second Ed, 2014.
5. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, Third Ed, 2012.

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, First Ed, 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

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

Semester-IV Course Details

Table 3: Semester-IV Credits and Evaluation Scheme

S. N.	Course Code	Course	Credits Assigned					Marks Distribution				
			C	L	T	P	Total	ISE		ESE		Total
								CA	MSE	The	Pra	
	Semester IV											
1	AI4PC_CR1	Applied Statistics for Data Science	2	-	-	-	2	15	15	45	-	75
2	AI4PC_LR1	Applied Statistics Lab	-	1	-	-	1	25	-	-	-	25
3	AI4PC_CR2	Database Management Systems	2	-	-	-	2	15	15	45	-	75
4	AI4PC_LR2	Database Management Systems Lab	-	1	-	-	1	25	-	-	25	50
5	AI4PC_CR3	Machine Learning	3	-	-	-	3	20	20	60	-	100
6	AI4PC_LR3	Machine Learning Lab	-	1	-	-	1	25	-	-	25	50
7	AI4VS_LR4	Web Programming Lab	-	2	-	-	2	25	-	-	25	50
8	IL4HM_CR1	Business Forecasting	2	-	-	-	2	50	-	-	-	50
9		MDM-I*	2	-	-	-	2	15	15	45	-	75
10		OEC-I $	2	-	-	-	2	15	15	45	-	75
11	ILSHM_CR1	Professional Communication and Soft Skills	1	-	-	-	1	25	-	-	-	25
12	ILSHM_LR1	Professional Communication and Soft Skills Lab	-	1	-	-	1	25	-	-	-	25
13	ILSHM_CR2	Human Values and Ethics	2	-	-	-	2	50	-	-	-	50
		Total	16	6	0	0	**22**	330	80	240	75	**725**

.

3 Semester-IV Course Syllabus

3.1 Applied Statistics for Data Science (AI4PC_CR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI4PC_CR1	Applied Statistics for Data Science	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 explore foundational probability concepts and their role in modeling data.
2	To introduce techniques for summarizing and visualizing data and teach concepts of hypothesis testing
3	To provide tools to analyze relationships between variables.
4	To learn regression and correlation techniques.
5	To introduce advance statistical techniques.

Course Outcomes

The student will be able to:	
CO1	summarize and visualize data effectively using statistical techniques.
CO2	apply probability distributions to model and understand data variability.
CO3	perform hypothesis testing and interpret results in data analysis.
CO4	build and evaluate regression models for predictive analysis.
CO5	implement advanced statistical techniques to solve real-world data science problems.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites		
		Set Theory and Relations, Permutations, combinations, and Pigeonhole principle. Introductory concepts of probability**.** Random Variables.	
1.0	**Probability and Distributions**		**05**
	1.1	Probability concepts and axioms, sample spaces. Random variables – discrete and continuous. PMF and PDF. Key probability distributions: Binomial, Normal, Exponential, Uniform – properties and applications.	
	1.2	Expectation and variance: Definitions, properties, interpretation, real-world relevance.	
2.0	**Descriptive Statistics and Data Visualization**		**05**
	2.1	Data types: categorical, numerical, ordinal, nominal. Measurement scales and implications.	

		Measures of central tendency and dispersion: Mean, median, mode, range, variance, standard deviation, IQR. Variability for qualitative and ranked data.	
	2.2	Exploratory Data Analysis (EDA): Histograms, boxplots, scatterplots, correlation matrices. Outliers, skewness, and distribution interpretation.	
3.0	**Statistical Inference and Modern Hypothesis Testing**		**06**
	3.1	Sampling techniques: simple random and stratified sampling. Sampling distributions and estimation intuition. Bayesian reasoning: Conditional probability, Bayes' theorem, prior, likelihood, posterior. Applications in AIML. Point estimation and confidence intervals. Confidence level, margin of error, effect of sample size.	
	3.2	Hypothesis testing framework: Null and alternative hypotheses, p-values, decision errors. Effect size vs statistical significance. Z-test and t-test (one-sample): Use cases, assumptions, interpretation. Resampling-based inference: Bootstrapping for confidence intervals. Permutation tests as non-parametric alternatives (A/B testing intuition).	
4.0	**Correlation and Regression Analysis**		**05**
	4.1	Correlation analysis: Pearson and Spearman correlation coefficients – comparison and use cases. Simple linear regression: Least squares regression line, interpretation of coefficients, R^2, residuals.	
	4.2	Regression assumptions: Linearity, independence, normality of errors, homoscedasticity. Consequences of assumption violations. Multiple regression: Multiple predictors, interpretation, regression toward the mean. Multicollinearity: Variance Inflation Factor (VIF), interpretation and remedies.	
5.0	**Statistical Testing in Practice**		**05**
	5.1	t-tests: Two-sample and paired t-tests – practical scenarios. ANOVA: One-way ANOVA – intuition, assumptions, post-hoc idea. Assumption checking for statistical tests: Normality and homoscedasticity – conceptual tools and diagnostics.	
	5.2	Multiple hypothesis testing: Motivation, Bonferroni correction, False Discovery Rate (conceptual). Statistical power analysis: Type I & Type II errors, power, effect size, sample size intuition.	
	5.3	Time Series Analysis: Basics of trends, seasonality, and autocorrelation.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Statistics for Engineers and Scientists, William Navidi, McGraw Hill, Sixth Ed, 2023.

Reference Books.

1. Practical Statistics for Data Scientists: 50 Essential Concepts, Peter Bruce, Andrew Bruce, and Peter Gedeck, O'Reilly Media, Second Ed, 2020.
2. An Introduction to Statistical Learning: With Applications in R, Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, Springer, Second Ed, 2021.

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc21_ma35/preview
2. NPTEL, https://onlinecourses.nptel.ac.in/noc24_ma30/preview

3.2 Applied Statistics Lab. (AI4PC_LR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI4PC_LR1	Applied Statistics 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 explore foundational probability concepts and their role in modeling data..
2	To introduce techniques for summarizing and visualizing data and teach concepts of hypothesis testing
3	To provide tools to analyze relationships between variables.
4	To learn regression and correlation techniques.
5	To introduce advance statistical techniques.

Course Outcomes

The student will be able to:	
CO1	summarize and visualize data effectively using statistical techniques.
CO2	apply probability distributions to model and understand data variability.
CO3	perform hypothesis testing and interpret results in data analysis.
CO4	build and evaluate regression models for predictive analysis.
CO5	implement advanced statistical techniques to solve real-world data science problems.

Course Contents

Module	Suggested List of Experiments /Tutorials /Assignments
1	**Expt1**: To write Python programs to generate random numbers and plot a histogram using Matplotlib. **Expt2**: To visualize and analyze probability distributions. A) Generate data for binomial, Poisson, and normal distributions. B) Plot the distributions and calculate probabilities for specific events. **Expt3**: Simulate rolling a die 100 times and calculate probabilities of outcomes. Tool: Python (random module) **Expt4**: Generate and plot a Gaussian distribution for a given mean and variance. Tool: Python (NumPy, Matplotlib) **Expt5**: Verify the Central Limit Theorem using random samples of different sizes. Tool: Python (NumPy, Matplotlib)
2	**Expt6**: Calculate and compare mean, median, and mode for a given dataset.

