Course Structure and Syllabus of the Proposed Programmes

CMR

EXPLORE TO INVENT

Distinct Programmes - Course Structure & Syllabus

Sl.No	School	UG/PG/ Integrated	Name of the Programme	Duration (Yrs)	Intake	To offer in	Category
1	Engineering & Technology	UG	Semiconductor Technology	4	60	2026-27	D+I
2		UG	Quantum Computing	4	60	2026-27	D+I
3		UG	Digital Twin Technology	4	60	2026-27	D+I
4		Integrated	AI in Health Care Technology	5	60	2026-27	D+I+M
5		PG	Computational Neuroscience & AI	2	12	2026-27	D+M
6		PG	Health Robotics and Assisted Nursing	2	12	2026-27	D+T
7	Health Sciences	UG	BSc - Digital Health	4	60	2026-27	D+M
8	Liberal Arts & Indian Culture	UG	B.A. (Hons.) Indian Knowledge Systems and Cultural Heritage	4	60	2026-27	D

D - Distinct, I – Industry-Supported, M – Multidisciplinary, T-Transdisciplinary

B.Tech in Semiconductor Technology

Year 1: Foundation (40 Credits)

I SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Mathematics I (Calculus & Differential Equations)	4
2	Engineering Physics (Solid State Physics, Quantum Basics)	4
3	Engineering Chemistry / Environmental Science	3
4	Introduction to Programming (C/Python)	3
5	Basic Electrical & Electronics Engineering	3
6	Communication Skills & Professional English	2
7	Engineering Graphics / Workshop Practice	1
	Total Credits	**20**

II SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Mathematics II (Probability, Statistics, Complex Analysis)	4
2	Materials Science & Engineering	3
3	Analog & Digital Electronics	3
4	Object-Oriented Programming	3
5	Engineering Mechanics	3
6	Design Thinking & Innovation	3
7	Internship	1
	Total Credits	**20**

Year 2: Core Electronics & Devices (40 Credits)

III SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Signals & Systems	4
2	Semiconductor Physics & Devices	4
3	Electronic Circuits	3
4	Microprocessors & Microcontrollers	3
5	Electromagnetic Theory	3
6	Humanities Elective (Ethics/Industrial Psychology)	2
7	Internship	1
	Total Credits	

IV SEMESTER (20 Credits)

S. No	Course Title	Credits
1	VLSI Design Fundamentals	4
2	Integrated Circuit Fabrication Technology	3
3	Analog & Mixed Signal Design	3
4	Control Systems	3
5	Open Elective I (CS/AI/IoT/Mechatronics)	3
6	Laboratory: Device Fabrication & Characterization	3
7	Internship	1
	Total Credits	

Year 3: Semiconductor Specialization (40 Credits)

V SEMESTER (20 Credits)

S. No	Course Title	Credits
1	CMOS Circuit Design	3
2	MEMS & Nanoelectronics	3
3	Wafer Fabrication & Cleanroom Practices	4
4	Semiconductor Packaging & Testing	3
5	Elective I (Photonics, Optoelectronics, Power Semiconductors)	3
6	Minor Project I (Chip Design / Fabrication Simulation)	4
	Total Credits	**20**

VI SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Advanced VLSI & SoC Design	3
2	Semiconductor Process Integration	3
3	EDA Tools & Verification	3
4	Embedded Systems & Applications	3
5	Open Elective II (AI for Chip Design, Quantum Computing, 5G Hardware)	3
6	Minor Project II (Prototype Device or Design Validation)	5
	Total Credits	**20**

Year 4: Industry & Research Integration (40 Credits)

VII SEMESTER

S. No	Course Title	Credits
1	Semiconductor Manufacturing & Supply Chain	3
2	Reliability & Failure Analysis of Semiconductors	3
3	Elective II (Nano-materials, Compound Semiconductors, Flexible Electronics)	3
4	Elective III (Automotive Electronics, Biomedical Devices, IoT Hardware)	3
5	Emerging Technologies in Semiconductors (AI Chips, Neuromorphic, Quantum Devices)	3
6	Industry Internship (2 months)	4
7	Major Project Phase I (Chip/Product Development)	4
	Total Credits	**19**

VIII SEMESTER

S. No	Course Title	Credits
1	Intellectual Property Rights & Tech Entrepreneurship	3
2	Major Project Phase II (Capstone Project with Industry/Research Lab)	10
3	Open Elective III (Interdisciplinary)	2
	Seminar / Viva-Voce / Portfolio Development	2
	Total Credits	**17**

Credit Distribution
Basic Sciences & Mathematics – 24
Engineering Sciences – 12
Core Electronics & Semiconductor Engineering – 45
Specialization & Professional Electives – 27
Open Electives – 8
Projects & Internships – 26
Humanities & Management – 18
Total = 160 Credits

B.Tech in Quantum Computing

Year 1: Foundation (40 Credits)

I SEMESTER

S. No	Course Title	Credits
1	Mathematics I (Calculus & Linear Algebra)	4
2	Physics I (Mechanics, Waves, Optics)	4
3	Chemistry / Environmental Science	3
4	Programming Fundamentals (Python/C)	3
5	Basic Electrical & Electronics Engineering	3
6	Communication Skills & Professional English	2
7	Engineering Graphics / Workshop Practice	1
	Total Credits	**20**

II SEMESTER

S. No	Course Title	Credits
1	Mathematics II (Probability, Statistics, Complex Variables)	4
2	Physics II (Modern Physics & Introduction to Quantum Mechanics)	4
3	Data Structures & Algorithms	3
4	Digital Logic & Computer Organization	3
5	Introduction to AI & Emerging Technologies	3
6	Humanities Elective (Ethics, Philosophy of Science)	2
7	Internship	1
	Total Credits	**20**

Year 2: Core Computing + Quantum Basics (40 Credits)

III SEMESTER

S. No	Course Title	Credits
1	Linear Algebra & Group Theory for Quantum Computing	4
2	Quantum Mechanics for Engineers	4
3	Operating Systems	3
4	Database Management Systems	3
5	Signals & Systems	3
6	Open Elective I (IoT/Robotics/Applied Math)	3
7	Internship	1
	Total Credits	**21**

IV SEMESTER

S. No	Course Title	Credits
1	Quantum Physics II (Spin, Entanglement, Measurement Theory)	3
2	Computer Networks & Cybersecurity	3
3	Algorithms & Complexity Theory	3
4	Quantum Programming (Qiskit, Cirq, PyQuil)	4
5	Machine Learning Foundations	3
6	Laboratory: Quantum Simulation Tools (IBM Q Experience)	3
7	Internship	1
	Total Credits	**20**

Year 3: Quantum Specialization (40 Credits)

V SEMESTER

S. No	Course Title	Credits
1	Quantum Algorithms (Shor's, Grover's, Variational Algorithms)	4
2	Quantum Error Correction & Fault Tolerance	3

3	Quantum Hardware (Superconducting Qubits, Trapped Ions, Photonics)	3
4	Quantum Information Theory	3
5	Elective I (Quantum Chemistry / Quantum Materials / Quantum Sensing)	3
6	Minor Project I (Quantum Simulation/Software)	4
	Total Credits	**20**

VI SEMESTER

S. No	Course Title	Credits
1	Quantum Cryptography & Quantum Communication	3
2	Cloud Quantum Computing (IBM, Google, Azure Quantum)	3
3	Quantum Machine Learning	4
4	Elective II (Quantum Optics, Topological Qubits, Neuromorphic Computing)	3
5	Open Elective II (AI for Quantum, Data Science, HPC)	3
6	Minor Project II (Prototype QC Application)	4
	Total Credits	**20**

Year 4: Industry & Research Integration (40 Credits)

VII SEMESTER

S. No	Course Title	Credits
1	Quantum Operating Systems & Compilers	3
2	Quantum Devices & Semiconductor Integration	3
3	Emerging Frontiers in Quantum Tech (Quantum Internet, Quantum Cloud, Quantum Metrology)	3
4	Elective III (Quantum Finance, Quantum Biology, Quantum AI)	3
5	Elective IV (Quantum Materials, Quantum Sensors, Space Applications)	3
6	Internship in Quantum Lab / Industry	4
7	Major Project Phase I (Product/System Prototype)	4
	Total Credits	**23**

VIII SEMESTER

S. No	Course Title	Credits
1	Tech Entrepreneurship & IPR in Quantum Technologies	3
2	Major Project Phase II (Capstone with Research Lab / Startup)	10
3	Open Elective III (Multidisciplinary – Policy, Ethics, Futuristic Tech)	2
4	Viva-Voce / Seminar / Portfolio	2
	Total Credits	**17**

Credit Distribution

Basic Sciences & Mathematics – 28
Core Computing (CS + Engineering Sciences) – 36
Core Quantum Engineering – 39

Professional Electives – 15
Open Electives – 9
Projects & Internships – 26
Humanities, Ethics & Policy – 7
Total = 160 Credits

B.Tech in Digital Twin Technology

Year 1: Foundation (40 Credits)

I SEMESTER

S. No	Course Title	Credits
1	Mathematics I (Calculus & Linear Algebra)	4
2	Physics for Engineers (Mechanics, Waves, Optics)	4
3	Chemistry / Environmental Science	3
4	Programming Fundamentals (Python/C)	3
5	Engineering Graphics & CAD	3
6	Communication Skills & Professional English	2
7	Workshop Practice / Basic Electronics	1
	Total Credits	**20**

II SEMESTER

S. No	Course Title	Credits
1	Mathematics II (Probability, Statistics, Differential Equations)	4
2	Engineering Mechanics & Materials	3
3	Data Structures & Algorithms	3
4	Electrical & Electronics Engineering Fundamentals	3
5	Introduction to IoT & Emerging Technologies	3
6	Design Thinking & Innovation	3
7	Internship	1
	Total Credits	**20**

Year 2: Core Computing + Systems (40 Credits)

III SEMESTER

S. No	Course Title	Credits
1	Signals & Systems	3
2	Database Management Systems	3
3	Computer Networks & Cybersecurity	4
4	Sensors, Actuators & Embedded Systems	3
5	Thermodynamics & Fluid Systems (for physical twins)	3
6	Humanities Elective (Industrial Psychology, Ethics)	3
7	Internship	1
	Total Credits	**20**

IV SEMESTER

S. No	Course Title	Credits
1	Modeling & Simulation Fundamentals	3

2	Control Systems & Automation	3
3	Cloud Computing & Edge Computing	3
4	Mechatronics & Cyber-Physical Systems	3
5	Open Elective I (AI/Robotics/AR-VR)	3
6	Laboratory: Simulation Tools (MATLAB, ANSYS, Simulink)	4
7	Internship	1
	Total Credits	**20**

Year 3: Digital Twin Specialization (40 Credits)

V SEMESTER

S. No	Course Title	Credits
1	Digital Twin Architecture & Platforms	4
2	3D Modeling & Additive Manufacturing (CAD/CAM/3D Printing)	3
3	Data Analytics & Machine Learning for Digital Twins	3
4	Industrial IoT (IIoT)	3
5	Elective I (Smart Cities / Healthcare Twins / Aerospace Twins)	3
6	Minor Project I (System-level Digital Twin Prototype)	4
	Total Credits	**2**

VI SEMESTER

S. No	Course Title	Credits
1	Cloud-Edge Integration for Digital Twins	3
2	AR/VR & XR Interfaces for Twin Visualization	3
3	Predictive Maintenance & Asset Management	3
4	Elective II (Defence DT, Automotive DT, Energy Systems)	3
5	Open Elective II (Blockchain, Quantum Tech, Sustainability)	3
6	Minor Project II (Industry Case Study with Simulation Lab)	5
	Total Credits	**20**

Year 4: Capstone, Industry & Research (40 Credits)

VII SEMESTER

S. No	Course Title	Credits
1	Advanced Digital Twin Applications (Smart Manufacturing, Defence, Healthcare)	3
2	AI-Driven Digital Twin Ecosystems	3
3	Emerging Trends in Digital Twin (Metaverse, Industry 5.0, Twin Transition for Sustainability)	3
4	Elective III (Robotics Twins, Human Digital Twins, Space Systems)	3
5	Elective IV (Autonomous Systems, IoT Security, Cognitive Twins)	3
6	Internship (2 months, Industry/Research Lab)	4
7	Major Project Phase I (DT Product/System Prototype)	4
	Total Credits	**23**

VIII SEMESTER

S. No	Course Title	Credits

1	Tech Entrepreneurship, IPR & Innovation Management	3
2	Major Project Phase II (Capstone – Industry/Startup Collaboration)	10
3	Open Elective III (Interdisciplinary / Management / Policy)	2
4	Seminar / Viva-Voce / Portfolio	2
	Total Credits	**17**

Credit Distribution
Basic Sciences & Mathematics – 24
Core Computing & Engineering Sciences – 36
Digital Twin Core & Labs – 37
Professional Electives – 15
Open Electives – 9
Projects & Internships – 26
Humanities, Ethics & Management – 13
Total = 160 Credits

M.Tech - AI in Healthcare Technology

Duration: 5 Years (10 Semesters)
Total Credits: 200

Credit Distribution
Basic Sciences (BS): 24–26
Engineering Sciences (ES): 20–22
Healthcare & Life Sciences (HS): 24–26
Professional Core (PC): 60–65
Professional Electives (PE): 18–20
Open Electives (OE): 12–15
Humanities & Management (HSMC): 8–10
Projects / Internships / Thesis: 30–35
Mandatory Courses (MC): Induction, Environmental Studies, Constitution of India, Professional Ethics (Non-credit)

Semester-wise Structure

I SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Mathematics – I (Calculus & Linear Algebra)	4
2	Engineering Physics / Chemistry	3
3	Programming for Problem Solving (Python/C)	3
4	Human Anatomy & Physiology	3
5	Communication Skills / Professional English	2
6	Programming Lab	2
7	Basic Sciences Lab	2
8	Induction / Environmental Studies (MC)	
	Total Credits	**20**

II SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Mathematics – II (Probability & Statistics, Differential Equations)	3
2	Data Structures & Algorithms	3
3	Principles of Electrical & Electronics Engineering	3
4	Biochemistry & Medical Biology	3

5	Healthcare Systems & Medical Terminology	3
6	Data Structures Lab	2
7	Biology / Biochemistry Lab	2
8	Internship	1
	Total Credits	**20**

III SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Object-Oriented Programming (Java/C++)	3
2	Database Management Systems	3
3	Biomedical Instrumentation	3
4	Signals & Systems	3
5	Open Elective – I	3
6	OOP & DBMS Lab	2
7	Biomedical Lab	2
8	Constitution of India / Universal Human Values (MC)	0
9	Internship	
	Total Credits	**19**

IV SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Operating Systems	3
2	Computer Networks & IoT for Healthcare	3
3	Fundamentals of Artificial Intelligence	3
4	Medical Imaging Systems	3
5	Open Elective – II	3
6	AI Lab	2
7	Imaging & IoT Lab	2
8	Mini Project – I	1
	Total Credits	**20**

V SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Machine Learning	3
2	Healthcare Data Analytics	3
3	Cloud Computing for Health Data	3
4	Medical Ethics, Regulations & Standards	3
5	Professional Elective – I	3
6	ML Lab	2
7	Healthcare Data Lab	2
8	Minor Project – II (AI for Clinical Dataset)	1
	Total Credits	**20**

VI SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Deep Learning	3
2	Natural Language Processing in Healthcare	3
3	Digital Health & Telemedicine	3
4	Biosignal Processing (ECG, EEG, EMG)	3
5	Professional Elective – II	3
6	DL Lab	2

7	Biosignal Lab	2
8	Innovation Lab / Prototype Development	1
	Total Credits	**20**

VII SEMESTER (20 Credits)

S. No	Course Title	Credits
1	AI in Medical Imaging (Radiology, Pathology, Ophthalmology)	3
2	Robotics in Surgery & Rehabilitation	3
3	Reinforcement Learning for Healthcare Systems	3
4	Professional Elective – III	3
5	Open Elective – III	3
6	Healthcare AI Lab	2
7	Seminar / Technical Writing	2
8	Mini Project – III (Clinical AI Pilot Project)	1
	Total Credits	**20**

VIII SEMESTER (20 Credits)-B. Tech Exit Point

S. No	Course Title	Credits
1	Advanced Healthcare Systems & Hospital Management	3
2	Cybersecurity & Privacy in Health Data	3
3	Professional Elective – IV	3
4	Comprehensive Viva / Qualifying Exam	2
5	Major Project – I (Capstone: AI-Healthcare Solution)	9
	Total Credits	**20**

IX SEMESTER (20 Credits)-M. Tech Phase

S. No	Course Title	Credits
1	Advanced Topics in AI for Healthcare (Precision Medicine, Genomics AI)	3
2	AI-driven Drug Discovery & Personalized Therapy	3
3	Research Methodology & Paper Writing	2
4	Professional Elective – V	3
5	Open Elective – IV	3
6	Major Project – II (Research/Product Development)	6
	Total Credits	**20**

X SEMESTER (20 Credits)-M. Tech Phase

S. No	Course Title	Credits
1	Dissertation / Thesis (Healthcare AI Application)	16
2	Seminar & Publications	2
3	Clinical / Industry Internship	2
	Total Credits	**20**

Elective Baskets

Professional Electives

AI in Oncology, Cardiology, Neurology

Wearable Devices & Remote Monitoring

AR/VR in Medical Training & Surgery

Predictive Analytics for Public Health

AI for Genomics & Precision Medicine

Digital Twins in Healthcare

Open Electives

Bioethics & Health Policy

Entrepreneurship in Healthcare Tech
Cognitive Science & Human Factors
Business Analytics in Pharma/Healthcare
Global Health & Sustainable Development

M.Tech in Computational Neuroscience and AI

Duration: 2 Years (4 Semesters) | **Total Credits:** 80 |
Program Type: Interdisciplinary (Engineering + Cognitive Science + AI)

I SEMESTER (Foundation (17 Credits)

S. No	Course Code	Course Title	L	T	P	Credits
1	CNS 101	Fundamentals of Neuroscience for Engineers	3	0	0	3
2	CNS 102	Mathematical Foundations for Neural Computation	3	1	0	4
3	CNS 103	Machine Learning & Deep Learning Techniques	3	0	2	4
4	CNS 104	Neural Signal Processing & Brain Data Analytics	3	0	2	4
5	CNS 105	Neuroscience & AI Simulation Lab (Python/MATLAB/NEURON)	0	0	4	2
6	CNS 106	Research Methodology & IPR (Audit/Non-Credit)	2	0	0	2
		Total Credits				**17**

II SEMESTER (Cognitive and Computational Models (18 Credits))

S. No	Course Code	Course Title	L	T	P	Credits
1	CNS 201	Cognitive Computing & Brain Modeling	3	0	2	4
2	CNS 202	Artificial Neural Systems & Spiking Neural Networks	3	0	2	4
3	CNS E1	Program Elective – I (choose 1)	3	0	0	3
4	CNS E2	Program Elective – II (choose 1)	3	0	0	3
5	CNS 203	Cognitive-AI Project / Innovation Lab	0	0	4	2
6	CNS 204	Technical Seminar / Review Presentation	0	2	0	2
		Total Credits				**18**

Elective Pool – I & II (Indicative):
- Neuro-Dynamics & Biophysical Modeling
- Neuromorphic Computing and Edge AI
- Reinforcement Learning and Decision Neuroscience
- Explainable AI for Biomedical Systems
- Natural Language Processing for Neural Data

III SEMESTER (Applications & Research Integration (17 Credits))

S. No	Course Code	Course Title	L	T	P	Credits
1	CNS 301	Neuroinformatics & Computational Cognition	3	0	0	3

2	CNS 302	Brain–Computer Interfaces & Neural Prosthetics	3	0	2	4
3	CNS E3	Program Elective – III	3	0	0	3
4	CNS OE1	Open/Interdisciplinary Elective (Industry / HealthTech / Robotics)	3	0	0	3
5	CNS 303	Mini Research Project / Design Studio – I	0	0	8	4
		Total Credits				**17**

Elective Pool – III (Open):
. Bioinformatics and Genomic Data Analytics
• Biomedical Signal & Image Processing
• Robotics and Neural Control Systems
• Human–Computer Interaction & AR/VR

IV SEMESTER (Dissertation & Capstone (13 Credits))

S. No	Course Code	Course Title	L	T	P	Credits
1	CNS 401	Major Thesis / Dissertation (Phase II)	0	0	24	12
2	CNS 402	Comprehensive Viva / Publication Seminar	0	0	0	1
		Total Credits				**13**

Overall Program Summary Semester Credits
Semester I 17
Semester II 18
Semester III 17
Semester IV 13
Total 80 Credits

M.Tech in Health Robotics and Assisted Nursing

Duration: 2 Years (4 Semesters) | **Total Credits:** 80 |
Eligibility: B.E./B.Tech in Biomedical / Electronics / Mechatronics / AI & Robotics / Instrumentation / Allied Health Sciences (B.Sc. Nursing, BPT, BOT, etc.) with bridge courses as needed.