	Tool: Python (Pandas, NumPy) or Excel **Expt7**: Create histograms and boxplots to visualize data distributions. Tool: Python (Matplotlib, Seaborn) **Expt8**: Identify and visualize outliers in a dataset using the IQR method. Tool: Python (Pandas, Seaborn)
3	Expt 9: Hypothesis testing for two sample groups (Z-test / t-test selection and interpretation), Tool: Python (SciPy) or Excel Expt 10: Confidence interval estimation for sample mean Tool: Python (NumPy, SciPy) Expt 11: Bootstrapping for confidence intervals Generate bootstrap samples. Compare bootstrap CI with parametric CI
4	**Expt 12**: Compute Pearson and Spearman correlation; visualize scatterplot Tool: Python (Pandas, Seaborn) **Expt 13:** Fit simple linear regression and make predictions Tool: Python (Scikit-learn, Matplotlib) **Expt 14**: Regression diagnostics Residual plots. Checking linearity and homoscedasticity Tool: Python (Statsmodels, Matplotlib) **Expt 15**: Multicollinearity analysis using VIF Compute VIF for multiple predictors. Interpret results. Tool: Python (Statsmodels)
5	**Expt 16**: One-way ANOVA for comparing multiple groups Tool: Python (SciPy / Statsmodels) or Excel **Expt 17:** Permutation test for A/B testing Compare two groups using permutation testing. Compare result with t-test Tool: Python (NumPy) **Expt 18**: Statistical power and sample size intuition Effect of sample size on power (visual / simulation-based).

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. Statistics for Engineers and Scientists, William Navidi, McGraw Hill, Sixth Ed, 2023.

Reference Books.

1. Practical Statistics for Data Scientists: 50 Essential Concepts, Peter Bruce, Andrew Bruce, and Peter Gedeck, O'Reilly Media, Second Ed, 2020.
2. An Introduction to Statistical Learning: With Applications in R, Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, Springer, Second Ed, 2021.

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc21_ma35/preview
2. NPTEL, https://onlinecourses.nptel.ac.in/noc24_ma30/preview

3.3 Database Management Systems (AI4PC_CR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI4PC_CR2	Database Management 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 introduce fundamental concepts of databases, including relational models, SQL queries, and database design principles
2	To understand relational models, entity-relationship diagrams, and normalization to optimize database structures.
3	To introduce transaction management, indexing, and query optimization for improving database performance.
4	To explore NoSQL databases, JSON-based storage, and when to use NoSQL over traditional RDBMS.
5	To understand database security mechanisms, user roles, access control, and backup strategies.

Course Outcomes

The student will be able to:	
CO1	describe database models and architecture and execute basic SQL operations.
CO2	design relational schemas, apply normalization techniques, and convert ER models into relational models.
CO3	apply transaction concepts, implement indexing, and analyze query performance using SQL.
CO4	store and retrieve JSON data in PostgreSQL and compare SQL vs NoSQL use cases.
CO5	implement role-based access control and perform database backup and recovery.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites: Nil		
1.0	**Database System Concepts and Architecture**		**05**
	1.1	Basics of database systems: Traditional file system vs. databases Characteristics of Databases. Data abstraction and data Independence. Database models: Hierarchical, Network, Relational, NoSQL	
	1.2	DBMS system architecture, Database architecture: 1-tier, 2-tier, 3-tier	
	1.3	Conceptual Modeling of a database, The Entity-Relationship (ER) Model, Entity Type, Entity Sets, Attributes and Keys. Relationship Types, Relationship Sets, Weak entity Types	

		Generalization, Specialization and Aggregation. Introduction to SQL: Basic queries (SELECT, INSERT, UPDATE, DELETE)	
2.0	Relational Databases & Normalization		**06**
	2.1	Introduction Relational model: Tables, attributes, tuples, keys (primary, foreign, candidate), Relational Model Constraints and Relational Database Schemas. Entity-Relationship (ER) Model: Entities, relationships, attributes.	
	2.2	Design guidelines for relational Schema, Functional Dependencies, Database tables. The need for normalization, normalization process, Improving the design, Normalization: 1NF, 2NF	
	2.3	Joins and Subqueries: INNER JOIN, LEFT JOIN, RIGHT JOIN, SELF JOIN, Constraints: NOT NULL, UNIQUE, CHECK, FOREIGN KEY	
3.0	**Transactions Management and Concurrency**		**05**
	3.1	Transaction concept, State Diagram, ACID Properties	
	3.2	Transaction Control Commands, Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based-protocols, Deadlock handling, Timestamp-based protocols**.**	
	3.3	Indexing: B-Trees, Hash-based indexing, Views and Stored Procedures	
4.0	**Non-Relational Databases (NoSQL)**		**05**
	4.1	Introduction to NoSQL databases: Differences from relational databases	
	4.2	Types of NoSQL databases: Key-Value Stores (e.g., Redis), Document Stores (e.g., MongoDB) Column-Family Stores (e.g., Cassandra), Graph Databases (e.g., Neo4j)	
	4.3	Use cases and applications of NoSQL	
5.0	**Database Security & Performance Optimization**		**05**
	5.1	Database security threats: SQL Injection, Data Privacy	
	5.2	Access Control & Authentication: Role-based access control (RBAC)	
	5.3	Backup and Recovery: Full, incremental, differential backups. Performance tuning techniques: Query optimization, Indexing best practices.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Database System Concepts, Korth, Slberchatz and Sudarshan, McGraw Hill, Sixth Ed, 2013.
2. Fundamentals of Database Systems, Elmasri and Navathe, Pearson education, Sixth Ed, 2017.
3. Database Management Systems, Raghu Ramkrishnan and Johannes Gehrke, TMH, McGraw Hill Education; Third Ed, 2002

Reference Books

1. Database Systems Design, Implementation and Management‖, Peter Rob and Carlos Coronel, Thomson Learning, Ninth Ed, 2009.
2. SQL & PL / SQL for Oracle 11g Black Book, P. S. Deshpande, Dreamtech Press, First Ed, 2011.
3. Database Management Systems, G. K. Gupta, McGraw – Hill, Third Ed, 2013.
4. Calculus and Analytic Geometry, George B. Thomas Jr. and Maurice D. Weir, Addison-Wesley Nineth Ed, 1996.

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc26_cs39/preview

3.4 Database Management Systems Lab. (AI4PC_LR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI4PC_LR1	Database Management Systems 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 introduce fundamental concepts of databases, including relational models, SQL queries, and database design principles
2	To understand relational models, entity-relationship diagrams, and normalization to optimize database structures.
3	To introduce transaction management, indexing, and query optimization for improving database performance.
4	To explore NoSQL databases, JSON-based storage, and when to use NoSQL over traditional RDBMS.
5	To understand database security mechanisms, user roles, access control, and backup strategies.