I SEMESTER (Foundations of Health Robotics (17 Credits))

S. No	Course Code	Course Title	L	T	P	Credits
1	HRA 101	Human Anatomy, Physiology & Biomechanics for Engineers	3	0	0	3
2	HRA 102	Fundamentals of Robotics and Mechatronic Systems	3	1	0	4
3	HRA 103	Sensors, Actuators & Control Systems in Healthcare Devices	3	0	2	4
4	HRA 104	AI & Machine Learning for Health Robotics	3	0	2	4
5	HRA 105	Health Robotics Simulation & Prototyping Lab (MATLAB / ROS / Arduino / SolidWorks)	0	0	4	2
6	HRA 106*	Research Methodology, Biostatistics & IPR (Audit Course)	2	0	0	0
		Total Credits				**17**

II SEMESTER (Intelligent Systems and Assisted Care (18 Credits))

S. No	Course Code	Course Title	L	T	P	Credits
1	HRA 201	Rehabilitation Robotics and Human–Robot Interaction	3	0	2	4
2	HRA 202	Embedded Systems & IoT for Healthcare Monitoring	3	0	2	4
3	HRA 203	Clinical Nursing Informatics and Patient Safety Systems	3	0	0	3
4	HRA E1	Elective – I (choose one)	3	0	0	3
5	HRA E2	Elective – II (choose one)	3	0	0	3
6	HRA 204	Technical Seminar & Case Study on Health Robotics	0	2	0	2
		Total Credits				**18**

Elective Pool – I & II (Illustrative):

• Assistive & Companion Robots for Elderly Care
• Biomedical Signal & Image Processing
• AI in Clinical Decision Support Systems
• Ethical and Regulatory Frameworks in Medical Robotics
• Robotic Surgery Systems & Haptics

III SEMESTER (Integration, Research & Application (17 Credits))

S. No	Course Code	Course Title	L	T	P	Credits
1	HRA 301	Intelligent Prosthetics & Exoskeleton Design	3	0	2	4
2	HRA 302	Tele-Nursing and Remote Assistance Systems	3	0	2	4
3	HRA E3	Elective – III	3	0	0	3
4	HRA OE1	Open / Interdisciplinary Elective (Innovation / Entrepreneurship / Bioethics)	3	0	0	3
5	HRA 303	Mini Project / Design Studio – I (Prototype Development)	0	0	8	4
		Total Credits				**17**

Elective Pool – III (Examples):

• Wearable Health Devices & Smart Fabrics
• Cyber-Physical Systems in Healthcare
• Advanced 3D Printing for Prosthetic Devices
• AI-Driven Rehabilitation Planning

IV SEMESTER (Dissertation & Industry Immersion (13 Credits))

S. No	Course Code	Course Title	L	T	P	Credits
1	HRA 401	Major Thesis / Industry-Linked Research Project	0	0	24	12
2	HRA 402	Comprehensive Viva / Research Publication Seminar	0	0	0	1
		Total Credits				**13**

Total Credits Summary
Semester Credits
Semester I 17
Semester II 18

Semester III 17
Semester IV 13
Total 80 Credits

BSc. in Digital Health

Duration: 4 Years (8 Semesters)
Total Credits: 180 (including Internship)

Credit Distribution
• **Basic Sciences (BS):** 20–22
• **Medical Sciences (MS):** 20–24
• **Professional Core (PC – Digital Health, Data, AI, ICT):** 70–75
• **Professional Electives (PE):** 10–12
• **Open Electives (OE):** 6–8
• **Humanities, Ethics & Management (HSMC):** 8–10
• **Research Project / Dissertation:** 5–6
• **Internship (Industry/Clinical/Tech):** 20–22
• **Mandatory Courses (MC):** Induction, Environmental Studies, Constitution of India, Professional Ethics (Non-credit)

I SEMESTER (19 Credits)

S. No	Course Title	Credits
1	Human Anatomy & Physiology – I	4
2	Introduction to Healthcare Systems	3
3	Basics of Computer Science & Digital Technologies	3
4	English Communication & Professional Skills	2
5	Mathematics for Data Analytics	3
6	Anatomy & Physiology Lab	2
7	Computer Fundamentals Lab	2
8	Environmental Studies (MC)	0
	Total Credits	**19**

II SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Human Anatomy & Physiology – II	4
2	Biochemistry & Pathology Basics	3
3	Database Management Systems	3
4	Health Information Systems & EHR	3
5	Programming Fundamentals (Python/R)	3
6	DBMS Lab	2
7	Digital Health Systems Lab	2
8	Constitution of India / Universal Human Values (MC)	0
	Total Credits	**20**

III SEMESTER (20 Credits)

S. No	Course Title	Credits
1	Medical Terminology & Clinical Workflows	3
2	Epidemiology & Public Health Informatics	3
3	Data Structures & Algorithms	3
4	Telemedicine & Telehealth Platforms	3

5	Open Elective – I	3
6	Data Structures Lab	2
7	Telemedicine Lab	3
	Total Credits	**20**

IV SEMESTER (22 Credits)

S. No	Course Title	Credits
1	Biostatistics & Research Methodology	3
2	Digital Health Devices, IoT & Wearables	3
3	Artificial Intelligence in Healthcare	3
4	Cybersecurity & Privacy in Health Data	3
5	Open Elective – II	3
6	AI in Healthcare Lab	3
7	IoT & Wearables Lab	4
	Total Credits	**22**

V SEMESTER (22 Credits)

S. No	Course Title	Credits
1	Cloud Computing & Health Data Storage	3
2	Machine Learning Applications in Healthcare	3
3	Blockchain & Digital Records Management	3
4	Health Data Analytics & Visualization	3
5	Professional Elective – I	3
6	ML in Healthcare Lab	3
7	Mini Project – I (Digital Health Prototype)	4
	Total Credits	**22**

VI SEMESTER (22 Credits)

S. No	Course Title	Credits
1	Advanced Digital Health Platforms (Smart Hospitals)	3
2	Mobile Health (mHealth) Applications	3
3	Predictive Analytics & Precision Medicine	3
4	Hospital Information Systems & Digital Transformation	3
5	Professional Elective – II	3
6	Digital Health Application Development Lab	3
7	Research Project / Dissertation	4
	Total Credits	**22**

VII SEMESTER (24 Credits) - Internship Phase - I)

S. No	Course Title	Credits
1	**Industry/Clinical Internship (6 months)** (Rotations: Hospitals, Health IT Companies, EHR Vendors, Telemedicine Firms)	20
2	Seminar & Technical Writing	4
	Total Credits	**24**

VIII SEMESTER (24 Credits) - Internship Phase - II)

S. No	Course Title	Credits
1	**Industry/Research Internship (6 months)** (Rotations: AI Health Startups, Global Digital Health Projects, WHO/NGO	20

	Health Informatics Labs)	
2	Comprehensive Viva & Exit Examination	4
	Total Credits	**24**

Professional Electives (Basket)
- AI & Deep Learning in Diagnostics
- Digital Therapeutics (DTx)
- Health Economics & Policy Analytics
- AR/VR for Healthcare Training
- Robotics in Surgery & Digital Assistance
- Genomics & Bioinformatics for Digital Health

B.A. (Hons.) Indian Knowledge Systems and Cultural Heritage

Duration: 4 Years (8 Semesters) | **Total Credits:** 160 |
Framework: NEP-2020 (CBCS, ABC, Multi-Entry–Exit)

Semester I – Foundations (20 Credits)

Code	Course Title	L	T	P	C
IKS 101	Foundations of Indian Knowledge Systems	3	0	0	3
IKS 102	Introduction to Sanskrit Language – Level I	2	1	0	3
IKS 103	Indian History & Civilization – Pre-Vedic to Gupta Era	3	0	0	3
AEC 101	Communication Skills in English	2	0	2	3
VAC 101	Yoga, Wellness & Human Values	1	0	2	2
MDC 101	Environmental Studies / Indian Ecology & Sustainability	3	0	0	3
Total		**14**	**1**	**4**	**20**

Semester II – Heritage & Philosophy (20 Credits)

Code	Course Title	L	T	P	C
IKS 201	Indian Philosophy – Darshanas & Thinkers	3	0	0	3
IKS 202	Sanskrit Language – Level II	2	1	0	3
IKS 203	Cultural Heritage of India: Art, Architecture & Literature	3	0	2	4
SEC 201	Digital Tools for Heritage Documentation	1	0	2	2
VAC 201	Indian Logic & Scientific Thought	2	0	0	2
OEC 201	Comparative Civilizations / Global Heritage Studies	3	0	0	3
Total		**14**	**1**	**4**	**20**

Semester III – Knowledge Traditions (20 Credits)

Code	Course Title	L	T	P	C
IKS 301	Vedic & Upanishadic Knowledge Traditions	3	0	0	3
IKS 302	Indian Society, Ethics & Governance	3	0	0	3
IKS 303	Heritage Conservation & Museum Studies	2	0	2	3
AEC 301	Telugu / Sanskrit for Knowledge Texts	2	1	0	3

VAC 301	Life Skills & Emotional Intelligence	1	0	2	2
OEC 301	Performing Arts, Music & Aesthetics of India	3	0	0	3
Total		**14**	**1**	**4**	**20**

Semester IV – Indian Sciences & Research (20 Credits)

Code	Course Title	L	T	P	C
IKS 401	Indian Sciences: Ayurveda, Astronomy & Mathematics	3	0	0	3
IKS 402	Indian Epics, Puranas & Narratives	3	0	0	3
IKS 403	Research Methodology in IKS	2	1	0	3
SEC 401	Heritage Field Study / Temple Architecture Mapping	0	0	4	2
OEC 401	Indian Polity & Legal Traditions	3	0	0	3
VAC 401	Value Education & Ethics of Governance	2	0	0	2
Total		**13**	**1**	**4**	**20**

Semester V – Integration & Practice (20 Credits)

Code	Course Title	L	T	P	C
IKS 501	Indian Knowledge & Modern Science Dialogue	3	0	0	3
IKS 502	Indigenous Technologies & Craft Traditions	2	0	2	3
IKS 503	Cultural Heritage Management	3	0	0	3
MNE 501	Multidisciplinary Elective I	3	0	0	3
EXP 501	Internship / Fieldwork in Museum / Cultural Centre	0	0	6	3
VAC 501	Employability & Career Skills	2	0	0	2
Total		**13**	**0**	**8**	**20**

Semester VI – Application & Outreach (20 Credits)

Code	Course Title	L	T	P	C
IKS 601	Indian Aesthetics & Performing Traditions	3	0	0	3
IKS 602	Contemporary Relevance of IKS	3	0	0	3
IKS 603	Heritage Laws & Intellectual Property	3	0	0	3
MNE 601	Multidisciplinary Elective II	3	0	0	3
PRJ 601	Community Heritage Project / Documentation	0	0	6	3
VAC 601	Personality Development & Leadership	2	0	0	2
Total		**14**	**0**	**6**	**20**

Semester VII – Advanced Studies (20 Credits)

Code	Course Title	L	T	P	C
IKS 701	Indian Knowledge Systems in Global Context	3	0	0	3
IKS 702	Advanced Sanskrit Texts & Commentaries	3	1	0	4
IKS 703	Research Seminar / Thesis Proposal	0	2	2	3

DSE 701	Discipline Elective (Yoga Science / Comparative Philosophy / Indian Logic)	3	0	0	3
EXP 701	Heritage Tourism / Outreach Internship	0	0	6	3
Total		**9**	**3**	**8**	**20**

Semester VIII – Capstone & Professional (20 Credits)

Code	Course Title	L	T	P	C
IKS 801	Dissertation / Major Project on IKS & Cultural Heritage	0	0	12	6
IKS 802	Entrepreneurship in Culture & Heritage Industries	2	0	2	3
OEC 801	Indian Knowledge for Sustainable Development	3	0	0	3
VAC 801	Professional Ethics & Global Citizenship	2	0	0	2
IKS 803	Comprehensive Viva / Portfolio Presentation	0	0	6	3
Total		**7**	**0**	**20**	**20**

Program Summary

Category	Total Credits	Percentage of Total (160 Cr)
Core Courses (IKS & Major Subjects)	88	**55 %**
Ability Enhancement Courses (AEC – Communication, Language, Life Skills)	16	**10 %**
Multidisciplinary / Discipline Electives (MNE / OEC / DSE)	24	**15 %**
Skill / Value Added Courses (VAC / SEC)	20	**12.5 %**
Interdisciplinary / Experiential (Internship, Project, Dissertation)	12	**7.5 %**
Total	**160**	**100 %**

Multiple Entry-Exit Options (as per NEP 2020)

- **Exit after 1 Year (40 Cr):** Certificate in Indian Knowledge and Culture
- **Exit after 2 Years (80 Cr):** Diploma in Indian Culture and Heritage
- **Exit after 3 Years (120 Cr):** B.A. in Indian Knowledge Systems and Heritage
- **4 Years (160 Cr): B.A. (Hons.) / B.A. (Hons. with Research)**

B.Tech in Semiconductor Technology

Duration: 4 Years (8 Semesters) | Total Credits: 160

B.Tech in Semiconductor Technology – Semester I

Mathematics I (Calculus & Differential Equations)
(BS – Basic Science Course) – 4 Credits / 60 Hours

Course Objectives:
• To strengthen theoretical foundations and analytical thinking.
• To develop applications related to semiconductor technology.
• To build problem-solving skills through systematic study.

Course Outcomes:
CO1 – Explain the fundamental concepts.
CO2 – Apply theoretical principles to practical problems.
CO3 – Analyze results and communicate effectively.
CO4 – Use computational or laboratory tools to support analysis.
CO5 – Integrate interdisciplinary knowledge for engineering applications.

Detailed Syllabus

Unit I – Differential Calculus (12 Hours)
Functions, limits, and continuity; partial differentiation; total derivatives; Jacobians; errors and approximations; applications of derivatives to engineering problems such as rates of change and maxima–minima of functions; curvature and radius of curvature; use of partial derivatives in error estimation.

Unit II – Applications of Partial Differentiation (12 Hours)
Maxima and minima of functions of two variables; constrained optimization using Lagrange multipliers; Taylor and Maclaurin expansions for functions of one and two variables; use of expansion in approximation of functions and modeling physical systems.

Unit III – First-order Differential Equations (12 Hours)
Formation and solution of first-order ODEs; separable, homogeneous, exact, and linear forms; integrating factors; Bernoulli and Clairaut equations; orthogonal trajectories; applications to current flow, thermal systems, and decay–growth models.

Unit IV – Higher-order Linear Differential Equations (12 Hours)
Linear differential equations with constant coefficients; Cauchy–Euler and Legendre equations; method of variation of parameters; simultaneous first-order equations; applications in oscillatory motion and electrical RLC circuits.

Unit V – Laplace Transforms (12 Hours)
Definition, properties, and inverse transforms; derivatives and integrals of transforms;

unit-step and delta functions; convolution theorem; solving linear ODEs using Laplace transforms for mechanical and electrical systems.

Text Books:
1. B.S. Grewal – Higher Engineering Mathematics (Khanna Publishers) 2. E. Kreyszig – Advanced Engineering Mathematics (Wiley)

Reference Books:
1. Erwin Kreyszig – Essential Mathematics for Engineers
2. P.N. Wartikar – Applied Mathematics for Engineers

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Engineering Physics (Solid State Physics & Quantum Basics)
(BS – Basic Science Course) – 4 Credits / 60 Hours

Course Objectives:
- To strengthen theoretical foundations and analytical thinking.
- To develop applications related to semiconductor technology.
- To build problem-solving skills through systematic study.

Course Outcomes:
CO1 – Explain the fundamental concepts.
CO2 – Apply theoretical principles to practical problems.
CO3 – Analyze results and communicate effectively.
CO4 – Use computational or laboratory tools to support analysis.
CO5 – Integrate interdisciplinary knowledge for engineering applications.

Detailed Syllabus

Unit I – Crystal Structure and Diffraction (12 Hours)
Lattice, unit cell, Bravais lattices, Miller indices, inter-planar spacing; X-ray diffraction and Bragg's law; determination of crystal structure; crystal imperfections and their influence on material properties.

Unit II – Quantum Theory and Applications (12 Hours)
Limitations of classical physics, Planck's quantum theory, photoelectric effect, Compton effect, de Broglie hypothesis, uncertainty principle, Schrödinger equation and its applications (particle in a box, potential barrier).

Unit III – Band Theory of Solids (12 Hours)
Energy bands in solids, Kronig–Penney model, effective mass, distinction between metals, semiconductors, and insulators; intrinsic and extrinsic semiconductors; carrier concentration and Fermi level position.

Unit IV – Dielectric and Optical Properties (12 Hours)
Polarization, dielectric constant, ferroelectricity; optical absorption and emission; photoconductivity, photoluminescence, and related semiconductor optical effects.

Unit V – Magnetic and Superconducting Materials (12 Hours)
Types of magnetic materials; B–H curves; domain theory; introduction to superconductivity – Meissner effect, critical temperature, type I & II superconductors, applications in magneto-electronics.

Text Books:
1. M.N. Avadhanulu & P.G. Kshirsagar –A Textbook of Engineering Physics
2. S.O. Pillai – Solid State Physics

Reference Books:
1. Arthur Beiser – Concepts of Modern Physics
2. R.K. Gaur & S.L. Gupta – Engineering Physics

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Engineering Chemistry / Environmental Science
(BS – Basic Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen theoretical foundations and analytical thinking.
• To develop applications related to semiconductor technology.
• To build problem-solving skills through systematic study.

Course Outcomes:
CO1 – Explain the fundamental concepts.
CO2 – Apply theoretical principles to practical problems.
CO3 – Analyze results and communicate effectively.
CO4 – Use computational or laboratory tools to support analysis.
CO5 – Integrate interdisciplinary knowledge for engineering applications.

Detailed Syllabus

Unit I – Water Chemistry (9 Hours)
Sources and impurities; hardness; treatment using ion exchange and reverse osmosis; desalination; cooling-tower and boiler feed-water chemistry.

Unit II – Corrosion and Protection (9 Hours)
Electrochemical theory; types of corrosion; galvanic and pitting corrosion; protective coatings, paints, and inhibitors; cathodic protection.

Unit III – Polymers and Nanomaterials (9 Hours)
Classification, polymerization mechanisms; conducting polymers; composites; synthesis and applications of nanomaterials in electronic devices.

Unit IV – Energy Sources and Batteries (9 Hours)
Conventional and renewable energy resources; fuel cells, batteries, and supercapacitors; solid oxide fuel cells and lithium-ion technology.

Unit V – Environmental Sustainability (9 Hours)
Pollution control; waste management; green chemistry principles; sustainable materials and circular economy concepts.

Text Books:
1. Jain & Jain – Engineering Chemistry
2. P. C. Jain – Environmental Studies

Reference Books:
1. S.S. Dara – Environmental Chemistry
2. De & De – Chemical Thermodynamics for Engineers

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Introduction to Programming (C / Python)
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
- To strengthen theoretical foundations and analytical thinking.
- To develop applications related to semiconductor technology.
- To build problem-solving skills through systematic study.

Course Outcomes:
CO1 – Explain the fundamental concepts.
CO2 – Apply theoretical principles to practical problems.
CO3 – Analyze results and communicate effectively.
CO4 – Use computational or laboratory tools to support analysis.
CO5 – Integrate interdisciplinary knowledge for engineering applications.

Detailed Syllabus

Unit I – Algorithm & Flowchart Design (9 Hours)
Problem solving approaches; algorithms and flowcharts; program structure; introduction to compilers, linkers, and IDEs.

Unit II – Fundamentals of C/Python (9 Hours)
Data types, variables, operators; conditional and looping constructs; simple programs illustrating control flow.

Unit III – Arrays, Strings & Functions (9 Hours)
Single and multi-dimensional arrays, string handling; functions, recursion, scope rules, and modular programming.

Unit IV – Structures, Pointers & File I/O (9 Hours)
Structure definition and usage, pointer concepts, dynamic memory allocation, file operations; handling data files for engineering applications.

Unit V – Python for Engineering (9 Hours)
Data structures (lists, tuples, dictionaries), user-defined functions, modules, packages; introduction to data visualization and device-data simulation.

Text Books:
1. E. Balagurusamy – Programming in ANSI C
2. Reema Thareja – Python Programming Using Problem Solving Approach

Reference Books:
1. Yashavant Kanetkar – Let Us C
2. Mark Lutz – Learning Python

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Basic Electrical & Electronics Engineering
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen theoretical foundations and analytical thinking.
• To develop applications related to semiconductor technology.
• To build problem-solving skills through systematic study.

Course Outcomes:
CO1 – Explain the fundamental concepts.
CO2 – Apply theoretical principles to practical problems.
CO3 – Analyze results and communicate effectively.
CO4 – Use computational or laboratory tools to support analysis.
CO5 – Integrate interdisciplinary knowledge for engineering applications.

Detailed Syllabus

Unit I – DC Circuits (9 Hours)
Ohm’s law, Kirchhoff’s laws; series-parallel networks; mesh and nodal analysis; Thevenin’s and Norton’s theorems; practical applications.

Unit II – AC Circuits (9 Hours)
Sinusoidal waveforms, RMS values, phase relations; impedance, power, resonance, and power factor improvement.

Unit III – Transformers and Machines (9 Hours)
Principle and construction of single-phase transformer, efficiency and losses; DC generators and motors; single-phase induction motor basics.

Unit IV – Semiconductor Devices (9 Hours)
PN junction, diode characteristics, Zener diode regulators; transistor configurations; FET and MOSFET introduction.

Unit V – Operational Amplifiers and Instrumentation (9 Hours)
Op-amp characteristics, applications (adder, comparator, integrator); measurement of voltage, current using CRO and digital instruments.

Text Books:
1. R.S. Sedha – Applied Electronics
2. D.P. Kothari – Basic Electrical Engineering

Reference Books:
1. V.K. Mehta – Principles of Electrical Engineering
2. Boylestad & Nashelsky – Electronic Devices and Circuit Theory

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Communication Skills & Professional English
(HS – Humanities and Social Science Course) – 2 Credits / 30 Hours

Course Objectives:
• To strengthen theoretical foundations and analytical thinking.
• To develop applications related to semiconductor technology.
• To build problem-solving skills through systematic study.

Course Outcomes:
CO1 – Explain the fundamental concepts.
CO2 – Apply theoretical principles to practical problems.
CO3 – Analyze results and communicate effectively.
CO4 – Use computational or laboratory tools to support analysis.
CO5 – Integrate interdisciplinary knowledge for engineering applications.

Detailed Syllabus

Unit I – Grammar and Usage (6 Hours)
Sentence structure, tenses, prepositions, and subject-verb agreement; error correction and vocabulary building.

Unit II – Listening & Reading Skills (6 Hours)
Listening comprehension through audio/video exercises; reading techniques—skimming, scanning, inference, and critical reading.

Unit III – Writing Skills (6 Hours)
Paragraph and essay writing; technical reports, emails, and memos; resume and cover-letter preparation.

Unit IV – Oral Communication (6 Hours)
Presentation techniques, group discussion, mock interviews; non-verbal communication and body language.

Unit V – Professional Development (6 Hours)
Work ethics, time management, leadership, and teamwork; cross-cultural communication and workplace etiquette.

Text Books:
1. Meenakshi Raman & Sangeeta Sharma – Technical Communication
2. Andrea J. Rutherford – Basic Communication Skills for Technology

Reference Books:
1. Krishna Mohanty – Professional English
2. Raymond Murphy – English Grammar in Use

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Engineering Graphics / Workshop Practice
(ES – Engineering Science Course) – 1 Credits / 15 Hours

Course Objectives:
• To strengthen theoretical foundations and analytical thinking.
• To develop applications related to semiconductor technology.
• To build problem-solving skills through systematic study.

Course Outcomes:
CO1 – Explain the fundamental concepts.
CO2 – Apply theoretical principles to practical problems.
CO3 – Analyze results and communicate effectively.
CO4 – Use computational or laboratory tools to support analysis.
CO5 – Integrate interdisciplinary knowledge for engineering applications.

Detailed Syllabus

Module I – Basics of Engineering Drawing (5 Hours)
Introduction to drawing instruments, BIS conventions, lettering, dimensioning, and scales.

Module II – Projection of Points and Solids (5 Hours)
Orthographic projection of points, lines, planes, simple solids; isometric projections.

Module III – Workshop Practice (5 Hours)
Fitting, carpentry, welding, sheet-metal work, and simple electrical wiring exercises emphasizing safety.

Text Books:
1. N.D. Bhatt – Engineering Drawing
2. S.K. Hajra Choudhury – Workshop Technology

Reference Books:
1. Gill & Gill – Engineering Graphics
2. K.L. Narayana – Production Technology

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

B.Tech in Semiconductor Technology – Semester II

Mathematics II (Probability, Statistics & Complex Analysis)
(BS – Basic Science Course) – 4 Credits / 60 Hours

Course Objectives:
• To strengthen theoretical understanding of core engineering principles.
• To connect knowledge with semiconductor applications.
• To enhance analytical and design skills.

Course Outcomes:
CO1 – Explain fundamental concepts and principles.
CO2 – Apply theory to solve engineering problems.
CO3 – Analyze systems and processes.
CO4 – Demonstrate professional and communication skills.
CO5 – Integrate multi-disciplinary knowledge.

Detailed Syllabus

Unit I – Probability Theory (12 Hours)
Basic probability concepts; sample space, events, conditional probability, Bayes theorem; random variables – discrete and continuous; probability mass and density functions; expectation and variance; applications in engineering data analysis.

Unit II – Statistical Distributions (12 Hours)
Binomial, Poisson, and normal distributions; mean and standard deviation; central limit theorem; moment generating functions; applications to measurement errors and reliability of semiconductor devices.

Unit III – Correlation and Regression (12 Hours)
Linear and non-linear regression; least square method; correlation coefficient; multiple regression; curve fitting; statistical quality control charts and their use in fabrication and process monitoring.

Unit IV – Complex Variables (12 Hours)
Complex numbers, functions of a complex variable, analytic functions; Cauchy–Riemann equations; conformal mapping; complex integration and Cauchy’s integral theorem; applications in electromagnetic and thermal field problems.

Unit V – Fourier and Laplace Transforms (12 Hours)
Fourier series and Fourier transforms; Laplace transform review and applications; Z-transform introduction; solution of boundary value problems in circuits and signals.

Text Books:
1. B.S. Grewal – Higher Engineering Mathematics

2. Erwin Kreyszig – Advanced Engineering Mathematics

Reference Books:
1. Miller & Freund – Probability and Statistics
2. Spiegel – Complex Variables (Schaum Series)

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Materials Science & Engineering
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen theoretical understanding of core engineering principles.
• To connect knowledge with semiconductor applications.
• To enhance analytical and design skills.

Course Outcomes:
CO1 – Explain fundamental concepts and principles.
CO2 – Apply theory to solve engineering problems.
CO3 – Analyze systems and processes.
CO4 – Demonstrate professional and communication skills.
CO5 – Integrate multi-disciplinary knowledge.

Detailed Syllabus

Unit I – Atomic Structure and Bonding (9 Hours)
Crystal structures, atomic packing factor, coordination number; types of atomic bonding – metallic, covalent, ionic, and van der Waals; effect of bonding on electrical and thermal properties of materials.

Unit II – Crystal Imperfections and Diffusion (9 Hours)
Point, line, and surface defects; dislocations and their role in material properties; diffusion mechanisms – Fick's laws; diffusion in semiconductors; dopant diffusion profiles.

Unit III – Mechanical and Thermal Properties (9 Hours)
Stress–strain relations, elastic and plastic deformation, hardness, toughness, creep, fatigue; thermal expansion and conductivity; failure of materials under cyclic load.

Unit IV – Electronic and Magnetic Properties (9 Hours)
Conductivity, resistivity, dielectric constant, magnetic susceptibility; semiconductors and superconductors; optical properties; effect of impurities on properties.

Unit V – Advanced Materials for Semiconductor Applications (9 Hours)
Thin-film materials, epitaxy, nanomaterials, and composite materials; fabrication methods (CVD, PVD, ALD); materials selection for IC fabrication and packaging.

Text Books:
1. Callister & Rethwisch – Materials Science and Engineering
2. V. Raghavan – Materials Science and Engineering

Reference Books:
1. Kasap – Principles of Electronic Materials
2. Askeland – Science and Engineering of Materials

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Analog & Digital Electronics
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen theoretical understanding of core engineering principles.
• To connect knowledge with semiconductor applications.
• To enhance analytical and design skills.

Course Outcomes:
CO1 – Explain fundamental concepts and principles.
CO2 – Apply theory to solve engineering problems.
CO3 – Analyze systems and processes.
CO4 – Demonstrate professional and communication skills.
CO5 – Integrate multi-disciplinary knowledge.

Detailed Syllabus

Unit I – Semiconductor Diodes and Applications (9 Hours)
PN-junction diode characteristics, Zener diode, rectifiers, clippers, clampers; filters; LED and photodiode working principles.

Unit II – BJT and FET Amplifiers (9 Hours)
Transistor characteristics; biasing and load line; small-signal models; CE and CS amplifiers; frequency response and multistage amplifiers.

Unit III – Operational Amplifiers (9 Hours)
Op-amp parameters and configurations; summing amplifier, comparator, integrator, differentiator; instrumentation amplifier; analog filters.

Unit IV – Digital Logic Circuits (9 Hours)
Number systems, Boolean algebra, logic gates, minimization using Karnaugh maps; combinational circuits – adders, multiplexers, encoders, decoders.

Unit V – Sequential Circuits and Memory Devices (9 Hours)
Flip-flops, registers, counters, state diagrams; memories – ROM, RAM, EPROM; introduction to PLDs and FPGA concepts.

Text Books:
1. Millman & Halkias – Electronic Devices and Circuits
2. M. Morris Mano – Digital Logic Design

Reference Books:
1. Sedra & Smith – Microelectronic Circuits
2. Floyd – Electronic Devices (Fundamentals of Digital Logic)

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Object-Oriented Programming
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen theoretical understanding of core engineering principles.
• To connect knowledge with semiconductor applications.
• To enhance analytical and design skills.

Course Outcomes:
CO1 – Explain fundamental concepts and principles.
CO2 – Apply theory to solve engineering problems.
CO3 – Analyze systems and processes.
CO4 – Demonstrate professional and communication skills.
CO5 – Integrate multi-disciplinary knowledge.

Detailed Syllabus

Unit I – Principles of OOP (9 Hours)
Concepts of classes, objects, abstraction, encapsulation, inheritance, and polymorphism; comparison with procedural programming; OOP advantages in large-scale system design.

Unit II – Classes and Objects (9 Hours)
Class definition, constructors, destructors, static members, overloading; arrays of objects; dynamic memory allocation; simple programs in C++ or Python OOP style.

Unit III – Inheritance and Polymorphism (9 Hours)
Single, multiple, and hierarchical inheritance; function overriding; virtual functions and dynamic binding; interfaces and abstract classes.

Unit IV – Templates and Exception Handling (9 Hours)
Function and class templates; standard template library (STL) containers; exception handling – try, catch, throw; file handling concepts.

Unit V – OOP Applications (9 Hours)
Simulation of devices, database management, GUI applications; integrating OOP with hardware modeling and design automation tasks.

Text Books:
1. E. Balagurusamy – Object Oriented Programming with C++
2. B. L. Jones – Python Programming

Reference Books:
1. Robert Lafore – Object Oriented Programming in C++
2. Lutz – Programming Python

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Engineering Mechanics
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen theoretical understanding of core engineering principles.
• To connect knowledge with semiconductor applications.
• To enhance analytical and design skills.

Course Outcomes:
CO1 – Explain fundamental concepts and principles.
CO2 – Apply theory to solve engineering problems.
CO3 – Analyze systems and processes.
CO4 – Demonstrate professional and communication skills.
CO5 – Integrate multi-disciplinary knowledge.

Detailed Syllabus

Unit I – Statics of Particles (9 Hours)
Forces in a plane, parallelogram law, equilibrium of particles, free body diagram, Lami's theorem, friction laws, and applications to machine components.

Unit II – Rigid Body Equilibrium (9 Hours)
Moment of forces and couples, Varignon's theorem, equilibrium in two and three dimensions; analysis of beams, frames, and trusses.

Unit III – Centroid and Moment of Inertia (9 Hours)
Centroid of lines, areas, and volumes; moment and product of inertia for composite sections; radius of gyration and parallel-axis theorem.

Unit IV – Kinematics of Particles (9 Hours)
Rectilinear and curvilinear motion; motion under constant acceleration; relative motion of particles; projectiles; introduction to rigid-body kinematics.

Unit V – Kinetics and Work-Energy Principle (9 Hours)
Newton's laws, D'Alembert's principle, impulse and momentum, work-energy theorem; applications to mechanical and aerospace systems.

Text Books:
1. Timoshenko & Young – Engineering Mechanics
2. S. Rajasekaran – Engineering Mechanics and Dynamics

Reference Books:
1. Beer & Johnston – Vector Mechanics for Engineers
2. Irving H. Shames – Engineering Mechanics

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Design Thinking & Innovation
(HS – Humanities and Social Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen theoretical understanding of core engineering principles.
• To connect knowledge with semiconductor applications.
• To enhance analytical and design skills.

Course Outcomes:
CO1 – Explain fundamental concepts and principles.
CO2 – Apply theory to solve engineering problems.
CO3 – Analyze systems and processes.
CO4 – Demonstrate professional and communication skills.
CO5 – Integrate multi-disciplinary knowledge.

Detailed Syllabus

Unit I – Introduction to Design Thinking (9 Hours)
Definition, history, and importance; human-centered design; stages of design thinking; divergent and convergent thinking techniques.

Unit II – Empathy and Problem Framing (9 Hours)
Empathy maps, observation methods, user research, identifying pain points; defining problem statements using 'How Might We' format.

Unit III – Ideation and Prototyping (9 Hours)
Brainstorming, mind mapping, lateral thinking; rapid prototyping tools; translating ideas into tangible models for feedback.

Unit IV – Testing and Iteration (9 Hours)
Collecting feedback, testing prototypes, refining designs; A/B testing; concept selection using Pugh matrix and decision tools.

Unit V – Innovation and Entrepreneurship (9 Hours)
Innovation ecosystems, TRL levels, intellectual property basics, startup process, case studies in semiconductor and electronics innovation.

Text Books:
1. Tim Brown – Change by Design
2. Nigel Cross – Design Thinking

Reference Books:
1. Kelley & Kelley – Creative Confidence
2. IDEO – Field Guide to Human-Centered Design

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Internship I (Industry Exposure)
(ES – Engineering Science Course) – 1 Credits / 15 Hours

Course Objectives:
• To strengthen theoretical understanding of core engineering principles.
• To connect knowledge with semiconductor applications.
• To enhance analytical and design skills.

Course Outcomes:
CO1 – Explain fundamental concepts and principles.
CO2 – Apply theory to solve engineering problems.
CO3 – Analyze systems and processes.
CO4 – Demonstrate professional and communication skills.
CO5 – Integrate multi-disciplinary knowledge.

Detailed Syllabus

Module I – Industrial Orientation (15 Hours)
Two-to-three-week industry exposure program in electronics/semiconductor

manufacturing or service industry. Students observe production workflows, maintenance systems, safety procedures, and documentation standards. Each student must submit an internship report and give a presentation summarizing their learning outcomes and improvement suggestions.

Assessment based on internship report (40%), industry supervisor feedback (30%), and pre sentation/viva (30%).

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

B.Tech in Semiconductor Technology – Semester III

Signals and Systems
(ES – Engineering Science Course) – 4 Credits / 60 Hours

Course Objectives:
• To build strong conceptual understanding and analytical ability.
• To integrate circuit, system, and device knowledge.
• To enhance laboratory and simulation skills.

Course Outcomes:
CO1 – Explain core concepts.
CO2 – Apply analytical tools for engineering problems.
CO3 – Design, simulate, or analyze circuits/systems.
CO4 – Demonstrate experimental and data interpretation skills.
CO5 – Work effectively in teams and communicate results.

Detailed Syllabus

Unit I – Introduction to Signals and Systems (12 Hours)
Classification of signals: continuous, discrete, periodic, deterministic, and random; basic operations on signals; systems – linearity, time invariance, causality, and stability; examples from communication and control systems.

Unit II – Time Domain Analysis (12 Hours)
Impulse response, convolution integral and sum; response of LTI systems; differential and difference equations; step and impulse responses; block diagram representation.

Unit III – Fourier Analysis of Signals (12 Hours)
Fourier series representation; Fourier transform properties; frequency spectra of continuous-time and discrete-time signals; amplitude and phase characteristics.

Unit IV – Laplace and Z-Transform Techniques (12 Hours)
Laplace transform for continuous-time systems; ROC, poles and zeros; system stability; Z-transform for discrete systems; inverse transform and difference equation solutions.

Unit V – Sampling and Applications (12 Hours)
Sampling theorem, aliasing; reconstruction of signals; introduction to filter design; applications in communication, DSP, and control.

Practical Component:

Laboratory Experiments: Signal generation and visualization, convolution using MATLAB/Python, frequency response analysis, and filter design exercises.

Expected Outcomes: Ability to analyze and simulate signals and systems using analytical and computational tools.

Text Books:
1. Alan V. Oppenheim & A.S. Willsky – Signals and Systems
2. Simon Haykin – Signals and Systems

Reference Books:
1. S. Salivahanan – Digital Signal Processing
2. Hsu – Schaum's Outline of Signals and Systems

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Semiconductor Physics and Devices
(BS – Basic Science Course) – 4 Credits / 60 Hours

Course Objectives:
• To build strong conceptual understanding and analytical ability.
• To integrate circuit, system, and device knowledge.
• To enhance laboratory and simulation skills.

Course Outcomes:
CO1 – Explain core concepts.
CO2 – Apply analytical tools for engineering problems.
CO3 – Design, simulate, or analyze circuits/systems.
CO4 – Demonstrate experimental and data interpretation skills.
CO5 – Work effectively in teams and communicate results.

Detailed Syllabus

Unit I – Semiconductor Crystal Structure (12 Hours)
Crystal lattice, bonding, and energy bands; Bloch theorem; effective mass approximation; energy band diagrams for intrinsic and extrinsic semiconductors.

Unit II – Carrier Transport Mechanisms (12 Hours)
Drift and diffusion of carriers; mobility, conductivity, and Hall effect; carrier lifetime and recombination; temperature dependence of carrier transport.

Unit III – PN Junction Diodes (12 Hours)
Energy band model of PN junction; depletion width and built-in potential; diode current equation; capacitance and transient response; Zener and LED characteristics.

Unit IV – Bipolar and Field-Effect Transistors (12 Hours)
Working principles, energy band diagrams, transfer and output characteristics; biasing and operating regions; small-signal equivalent circuits.

Unit V – Advanced Device Concepts (12 Hours)
Schottky diodes, MOS capacitors, CMOS fundamentals, and overview of modern nanoscale transistors (FinFET, GAAFET).

Text Books:
1. Donald Neamen – Semiconductor Physics and Devices
2. S.M. Sze – Physics of Semiconductor Devices

Reference Books:
1. Ben Streetman – Solid State Electronic Devices
2. Y. Taur & T. H. Ning – Fundamentals of Modern VLSI Devices

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Electronic Circuits
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To build strong conceptual understanding and analytical ability.
• To integrate circuit, system, and device knowledge.
• To enhance laboratory and simulation skills.