Course Outcomes

The student will be able to:	
CO1	describe database models and architecture and execute basic SQL operations.
CO2	design relational schemas, apply normalization techniques, and convert ER models into relational models.
CO3	apply transaction concepts, implement indexing, and analyze query performance using SQL.
CO4	store and retrieve JSON data in PostgreSQL and compare SQL vs NoSQL use cases.
CO5	implement role-based access control and perform database backup and recovery.

Course Contents

Module	Suggested List of Experiments /Tutorials /Assignments
1	Experiment 1: Create and manage databases and tables in MySQL. Tasks: Create a database, define tables, set primary/foreign keys, and apply constraints. Experiment 2: Perform basic SQL operations (CRUD). Tasks: Insert, update, delete, and retrieve data using SELECT queries with conditions.
2	Experiment 3: Use advanced SQL queries for data analysis. Tasks: Practice JOINs, GROUP BY, HAVING, and nested queries. Experiment 4: Identify real world problem and develop the problem statement. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model. Experiment 5: Setup and configure a PostgreSQL database.

	Tasks: Install PostgreSQL, create users, and manage access control. Experiment 6: Design an Entity-Relationship (ER) model for a university database. And implement normalization (up to BCNF) using SQL or PostgreSQL.
3	Experiment 7: Implement ACID transactions using BEGIN, COMMIT, ROLLBACK. And create indexes and analyze query performance using EXPLAIN ANALYZE.
4	Experiment 8: Explore PostgreSQL-specific features like arrays and JSON data types. Tasks: Store and query hierarchical data using JSON functions. Experiment 9: Set up and connect to a MongoDB database. Tasks: Install MongoDB, create databases, and use mongo shell for basic operations. Experiment 10: Perform CRUD operations in MongoDB. Tasks: Insert documents, update fields, delete documents, and use find() queries. Experiment 11: Work with MongoDB aggregation framework. Tasks: Perform data analysis using $group, $match, and $project. Experiment 12: Connect a database to a web application. Tasks: Use a programming language (e.g., Python, Node.js) to interact with SQL and NoSQL databases via an API.
5	Experiment 13: Implement role-based access control (RBAC) in SQL or PostgreSQL. Experiment 14: Perform database backup and restoration using pg_dump and pg_restore.

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. Database System Concepts, Korth, Slberchatz and Sudarshan, McGraw Hill, Sixth Ed, 2013.
2. Fundamentals of Database Systems, Elmasri and Navathe, Pearson education, Sixth Ed, 2017.
3. Database Management Systems, Raghu Ramkrishnan and Johannes Gehrke, TMH, McGraw Hill Education; Third Ed, 2002

Reference Books

1. Database Systems Design, Implementation and Management‖, Peter Rob and Carlos Coronel, Thomson Learning, Ninth Ed, 2009.
2. SQL & PL / SQL for Oracle 11g Black Book, P. S. Deshpande, Dreamtech Press, First Ed, 2011.
3. Database Management Systems, G. K. Gupta, McGraw – Hill, Third Ed, 2013.
4. Calculus and Analytic Geometry, George B. Thomas Jr. and Maurice D. Weir, Addison-Wesley Nineth Ed, 1996.

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc26_cs39/preview

3.5 Machine Learning (AI4PC_CR3)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI4PC_CR3	Machine Learning (ML)	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 provide students with an understanding of the foundational concepts and techniques in Machine Learning.
2	To enable students to implement basic supervised ML algorithms and analyze their effectiveness in solving real-world problems.
3	To equip students with the ability to evaluate and select appropriate ML models for specific applications.
4	To understand unsupervised ML techniques.
5	To learn the concepts of reinforcement learning.

Course Outcomes

The student will be able to:	
CO1	explain the basics of ML, its applications, and challenges in various domains.
CO2	implement and evaluate supervised learning models.
CO3	implement and evaluate advanced supervised learning models.
CO4	apply unsupervised learning techniques to discover hidden patterns in data.
CO5	illustrate the concepts of Reinforcement learning.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites		
		Python programming, probability, and Statistics	
1.0	**Introduction to Machine Learning**		**07**
	1.1	Overview of AI and Machine Learning, Applications of Machine Learning in various domains. Types of Machine Learning, Models of Machine learning: Geometric model, Probabilistic Models, Logical Models, etc. Core ML Concepts: Generalization Bias variance tradeoff. Overfitting vs Underfitting Train-Validation-Test Split, Cross-Validation (K-Fold) Hypothesis spaces, Inductive bias	
	1.2	Machine Learning as Function Approximation. Decision Tree, KNN. The ML pipeline: Data collection, preprocessing, model training, testing, evaluation, and deployment	

2.0	**Supervised Learning Techniques**		**08**
	2.1	Regression methods: Simple and Multiple Linear Regression, OLS and MLE approach. Cost Function: Mean Squared Error (MSE), Closed-form solution vs Gradient Descent approach, Gradient-Based Optimization: Gradient Descent, GD variants, learning rate and convergence behavior, Chain rule for computing gradients, Momentum: Accelerating convergence, Intuition: Ball rolling downhill, Exponential moving average of gradients, Nesterov Accelerated Gradient: Look-ahead momentum. Logistic Regression: Sigmoid function, Binary cross-entropy loss, Decision boundary.	
	2.2	Introduction to Neural Networks, Perceptron: Single neuron model, Network architecture: Layers and connections, Activation functions (Sigmoid, ReLU), Forward propagation: Computing predictions, Backpropagation algorithm: Computing gradients.	
3.0	**Advanced Supervised Learning**		**08**
	3.1	Feature Engineering. Concept of Feature, Pre-processing of data, Feature Extraction, Statistical feature engineering:count-based, Length, Mean, Median, Mode etc. Regularization & Model Selection Regularization as optimization trade-off: Data fit vs model complexity, L1 vs L2. Overfitting and underfitting: Causes and remedies	
	3.2	Support Vector Machines, Support Vector Regression. Naive Bayes Classifier: Assumptions, pros, & cons. SVM optimization: Margin maximization as an objective, Hinge loss.	
	3.3	Ensemble Methods: Bagging and Boosting, Random Forests, concept of XGBoost. Performance Metrics: Confusion Matrix, Kappa Statistics, Sensitivity, Specificity, Precision, Recall, F-measure, ROC curve	
4.0	**Unsupervised Learning & Dimensionality Reduction**		**08**
	4.1	K-means and K-medoids clustering. Hierarchical Clustering: Agglomerative and divisive methods. Outlier and anomaly detection.	
	4.2	Dimensionality Reduction Techniques, Principal Component Analysis Linear Discriminant Analysis. Singular Valued Decomposition	
	4.3	k-means as an optimization problem, Objective function of k-means, Why k-means can get stuck in local minima, Initialization sensitivity	
5.0	**Introduction to Reinforcement Learning**		**08**
	5.1	Reinforcement Learning Fundamentals, RL vs Other ML Paradigms, Applications. Agent-Environment Interface.	
	5.2	Markov Decision Process (MDP), Value Functions, Bellman Equations,	
	5.3	Q-Learning Algorithm: Q-Table, Q-Learning Update Rule, Temporal Difference (TD) Learning, ε-greedy Policy.	
		Total Hours	**39**

Suggested Learning Resources

Textbooks

1. Introduction to Machine Learning with Python: A Guide for Data Scientists by Andreas C. Müller and Sarah Guido, Shroff, O'Reilly, First Ed, 2016.
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, Shroff, O'Reilly Third Ed, 2022.
3. Reinforcement Learning, Richard S. Sutton & Andrew G. Barto, Bradford Books, Second Ed, 2018.