Course Outcomes:
CO1 – Explain core concepts.
CO2 – Apply analytical tools for engineering problems.
CO3 – Design, simulate, or analyze circuits/systems.
CO4 – Demonstrate experimental and data interpretation skills.
CO5 – Work effectively in teams and communicate results.

Detailed Syllabus

Unit I – Biasing and Stability of BJTs (9 Hours)
Biasing methods: fixed, voltage-divider, feedback; stability analysis; thermal stabilization; load line and Q-point selection.

Unit II – Small Signal Amplifiers (9 Hours)
CE, CB, and CC configurations; hybrid-π model; mid-frequency response; multistage coupling; differential amplifiers.

Unit III – Power Amplifiers and Feedback (9 Hours)
Class A, B, AB and C amplifiers; push-pull operation; distortion and efficiency; feedback types and stability criteria.

Unit IV – Oscillators and Wave Shaping (9 Hours)
RC, LC, and crystal oscillators; Schmitt trigger, clippers, clampers, and waveform generators; op-amp-based oscillators.

Unit V – Voltage Regulators and SMPS (9 Hours)
Linear voltage regulators; IC 723 and 78XX/79XX series; introduction to switching regulators and DC-DC converters.

Practical Component:

Laboratory Experiments: Biasing of transistors, amplifier frequency response, oscillator design, and voltage regulator construction.

Expected Outcomes: Ability to design and test basic amplifier and oscillator circuits using hardware and simulation tools.

Text Books:
1. Millman & Halkias – Integrated Electronics
2. Sedra & Smith – Microelectronic Circuits

Reference Books:
1. Boylestad & Nashelsky – Electronic Devices and Circuit Theory
2. A.P. Malvino – Electronic Principles

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Microprocessors and Microcontrollers
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To build strong conceptual understanding and analytical ability.
• To integrate circuit, system, and device knowledge.
• To enhance laboratory and simulation skills.

Course Outcomes:
CO1 – Explain core concepts.
CO2 – Apply analytical tools for engineering problems.
CO3 – Design, simulate, or analyze circuits/systems.
CO4 – Demonstrate experimental and data interpretation skills.
CO5 – Work effectively in teams and communicate results.

Detailed Syllabus

Unit I – Architecture of 8085 and 8086 (9 Hours)
Basic architecture, pin configuration, addressing modes; instruction sets and timing diagrams; interrupt system.

Unit II – Programming with 8085/8086 (9 Hours)
Assembly language programming: arithmetic, logical, and branch instructions; subroutines; counters and delays.

Unit III – Interfacing Techniques (9 Hours)
I/O interfacing, ADC/DAC interface, stepper motor control, and display interfacing; memory-mapped I/O concepts.

Unit IV – Microcontroller Architecture (9 Hours)
Architecture of 8051; instruction set, addressing modes, timers, and interrupts; serial communication; embedded system introduction.

Unit V – Applications and Programming (9 Hours)
Sensor interfacing, real-time data acquisition; case studies of embedded control in automation and instrumentation.

Practical Component:

Laboratory Experiments: Assembly language programs using emulator, interfacing LEDs, seven-segment display, motors, and sensors.

Expected Outcomes: Ability to develop embedded control applications using microcontrollers.

Text Books:
1. Ramesh S. Gaonkar – Microprocessor Architecture Programming and Applications
2. Muhammad Ali Mazidi – 8051 Microcontroller

Reference Books:
1. Douglas V. Hall – Microprocessors and Interfacing
2. Barry B. Brey – Intel Microprocessors

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Electromagnetic Theory
(BS – Basic Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To build strong conceptual understanding and analytical ability.
• To integrate circuit, system, and device knowledge.
• To enhance laboratory and simulation skills.

Course Outcomes:
CO1 – Explain core concepts.
CO2 – Apply analytical tools for engineering problems.
CO3 – Design, simulate, or analyze circuits/systems.
CO4 – Demonstrate experimental and data interpretation skills.
CO5 – Work effectively in teams and communicate results.

Detailed Syllabus

Unit I – Vector Analysis (9 Hours)
Vector algebra and calculus; gradient, divergence, and curl; line, surface, and volume integrals; Gauss's, Stokes's, and Green's theorems.

Unit II – Electrostatics (9 Hours)
Coulomb's law, electric field intensity, flux density; Gauss's law applications; potential and potential gradient; capacitance and boundary conditions.

Unit III – Magnetostatics (9 Hours)
Biot–Savart law, Ampere's law, magnetic field intensity and flux density, magnetic materials, boundary conditions.

Unit IV – Electromagnetic Induction (9 Hours)
Faraday's law, induced EMF, Maxwell's equations in integral and differential form; displacement current concept.

Unit V – Electromagnetic Waves (9 Hours)
Wave equation derivation; plane wave propagation in free space, conductors, and dielectrics; Poynting theorem; skin depth and power flow.

Text Books:
1. Matthew N.O. Sadiku – Elements of Electromagnetics
2. W.H. Hayt – Engineering Electromagnetics

Reference Books:
1. David K. Cheng – Field and Wave Electromagnetics
2. John D. Kraus – Electromagnetics

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Humanities Elective (Ethics / Industrial Psychology)
(HS – Humanities and Social Science Course) – 2 Credits / 30 Hours

Course Objectives:
• To build strong conceptual understanding and analytical ability.

• To integrate circuit, system, and device knowledge.
• To enhance laboratory and simulation skills.

Course Outcomes:
CO1 – Explain core concepts.
CO2 – Apply analytical tools for engineering problems.
CO3 – Design, simulate, or analyze circuits/systems.
CO4 – Demonstrate experimental and data interpretation skills.
CO5 – Work effectively in teams and communicate results.

Detailed Syllabus

Unit I – Human Values and Ethics (6 Hours)
Morality, integrity, honesty, and courage; professional codes of ethics; ethical theories; importance of values in engineering.

Unit II – Workplace Ethics and Responsibilities (6 Hours)
Environmental ethics, responsibility toward society, sustainability; whistle-blowing and risk analysis.

Unit III – Industrial Psychology Basics (6 Hours)
Motivation theories, personality traits, stress management; leadership and communication skills.

Unit IV – Group Dynamics and Teamwork (6 Hours)
Group formation, conflict resolution, and negotiation; inter-departmental coordination in engineering industries.

Unit V – Case Studies and Ethical Decision Making (6 Hours)
Real-life engineering ethics cases; codes by IEEE, ASME; role-playing exercises for ethical reasoning.

Text Books:
1. Mike Martin & Roland Schinzinger – Ethics in Engineering
2. K. Aswathappa – Organizational Behaviour

Reference Books:
1. R. Subramanian – Professional Ethics
2. Stephen Robbins – Organizational Behaviour

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Internship II (Industry Exposure)
(ES – Engineering Science Course) – 1 Credits / 15 Hours

Course Objectives:
• To build strong conceptual understanding and analytical ability.
• To integrate circuit, system, and device knowledge.
• To enhance laboratory and simulation skills.

Course Outcomes:
CO1 – Explain core concepts.
CO2 – Apply analytical tools for engineering problems.
CO3 – Design, simulate, or analyze circuits/systems.
CO4 – Demonstrate experimental and data interpretation skills.
CO5 – Work effectively in teams and communicate results.

Detailed Syllabus

Module I – Industrial Training (15 Hours)
Students undertake 2–3 weeks internship in semiconductor or electronics manufacturing/service companies. Activities include observing process flow, data acquisition systems, and maintenance practices. Each student must maintain a diary, prepare a report, and present key learnings.

Assessment Criteria: Report (40%), Supervisor Feedback (30%), Presentation/Viva (30%).

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

B.Tech in Semiconductor Technology – Semester IV

VLSI Design Fundamentals
(ES – Engineering Science Course) – 4 Credits / 60 Hours

Course Objectives:
• To develop conceptual and practical understanding of advanced electronics.
• To integrate fabrication, design, and control principles.
• To prepare students for industry and research roles.

Course Outcomes:
CO1 – Explain theoretical concepts.
CO2 – Apply techniques for circuit and system design.
CO3 – Analyze and simulate VLSI/fabrication systems.
CO4 – Perform laboratory or design tasks independently.
CO5 – Communicate technical findings effectively.

Detailed Syllabus

Unit I – MOS Transistor Theory (12 Hours)
MOS structure and operation; threshold voltage; current–voltage characteristics; channel length modulation; body effect; subthreshold conduction.

Unit II – CMOS Inverter and Logic Gates (12 Hours)
Static and dynamic behavior of CMOS inverter; noise margins, propagation delay; CMOS NAND, NOR, XOR gates; transmission gates.

Unit III – Combinational Logic Design (12 Hours)
Design equations and Boolean simplification; pass transistor logic; static and dynamic logic families; logic optimization and layout considerations.

Unit IV – Sequential Logic Design (12 Hours)
Latch and flip-flop design; timing and synchronization; dynamic storage elements; clock distribution and clock skew.

Unit V – Layout, Design Rules and Verification (12 Hours)
Layout design using lambda rules; stick diagrams; parasitic capacitance; design rule check (DRC); introduction to EDA tools for layout verification.

Practical Component:
Laboratory Experiments: Simulation of CMOS inverter and logic gates using Tanner/Cadence tools; layout design and verification.

Expected Outcomes: Students will understand CMOS operation, logic design, and layout verification process.

Text Books:
1. Neil H.E. Weste & David Harris – CMOS VLSI Design
2. Douglas Pucknell – Basic VLSI Design

Reference Books:
1. Jan M. Rabaey – Digital Integrated Circuits
2. E. Fabricius – Introduction to VLSI Design

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Integrated Circuit Fabrication Technology
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To develop conceptual and practical understanding of advanced electronics.
• To integrate fabrication, design, and control principles.
• To prepare students for industry and research roles.

Course Outcomes:
CO1 – Explain theoretical concepts.
CO2 – Apply techniques for circuit and system design.
CO3 – Analyze and simulate VLSI/fabrication systems.
CO4 – Perform laboratory or design tasks independently.
CO5 – Communicate technical findings effectively.

Detailed Syllabus

Unit I – Overview of IC Fabrication (9 Hours)
Introduction to IC technology; cleanroom classification and contamination control; wafer preparation and crystal growth (Czochralski, float-zone).

Unit II – Oxidation and Diffusion (9 Hours)
Thermal oxidation kinetics, Deal-Grove model; diffusion theory; dopant diffusion profiles; drive-in and pre-deposition processes.

Unit III – Photolithography and Etching (9 Hours)
Photoresists and pattern transfer; exposure systems; resolution limits; wet and dry etching techniques; anisotropic etching.

Unit IV – Thin Film Deposition (9 Hours)
Physical and chemical vapor deposition (PVD, CVD, ALD); sputtering; epitaxy techniques; film characterization and uniformity control.

Unit V – Process Integration and Packaging (9 Hours)
CMOS process flow; planarization, metallization, and interconnects; wafer bonding; packaging, wire bonding, and encapsulation.

Text Books:
1. S.M. Sze – VLSI Technology
2. Campbell – Fabrication Engineering at the Micro- and Nanoscale

Reference Books:
1. Jaeger – Introduction to Microelectronic Fabrication
2. Runyan – Semiconductor Integrated Circuit Processing Technology

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Analog and Mixed Signal Design
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To develop conceptual and practical understanding of advanced electronics.
• To integrate fabrication, design, and control principles.
• To prepare students for industry and research roles.

Course Outcomes:
CO1 – Explain theoretical concepts.
CO2 – Apply techniques for circuit and system design.
CO3 – Analyze and simulate VLSI/fabrication systems.
CO4 – Perform laboratory or design tasks independently.
CO5 – Communicate technical findings effectively.

Detailed Syllabus

Unit I – Analog Building Blocks (9 Hours)
Op-amp review; differential pair, current mirrors, and active loads; single-stage amplifiers – gain, bandwidth, and noise.

Unit II – Frequency Response and Stability (9 Hours)
Frequency compensation; Miller effect; feedback amplifiers; gain-bandwidth product; slew rate limitations.

Unit III – Mixed Signal Circuits (9 Hours)
Sample and hold circuits, comparators, DAC and ADC architectures, clocked comparators, and switched-capacitor circuits.

Unit IV – Noise and Distortion Analysis (9 Hours)
Noise sources in analog circuits; SNR and dynamic range; distortion and linearity metrics; layout considerations for analog blocks.

Unit V – Practical Design and Simulation (9 Hours)
Design of operational amplifier stages, analog filters; mixed-signal simulation using SPICE or Cadence Virtuoso environment.

Practical Component:
Laboratory Experiments: Design and simulation of amplifiers, DACs, and ADCs using SPICE tools.

Expected Outcomes: Students will be able to analyze and design mixed-signal circuits for data conversion applications.

Text Books:
1. Behzad Razavi – Design of Analog CMOS Integrated Circuits
2. Gray & Meyer – Analysis and Design of Analog Integrated Circuits

Reference Books:
1. R. Jacob Baker – CMOS Circuit Design Layout and Simulation
2. Allen & Holberg – CMOS Analog Circuit Design

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Control Systems
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To develop conceptual and practical understanding of advanced electronics.
• To integrate fabrication, design, and control principles.
• To prepare students for industry and research roles.

Course Outcomes:
CO1 – Explain theoretical concepts.
CO2 – Apply techniques for circuit and system design.
CO3 – Analyze and simulate VLSI/fabrication systems.
CO4 – Perform laboratory or design tasks independently.
CO5 – Communicate technical findings effectively.

Detailed Syllabus

Unit I – Introduction to Control Systems (9 Hours)
Open- and closed-loop systems; transfer function; modeling of electrical, mechanical, and thermal systems; block diagram and signal flow representation.

Unit II – Time Domain Analysis (9 Hours)
Transient and steady-state response; time constants; performance indices; error analysis and system stability assessment.

Unit III – Frequency Domain Analysis (9 Hours)
Bode plots, polar plots, and Nyquist stability criterion; gain margin and phase margin; frequency response compensation.

Unit IV – State Space Analysis (9 Hours)
State variables, modeling, and solution of state equations; controllability and observability; state feedback design.

Unit V – Modern Applications (9 Hours)
PID controller tuning, digital control, and simulation using MATLAB/Simulink; applications in automation and robotics.

Text Books:
1. K. Ogata – Modern Control Engineering
2. Nagrath & Gopal – Control Systems Engineering

Reference Books:
1. B.C. Kuo – Automatic Control Systems
2. Norman S. Nise – Control Systems Engineering

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Open Elective I – Artificial Intelligence for Engineers
(ES – Open Elective Course) – 3 Credits / 45 Hours

Course Objectives:
• To develop conceptual and practical understanding of advanced electronics.
• To integrate fabrication, design, and control principles.
• To prepare students for industry and research roles.

Course Outcomes:
CO1 – Explain theoretical concepts.
CO2 – Apply techniques for circuit and system design.
CO3 – Analyze and simulate VLSI/fabrication systems.
CO4 – Perform laboratory or design tasks independently.
CO5 – Communicate technical findings effectively.

Detailed Syllabus

Unit I – Introduction to AI (9 Hours)
Definition, history, and applications of AI; problem solving using search algorithms; uninformed and informed search; AI in engineering and design.

Unit II – Knowledge Representation and Reasoning (9 Hours)
Propositional logic, first-order logic; inference and unification; rule-based systems; fuzzy logic fundamentals.

Unit III – Machine Learning Basics (9 Hours)
Supervised, unsupervised, and reinforcement learning; regression and classification; decision trees, KNN, and clustering methods.

Unit IV – Neural Networks and Deep Learning (9 Hours)
Perceptron, backpropagation, activation functions; CNN and RNN basics; AI frameworks (TensorFlow, PyTorch).

Unit V – AI Applications in Engineering (9 Hours)
AI for semiconductor manufacturing, predictive maintenance, process optimization, and robotics; ethical considerations in AI systems.

Text Books:
1. Stuart Russell & Peter Norvig – Artificial Intelligence: A Modern Approach
2. Tom Mitchell – Machine Learning

Reference Books:
1. Ian Goodfellow – Deep Learning
2. Ethem Alpaydin – Introduction to Machine Learning

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Laboratory – Device Fabrication and Characterization (ES – Practical Course) – 3 Credits / 45 Hours

Course Objectives:
• To develop conceptual and practical understanding of advanced electronics.
• To integrate fabrication, design, and control principles.
• To prepare students for industry and research roles.

Course Outcomes:
CO1 – Explain theoretical concepts.
CO2 – Apply techniques for circuit and system design.
CO3 – Analyze and simulate VLSI/fabrication systems.
CO4 – Perform laboratory or design tasks independently.
CO5 – Communicate technical findings effectively.

Detailed Syllabus

Module I – Fabrication Techniques (15 Hours)
Hands-on exposure to photolithography, oxidation, diffusion, and thin-film deposition in a simulated cleanroom environment; safety and contamination control.

Module II – Characterization Methods (15 Hours)
Measurement of I-V and C-V characteristics; resistivity, Hall effect, and thin-film thickness measurement; data analysis and reporting.

Text Books:
1. S.M. Sze – Semiconductor Device Theory and Technology
2. Jaeger – Microelectronic Fabrication

Reference Books:
1. Taur & Ning – Modern VLSI Devices
2. Campbell – Fabrication Engineering at the Micro- and Nanoscale

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Internship III (Industry Exposure)
(ES – Engineering Science Course) – 1 Credits / 15 Hours

Course Objectives:
• To develop conceptual and practical understanding of advanced electronics.
• To integrate fabrication, design, and control principles.
• To prepare students for industry and research roles.

Course Outcomes:
CO1 – Explain theoretical concepts.
CO2 – Apply techniques for circuit and system design.
CO3 – Analyze and simulate VLSI/fabrication systems.
CO4 – Perform laboratory or design tasks independently.
CO5 – Communicate technical findings effectively.

Detailed Syllabus

Module I – Industry Training (15 Hours)
Students undergo 2–3 weeks internship in semiconductor, VLSI, or electronics industry. Focus areas: process integration, testing, and quality assurance. Deliverables include a

logbook, report, and viva presentation summarizing key technical insights and skill development.

Assessment Criteria: Report (40%), Industry Supervisor Feedback (30%), Presentation/Viva (30%).

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

B.Tech in Semiconductor Technology – Semester V

CMOS Circuit Design (ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To develop domain expertise in semiconductor design and fabrication.
• To link theoretical knowledge with industrial applications.
• To build analytical, simulation, and experimental skills.

Course Outcomes:
CO1 – Understand the principles of semiconductor circuits and devices.
CO2 – Apply design and analytical tools to engineering problems.
CO3 – Demonstrate skills in fabrication, characterization, or simulation.
CO4 – Interpret data and present results effectively.
CO5 – Function in multidisciplinary teams with ethical responsibility.

Detailed Syllabus

Unit I – MOS Transistor Characteristics (9 Hours)
MOSFET structure, operation regions, current equations, and threshold voltage; channel length modulation; body effect; transconductance parameters.

Unit II – CMOS Inverter Design (9 Hours)
Static and dynamic characteristics, propagation delay, power dissipation, noise margin, and sizing for performance optimization.

Unit III – Combinational Logic Design (9 Hours)
Design of CMOS logic gates – NAND, NOR, XOR; complementary and ratioed logic; pass transistor logic; transmission gate design.

Unit IV – Sequential Circuits and Timing (9 Hours)
Latch and flip-flop design; timing parameters; setup and hold times; metastability; synchronization; clock distribution networks.

Unit V – Design Automation and Simulation (9 Hours)
Layout design using EDA tools (Cadence/Tanner); design rule checking, LVS, and post-layout simulation; low-power design techniques.

Practical Component:
Laboratory Experiments: Design and simulation of CMOS logic circuits using EDA tools; static and dynamic analysis of inverters.
Expected Outcomes: Students will be able to design, analyze, and simulate CMOS circuits and logic families.

Text Books: 1. Neil H.E. Weste & David Harris – CMOS VLSI Design 2. Jan M. Rabaey –

Digital Integrated Circuits
Reference Books: 1. Sedra & Smith – Microelectronic Circuits 2. Kang & Leblebici – CMOS Digital Integrated Circuits

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

MEMS and Nanoelectronics (ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To develop domain expertise in semiconductor design and fabrication.
• To link theoretical knowledge with industrial applications.
• To build analytical, simulation, and experimental skills.

Course Outcomes:
CO1 – Understand the principles of semiconductor circuits and devices.
CO2 – Apply design and analytical tools to engineering problems.
CO3 – Demonstrate skills in fabrication, characterization, or simulation.
CO4 – Interpret data and present results effectively.
CO5 – Function in multidisciplinary teams with ethical responsibility.

Detailed Syllabus

Unit I – Introduction to MEMS (9 Hours)
Overview of micro-electro-mechanical systems; scaling laws; microsystem components; materials used in MEMS; MEMS design process.

Unit II – Fabrication Techniques (9 Hours)
Bulk micromachining, surface micromachining, LIGA process, wafer bonding, deep reactive ion etching, and thin-film deposition techniques.

Unit III – MEMS Sensors and Actuators (9 Hours)
Principles of pressure, thermal, piezoelectric, and capacitive sensors; actuators – electrostatic, piezoelectric, and thermal types; signal conditioning circuits.

Unit IV – Nanoelectronics Fundamentals (9 Hours)
Quantum confinement effects; tunneling; nanowires, nanotubes, and quantum dots; molecular and spin electronics concepts.

Unit V – Applications of MEMS and NEMS (9 Hours)
MEMS for automotive, biomedical, and RF systems; integration with CMOS; challenges in reliability and packaging of MEMS devices.

Practical Component:
Laboratory Experiments: Simulation of MEMS sensors using COMSOL/MATLAB; fabrication process visualization; characterization using SEM/AFM.

Expected Outcomes: Students will gain knowledge of MEMS fabrication and nanoelectronic device principles.

Text Books: 1. Tai-Ran Hsu – MEMS and Microsystems Design and Manufacture 2. N. Maluf – An Introduction to Microelectromechanical Systems Engineering
Reference Books: 1. Marc Madou – Fundamentals of Microfabrication 2. Bhattacharya – Nanotechnology for Electronics

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Wafer Fabrication and Cleanroom Practices
(ES – Engineering Science Course) – 4 Credits / 60 Hours

Course Objectives:
• To develop domain expertise in semiconductor design and fabrication.
• To link theoretical knowledge with industrial applications.
• To build analytical, simulation, and experimental skills.

Course Outcomes:
CO1 – Understand the principles of semiconductor circuits and devices.
CO2 – Apply design and analytical tools to engineering problems.
CO3 – Demonstrate skills in fabrication, characterization, or simulation.
CO4 – Interpret data and present results effectively.
CO5 – Function in multidisciplinary teams with ethical responsibility.

Detailed Syllabus

Unit I – Wafer Preparation (12 Hours)
Crystal growth methods – Czochralski, Bridgman, and float-zone; wafer slicing, lapping, etching, and polishing; wafer cleaning and characterization.

Unit II – Thermal Processes (12 Hours)
Oxidation kinetics, diffusion mechanisms, and ion implantation; dopant activation and annealing; process modeling and simulation.

Unit III – Photolithography and Etching (12 Hours)
Photoresist materials, spin coating, exposure systems, resolution enhancement, wet/dry etching, and plasma etching techniques.

Unit IV – Deposition Techniques (12 Hours)
CVD, PVD, ALD, and epitaxy methods; sputtering systems; film stress and adhesion; characterization using ellipsometry and profilometry.

Unit V – Cleanroom and Safety Practices (12 Hours)
Cleanroom classes, laminar flow, contamination control, gowning protocols, safety standards (ISO 14644); yield enhancement and SPC methods.

Practical Component:
Laboratory Experiments: Hands-on training in cleanroom protocol, photolithography, and thin-film deposition; measurement of process parameters.
Expected Outcomes: Ability to apply semiconductor process steps maintaining cleanroom and safety compliance.

Text Books: 1. S.M. Sze – VLSI Technology 2. Jaeger – Microelectronic Fabrication
Reference Books: 1. Campbell – Fabrication Engineering at the Micro- and Nanoscale 2. Runyan – Semiconductor Integrated Circuit Processing

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Semiconductor Packaging and Testing (ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To develop domain expertise in semiconductor design and fabrication.
• To link theoretical knowledge with industrial applications.
• To build analytical, simulation, and experimental skills.

Course Outcomes:
CO1 – Understand the principles of semiconductor circuits and devices.
CO2 – Apply design and analytical tools to engineering problems.
CO3 – Demonstrate skills in fabrication, characterization, or simulation.
CO4 – Interpret data and present results effectively.
CO5 – Function in multidisciplinary teams with ethical responsibility.

Detailed Syllabus

Unit I – Overview of Semiconductor Packaging (9 Hours)
Packaging hierarchy, functions, and materials; mechanical, electrical, and thermal considerations; through-hole and surface mount technologies.

Unit II – Assembly and Interconnection (9 Hours)
Die attach methods, wire bonding, flip-chip bonding, and encapsulation; PCB design guidelines and substrate technologies.

Unit III – Testing and Reliability (9 Hours)
Electrical testing – parametric, functional, and burn-in; mechanical reliability, thermal cycling, and accelerated life testing.

Unit IV – Advanced Packaging Technologies (9 Hours)
Wafer-level packaging, 3D integration, system-in-package (SiP), and fan-out wafer-level packaging; TSV technology and chip stacking.

Unit V – Testing Automation and Failure Analysis (9 Hours)
Automated test equipment (ATE), data logging, test interface boards; failure analysis using microscopy and spectroscopy methods.

Text Books: 1. Tummala – Microelectronics Packaging Handbook 2. Harper – Electronic Packaging and Interconnection Handbook
Reference Books: 1. Lee – Advanced Electronic Packaging 2. Prasad – Surface Mount Technology

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Elective I – Optoelectronic Devices and Applications
(ES – Open Elective Course) – 3 Credits / 45 Hours

Course Objectives:
• To develop domain expertise in semiconductor design and fabrication.
• To link theoretical knowledge with industrial applications.
• To build analytical, simulation, and experimental skills.

Course Outcomes:
CO1 – Understand the principles of semiconductor circuits and devices.
CO2 – Apply design and analytical tools to engineering problems.
CO3 – Demonstrate skills in fabrication, characterization, or simulation.
CO4 – Interpret data and present results effectively.
CO5 – Function in multidisciplinary teams with ethical responsibility.

Detailed Syllabus

Unit I – Fundamentals of Optoelectronics (9 Hours)
Interaction of light and matter; absorption, emission, and stimulated emission; optical transitions in semiconductors.

Unit II – Light-Emitting Devices (9 Hours)
LED principles, materials, and efficiencies; OLED technology; high-brightness LEDs and applications in displays and lighting.

Unit III – Laser Devices (9 Hours)
Principle of laser action, population inversion, cavity design; semiconductor laser diodes, DFB and VCSEL structures.

Unit IV – Photodetectors and Solar Cells (9 Hours)
PIN and avalanche photodiodes, phototransistors, CCD and CMOS sensors; photovoltaic effect, solar cell design, and quantum efficiency.

Unit V – Optoelectronic Integration and Applications (9 Hours)
Optical communication systems, fiber coupling, optoelectronic ICs, LiDAR sensors, and emerging photonic integrated circuits.

Text Books: 1. Pankaj Bhattacharya –
Semiconductor Optoelectronic Devices 2. Wilson & Hawkes – Optoelectronics An Introduction
Reference Books: 1. Sze & Ng – Physics of Semiconductor Devices 2. Singh –
Optoelectronics An Introduction

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Minor Project I (Chip Design / Fabrication Simulation)
(ES – Project Course) – 4 Credits / 60 Hours

Course Objectives:
• To develop domain expertise in semiconductor design and fabrication.
• To link theoretical knowledge with industrial applications.
• To build analytical, simulation, and experimental skills.

Course Outcomes:
CO1 – Understand the principles of semiconductor circuits and devices.
CO2 – Apply design and analytical tools to engineering problems.
CO3 – Demonstrate skills in fabrication, characterization, or simulation.
CO4 – Interpret data and present results effectively.
CO5 – Function in multidisciplinary teams with ethical responsibility.

Detailed Syllabus

Module I – Project Development (60 Hours)
Students undertake a mini project in CMOS circuit design or semiconductor process simulation using CADENCE/TCAD. The project includes proposal submission, design implementation, simulation, and presentation of results.

Evaluation Scheme: Project Report (40%), Demonstration (30%), Presentation/Viva (30%).

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

B.Tech in Semiconductor Technology – Semester VI

Advanced VLSI and SoC Design
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To advance knowledge in semiconductor design, EDA, and embedded applications.
• To integrate analytical, simulation, and design verification skills.
• To prepare students for research and industry roles.

Course Outcomes:
CO1 – Explain core theoretical and practical aspects of semiconductor systems.
CO2 – Use EDA and embedded tools effectively.
CO3 – Develop and verify designs meeting specifications.
CO4 – Work independently on simulation and validation.
CO5 – Document and communicate technical results professionally.

Detailed Syllabus

Unit I – VLSI Design Flow (9 Hours)
Review of CMOS circuits; front-end and back-end design flow; hardware description languages (HDLs); synthesis and timing analysis.

Unit II – System-on-Chip Architecture (9 Hours)
SoC design concepts; IP integration; bus architectures (AMBA, AXI); on-chip communication and memory hierarchy.

Unit III – Low Power VLSI Design (9 Hours)
Sources of power dissipation; power optimization at circuit and system level; clock gating; voltage scaling; power estimation tools.

Unit IV – Physical Design and Routing (9 Hours)
Floorplanning, placement, and routing algorithms; clock tree synthesis; design rule checks; timing closure; signal integrity.

Unit V – Design Verification and Testing (9 Hours)
Functional verification using HDL testbenches; coverage analysis; scan design; BIST concepts; post-layout verification.

Practical Component:
Laboratory Experiments: HDL-based logic design, synthesis, and place-and-route using EDA tools (Cadence/Synopsys).

Text Books: 1. Weste & Harris – CMOS VLSI Design 2. Jan Rabaey – Digital Integrated Circuits

Reference Books: 1. Pucknell & Eshraghian – Basic VLSI Design 2. David Harris – Digital Design and Computer Architecture

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Semiconductor Process Integration
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To advance knowledge in semiconductor design, EDA, and embedded applications.
• To integrate analytical, simulation, and design verification skills.
• To prepare students for research and industry roles.

Course Outcomes:
CO1 – Explain core theoretical and practical aspects of semiconductor systems.
CO2 – Use EDA and embedded tools effectively.
CO3 – Develop and verify designs meeting specifications.
CO4 – Work independently on simulation and validation.
CO5 – Document and communicate technical results professionally.

Detailed Syllabus

Unit I – Introduction to Process Integration (9 Hours)
Overview of device fabrication steps and their interdependencies; CMOS process flow; unit processes and integration challenges.

Unit II – Isolation and Well Formation (9 Hours)
LOCOS, shallow trench isolation (STI); twin-tub and triple-well processes; threshold voltage adjustment.

Unit III – Gate Stack Formation (9 Hours)
Gate oxidation, high-κ dielectrics, metal gates; work function engineering; gate patterning and scaling limitations.

Unit IV – Metallization and Interconnects (9 Hours)
Contact formation, barrier layers, Cu/Al interconnects, low-κ dielectrics, chemical-mechanical polishing (CMP).

Unit V – Yield Enhancement and Reliability (9 Hours)
Defects and process control; reliability mechanisms (BTI, HCI, TDDB); yield modeling and design for manufacturability.

Practical Component:
Laboratory Experiments: Process simulation using TCAD tools (Synopsys Sentaurus, Silvaco); analysis of integration flow for CMOS devices.

Text Books: 1. S.M. Sze – VLSI Technology 2. Jaeger – Microelectronic Fabrication
Reference Books: 1. Runyan – Semiconductor Processing Technology 2. Campbell – Fabrication Engineering at the Micro and Nanoscale

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

EDA Tools and Verification
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To advance knowledge in semiconductor design, EDA, and embedded applications.
• To integrate analytical, simulation, and design verification skills.
• To prepare students for research and industry roles.

Course Outcomes:
CO1 – Explain core theoretical and practical aspects of semiconductor systems.
CO2 – Use EDA and embedded tools effectively.
CO3 – Develop and verify designs meeting specifications.
CO4 – Work independently on simulation and validation.
CO5 – Document and communicate technical results professionally.

Detailed Syllabus

Unit I – EDA Design Flow (9 Hours)
Role of EDA tools in design automation; front-end vs. back-end flow; netlist generation; timing and power analysis.

Unit II – Logic Synthesis and Simulation (9 Hours)
Behavioral and RTL synthesis; logic optimization; gate-level simulation; static timing analysis (STA).

Unit III – Verification Methodologies (9 Hours)
Functional verification using SystemVerilog and UVM; assertion-based verification; constrained random testing.

Unit IV – Design for Testability (9 Hours)
Scan design, boundary scan (JTAG); fault modeling; automatic test pattern generation (ATPG).

Unit V – Case Studies and Tool Usage (9 Hours)
Verification of digital blocks using industry EDA suites; integration with simulation and synthesis tools.

Practical Component:
Laboratory Experiments: HDL-based verification using ModelSim or Synopsys VCS; coverage analysis and testbench creation.

Text Books: 1. Bergeron – Writing Testbenches 2. Chris Spear – SystemVerilog for Verification
Reference Books: 1. D. Patterson & J. Hennessy –
Computer Organization and Design 2. W. Wolf – Modern VLSI Design

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Embedded Systems and Applications
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To advance knowledge in semiconductor design, EDA, and embedded applications.
• To integrate analytical, simulation, and design verification skills.
• To prepare students for research and industry roles.

Course Outcomes:
CO1 – Explain core theoretical and practical aspects of semiconductor systems.
CO2 – Use EDA and embedded tools effectively.
CO3 – Develop and verify designs meeting specifications.
CO4 – Work independently on simulation and validation.
CO5 – Document and communicate technical results professionally.

Detailed Syllabus

Unit I – Introduction to Embedded Systems (9 Hours)
Definition, characteristics, and applications; embedded hardware architecture; microcontrollers vs. processors; system design overview.

Unit II – Embedded Hardware (9 Hours)
Processor cores, memory, and I/O interfaces; sensors and actuators; ADC/DAC; communication protocols (UART, I2C, SPI).

Unit III – Embedded Software (9 Hours)
Firmware design, device drivers, RTOS concepts; multitasking and scheduling; software-hardware co-design.

Unit IV – System Development Tools (9 Hours)
Cross-compilers, debuggers, emulators; IDEs (Keil, Arduino, Raspberry Pi); embedded C and Python programming.

Unit V – Applications and Case Studies (9 Hours)
IoT, wearable electronics, automotive and biomedical systems; energy management; cyber-physical systems integration.

Practical Component:

Laboratory Experiments: Development of embedded applications using Arduino/Raspberry Pi; sensor interfacing and control tasks.

Text Books: 1. Raj Kamala – Embedded System Design 2. Mazidi – The 8051 Microcontroller and Embedded Systems
Reference Books: 1. Shibu – Introduction to Embedded Systems 2. Simon – An Embedded Software Primer

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Open Elective II – AI for Chip Design
(ES – Open Elective Course) – 3 Credits / 45 Hours

Course Objectives:
• To advance knowledge in semiconductor design, EDA, and embedded applications.
• To integrate analytical, simulation, and design verification skills.
• To prepare students for research and industry roles.

Course Outcomes:
CO1 – Explain core theoretical and practical aspects of semiconductor systems.
CO2 – Use EDA and embedded tools effectively.
CO3 – Develop and verify designs meeting specifications.
CO4 – Work independently on simulation and validation.
CO5 – Document and communicate technical results professionally.

Detailed Syllabus

Unit I – Overview of AI in VLSI (9 Hours)
Introduction to machine learning concepts; AI applications in electronic design automation; optimization and prediction in chip design.

Unit II – Data Driven Design (9 Hours)
EDA datasets; feature extraction from layouts and circuits; data preprocessing and visualization for learning models.

Unit III – Machine Learning in EDA (9 Hours)
Regression and classification for design prediction; placement and routing optimization using ML algorithms; reinforcement learning for circuit tuning.

Unit IV – AI for Reliability and Testing (9 Hours)
Defect prediction; yield enhancement; test pattern generation using AI models; case studies on fault classification.

Unit V – AI Frameworks and Implementation (9 Hours)
Python libraries (TensorFlow, Keras) for EDA datasets; model training and validation; ethical use of AI in design processes.

Text Books: 1. Rajeev – AI for EDA 2. Stuart Russell – Artificial Intelligence A Modern Approach
Reference Books: 1. Ian Goodfellow – Deep Learning 2. Tom Mitchell – Machine Learning

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Minor Project II (Prototype Device or Design Validation)
(ES – Project Course) – 5 Credits / 75 Hours

Course Objectives:
• To advance knowledge in semiconductor design, EDA, and embedded applications.
• To integrate analytical, simulation, and design verification skills.
• To prepare students for research and industry roles.

Course Outcomes:
CO1 – Explain core theoretical and practical aspects of semiconductor systems.
CO2 – Use EDA and embedded tools effectively.
CO3 – Develop and verify designs meeting specifications.
CO4 – Work independently on simulation and validation.
CO5 – Document and communicate technical results professionally.

Detailed Syllabus

Module I – Project Execution (75 Hours)
Students execute a prototype or simulation-based project integrating semiconductor design, embedded systems, or fabrication processes. Deliverables include literature survey, system design, validation, and report presentation.

Evaluation Scheme: Report (40%), Demonstration (30%), Presentation/Viva (30%).

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

B.Tech in Semiconductor Technology – Semester VII

Semiconductor Manufacturing and Supply Chain
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen industry-oriented knowledge in semiconductor design and manufacturing.
• To promote applied research and emerging technology competence.
• To enhance professional and project management skills.

Course Outcomes:
CO1 – Explain advanced concepts in semiconductor technology.
CO2 – Analyze processes and systems for improvement.
CO3 – Apply knowledge to practical and industrial problems.
CO4 – Engage in multidisciplinary team projects.
CO5 – Demonstrate leadership and research ethics.

Detailed Syllabus

Unit I – Semiconductor Manufacturing Ecosystem (9 Hours)
Overview of global semiconductor manufacturing; wafer fabs, foundries, and IDMs; process flow from design to fabrication; major industry players and regions.

Unit II – Manufacturing Operations and Yield Management (9 Hours)
Fab operations; cycle time and throughput; process control and SPC; yield loss mechanisms; statistical process control charts.

Unit III – Supply Chain Design and Logistics (9 Hours)
Supply chain models in semiconductor industry; materials management, procurement, inventory control, logistics optimization.

Unit IV – Quality and Six Sigma in Semiconductor Production (9 Hours)
TQM, Six Sigma methodology, DMAIC cycle; lean manufacturing; defect density and DPMO calculations; ISO 9001 compliance.

Unit V – Case Studies and Global Challenges (9 Hours)
Chip shortages, geopolitical influences, and sustainable manufacturing; fabless–foundry collaboration; semiconductor policy initiatives in India.

Text Books: 1. Matthias Schleife – Semiconductor Manufacturing Handbook 2. Robert Doering – Handbook of Semiconductor Manufacturing Technology
Reference Books: 1. Tummala – Microelectronics Packaging 2. Christopher – Logistics and Supply Chain Management

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Reliability and Failure Analysis of Semiconductors
(ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen industry-oriented knowledge in semiconductor design and manufacturing.
• To promote applied research and emerging technology competence.
• To enhance professional and project management skills.

Course Outcomes:
CO1 – Explain advanced concepts in semiconductor technology.
CO2 – Analyze processes and systems for improvement.
CO3 – Apply knowledge to practical and industrial problems.
CO4 – Engage in multidisciplinary team projects.
CO5 – Demonstrate leadership and research ethics.

Detailed Syllabus

Unit I – Fundamentals of Reliability Engineering (9 Hours)
Reliability concepts; failure rate and MTBF; exponential and Weibull models; reliability block diagrams and life data analysis.