Reference Books

1. Pattern Recognition and Machine Learning, Christopher M. Bishop, springer, First Ed, 2006.

2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, Shroff, O'Reilly; Third Ed, 2022.

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc23_cs18/preview
2. NPTEL, https://onlinecourses.nptel.ac.in/noc20_cs95/preview

3.6 Machine Learning Lab. (AI4PC_LR3)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI4PC_LR3	Machine Learning 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 provide students with an understanding of the foundational concepts and techniques in Machine Learning.
2	To enable students to implement basic supervised ML algorithms and analyze their effectiveness in solving real-world problems.
3	To equip students with the ability to evaluate and select appropriate ML models for specific applications.
4	To understand unsupervised ML techniques.
5	To learn the concepts of ML model evaluation.

Course Outcomes

The student will be able to:	
CO1	use the python libraries useful for machine Learning.
CO2	preprocess raw data and extract meaningful features for ML models.
CO3	implement and evaluate supervised learning models.
CO4	apply unsupervised learning techniques to discover hidden patterns in data.
CO5	evaluate and compare machine learning models using performance metrics

Course Contents

Module	Suggested List of Experiments /Tutorials /Assignments
1	**Expt1**: Implement the end-to-end machine learning pipeline. 1. Collect a dataset (e.g., Iris or Titanic) 2. Preprocess the data (handle missing values, scaling, encoding). 3. Split the data into training and testing sets. Train a linear regression model using scikit-learn. Evaluate the model using metrics like MSE or accuracy.
2	Expt2: Compare analytical and gradient descent approaches for linear regression. 1. Implement linear regression analytically (normal equation). 2. Implement gradient descent for linear regression. 3. Compare the results in terms of cost function minimization and execution time Expt3: Train and evaluate a logistic regression model. 1. Use a binary classification dataset (e.g., Breast Cancer Dataset). 2. Preprocess the data and train a logistic regression model.

	3. Visualize the decision boundary. 4. Evaluate the model using precision, recall, F1-score, and ROC curve. Expt4: Build and evaluate a decision tree for classification. 1. Use a dataset like the Titanic dataset. 2. Train a decision tree classifier using Gini index and entropy. 3. Visualize the decision tree using graphviz. Analyze the tree depth and its effect on overfitting. Expt5: Understand and apply k-NN for classification. 1. Use a dataset like Iris. Train a k-NN classifier with different values of k. 2. Experiment with different distance metrics (e.g., Euclidean, Manhattan). 3. Analyze the effect of k on model accuracy.
3	Expt6: Perform clustering using K-means and hierarchical techniques. 1. Use a dataset like Mall Customers or Wholesale Customers. 2. Apply K-means clustering and determine the optimal k using the elbow method. 3. Visualize clusters using 2D plots. 4. Apply agglomerative hierarchical clustering and visualize the dendrogram.
4	Expt7: Apply PCA and LDA to reduce dataset dimensions. 1. Use a dataset with multiple features (e.g., Wine Dataset). 2. Apply PCA and retain top components that explain 90% variance. 3. Apply LDA for dimensionality reduction. 4. Visualize the reduced dataset in 2D and 3D spaces. Expt8: Understand and implement Random Forest and Boosting techniques. 1. Train a Random Forest classifier on a classification dataset. 2. Evaluate feature importance using the model. 3. Train a Gradient Boosting model (XGBoost) and compare with Random Forest. Expt9: Evaluate and compare machine learning models using performance metrics. 1. Train Logistic Regression, Decision Tree, and SVM models on the same dataset. 2. Evaluate each model using a confusion matrix, precision, recall, F1-score, and ROC curve. Compare models & interpret which performs best for given dataset. Expt10: Mini project

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

Suggested Learning Resources

Textbooks

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, Shroff, O'Reilly Third Ed, 2022.

Reference Books

1. Pattern Recognition and Machine Learning, Christopher M. Bishop, springer, First Ed, 2006.
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, Shroff, O'Reilly; Third Ed, 2022.

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc23_cs18/preview

3.7 Web Programming Lab. (AI4VS_LR4)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI4VS_LR4	Web Programming Lab.	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 equip students with hands-on experience in designing and developing interactive and responsive web applications using HTML, CSS, JavaScript, and frontend frameworks
2	To make students understand the concepts of React.
3	To familiarize students with the concepts of Express.js.
4	To develop database related skills for web applications.
5	To develop dynamic and interactive web applications using React for the frontend and Express.js for building scalable backend services.

Course Outcomes

The student will be able to:	
CO1	design and develop structured, responsive, and interactive web pages using HTML, CSS, and JavaScript.
CO2	design and develop frontend applications using React.
CO3	design and develop backend logic using Express.js.
CO4	implement database operations for web applications.
CO5	design and develop full-stack web applications by integrating React for the frontend and Express.js for handling backend logic and API communication.

Course Contents

Batchwise Lectures (2 Hrs each)	Suggested List of Experiments /Tutorials /Assignments
Lecture-1a: What is version control & why it matters GitHub repository creation clone, add, commit, push, pull Basic .gitignore Individual vs team repositories Lecture-1b: HTML Foundations What is Web Programming? Frontend vs Backend. How the web works: Browser, URL, HTTP. HTML basics: Tags, attributes, structure Headings, paragraphs, lists, Tables, images, links, Forms & input types. HTML best practices & accessibility basics	Experiments on Web Programming (2 Hrs each) Expt1a: Create Git project Expt1b: HTML Foundations – Portfolio Structure Create basic personal portfolio webpage, with Sections: About Me, Education, Skills, Contact, using headings, lists, tables, forms.
Lecture-2: CSS and JavaScript Basics CSS fundamentals: Selectors, box model, Colors,	Expt2: CSS and JavaScript Basics – Layout, Styling, Logic & Events.