Unit II – Failure Mechanisms in Semiconductors (9 Hours)
Electromigration, TDDB, NBTI, HCI, ESD failures; package-related and interconnect failures; moisture and thermal effects.

Unit III – Reliability Testing and Qualification (9 Hours)
Accelerated life testing; temperature and humidity stress tests; thermal cycling and burn-in; JEDEC and MIL standards.

Unit IV – Failure Analysis Techniques (9 Hours)
Physical and chemical analysis using SEM, TEM, FIB, SIMS; electrical characterization; root cause analysis; FA reporting.

Unit V – Design for Reliability and Predictive Models (9 Hours)
Design for reliability (DFR); physics-of-failure approach; reliability modeling using simulation; case studies from power devices and memories.

Text Books: 1. Baliga – Power Semiconductor Devices 2. Hugh Hill – Electronic Component Reliability
Reference Books: 1. J. Sacco – Reliability of Semiconductor Devices 2. Pecht – Product Reliability Engineering

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Elective II – Flexible Electronics and Applications
(ES – Open Elective Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen industry-oriented knowledge in semiconductor design and manufacturing.
• To promote applied research and emerging technology competence.
• To enhance professional and project management skills.

Course Outcomes:
CO1 – Explain advanced concepts in semiconductor technology.
CO2 – Analyze processes and systems for improvement.
CO3 – Apply knowledge to practical and industrial problems.
CO4 – Engage in multidisciplinary team projects.
CO5 – Demonstrate leadership and research ethics.

Detailed Syllabus (Expanded Unit-wise Content and Hours):

Unit I – Introduction to Flexible Electronics (9 Hours)
Concept, evolution, and advantages; comparison with rigid electronics; market and applications in wearable devices and sensors.

Unit II – Materials and Substrates (9 Hours)
Organic and inorganic semiconductors; polymeric substrates; conductive inks; material compatibility and reliability issues.

Unit III – Fabrication Processes (9 Hours)
Printing and coating methods – inkjet, roll-to-roll, and screen printing; low-temperature deposition techniques; encapsulation.

Unit IV – Devices and Circuits (9 Hours)
Thin-film transistors, flexible sensors, displays, and energy harvesters; stretchable interconnects and hybrid integration.

Unit V – Applications and Future Trends (9 Hours)
Biomedical patches, smart textiles, flexible photovoltaics; challenges in commercialization and sustainability aspects.

Text Books: 1. Someya – Flexible Electronics 2. Rogers – Materials for Flexible and Stretchable Electronics
Reference Books: 1. Gleskova – Thin Film Transistors 2. Kelley – Printed Electronics Handbook

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Elective III – Automotive Electronics and Embedded Control
(ES – Open Elective Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen industry-oriented knowledge in semiconductor design and manufacturing.
• To promote applied research and emerging technology competence.
• To enhance professional and project management skills.

Course Outcomes:
CO1 – Explain advanced concepts in semiconductor technology.
CO2 – Analyze processes and systems for improvement.
CO3 – Apply knowledge to practical and industrial problems.
CO4 – Engage in multidisciplinary team projects.
CO5 – Demonstrate leadership and research ethics.

Detailed Syllabus

Unit I – Automotive Electronics Fundamentals (9 Hours)
Automotive system overview; sensors, actuators, ECUs; vehicle communication networks (CAN, LIN, FlexRay).

Unit II – Embedded Control Systems (9 Hours)
Microcontrollers and DSPs in automotive control; real-time systems; ECU design and safety standards (ISO 26262).

Unit III – Powertrain and Chassis Systems (9 Hours)
Engine management, transmission control, braking and stability control systems; hybrid vehicle electronics.

Unit IV – Infotainment and ADAS (9 Hours)
In-vehicle infotainment, telematics, and human–machine interface; advanced driver-assistance systems (radar, LiDAR, vision sensors).

Unit V – Emerging Trends (9 Hours)
Electric vehicle systems, battery management, autonomous vehicles; cybersecurity and connectivity in vehicles.

Text Books: 1. Bosch – Automotive Handbook 2. Tom Dent – Automotive Electronics Design Fundamentals
Reference Books: 1. William Ribbens – Understanding Automotive Electronics 2. Raj Kamala – Embedded System Design

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Emerging Technologies in Semiconductors (AI Chips, Neuromorphic, Quantum Devices) (ES – Engineering Science Course) – 3 Credits / 45 Hours

Course Objectives:
• To strengthen industry-oriented knowledge in semiconductor design and manufacturing.
• To promote applied research and emerging technology competence.
• To enhance professional and project management skills.

Course Outcomes:
CO1 – Explain advanced concepts in semiconductor technology.
CO2 – Analyze processes and systems for improvement.
CO3 – Apply knowledge to practical and industrial problems.
CO4 – Engage in multidisciplinary team projects.
CO5 – Demonstrate leadership and research ethics.

Detailed Syllabus

Unit I – AI and Edge Computing Chips (9 Hours)
Architectures for AI accelerators; TPU, GPU, and FPGA-based computation; energy-efficient deep learning hardware.

Unit II – Neuromorphic Computing (9 Hours)
Principles of brain-inspired computing; spiking neural networks; memristors; hardware design and learning algorithms.

Unit III – Quantum Computing Basics (9 Hours)
Qubits, superposition, and entanglement; quantum logic gates; quantum algorithms and hardware implementations.

Unit IV – Material and Device Innovations (9 Hours)
2D materials (graphene, MoS_2), topological insulators; single-electron transistors and tunnel junction devices.

Unit V – Future Trends and Applications (9 Hours)
AI–quantum hybrid systems; neuromorphic vision sensors; industry applications and research directions.

Text Books: 1. Mead – Analog VLSI and Neural Systems 2. Nielsen & Chuang – Quantum Computation and Quantum Information
Reference Books: 1. Sze & Ng – Physics of Semiconductor Devices 2. Tambe – Neuromorphic Computing and Engineering

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Industry Internship (2 months) (ES – Practical Course) – 4 Credits / 60 Hours

Course Objectives:
• To strengthen industry-oriented knowledge in semiconductor design and manufacturing.
• To promote applied research and emerging technology competence.
• To enhance professional and project management skills.

Course Outcomes:
CO1 – Explain advanced concepts in semiconductor technology.
CO2 – Analyze processes and systems for improvement.
CO3 – Apply knowledge to practical and industrial problems.
CO4 – Engage in multidisciplinary team projects.
CO5 – Demonstrate leadership and research ethics.

Detailed Syllabus

Module I – Industrial Attachment (60 Hours)
Students complete a minimum 8-week internship in semiconductor, VLSI, or electronics industry. Activities include process observation, project partic ipation, and report submission highlighting technical learning and professional skills gained.

Assessment Criteria: Industry Supervisor Feedback (30%), Report (40%), Presentation/Viva (30%) .

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

Major Project Phase I (Chip/Product Development)
(ES – Project Course) – 4 Credits / 60 Hours

Course Objectives:
• To strengthen industry-oriented knowledge in semiconductor design and manufacturing.
• To promote applied research and emerging technology competence.
• To enhance professional and project management skills.

Course Outcomes:
CO1 – Explain advanced concepts in semiconductor technology.
CO2 – Analyze processes and systems for improvement.
CO3 – Apply knowledge to practical and industrial problems.
CO4 – Engage in multidisciplinary team projects.
CO5 – Demonstrate leadership and research ethics.

Detailed Syllabus

Module I – Project Design and Development (60 Hours)
Students initiate a major project in chip or product development. Tasks include problem identificati on, literature survey, design planning, and prototype concept development under faculty/industry mentor.

Evaluation Scheme: Proposal (20%), Mid-Review (30%), Final Report & Presentation (50%).

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Exam (60%)

B.Tech in Semiconductor Technology – Semester VIII

Intellectual Property Rights & Tech Entrepreneurship

Course Objectives:
- To impart knowledge of intellectual property laws and their role in technology and innovation.
- To nurture entrepreneurial thinking among engineering graduates for semiconductor startups and R&D commercialization.

Course Outcomes:
CO1: Understand the fundamentals of patents, copyrights, and trademarks.
CO2: Apply IP management in technology-based ventures.
CO3: Demonstrate entrepreneurial strategies for innovation-based enterprises.

Unit I – Introduction to Intellectual Property (6 hrs)
Concept, scope, and importance of IP; patents, copyrights, trademarks, industrial design rights; international IP regimes (WIPO, TRIPS).

Unit II – Patents and Process (8 hrs)
Patentability criteria, drafting patent applications, filing process (Indian & PCT), patent search, infringement, and litigation.

Unit III – Technology Transfer and Commercialization (8 hrs)
Licensing models, IP valuation, spin-offs, technology transfer offices (TTOs).

Unit IV – Entrepreneurship and Start-up Ecosystem (8 hrs)
Business models, incubation, venture capital, start-up funding, government schemes for semiconductor innovation.

Unit V – Case Studies and Ethics (6 hrs)
Case studies of global semiconductor companies and Indian startups; ethical issues in innovation and IP management.

Text Books:
1. Deborah E. Bouchoux, 'Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets', Cengage Learning.
2. S. S. Khanka, 'Entrepreneurial Development', S. Chand.
3. P. Narayanan, 'Intellectual Property Law', Eastern Law House.

Major Project Phase II (Capstone Project)

Course Objectives:
- To synthesize knowledge gained throughout the program and apply it in a real-world semiconductor project.
- To promote independent research, design thinking, and problem-solving for industrial or societal applications.

Course Outcomes:
CO1: Demonstrate ability to design and implement a semiconductor system/device.
CO2: Exhibit competence in project management, documentation, and teamwork.
CO3: Present and defend findings before academic and industry experts.

Project Guidelines:
• Project must be industry-linked, R&D-focused, or application-driven in semiconductor technology.
• Topics may include chip design, MEMS/NEMS devices, process integration, testing & validation, or emerging semiconductor materials.
• Evaluation will be based on literature survey, project design, progress presentation, final report, and viva voce.
• Deliverables: Project Report, Prototype/Simulation Results, Poster, and Presentation.

Hours: Minimum 10 hours/week (Lab/Field/Research work).

Open Elective III (Interdisciplinary) [

Students can select any one elective from interdisciplinary areas to broaden their academic exposure:

1. Sustainable Semiconductor Manufacturing
2. AI & Data Analytics for Electronic Systems
3. Business Strategy for Technology Management
4. Quantum Computing Fundamentals
5. Policy and Regulation in Semiconductor Industry

Each elective shall have 30–35 contact hours and be assessed through internal evaluation (50%) and end-semester examination (50%).

Seminar / Viva-Voce / Portfolio Development [L:0 T:0 P:2 C:2]

Course Objectives:
- To enhance communication, technical documentation, and presentation skills.
- To evaluate student's comprehensive understanding of the program outcomes.

Course Outcomes:
CO1: Prepare and deliver a technical presentation on emerging semiconductor topics.
CO2: Develop an academic portfolio including publications, project documentation, and achievements.
CO3: Defend project work in a viva-voce with clarity and confidence.

Evaluation Components:
• Technical Presentation (30%)
• Report/Portfolio Submission (40%)
• Viva-Voce (30%)

B.Tech – Quantum Computing
Detailed Syllabus – Semester I

Mathematics I (Calculus & Linear Algebra)
(BS – 4 Credits / 60 Hours)

Course Objectives:
• To introduce the fundamentals of calculus and linear algebra with applications in quantum and engineering systems.
• To develop mathematical reasoning and vector analysis skills for field and state-space prob lems.
• To apply matrix and eigen analysis in modeling quantum states and transformations.

Course Outcomes:
CO1 – Understand differential and integral calculus concepts for engineering applications.
CO2 – Apply vector calculus in physical and quantum systems.
CO3 – Use matrix operations and eigenvalue methods for linear transformations.
CO4 – Solve engineering problems using multivariable calculus and differential equations.
CO5 – Model and analyze physical systems using Hilbert-space representations.

Detailed Syllabus:

Unit 1 – Differential Calculus (12 Hours)
Limits, continuity, partial derivatives, Jacobian, Taylor series, applications in optimization.

Unit 2 – Integral Calculus (12 Hours)
Definite and multiple integrals, Green's, Gauss's and Stokes's theorems with applications.

Unit 3 – Vector Calculus (12 Hours)
Gradient, divergence, curl and their physical significance in fields and wave functions.

Unit 4 – Linear Algebra (12 Hours)
Matrices, determinants, rank, inverse, systems of linear equations.

Unit 5 – Eigenvalue Analysis (12 Hours)
Eigenvalues, eigenvectors, orthogonality, unitary matrices, Hilbert space concepts.

Text Books:
B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers.
Erwin Kreyszig – Advanced Engineering Mathematics, Wiley.

Reference Books:
Gilbert Strang – Linear Algebra and Its Applications.
Shankar – Principles of Quantum Mechanics (for contextual examples).

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Physics I (Mechanics, Waves & Optics)
(BS – 4 Credits / 60 Hours)

Course Objectives:
• To introduce principles of mechanics, oscillations, and optics as a foundation for quantum physics.
• To establish connections between classical mechanics and wave-particle duality.
• To develop experimental and analytical skills relevant to quantum technologies.

Course Outcomes:
CO1 – Describe laws of motion and energy conservation in mechanical systems.
CO2 – Analyze oscillatory and wave phenomena in continuous media.
CO3 – Explain optical interference, diffraction and polarization.
CO4 – Relate classical waves to quantum superposition principles.
CO5 – Perform and interpret basic physics experiments.

Detailed Syllabus:

Unit 1 – Mechanics (12 Hours)
Linear and rotational dynamics, momentum and energy conservation, applications to atomic motion.

Unit 2 – Oscillations (12 Hours)
Simple harmonic motion, damping, resonance and coupled oscillators.

Unit 3 – Wave Motion (12 Hours)
Progressive and standing waves, superposition, Doppler effect.

Unit 4 – Optics (12 Hours)
Interference, diffraction, polarization, optical instruments.

Unit 5 – Quantum Prelude (12 Hours)
Photoelectric effect, Planck's hypothesis, de Broglie waves, wave–particle duality.

Practical Component:
Experiments on oscillations, optical interference and basic measurements using laser and ph otodiodes.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Chemistry
(BS – 3 Credits / 45 Hours)

Course Objectives:
• To understand atomic structure, bonding and chemical thermodynamics as a basis for mat

erials and quantum applications.
• To introduce concepts of nanomaterials and surface chemistry in quantum devices.
• To develop laboratory skills for chemical analysis and synthesis.

Course Outcomes:
CO1 – Explain atomic structure and bonding theories.
CO2 – Analyze thermodynamic and electrochemical processes.
CO3 – Characterize materials and chemical reactions.
CO4 – Discuss nanomaterials and quantum effects in chemistry.
CO5 – Perform chemical experiments with safe practices.

Detailed Syllabus:

Unit 1 – Atomic Structure (9 Hours)
Quantum numbers, hybridization, molecular orbitals.

Unit 2 – Thermodynamics (9 Hours)
Laws of thermodynamics, enthalpy, entropy, Gibbs free energy.

Unit 3 – Electrochemistry (9 Hours)
Conductance, Nernst equation, batteries, fuel cells.

Unit 4 – Materials Chemistry (9 Hours)
Polymers, ceramics, semiconductors and their applications.

Unit 5 – Nanomaterials (9 Hours)
Synthesis, quantum confinement, applications in sensors and quantum devices.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Environmental Science
(BS – 3 Credits / 45 Hours)

Course Objectives:
• To foster environmental awareness and sustainability principles in engineering practice.
• To introduce ecosystem dynamics and pollution management.
• To relate clean energy technologies to sustainable quantum hardware manufacturing.

Course Outcomes:
CO1 – Understand ecosystems and energy flow concepts.
CO2 – Identify pollution sources and mitigation strategies.
CO3 – Comprehend environmental laws and ethical issues.
CO4 – Adopt sustainable and green engineering approaches.
CO5 – Analyze environmental impact of emerging technologies.

Detailed Syllabus:

Unit 1 – Ecosystems (9 Hours)
Structure, functions, biogeochemical cycles.

Unit 2 – Biodiversity (9 Hours)
Hotspots, conservation methods.

Unit 3 – Pollution (9 Hours)
Types, effects, and control methods.

Unit 4 – Environmental Policies (9 Hours)
Acts, rules, EIA, waste management.

Unit 5 – Sustainability (9 Hours)
Renewable energy, carbon footprint, climate change.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Programming Fundamentals (Python/C)
(ES – 3 Credits / 45 Hours)

Course Objectives:
• To introduce structured and object-based programming approaches for scientific computa tion.
• To develop algorithmic thinking and coding skills using Python or C.
• To apply programming for simulation and data analysis in quantum contexts.

Course Outcomes:
CO1 – Apply fundamentals of programming to solve engineering problems.
CO2 – Use control structures and functions for algorithm implementation.
CO3 – Perform data processing and file handling.
CO4 – Simulate numerical problems and basic quantum models.
CO5 – Demonstrate teamwork through mini projects and documentation.

Detailed Syllabus:

Unit 1 – Introduction (9 Hours)
Algorithms, flowcharts, structure of C/Python programs.

Unit 2 – Data Types (9 Hours)
Variables, operators, loops and conditionals.

Unit 3 – Functions (9 Hours)
Parameter passing, recursion, libraries.

Unit 4 – Arrays and Strings (9 Hours)
Operations on data structures, search and sort.

Unit 5 – Applications (9 Hours)
Matrix manipulation, data visualization, simulation tasks.

Practical Component:
Laboratory Sessions: Programming practice for mathematical and quantum simulations usin g Python libraries like NumPy and Matplotlib.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Quantum Computing
Detailed Syllabus – Semester II

Mathematics II (Probability, Statistics & Complex Variables)
(BS – 4 Credits / 60 Hours)

Course Objectives:
• To introduce probability, statistics, and complex analysis essential for data-driven and quantum systems.
• To apply probabilistic models in quantum computation and error analysis.
• To understand complex variables in modeling wave and quantum phenomena.

Course Outcomes:
CO1 – Understand probability distributions and random variables in engineering contexts.
CO2 – Apply statistical tools for data analysis and uncertainty estimation.
CO3 – Use complex analysis to solve physical and computational problems.
CO4 – Model stochastic and quantum systems using probabilistic principles.
CO5 – Employ statistical software for analysis and simulation tasks.

Detailed Syllabus:

Unit 1 – Probability Theory (12 Hours)
Sample space, conditional probability, Bayes' theorem, random variables, expectation.

Unit 2 – Statistical Distributions (12 Hours)
Binomial, Poisson, normal, and exponential distributions; central limit theorem.

Unit 3 – Statistical Inference (12 Hours)
Hypothesis testing, correlation, regression, goodness of fit.

Unit 4 – Complex Variables (12 Hours)
Analytic functions, Cauchy-Riemann equations, integration, residues.

Unit 5 – Applications (12 Hours)
Probability in quantum measurements, noise analysis, data modeling.

Text Books:
B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers
Erwin Kreyszig – Advanced Engineering Mathematics, Wiley

Reference Books:
S.C. Gupta & V.K. Kapoor – Fundamentals of Mathematical Statistics

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Physics II (Modern Physics & Introduction to Quantum Mechanics)
(BS – 4 Credits / 60 Hours)

Course Objectives:
• To introduce quantum mechanics principles and their applications in modern engineering.
• To explain atomic structure, energy quantization, and wave-particle duality.
• To relate quantum concepts to emerging quantum computing and nanotechnologies.

Course Outcomes:
CO1 – Understand the origin and postulates of quantum mechanics.
CO2 – Solve Schrödinger equation for basic potential systems.
CO3 – Describe atomic and crystal structures underlying quantum devices.
CO4 – Apply principles of wave-particle duality to micro-scale systems.
CO5 – Correlate modern physics concepts to quantum computing applications.

Detailed Syllabus:

Unit 1 – Quantum Origins (12 Hours)
Blackbody radiation, photoelectric effect, Compton scattering, de Broglie hypothesis.

Unit 2 – Wave-Particle Duality (12 Hours)
Heisenberg uncertainty principle, wavefunctions, probability interpretation.