fonts, spacing, Layout techniques: Flexbox, CSS Grid. Responsive design basics, DevTools for debugging CSS. JavaScript fundamentals: Variables, data types, Functions & conditions, Arrays & objects, Events & event listeners, Introduction to DOM	a) Style portfolio webpage designed in Expt-1, Use Flexbox for navbar, Use Grid for page layout Make page responsive. b) Add to portfolio webpage, button click events, Change text/content dynamically, Basic DOM manipulation on portfolio page
Lecture-3: DOM Manipulation DOM tree & selectors, Creating & removing elements, Class, List & inline styles, event delegation	Expt3: DOM Manipulation – Dynamic To-Do List a) Add a new Section on personal portfolio webpage to create a dynamic to-do list (add, remove items) and b) use DOM manipulation to change styles and content dynamically.
Lecture-4: JavaScript Form Validation Client-side validation concepts, Regex basics (email, phone), Password strength rules, Prevent default form submission Browser Storage: Client-side storage, local Storage vs session Storage, JSON stringify & parse, Use cases	Expt4: Form Validation with JavaScript a) Validate fields like email, phone number, password strength on personal portfolio webpage using JavaScript and display error messages if inputs are invalid. b) Using JavaScript, implement a dark mode toggle and save user preference in local storage. c) Store user form data & display it on page refresh.
Lecture-5: React Introduction Why React? Single-Page Application vs Single-Page Application, React project structure, Components: Functional, Class. Props concept, Parent-Child data flow, Reusable components	Expt5: React Props & Component Communication a) Create a React app with functional and class components. Render portfolio section in React b) Implement props to pass data between React components. Display dynamic profile data.
Lecture-6: React State Management State vs props, useState hook, Controlled components, programing examples using useState.	Expt6: React State Management – useState a) Using React create a login form with controlled components and display user input data dynamically on the webpage. b) Build a counter app with useState. Create controlled form in React
Lecture-7: Side Effects & API Calls Lifecycle concepts, useEffect hook, Fetch API, Async/await.	Expt7: Side Effects & API Calls – useEffect Fetch data from public API using useEffect and Display list/cards dynamically.
Lecture-8: Backend Basics – Express.js Backend role in web apps, Node.js overview, Express basics: Routes, Middleware, nodemon.	Expt8: Backend Basics – Express.js Create a simple Express server, “Hello World” API, use nodemon for auto-restarting the server. Also test using browser/Postman.
Lecture-9: Database Integration – MongoDB What is NoSQL? MongoDB basics, Mongoose overview, REST API concept	Expt9: Database Integration – MongoDB Create a MongoDB database, store user data, retrieve users using API calls and display data in React frontend.
Lecture-10: Full Stack Web App Project structure, Frontend–Backend integration, Deployment overview, Best practices	Expt10 - Expt11 - Expt12: Mini-project - Full Stack Web App

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

Suggested Learning Resources

Textbooks

1. Web Programming: Building Internet Applications, Chris Bates, John Wiley & Sons Inc; Third Ed, 2006.
2. Full Stack Web Development with React and Node.js, Shama Hoque, Packt Publishing; Second Ed, 2020.

Reference Books

1. Learning React, Alex Banks & Eve Porcello, O'Reilly Media; Second Ed, 2020.

Web Resources

1. W3Schools Web Development Tutorials – Covers HTML, CSS, JavaScript. https://www.w3schools.com/
2. React Official Documentation –React fundamentals and hooks: https://reactjs.org/docs/getting-started.html

3.8 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	explain 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**		**05**
	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	
3.0	**Regression, Seasonality, and Decomposition Methods**		**05**
	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	
	5.2	Human Judgement in Time Series Analysis	
	5.3	Monte Carlo Simulation and Risk Analytics, Predictive Analytics using @Risk software/Python	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

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

Reference Books

1. Business Analytics, (PART 4: Regressions Analysis and Time Series Forecasting), Albright and Winston, Cengage Learning, Fifth Ed., 2015.
2. Forecasting Methods and Applications, Spyros G. Makridakis, Steven C. Wheelwright, Rob J. Hyndman, John Willey and Sons, Third Ed, 1997.
3. An Introduction to Management Science: Quantitative Approaches to Decision Making, David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, Jeffrey D. Camm, and Kipp Martin, Cengage Learning, Thirteenth Ed, 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

3.9 Multidisciplinary Minor Courses (ET4MM_CX1)

3.9.1 Digital System Design (ET4MM_CX1)

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.	Objective
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**	**05**

	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**	**05**
	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. John F. Warkerly, "Digital Design Principles and Practices", Pearson Education, Fifth Edition (2018).
2. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson Education, Fifth Edition (2013).
3. R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill Education, Forth Edition (2010).
4. A. Anand Kumar, "Fundamentals of Digital Circuits", PHI, Fourth Edition (2016).
5. Volnei A. Pedroni, "Digital Electronics and Design with VHDL" Morgan Kaufmann Publisher, First

Edition (2008).
6. Stephen Brown & Zvonko Vranesic, “Fundamentals of Digital Logic with Verilog Design”, Third Edition, MGH (2014).

Reference Books

1. Thomas L. Floyd, “Digital Fundamentals”, Pearson Prentice Hall, Eleventh Global Edition (2015).
2. Mandal, “Digital Electronics Principles and Applications”, McGraw Hill Education, First Edition (2010).
3. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss “Digital Systems Principles and Applications”, Ninth Edition, PHI (2009).
4. Donald P. Leach / Albert Paul Malvino/Gautam Saha, “Digital Principles and Applications”, The McGraw Hill, Eight Edition (2015).
5. Stephen Brown & Zvonko Vranesic, “Fundamentals of Digital Logic Design with VHDL”, Second Edition, TMH (2009).
6. J. Bhasker, “A Verilog HDL Primer”, Star Galaxy Press, Third Edition (1997).

Web Resources

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

3.9.2 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

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 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 learner 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	**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	**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	**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	**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	**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. I. Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. M. Ehsani, Y. Gao, S.E. Gay and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press. 2005
3. Sheldon Williamsom, Energy Management Strategies for Electric and Plug-in Hybrid Vehicles, Springer 2013
4. J. Larminie and J. Lowry, Electric Vehicle Technology Explained, Wiley, 2003

Reference Books

1. B. K Bose, Modern Power Electronics and AC Drives, Pearson Education 2002
2. C. MI, M. Abul and D. W. Gao, Hybrid Electrical Vehicle Principles and Application with Practical Perspectives, Wiley 2011
3. Robert A. Huggins, Energy Storage, Springer 2010
4. NPTEL/ Swayam Course: Intro. to Hybrid and Electric Vehicles - Prof. Praveen Kumar & Prof. S. Majhi (IIT Guwahati): https://nptel.ac.in/courses/108/103/108103009

Web Resources

1. https://onlinecourses.nptel.ac.in/noc24_ee30/preview
2. Electric Vehicles and Renewable Energy, IIT Madras, https://nptel.ac.in/courses/108106182

3.9.3 Introduction to Additive Manufacturing (ME4MM_CX1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ME4MM_CX1	Introduction to Additive Manufacturing	2	2

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
	Prerequisites		
	Engineering Graphics		
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	**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 Hours	**26**

Suggested Learning Resources

Textbooks

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

Reference Books

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

3.9.4 Introduction to Robotics (ME4MM_CX2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ME4MM_CX2	Introduction to Robotics	2	2

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 Hours	**26**

Suggested Learning Resources

Textbooks

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

Reference Books

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

3.9.5 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 learn about key communication protocols used in IoT systems and their application in device communication.
3	To gain practical knowledge of the hardware components used in IoT, including sensors, actuators, and microcontrollers.
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	implement communication between devices using protocols such as MQTT, HTTP, and CoAP.
CO3	design basic IoT circuits by interfacing sensors and actuators with microcontrollers.
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 the Internet of Things**		**05**
	1.1	Overview of IoT: Introduction, definition, history, and evolution, Applications of IoT- Healthcare, smart cities, industrial IoT, smart homes, etc.	
	1.2	IoT Architecture: Layers (sensing, networking, data processing) and devices	

	1.3	Core IoT Components: Sensors, actuators, microcontrollers, communication technologies	
2.0	**IoT Communication Protocols**		**05**
	2.1	Wired vs. wireless communication	
	2.2	IoT Communication Protocols: MQTT, HTTP, CoAP	
	2.3	Wireless Communication Technologies: Wi-Fi, Bluetooth, Zigbee, LoRa, LPWAN, 5G, Networking in IoT: Overview of IoT networks, IP addressing, and protocols	
3.0	**IoT Hardware and Devices**		**05**
	3.1	Sensors and Actuators: Types of sensors and actuators, its interfacing with IoT devices	
	3.2	Microcontrollers: Introduction to Arduino, Raspberry Pi, and ESP32	
	3.3	Interfacing Sensors: Connecting and programming sensors with microcontrollers- GPIO, I2C, SPI, and other hardware 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	
	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 (1 hour)	
	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 ApproachArshdeep Bahga, Vijay Madisetti, Universities Press, Second Ed, 2015.
2. Internet of Things: Principles and Paradigms, Rajkumar Buyya, Amir Vahid Dastjerdi, Morgan Kauffman, First Ed, 2016.
3. Designing the Internet of Things, Adrian McEwen, Hakim Cassimally, Wiley, First Ed, 2013.
4. Practical Internet of Things Security, Brian Russell, Drew Van Duren, Packt Publishing, Second Ed, 2018.

Reference Books

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

3.10 Open Elective Courses (IL4OE_CXX)

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

Reference Books

1. Fundamentals of Intellectual Property for Engineers, K, Bansal, P. Bansal, BS Publications, First Ed, 2014.

Web Resources

1. Intellectual Property: A Primer for Academia, Rupinder Tewari, Mamta Bharadwai, Publication Bureau, Panjab University, 2021.
   https://tinyurl.com/mvsvvafj
   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	describe 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**		**05**
	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**		**05**
	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.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

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

Reference Books

1. IT Systems Management: Designing, Implementing and Managing World - Class Infrastructures, Rich-

Schiesser, Prentice Hall, Second Ed, 2010.
2. COBIT 2019 Framework: Introduction and Methodology, Dr. David Lanter, ISACA, First Ed, 2019.
3. Open Source Security Testing Methodology Manual (OSSTMM) v3, Pete Herzog, Third Ed, 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/
5. https://nvlpubs.nist.gov/nistpubs/legacy/sp/nistspecialpublication800-30r1.pdf
6. 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, Morgan, C.T., King, R.A., Weisz, J.R., amp; Schopler, J., Singapore: Mcgraw-Hill, Seventh Ed, 2007.
2. Psychology, D.G. Myers, Worth Publishers-New York, Fifth Ed, 2004.
3. Psychology, R.A. Baron, Prentice Hall, India, , Fifth Ed, 2002.
4. Introduction To Psychology, J. Kalat, Wordsworth Pub. Co., Eight Ed, 2007.
5. Introduction To Psychology, E.R. Hilgard, R. L. Atkinson, Wordsworth Pub. Co., , Fourteenth Ed, 2013.

Reference Books

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

Web Resources

1. NPTEL Course on Psychology https://archive.nptel.ac.in/courses/109/104/109104105/ http://www.digimat.in/nptel/courses/video/109104105/L01.html

3.10.4 Personal Finance, Investments and Taxation (IL4OE_CX4)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX4	Personal Finance, Investments and Taxation	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**		**05**
	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**		**04**
	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, Monika Halan, HarperCollins India, Second Ed, 2023.
2. Retire Rich: Invest Wisely to A Secure Future, P.V. Subramanyam, CNBC TV18, First Ed, 2013.
3. Taxation of Individuals, Dr. Girish Ahuja, Ravi Gupta, Commercial Law Publishers, Seventeenth Ed, 2024.
4. Income Tax: Law and Practice,., Dr. H.C. Mehrotra, Dr. S.P. Goyal, Sahitya Bhawan Publications, Sixty-fifth Ed, 2024.
5. How to Save Taxes through Tax Planning, Amit Tiwari, Bharat Law House, First Ed, 2024.

Reference Books

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

Web Resources

1. Million Dollar Life Lessons- T. Harv Eker
   https://www.harveker.com/
5. Employee Provident Fund Organization portal
   https://www.epfindia.gov.in/site_en/index.php
6. Income Tax Department e-filing portal
   https://eportal.incometax.gov.in/iec/foservices/#/login
7. National Pension Scheme portal
   https://enps.nsdl.com/eNPS/NationalPensionSystem.html
8. National Stock Exchange portal
   https://www.nseindia.com/
9. Bombay Stock Exchange portal
   https://www.bseindia.com/

3.10.5 Adolescent Health and Wellbeing (IL4OE_CX5)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX5	Adolescent Health and Wellbeing	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 fundamental concepts of food, nutrients, and meal planning, enabling learners to understand the role of balanced nutrition in maintaining overall health and wellbeing.
2	To familiarize learners with adolescent health indicators, nutritional needs, and mental wellbeing, highlighting the importance of nutrition during this critical developmental stage.
3	To explain the physiological, psychological, and nutritional changes during adolescence and their long-term impact on health, immunity, and lifestyle-related outcomes.
4	To provide knowledge of nutritional care processes, dietary counselling, deficiency management, and national initiatives supporting adolescent health.
5	To develop awareness of healthy behavioral practices related to diet, physical activity, and weight management for sustainable adolescent wellbeing.

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 behaviours 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, National Institute of Nutrition (ICMR), Indian Council of Medical Research, Guideline document, 2011.
2. Guidelines for Parents: Nutrition for Adolescents, Indian Academy of Paediatrics, Indian Academy of Paediatrics, Guideline document, 2016.
3. Implementing Adolescent Nutrition Guidelines, UNICEF, UNICEF, Guideline document, 2018.