Unit 3 – Schrödinger Equation (12 Hours)
Formulation and solutions for potential wells and barriers.

Unit 4 – Atomic Structure (12 Hours)
Bohr's model, quantum numbers, electron spin, Pauli exclusion principle.

Unit 5 – Applications (12 Hours)
Semiconductors, superconductivity, tunneling, quantum dots and nanostructures.

Practical Component:
Experiments: Photoelectric effect, Hall effect, electron charge-to-mass ratio, Planck's constant measurement.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Data Structures & Algorithms
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To provide understanding of fundamental data structures and algorithmic techniques.
• To develop efficient data organization, manipulation, and retrieval mechanisms.
• To enable algorithmic thinking for problem solving and quantum-inspired computation.

Course Outcomes:
CO1 – Identify and apply suitable data structures for computational problems.
CO2 – Design and implement algorithms using time and space complexity analysis.
CO3 – Demonstrate recursive algorithms and sorting techniques.
CO4 – Utilize dynamic data structures like linked lists, stacks, and queues.
CO5 – Develop applications using algorithmic and quantum-inspired paradigms.

Detailed Syllabus:

Unit 1 – Introduction (9 Hours)
Algorithm complexity, Big O notation, performance analysis.

Unit 2 – Linear Data Structures (9 Hours)
Arrays, linked lists, stacks, queues, applications.

Unit 3 – Nonlinear Data Structures (9 Hours)
Trees, graphs, traversals, hashing.

Unit 4 – Sorting & Searching (9 Hours)
Bubble, insertion, quick, merge sort; linear and binary search.

Unit 5 – Advanced Topics (9 Hours)
Dynamic programming, greedy methods, quantum-inspired algorithms.

Practical Component:
Programming Exercises: Implementing data structures and algorithm analysis in Python/C++.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Digital Logic & Computer Organization
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To provide foundational knowledge of digital circuits and computer architecture.
• To introduce logic gates, Boolean algebra, and sequential circuits.
• To relate digital logic principles to quantum logic and reversible computation.

Course Outcomes:
CO1 – Understand number systems, Boolean algebra, and logic simplification.
CO2 – Design combinational and sequential logic circuits.
CO3 – Explain CPU organization and instruction execution.
CO4 – Apply memory and I/O concepts for computing systems.
CO5 – Connect reversible logic concepts to quantum computing architectures.

Detailed Syllabus:

Unit 1 – Number Systems (9 Hours)
Binary, octal, hexadecimal, conversions, Boolean algebra.

Unit 2 – Combinational Circuits (9 Hours)
Adders, multiplexers, encoders, decoders.

Unit 3 – Sequential Circuits (9 Hours)
Flip-flops, counters, shift registers.

Unit 4 – Computer Architecture (9 Hours)
CPU design, memory hierarchy, control unit.

Unit 5 – Quantum Context (9 Hours)
Reversible logic, quantum gates, qubit encoding overview.

Practical Component:
Lab Experiments: Logic gate design using hardware simulation tools and Verilog.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Introduction to AI & Emerging Technologies (ES – 3 Credits / 45 Hours)

Course Objectives:
• To introduce artificial intelligence concepts and their role in emerging technologies.
• To familiarize students with machine learning, IoT, blockchain, and quantum computing integration.
• To promote interdisciplinary understanding between classical and quantum AI models.

Course Outcomes:
CO1 – Explain core principles of AI, ML, and data analytics.
CO2 – Apply supervised and unsupervised learning techniques.
CO3 – Analyze applications of IoT, cloud, and edge computing.
CO4 – Describe the role of AI in quantum technology development.
CO5 – Explore ethical and social implications of emerging technologies.

Detailed Syllabus:

Unit 1 – AI Fundamentals (9 Hours)
History, scope, intelligent agents, search algorithms.

Unit 2 – Machine Learning (9 Hours)
Supervised, unsupervised, reinforcement learning.

Unit 3 – Emerging Technologies (9 Hours)
IoT, blockchain, cybersecurity, digital twins.

Unit 4 – Quantum AI (9 Hours)
Quantum data, qubit-based ML, hybrid models.

Unit 5 – Applications (9 Hours)
AI for healthcare, robotics, and sustainable development.

Text Books:
Stuart Russell & Peter Norvig – Artificial Intelligence: A Modern Approach.
Ian Goodfellow et al. – Deep Learning.

Reference Books:
Andreas C. Müller – Introduction to Machine Learning with Python.
Geron – Hands-on Machine Learning with Scikit-Learn, Keras & TensorFlow.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Humanities Elective (Ethics & Philosophy of Science)
(HS – 2 Credits / 30 Hours)

Course Objectives:
• To develop ethical reasoning and understanding of scientific inquiry.
• To examine human values, technology impact, and social responsibility.
• To connect philosophical concepts to contemporary scientific developments.

Course Outcomes:
CO1 – Understand ethical theories and frameworks.
CO2 – Analyze science's philosophical foundations.
CO3 – Apply ethics in engineering and research contexts.
CO4 – Evaluate implications of technology on society and environment.
CO5 – Demonstrate professional integrity and responsibility.

Detailed Syllabus:

Unit 1 – Ethical Foundations (6 Hours)
Moral values, professional ethics, integrity.

Unit 2 – Philosophy of Science (6 Hours)
Scientific method, falsification, paradigm shifts.

Unit 3 – Technology & Society (6 Hours)
Human-technology relations, AI ethics.

Unit 4 – Contemporary Issues (6 Hours)
Environmental ethics, data privacy, AI bias.

Unit 5 – Case Studies (6 Hours)
Ethical dilemmas in research and innovation.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Internship I (Industry Exposure)
(PR – 1 Credits / 15 Hours)

Course Objectives:
- To provide industrial exposure and practical understanding of engineering systems.
- To develop communication, teamwork, and problem-solving abilities.
- To correlate academic learning with professional practices.

Course Outcomes:
CO1 – Demonstrate understanding of industrial processes.
CO2 – Apply theoretical knowledge in real-world contexts.
CO3 – Exhibit teamwork, ethics, and communication skills.
CO4 – Prepare internship reports summarizing learning outcomes.
CO5 – Engage in continuous professional development.

Detailed Syllabus:

Unit 1 – Industrial Orientation (5 Hours)
Observation of manufacturing or research processes.

Unit 2 – Report & Presentation (10 Hours)
Documentation and presentation of findings.

Practical Component:
Minimum two-week internship or equivalent online industry certification program.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Quantum Computing
Detailed Syllabus – Semester III

Linear Algebra & Group Theory for Quantum Computing
(BS – 4 Credits / 60 Hours)

Course Objectives:
- To develop mathematical foundations for quantum mechanics and computation.
- To apply linear algebra and symmetry concepts in representing qubit operations.
- To introduce group theory and its relevance to quantum algorithms and error correction.

Course Outcomes:
CO1 – Understand vector spaces, linear transformations, and orthogonality.
CO2 – Apply eigenvalue and matrix decomposition techniques in quantum models.
CO3 – Analyze symmetry and group operations in physical systems.
CO4 – Utilize tensor products and Hilbert space formalism for multi-qubit systems.
CO5 – Employ mathematical tools for quantum simulations and algorithm design.

Detailed Syllabus:

Unit 1 – Vector Spaces & Matrices (12 Hours)
Vectors, basis, inner products, orthogonal projections, matrix algebra.

Unit 2 – Eigenvalue Problems (12 Hours)
Diagonalization, spectral theorem, Hermitian and unitary matrices.

Unit 3 – Tensor & Kronecker Products (12 Hours)
Multi-qubit representation, density matrices, unitary evolution.

Unit 4 – Group Theory Basics (12 Hours)
Symmetry groups, permutations, Lie groups, and representations.

Unit 5 – Applications (12 Hours)
Pauli matrices, commutators, quantum gates, and group symmetries in quantum circuits.

Text Books:
Gilbert Strang – Linear Algebra and Its Applications
Michael A. Nielsen & Isaac Chuang – Quantum Computation and Quantum Information

Reference Books:
D. McMahon – Quantum Computing Explained
W. Greiner – Quantum Mechanics: An Introduction

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Quantum Mechanics for Engineers
(BS – 4 Credits / 60 Hours)

Course Objectives:
• To explain quantum mechanical principles applicable to physical and engineering systems.
• To describe Schrödinger formalism and operator methods in computing contexts.
• To relate quantum mechanics to modern technologies such as semiconductors and quantum circuits.

Course Outcomes:
CO1 – Understand the mathematical postulates of quantum mechanics.
CO2 – Solve Schrödinger equation for standard potentials.
CO3 – Interpret wavefunctions and probability densities.
CO4 – Apply operators, commutators, and expectation values to observables.
CO5 – Relate quantum mechanics to real-world materials and devices.

Detailed Syllabus:

Unit 1 – Foundations (12 Hours)
Wave-particle duality, uncertainty principle, postulates of quantum mechanics.

Unit 2 – Schrödinger Equation (12 Hours)
Time-dependent and independent equations, boundary conditions.

Unit 3 – Quantum Operators (12 Hours)
Linear operators, Hermitian operators, commutation relations, expectation values.

Unit 4 – Applications (12 Hours)
Particle in a box, tunneling, harmonic oscillator.

Unit 5 – Quantum Devices (12 Hours)
Semiconductor quantum wells, qubits, and tunneling diodes.

Practical Component:
Simulations using Python and Qiskit for wavefunctions and tunneling effects.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Operating Systems
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce operating system architecture, process management, and memory handling.
• To develop multitasking and synchronization skills through simulation and design.

• To expose students to system-level software concepts relevant to quantum-classical integration.

Course Outcomes:
CO1 – Understand the structure and functions of operating systems.
CO2 – Implement process and thread synchronization techniques.
CO3 – Apply memory management and scheduling algorithms.
CO4 – Manage file systems and device interfaces.
CO5 – Explore design aspects of hybrid OS for quantum computing.

Detailed Syllabus:

Unit 1 – OS Basics (9 Hours)
Architecture, kernel functions, system calls, OS types.

Unit 2 – Process Management (9 Hours)
Scheduling, interprocess communication, deadlocks.

Unit 3 – Memory Management (9 Hours)
Paging, segmentation, virtual memory, fragmentation.

Unit 4 – File Systems (9 Hours)
Organization, allocation methods, access control.

Unit 5 – Advanced Topics (9 Hours)
Quantum OS overview, concurrency, security, virtualization.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Database Management Systems
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce data modeling, relational database design, and SQL programming.
• To apply normalization and transaction concepts for database integrity.
• To explore quantum databases and hybrid data models.

Course Outcomes:
CO1 – Understand ER modeling and relational schema design.
CO2 – Use SQL for database creation, manipulation, and queries.
CO3 – Apply normalization and indexing for performance optimization.
CO4 – Implement concurrency control and recovery mechanisms.
CO5 – Analyze emerging paradigms like quantum and graph databases.

Detailed Syllabus:

Unit 1 – Data Modeling (9 Hours)
ER model, relational model, integrity constraints.

Unit 2 – SQL (9 Hours)
DDL, DML, DCL operations, queries, joins, subqueries.

Unit 3 – Normalization (9 Hours)
1NF to 5NF, dependency preservation, anomalies.

Unit 4 – Transactions (9 Hours)
ACID properties, concurrency control, deadlock management.

Unit 5 – Quantum Databases (9 Hours)
Quantum search algorithms, storage paradigms.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Signals & Systems
(ES – 3 Credits / 45 Hours)

Course Objectives:
• To introduce fundamentals of signals, systems, and transforms.
• To apply Fourier and Laplace techniques to analyze continuous and discrete systems.
• To contextualize signal representation in quantum communication and information theory.

Course Outcomes:
CO1 – Represent and classify signals and systems.
CO2 – Perform Fourier and Laplace analysis on linear systems.
CO3 – Analyze convolution and correlation operations.
CO4 – Use z-transform and discrete-time methods for digital systems.
CO5 – Relate classical signals to quantum information transmission.

Detailed Syllabus:

Unit 1 – Signal Representation (9 Hours)
Continuous and discrete-time signals, energy and power, periodicity.

Unit 2 – System Properties (9 Hours)
Linearity, time invariance, causality, stability.

Unit 3 – Convolution & Correlation (9 Hours)
Impulse response, convolution integral and sum.

Unit 4 – Transforms (9 Hours)
Laplace, Fourier, z-transforms and their applications.

Unit 5 – Quantum Context (9 Hours)
Quantum states as signal spaces, entanglement as correlation.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Open Elective I – IoT for Quantum-Enabled Systems (OE – 3 Credits / 45 Hours)

Course Objectives:
• To introduce the architecture and protocols of Internet of Things systems.
• To explore IoT data handling integrated with cloud and quantum computation.
• To apply sensor networks and quantum communication for smart applications.

Course Outcomes:
CO1 – Describe IoT components, architecture, and communication protocols.
CO2 – Apply IoT frameworks for real-time monitoring and control.
CO3 – Integrate cloud and edge computing for IoT data management.
CO4 – Analyze security and performance in IoT-Quantum integrated systems.
CO5 – Develop prototypes using IoT sensors and cloud platforms.

Detailed Syllabus:

Unit 1 – IoT Architecture (9 Hours)
Layered architecture, sensors, actuators, gateways, and connectivity.

Unit 2 – Communication Protocols (9 Hours)
ZigBee, MQTT, CoAP, Bluetooth, 5G, LPWAN.

Unit 3 – IoT Platforms (9 Hours)
AWS IoT, Google Cloud IoT, ThingSpeak integration.

Unit 4 – Quantum IoT (9 Hours)
Quantum sensors, cryptography, and quantum communication.

Unit 5 – Applications (9 Hours)
Smart cities, healthcare, and hybrid IoT-Quantum networks.

Practical Component:
IoT Mini Project: Sensor data acquisition and visualization using Raspberry Pi/Arduino connected to a cloud dashboard.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Internship I (Industry Exposure) (PR – 1 Credits / 15 Hours)

Course Objectives:
• To provide practical exposure to industrial or research environments.
• To enable application of theoretical knowledge to real-world technology systems.
• To promote interdisciplinary understanding and communication skills.

Course Outcomes:
CO1 – Gain insight into organizational workflows and technical practices.
CO2 – Apply engineering knowledge in practical problem-solving.
CO3 – Work collaboratively in industrial or lab environments.
CO4 – Demonstrate technical documentation and presentation abilities.
CO5 – Develop professionalism and ethical responsibility.

Detailed Syllabus:

Unit 1 – Orientation & Training (6 Hours)
Observation of technology implementation in industry.

Unit 2 – Report Preparation (9 Hours)
Documentation of learning outcomes and project summary.

Practical Component:
Internship duration: Minimum 2 weeks / online certified training in a relevant domain.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Quantum Computing
Detailed Syllabus – Semester IV

Quantum Physics II (Spin, Entanglement & Measurement Theory)
(BS – 3 Credits / 45 Hours)

Course Objectives:
• To study quantum theory related to spin, angular momentum, and entanglement.
• To introduce measurement postulates and quantum state formalism.
• To apply quantum correlation theory in communication and computation systems.

Course Outcomes:
CO1 – Understand quantum spin and angular momentum operators.
CO2 – Explain two-level systems and Bloch sphere representation.
CO3 – Analyze quantum entanglement and Bell inequalities.
CO4 – Describe quantum measurement and density matrix formalisms.
CO5 – Apply these concepts to quantum information and communication applications.

Detailed Syllabus:

Unit 1 – Spin & Angular Momentum (9 Hours)
Spin operators, commutation relations, Pauli matrices, spinor representations.

Unit 2 – Two-Level Quantum Systems (9 Hours)
Qubit representation, superposition, Bloch sphere.

Unit 3 – Entanglement Theory (9 Hours)
Bell states, EPR paradox, measurement correlations.

Unit 4 – Measurement Postulates (9 Hours)
Density matrix, projective measurement, decoherence models.

Unit 5 – Applications (9 Hours)
Quantum teleportation, entanglement swapping, decoherence control.

Text Books:
Sakurai – Modern Quantum Mechanics
Nielsen & Chuang – Quantum Computation and Quantum Information

Reference Books:
J.J. Sakurai – Advanced Quantum Mechanics
Cohen-Tannoudji – Quantum Mechanics

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Computer Networks & Cybersecurity
(PC – 3 Credits / 45 Hours)

Course Objectives:
- To introduce network architectures, protocols, and security principles.
- To understand data transmission mechanisms and cybersecurity frameworks.
- To relate network security to quantum cryptography and post-quantum protocols.

Course Outcomes:
CO1 – Explain network topologies, models, and protocol layers.
CO2 – Configure and analyze network devices and data flows.
CO3 – Understand cryptographic algorithms and security architectures.
CO4 – Implement basic network security solutions.
CO5 – Appreciate emerging quantum-resistant security methods.

Detailed Syllabus:

Unit 1 – Network Fundamentals (9 Hours)
OSI and TCP/IP models, topologies, IP addressing.

Unit 2 – Routing and Switching (9 Hours)
Subnetting, VLANs, routing algorithms.

Unit 3 – Security Basics (9 Hours)
Encryption, hashing, digital signatures.

Unit 4 – Cybersecurity Frameworks (9 Hours)
Firewalls, IDS, malware defense.

Unit 5 – Quantum Security (9 Hours)
Quantum key distribution, post-quantum cryptography.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Algorithms & Complexity Theory
(PC – 3 Credits / 45 Hours)

Course Objectives:
- To study algorithm design techniques and complexity analysis.
- To explore NP completeness and computational limits.
- To introduce quantum algorithms and their complexity advantages.

Course Outcomes:
CO1 – Analyze algorithm performance using asymptotic notation.
CO2 – Apply divide-and-conquer, greedy, and dynamic programming strategies.

CO3 – Understand P, NP, and NP-Complete problems.
CO4 – Relate classical and quantum algorithm complexities.
CO5 – Design efficient solutions using quantum speed-ups.

Detailed Syllabus:

Unit 1 – Algorithm Analysis (9 Hours)
Asymptotic notation, recurrences, sorting and searching complexity.

Unit 2 – Design Techniques (9 Hours)
Divide and conquer, greedy, dynamic programming.

Unit 3 – Graph Algorithms (9 Hours)
Shortest paths, minimum spanning trees.

Unit 4 – Complexity Classes (9 Hours)
P, NP, NP-hard, NP-complete problems.

Unit 5 – Quantum Algorithms (9 Hours)
Overview of Shor's and Grover's algorithms, quantum advantage.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Quantum Programming (Qiskit, Cirq, PyQuil)
(PC – 4 Credits / 60 Hours)

Course Objectives:
• To develop skills in quantum programming and simulation using modern platforms.
• To design and test quantum circuits and algorithms on real and simulated hardware.
• To apply quantum libraries for algorithm development and visualization.

Course Outcomes:
CO1 – Understand quantum circuit representation and programming frameworks.
CO2 – Use Qiskit, Cirq, and PyQuil for quantum algorithm implementation.
CO3 – Simulate quantum gates and measurement operations.
CO4 – Evaluate algorithm performance on noisy quantum hardware.
CO5 – Develop applications and visualizations for quantum experiments.

Detailed Syllabus:

Unit 1 – Introduction to Quantum Programming (12 Hours)
Quantum logic gates, qubit initialization, measurement postulates.

Unit 2 – Qiskit Framework (12 Hours)
Circuit creation, simulation, execution on IBM Q, Bloch sphere visualization.

Unit 3 – Cirq Framework (12 Hours)
Circuit design, noise models, execution on Google Quantum Engine.

Unit 4 – PyQuil Framework (12 Hours)
Quantum Virtual Machine, gate composition, measurement analysis.

Unit 5 – Hybrid Applications (12 Hours)
Building quantum-classical hybrid workflows for optimization and ML.

Practical Component:
Lab Exercises:
• Build and simulate quantum circuits using Qiskit and Cirq.
• Implement Grover's and Deutsch-Jozsa algorithms.
• Visualize state vectors and probabilities.
• Run algorithms on IBM Quantum Experience and analyze noise effects.

Text Books:
Abhijit Das – Introduction to Quantum Computing and Quantum Programming.
Qiskit Textbook – IBM Quantum Documentation.