Reference Books

1. Guideline: Implementing Effective Actions for Improving Adolescent Nutrition, World Health Organization, World Health Organization, Guideline document, 2018.
2. National Health Programs of India: National Policies and Legislations Related to Health, J. Kishore, Century Publications, Thirteenth Ed, 2019.
3. Fitness Protocols and Guidelines for 5–18 Years, Ministry of Youth Affairs & Sports, Government of India, Guideline document, 2018.
4. Adolescence in India: Issues, Challenges and Possibilities, Swati Patra, Springer India, First Ed, 2017

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; Eleventh 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, Eleventh Ed. 2020.

Reference Books

1. Human Management, Stephen P. Robbins, Pearson Education; Fourteenth Ed, 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 Foreign Language – German (IL4OE_CX7)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX7	Foreign Language – German	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**		**05**
	2.1	Greetings, beginning of conversation, Introduction of oneself, numbers, counting and dates.	
3.0	**Text Interpretation and Composition**		**05**
	3.1	Reading, Comprehension and writing - (Type of Text).	
	3.2	Dialogs, Monologs, Biodata.	
4.0	**German 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**		**05**
	5.1	Emails , Technical Reports , Making presentations.	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

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

Reference Books

1. German Conversational Course - Level 1, Pimsleur, Simon & Schuster Audio, First Ed, 2005.
2. German Made Easy Level 1: An Easy Step-By-Step Approach To Learn German for Beginners, Lingo Mastery, 2 First Ed, 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 Foreign Language – French (IL4OE_CX8)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
IL4OE_CX8	Foreign Language – French	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	*explain* 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**		**05**
	1.1	Basic grammar.	

	1.2	Pronunciation and basic expressions.	
2.0	**Communication**		**05**
	2.1	Greetings, beginning of conversation, Introduction of oneself, numbers, counting and dates	
3.0	**Text Interpretation and Composition**		**05**
	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**		**05**
	5.1	Emails, Technical Reports, Making presentations	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

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

Reference Books

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

Web Resources

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

3.11 Professional Communication and Soft Skills (ILSHM_CR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
ILSHM_CR1	Professional Communication and Soft Skills	1	1

Examination and Evaluation Scheme

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

Course Objectives

S. N.	Objectives
1	To equip students with the skills required for aptitude tests and competitive exams
2	To aid students understanding and usage of advanced technical writing, focusing on clear, concise and well-structured reports
3	To develop key employability skills necessary for securing a job and work well in professional environments
4	To enhance the ability to design and deliver professional presentations with a focus on clarity, engagement and impactful delivery
5	To introduce students to AI tools that can enhance their technical and professional skills across various domains

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 Communication Skills & Ethics		
1.0	**Aptitude Tests and Competitive Exams**		**3**
	1.1	Quantitative Aptitude: Number series, Percentages	
	1.2	Logical Reasoning: Puzzles, Analogies, Verbal Reasoning: Reading Comprehension, Sentence Completion	
	1.3	GRE, TOEFL, IELTS and GATE, Exam Pattern and Syllabus Breakdown, Time Management Strategies for Exam Preparation	
2.0	**Advanced Technical Writing and Reports**		**2**
	2.1	Structure of Technical Documents: Executive Summaries, Introduction, Methodology, Findings, Conclusions and Recommendations	

	2.2	Language and Tone for Technical Communication	
	2.3	Use of Graphs, Tables and Data Visualization, Research-based Writing and Citations (Using LaTex)	
3.0	**Employability Skills**		
	3.1	Types of Interviews: Telephonic, Face-to-Face and Video	
	3.2	STAR Method for Answering Behavioral Questions, Preparing for Interviews: Resume writing, platforms for checking resume efficiency, company and profile research, documents and conduct	**4**
	3.3	Group Discussions, Leadership, Listening Skills and Body Language, Structuring Arguments and Building Consensus, Emotional Intelligence, Conflict Resolution and Building Professional Relationships	
4.0	**Advanced Presentation Skills**		
	4.1	Structuring a Presentation: Introduction, Body and Conclusion	
	4.2	Visual Design: Effective Use of Slides, SmartArt, charts and Animation	**2**
	4.3	Voice Modulation, Body Language, and Eye Contact, Handling Audience Questions and Managing Feedback, Presentations using Canva, Prezi and other creative tools	
5.0	**Use of AI Tools supporting Professional Growth**		
	5.1	5.1 AI-powered research assistants and writing tools (e.g., ChatGPT, Grammarly etc.)	
	5.2	5.2 Using AI for plagiarism detection and content generation	**2**
	5.3	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, Dr. K. Alex, S. Chand Publishing, Fourth Ed, 2021.
2. Business Communication, Leslikar, Flatley, Rentz and Pande, Cengage Learning, Twelth Ed, 2021.

Reference Books

1. The IUP Journal of Soft Skills, IUP Publications.
2. Managing Soft Skills for Personality Development, B. N. Ghosh, IUP Publications, First Ed, 2023.
3. Soft Skills and Employability Skills, Sabina Pillai, Agna Fernandez, IUP Publications, First Ed, 2023.

Web Resources

1. Past papers of GATE
   https://www.gateacademy.co.in/py-papers
2. IELTS mock tests
   https://www.bestmytest.com/ielts/test?gad_source=1&gclid=Cj0KCQiAkJO8BhCGARIsAkswyigx134y2mioqs3S5_ZiHxK9ijqJ7QS_MHS4zGRvOajrDJYPbtOEJgaAiZeEALw_wcB
3. TOEFL material
   https://tstprep.com/free-resources/
4. GRE mock tests
   https://magoosh.com/gre/gre-practice-test/
   https://crunchprep.com/gre/free-gre-practice-tests

3.12 Professional Communication and Soft Skills Lab (ILSHM_LR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AE 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

Sr. 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 students 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

Sr. No.	Suggested 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, Dr. K. Alex, S. Chand Publishing, Fourth Ed, 2021.
2. Business Communication, Leslikar, Flatley, Rentz and Pande, Cengage Learning, Twelth Ed, 2021.

Reference Books

1. The IUP Journal of Soft Skills, IUP Publications.
2. Managing Soft Skills for Personality Development, B. N. Ghosh, IUP Publications, First Ed, 2023.
3. Soft Skills and Employability Skills, Sabina Pillai, Agna Fernandez, IUP Publications, First Ed, 2023.

Web Resources

1. GATE mock tests
   https://www.gateacademy.co.in/py-papers
2. IELTS mock tests
   https://www.bestmytest.com/ielts/test?gad_source=1&gclid=Cj0KCQiAkJO8BhCGARIsAMkswyigx134y2mioqs3S5_ZiHxK9ijqJ7QS_MHS4zGRvOajrDJYPbtOEJgaAiZeEALw_wcB
3. TOEFL material
   https://tstprep.com/free-resources/
4. GRE mock tests
   https://magoosh.com/gre/gre-practice-test/
   https://crunchprep.com/gre/free-gre-practice-tests

3.13 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.	
	4.3	Code of ethics for engineers. 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, R. R. Gaur, R. Asthana, G. P. Bagaria, PHI, Third Ed, 2023.

Reference Books

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

4 Second Year Exit Courses

4.1 Data Science for Engineers (AI4EX_CR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI4EX_CR1	Data Science for Engineers	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 fundamental linear algebra concepts essential for understanding data science models and computations.
2	To build a strong foundation in statistical concepts, probability distributions, and hypothesis testing for data analysis.
3	To introduce optimization techniques and their applications in solving data science problems efficiently.
4	To develop an understanding of regression techniques for predictive modeling and classification.
5	To introduce fundamental classification and clustering techniques used in machine learning.

Course Outcomes

The student will be able to:	
CO1	apply vector and matrix operations to solve linear systems, understand rank and null space, and compute pseudo-inverses for data-driven problems.
CO2	analyze data using descriptive statistics, compute covariance matrices, and interpret probability distributions for decision-making.
CO3	formulate and solve optimization problems relevant to data science using appropriate frameworks.
CO4	apply linear and logistic regression models, evaluate their assumptions, and interpret the significance of different variables in predictive analysis.
CO5	implement kNN for classification and k-means for clustering, and evaluate their effectiveness in different datasets.

Course Contents

Module	Unit	Detailed Contents	Hours
	Prerequisites		
1.0	**Linear algebra for data science**		**05**
	1.1	Course philosophy and introduction to R	
	1.2	Algebraic view - vectors, matrices, product of matrix & vector, rank, null space, solution of over-determined set of equations and pseudo-	

		inverse)	
	1.3	Geometric view - vectors, distance, projections, eigenvalue decomposition	
2.0	**Statistics**		**05**
	2.1	Statistics (descriptive statistics, notion of probability, distributions, mean, variance, covariance, covariance matrix,	
	2.2	Understanding univariate and multivariate normal distributions, introduction to hypothesis testing, confidence interval for estimates)	
3.0	**Optimization**		**06**
	3.1	Introduction to optimization	
	3.2	Typology of data science problems and a solution framework	
4.0	**Linear and Logistics Regression**		**06**
	4.1	Simple linear regression and verifying assumptions used in linear regression	
	4.2	Multivariate linear regression, model assessment, assessing importance of different variables, subset selection	
	4.3	Classification using logistic regression	
5.0	**Classification and Clustering**		**04**
	5.1	Classification using kNN	
	5.2	k-means clustering	
		Total Hours	**26**

Suggested Learning Resources

Textbooks

1. Introduction to Linear Algebra, Gilbert Strang, Wellesley-Cambridge Press / Pearson Education, 4th Ed, 2009.
2. Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, John Wiley & Sons, 5th Ed, 2010.

Reference Books

1. An Introduction to Statistical Learning: With Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st Ed, 2013.
2. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer, 1st Ed, 2006.

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc21_ma35/preview

4.2 Data Science Lab. (AI4EX_LR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI4EX_LR1	Data Science 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 introduce fundamental linear algebra concepts essential for understanding data science models and computations.
2	To build a strong foundation in statistical concepts, probability distributions, and hypothesis testing for data analysis.
3	To introduce optimization techniques and their applications in solving data science problems efficiently.
4	To develop an understanding of regression techniques for predictive modeling and classification.
5	To introduce fundamental classification and clustering techniques used in machine learning.

Course Outcomes

The student will be able to:	
CO1	apply vector and matrix operations to solve linear systems, understand rank and null space, and compute pseudo-inverses for data-driven problems.
CO2	analyze data using descriptive statistics, compute covariance matrices, and interpret probability distributions for decision-making.
CO3	formulate and solve optimization problems relevant to data science using appropriate frameworks.
CO4	apply linear and logistic regression models, evaluate their assumptions, and interpret the significance of different variables in predictive analysis.
CO5	implement kNN for classification and k-means for clustering, and evaluate their effectiveness in different datasets.

Course Contents

Module	Suggested List of Experiments /Tutorials /Assignments
1	**Expt1**: Implement vector and matrix operations (addition, multiplication, rank, null space). Compute the pseudo-inverse of a matrix. Perform Eigenvalue decomposition and interpret results. Tools: Python (NumPy), R
2	**Expt2**: Compute mean, variance, covariance matrix for a given dataset.

	Visualize univariate and multivariate normal distributions. Conduct a hypothesis test and interpret p-values. Tools: Python (Pandas, Matplotlib, SciPy), R
3	**Expt3**: Implement gradient descent for minimizing a cost function. Compare batch gradient descent vs. stochastic gradient descent. Visualize the convergence of the cost function. Tools: Python (NumPy, Matplotlib, SciPy)
4	**Expt4**: Use simple and multiple linear regression to predict house prices. Evaluate the goodness of fit using R^2 and adjusted R^2. Analyze feature importance and subset selection. Tools: Python (Scikit-learn, Pandas, Matplotlib)
5	**Expt5**: Apply k-Means clustering on a customer dataset. Determine the optimal number of clusters using the Elbow method. Visualize the clustered data using scatter plots. Tools: Python (Scikit-learn, Seaborn, Matplotlib)

Note: Lab course shall consist of minimum 5-7 experiments covering all the topics but not limited to the suggested list.

Suggested Learning Resources

Textbooks

1. Introduction to Linear Algebra, Gilbert Strang, Wellesley-Cambridge Press / Pearson Education, 4th Ed, 2009.
2. Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, John Wiley & Sons, 5th Ed, 2010.

Reference Books

1. An Introduction to Statistical Learning: With Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st Ed, 2013.
2. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer, 1st Ed, 2006.

Web Resources

1. NPTEL, https://onlinecourses.nptel.ac.in/noc21_ma35/preview

4.3 Internship (AI4EX_PR1)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI4EX_PR1	Internship	16	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**

4.4 Project on Data Science (AI4EX_PR2)

Teaching Scheme

Course Code	Course Name	Contact Hours	Credits
AI4EX_PR2	Project on Data Science	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 *acquaint* with the process of identifying the issues and formulating a problem statement.
2	To *explore* the various approaches to solve the problem.
3	To *identify* the resources for implementation of the project.
4	To *design*, *implement* and *test* the intended solution.
5	To *inculcate* the process of self-learning and *develop* effective communication skills.

Course Outcomes

The student will be able to:	
CO1	*carry* out literature review and identify problems.
CO2	*apply* knowledge and skill to solve the problem.
CO3	*design, implement* and *test* a working prototype.
CO4	*document* and *demonstrate* the work carried out.
CO5	*build* self-learning capabilities.

Guidelines

A. Process of project identification and implementation for exit program

- Students shall carry out a survey and identify needs, which shall be converted into problem statement for project in consultation with the faculty mentor.
- Students shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled
- A log book is to be prepared to record weekly work progress,.

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.

C. **End Semester Examination**

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

- Project shall be assessed through a presentation and demonstration of working model to a panel of Internal and External Examiners preferably from industry.

Mark distribution for project 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**