Reference Books:
Cirq Developers – Google Quantum Documentation.
PyQuil Documentation – Rigetti Computing.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Machine Learning Foundations
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce fundamentals of machine learning and pattern recognition.
• To develop supervised and unsupervised learning models.
• To prepare students for quantum-enhanced machine learning applications.

Course Outcomes:
CO1 – Understand concepts of data preprocessing and model training.
CO2 – Apply regression, classification, and clustering techniques.
CO3 – Evaluate models using performance metrics.
CO4 – Use Python libraries for ML implementation.
CO5 – Explore quantum extensions to classical ML models.

Detailed Syllabus:

Unit 1 – Introduction to ML (9 Hours)
Learning types, pipeline, data preprocessing.

Unit 2 – Supervised Learning (9 Hours)
Regression, decision trees, SVM.

Unit 3 – Unsupervised Learning (9 Hours)
Clustering, PCA, dimensionality reduction.

Unit 4 – Model Evaluation (9 Hours)
Confusion matrix, precision, recall, cross-validation.

Unit 5 – Quantum ML Overview (9 Hours)
Quantum feature maps, kernels, VQA models.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Laboratory: Quantum Simulation Tools (IBM Q Experience) (ES – 3 Credits / 45 Hours)

Course Objectives:
- To gain hands-on experience in quantum simulation environments.
- To visualize quantum operations and simulate algorithms using real hardware interfaces.
- To apply quantum software tools for problem solving.

Course Outcomes:
CO1 – Configure IBM Q Experience workspace.
CO2 – Design quantum circuits for basic algorithms.
CO3 – Simulate and measure quantum states.
CO4 – Compare theoretical and experimental results.
CO5 – Document and present simulation findings.

Detailed Syllabus:

Unit 1 – Lab Modules (15 Hours)
Qubit operations, quantum gates, superposition and entanglement.

Unit 2 – Algorithm Simulations (15 Hours)
Deutsch-Jozsa, Grover, Quantum Teleportation.

Unit 3 – Hardware Interface (15 Hours)
Cloud execution, noise analysis, error correction.

Practical Component:
Students perform experiments using IBM Q Experience and document their observations wit h visualizations.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Internship II (Industry / Research Exposure)
(PR – 1 Credits / 15 Hours)

Course Objectives:
- To extend industrial exposure and research experience in quantum computing or related d omains.
- To enable practical application of academic knowledge in professional settings.
- To foster innovation and teamwork in real-world projects.

Course Outcomes:
CO1 – Apply theoretical concepts to industrial or research problems.
CO2 – Demonstrate professional communication and reporting skills.
CO3 – Collaborate effectively in team-based settings.
CO4 – Identify industrial trends in quantum technologies.
CO5 – Present project outcomes through structured reports and presentations.

Detailed Syllabus:

Unit 1 – Industrial Engagement (6 Hours)
Observation of quantum hardware/software operations.

Unit 2 – Project Reporting (9 Hours)
Preparation and presentation of internship summary.

Practical Component:
Minimum two-week internship or approved online training in quantum computing tools.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Quantum Computing
Detailed Syllabus – Semester V

Quantum Algorithms (Shor's, Grover's, Variational Algorithms)
(PC – 4 Credits / 60 Hours)

Course Objectives:
• To develop understanding of major quantum algorithms and their computational implications.
• To design and analyze algorithms using superposition, entanglement, and interference.
• To explore hybrid and variational quantum algorithms for optimization and learning tasks.

Course Outcomes:
CO1 – Explain the fundamentals of quantum computation and complexity.
CO2 – Implement Shor's and Grover's algorithms using quantum frameworks.
CO3 – Analyze algorithmic efficiency in classical vs quantum contexts.
CO4 – Apply VQE and QAOA for optimization problems.
CO5 – Develop small-scale quantum algorithm applications using open-source tools.

Detailed Syllabus:

Unit 1 – Introduction to Quantum Algorithms (12 Hours)
Quantum circuit model, computational basis, oracle-based computation.

Unit 2 – Shor's Algorithm (12 Hours)
Quantum Fourier transform, modular exponentiation, integer factorization.

Unit 3 – Grover's Algorithm (12 Hours)
Amplitude amplification, search problems, algorithm complexity.

Unit 4 – Variational Algorithms (12 Hours)
VQE, QAOA, hybrid quantum-classical models.

Unit 5 – Applications (12 Hours)
Quantum algorithms for optimization, chemistry, and ML tasks.

Practical Component:
Lab Exercises: Implement Shor's, Grover's, and Variational algorithms using Qiskit or Cirq; analyze runtime and success probability.

Text Books:
Nielsen & Chuang – Quantum Computation and Quantum Information.
Benenti, Casati & Strini – Principles of Quantum Computation and Information.

Reference Books:
Qiskit Textbook – IBM Quantum Learning.
Eleanor Rieffel & Wolfgang Polak – Quantum Computing: A Gentle Introduction.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Quantum Error Correction & Fault Tolerance
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To understand noise models, error sources, and decoherence in quantum systems.
• To study error correction codes and fault-tolerant design techniques.
• To explore practical implementations in quantum hardware.

Course Outcomes:
CO1 – Identify sources of quantum noise and decoherence.
CO2 – Apply classical and quantum error correction techniques.
CO3 – Analyze stabilizer codes and logical qubits.
CO4 – Design fault-tolerant gates and circuits.
CO5 – Evaluate threshold theorems and physical error models.

Detailed Syllabus:

Unit 1 – Quantum Noise Models (9 Hours)
Bit-flip, phase-flip, depolarizing, and amplitude-damping channels.

Unit 2 – Quantum Error Correction Codes (9 Hours)
Shor, Steane, and surface codes.

Unit 3 – Stabilizer Formalism (9 Hours)
Pauli group, syndrome measurement, logical qubits.

Unit 4 – Fault-Tolerant Computing (9 Hours)
Concatenated codes, transversal gates, threshold theorem.

Unit 5 – Practical Implementation (9 Hours)
Error correction in superconducting and ion-trap systems.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Quantum Hardware (Superconducting Qubits, Trapped Ions, Photonics)
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To explore physical implementations of qubits and hardware architectures.

• To understand quantum control, cryogenic design, and readout mechanisms.
• To compare technologies and assess scalability challenges.

Course Outcomes:
CO1 – Describe hardware platforms for qubit realization.
CO2 – Understand qubit initialization, control, and measurement principles.
CO3 – Analyze coupling mechanisms and coherence properties.
CO4 – Compare superconducting, ion-trap, and photonic architectures.
CO5 – Assess challenges in large-scale hardware integration.

Detailed Syllabus:

Unit 1 – Superconducting Qubits (9 Hours)
Josephson junctions, transmon qubits, control circuits.

Unit 2 – Trapped Ions (9 Hours)
Ion confinement, laser cooling, optical transitions.

Unit 3 – Photonic Qubits (9 Hours)
Single photon sources, beam splitters, quantum interference.

Unit 4 – Quantum Control & Readout (9 Hours)
Cryogenics, microwave control, noise reduction.

Unit 5 – Scalability & Challenges (9 Hours)
Error sources, integration with CMOS and hybrid systems.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Quantum Information Theory
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce the concepts of quantum information and communication channels.
• To analyze entropy, mutual information, and quantum capacity.
• To study quantum teleportation, dense coding, and cryptographic protocols.

Course Outcomes:
CO1 – Understand classical and quantum information measures.
CO2 – Apply von Neumann entropy to analyze quantum systems.
CO3 – Explain quantum channel capacity and communication theorems.
CO4 – Demonstrate quantum teleportation and dense coding.
CO5 – Explore quantum cryptography and secure communication.

Detailed Syllabus:

Unit 1 – Information Measures (9 Hours)
Shannon entropy, von Neumann entropy, mutual information.

Unit 2 – Quantum Channels (9 Hours)
Kraus operators, completely positive maps, decoherence models.

Unit 3 – Quantum Communication (9 Hours)
Teleportation, superdense coding, quantum key distribution.

Unit 4 – Quantum Capacity (9 Hours)
No-cloning theorem, Holevo bound, channel capacity.

Unit 5 – Applications (9 Hours)
Quantum networks and secure communication.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Elective I – Quantum Sensing
(PE – 3 Credits / 45 Hours)

Course Objectives:
• To understand the principles and technologies of quantum sensing and metrology.
• To apply quantum coherence and entanglement to achieve ultra-sensitive measurements.
• To explore applications in navigation, imaging, and precision timekeeping.

Course Outcomes:
CO1 – Explain the fundamentals of quantum measurement and sensitivity enhancement.
CO2 – Describe the operation of spin-based and optical quantum sensors.
CO3 – Analyze signal-to-noise ratio improvements using quantum effects.
CO4 – Apply quantum sensing principles in imaging and magnetic field detection.
CO5 – Evaluate performance metrics of various quantum sensing technologies.

Detailed Syllabus:

Unit 1 – Introduction to Quantum Sensing (9 Hours)
Quantum superposition, coherence, measurement limits.

Unit 2 – Spin-Based Sensors (9 Hours)
NV centers in diamond, magnetometry, and gyroscopes.

Unit 3 – Optical Sensing (9 Hours)
Interferometry, atomic clocks, and photon-based sensing.

Unit 4 – Quantum Metrology (9 Hours)
Heisenberg limit, entangled sensors, precision enhancement.

Unit 5 – Applications (9 Hours)
Navigation, imaging, gravimetry, and environmental sensing.

Text Books:
C.L. Degen, F. Reinhard & P. Cappellaro – Quantum Sensing.
Giovannetti, Lloyd & Maccone – Advances in Quantum Metrology.

Reference Books:
Taylor et al. – High-Sensitivity Diamond Magnetometry.
Jelezko & Wrachtrup – Quantum Sensing with NV Centers.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Minor Project I (Quantum Simulation / Software)
(PR – 4 Credits / 60 Hours)

Course Objectives:
• To engage students in hands-on project work in quantum software or simulation.
• To integrate learning outcomes from quantum programming and hardware courses.
• To encourage teamwork and research-based design thinking.

Course Outcomes:
CO1 – Formulate a problem statement in the area of quantum computing.
CO2 – Design and implement a quantum or hybrid simulation project.
CO3 – Demonstrate project planning and execution skills.
CO4 – Analyze performance metrics and present outcomes.
CO5 – Document project results in a technical report and presentation.

Detailed Syllabus:

Unit 1 – Project Ideation (15 Hours)
Topic selection, feasibility analysis, literature review.

Unit 2 – Implementation (15 Hours)
Quantum circuit design, testing, and simulation.

Unit 3 – Evaluation (15 Hours)
Report writing, review, and viva-voce.

Practical Component:
Students will complete a team-based mini-project using quantum software platforms such as Qiskit, Cirq, or IBM Quantum.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Quantum Computing
Detailed Syllabus – Semester VI

Quantum Cryptography & Quantum Communication
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce quantum cryptographic principles and secure communication systems.
• To understand quantum key distribution protocols and their security analysis.
• To explore emerging technologies in quantum networks and post-quantum cryptography.

Course Outcomes:
CO1 – Understand classical vs quantum cryptographic principles.
CO2 – Explain BB84 and E91 quantum key distribution protocols.
CO3 – Analyze security against eavesdropping and quantum hacking.
CO4 – Study quantum teleportation and communication channels.
CO5 – Relate quantum cryptography to emerging network applications.

Detailed Syllabus:

Unit 1 – Introduction to Cryptography (9 Hours)
Classical encryption, symmetric/asymmetric cryptography, limitations.

Unit 2 – Quantum Key Distribution (9 Hours)
BB84, E91, decoy-state protocols, quantum random number generation.

Unit 3 – Quantum Communication (9 Hours)
Teleportation, superdense coding, quantum repeaters.

Unit 4 – Security Analysis (9 Hours)
Attacks, no-cloning theorem, QBER estimation.

Unit 5 – Applications (9 Hours)
Quantum internet, secure voting, and quantum cloud security.

Practical Component:
Lab Exercises: Implement BB84 simulation in Python/Qiskit; analyze key rates and eavesdropping scenarios.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Cloud Quantum Computing (IBM, Google, Azure Quantum)
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce cloud-based quantum computing platforms and services.
• To provide hands-on experience with IBM Quantum, Google Cirq, and Azure Quantum.
• To explore hybrid cloud models integrating classical and quantum workloads.

Course Outcomes:
CO1 – Understand architecture and access mechanisms for cloud quantum systems.
CO2 – Utilize IBM, Google, and Azure platforms for circuit execution.
CO3 – Manage quantum resources and scheduling in hybrid environments.
CO4 – Implement cloud-based simulation and benchmarking tasks.
CO5 – Evaluate platform performance and noise resilience.

Detailed Syllabus:

Unit 1 – Quantum Cloud Platforms (9 Hours)
Architecture, APIs, and resource allocation models.

Unit 2 – IBM Quantum Experience (9 Hours)
Qiskit Runtime, job management, backend configuration.

Unit 3 – Google Cirq & Sycamore (9 Hours)
Circuit definition, simulator execution, workflow integration.

Unit 4 – Azure Quantum (9 Hours)
Q#, resource estimation, hybrid workload orchestration.

Unit 5 – Performance & Security (9 Hours)
Noise mitigation, error analysis, cloud-based access control.

Practical Component:
Practical: Execution of circuits on cloud quantum systems; comparison of IBM, Google, and Azure environments.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Quantum Machine Learning
(PC – 4 Credits / 60 Hours)

Course Objectives:
• To study principles of machine learning in quantum contexts.
• To develop algorithms combining quantum computation with data analysis.
• To explore quantum feature maps and variational learning architectures.

Course Outcomes:
CO1 – Explain foundational concepts of ML adapted to quantum computation.
CO2 – Implement quantum classification and regression models.

CO3 – Apply variational circuits for optimization and learning tasks.
CO4 – Analyze hybrid quantum-classical training approaches.
CO5 – Evaluate performance of quantum ML algorithms using real data.

Detailed Syllabus:

Unit 1 – Introduction to Quantum ML (12 Hours)
Hybrid computation, data encoding, quantum advantage.

Unit 2 – Quantum Data Representation (12 Hours)
Feature maps, kernels, amplitude and basis encoding.

Unit 3 – Quantum Learning Models (12 Hours)
Quantum SVMs, quantum neural networks, quantum Boltzmann machines.

Unit 4 – Variational Learning (12 Hours)
VQE and QAOA-based optimization, gradient estimation.

Unit 5 – Applications (12 Hours)
Pattern recognition, classification, quantum generative models.

Practical Component:
Lab: Implement quantum ML models using Qiskit Machine Learning and PennyLane; evaluate accuracy and loss convergence.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Elective II – Quantum Optics
(PE – 3 Credits / 45 Hours)

Course Objectives:
• To understand the fundamentals of light-matter interaction and quantization of electromagnetic fields.
• To study photon statistics, coherence, and optical quantum state manipulation.
• To explore quantum optical technologies for computing and communication.

Course Outcomes:
CO1 – Describe quantization of light and photon properties.
CO2 – Analyze coherence, interference, and photon correlation functions.
CO3 – Apply quantum optical principles to lasers and optical devices.
CO4 – Understand squeezed states and optical entanglement generation.
CO5 – Examine applications in communication and quantum photonics.

Detailed Syllabus:

Unit 1 – Quantization of Light (9 Hours)
Photons, field quantization, harmonic oscillator analogy.

Unit 2 – Coherence Theory (9 Hours)
First- and second-order coherence, interference and visibility.

Unit 3 – Photon Statistics (9 Hours)
Poissonian, sub-Poissonian, and super-Poissonian light.

Unit 4 – Nonlinear & Quantum Optical Effects (9 Hours)
Squeezed states, SPDC, optical entanglement.

Unit 5 – Applications (9 Hours)
Quantum communication, photonic quantum computing, metrology.

Text Books:
Gerry & Knight – Introductory Quantum Optics.
Walls & Milburn – Quantum Optics.

Reference Books:
Scully & Zubairy – Quantum Optics.
Fox – Quantum Optics: An Introduction.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Open Elective II – AI for Quantum Systems (OE – 3 Credits / 45 Hours)

Course Objectives:
• To integrate artificial intelligence and machine learning with quantum computing frameworks.
• To study applications of AI in quantum error correction, optimization, and design.
• To explore reinforcement learning for quantum control and scheduling.

Course Outcomes:
CO1 – Understand AI architectures and their roles in quantum system modeling.
CO2 – Apply ML techniques to quantum data analysis and prediction.
CO3 – Utilize reinforcement learning for quantum gate calibration and error mitigation.
CO4 – Develop hybrid AI-quantum optimization workflows.
CO5 – Explore automation and intelligence in quantum research environments.

Detailed Syllabus:

Unit 1 – Introduction to AI for Quantum (9 Hours)
AI paradigms, ML integration, quantum data structures.

Unit 2 – ML for Quantum Systems (9 Hours)
Supervised learning for quantum noise analysis.

Unit 3 – Reinforcement Learning (9 Hours)
Quantum control optimization, scheduling algorithms.

Unit 4 – AI-Assisted Quantum Design (9 Hours)
Automated circuit design, neural network-guided algorithms.

Unit 5 – Applications (9 Hours)
AI-driven quantum research, optimization in hybrid environments.

Text Books:
P. Wittek – Quantum Machine Learning: What Quantum Computing Means to Data Science.
Abhijit Das – Introduction to Quantum Computing and Quantum Programming.

Reference Books:
Qiskit Machine Learning Documentation.
Sutton & Barto – Reinforcement Learning: An Introduction.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Minor Project II (Prototype QC Application)
(PR – 4 Credits / 60 Hours)

Course Objectives:
• To enable design and development of prototype quantum computing applications.
• To promote interdisciplinary innovation in hardware, software, or simulation domains.
• To enhance research, documentation, and presentation skills through project execution.

Course Outcomes:
CO1 – Identify real-world quantum computing problems and design project objectives.
CO2 – Develop prototype or simulation models using quantum platforms.
CO3 – Demonstrate technical execution, teamwork, and problem-solving.
CO4 – Analyze and validate results with appropriate evaluation metrics.
CO5 – Present and document project deliverables effectively.

Detailed Syllabus:

Unit 1 – Project Planning (15 Hours)
Topic selection, feasibility analysis, proposal preparation.

Unit 2 – Design & Implementation (15 Hours)
Hardware/software development, simulation and testing.

Unit 3 – Evaluation & Presentation (15 Hours)
Documentation, review, viva-voce.

Practical Component:
Project-based learning: Students will design, implement, and present a prototype quantum computing application.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Quantum Computing
Detailed Syllabus – Semester VII

Quantum Operating Systems & Compilers
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To understand the principles and architecture of quantum operating systems and compiler s.
• To explore resource management, scheduling, and error handling for quantum processors.
• To study compilation techniques for translating quantum programs to hardware instructio ns.

Course Outcomes:
CO1 – Describe the functions and architecture of quantum operating systems.
CO2 – Explain process management and scheduling in quantum multi-programming environments .
CO3 – Understand compiler design for quantum gate optimization and mapping.
CO4 – Analyze error correction and fault tolerance integration at OS level.
CO5 – Evaluate recent advances in quantum resource virtualization and cloud control.

Detailed Syllabus:

Unit 1 – Introduction to Quantum OS (9 Hours)
Architecture, functions, hardware interface, quantum kernel design.

Unit 2 – Process & Resource Management (9 Hours)
Scheduling, concurrency, quantum memory allocation.

Unit 3 – Compiler Architecture (9 Hours)
Parsing, intermediate representation, gate decomposition, optimization.

Unit 4 – Hardware Mapping (9 Hours)
Topology aware mapping, routing, and error mitigation.

Unit 5 – Trends & Frameworks (9 Hours)
XACC, QIR, quantum containers, multi-tenant quantum OS.

Text Books:
Abhijit Das – Introduction to Quantum Computing and Quantum Programming.
IBM Quantum Documentation – Quantum OS and Runtime Systems.

Reference Books:
McArdle et al. – Software for Quantum Computing: Compiler and Runtime Perspectives.
Cirq Developers – Quantum Compilation Manual.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Quantum Devices & Semiconductor Integration
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To study the design and fabrication of quantum devices using semiconductor materials.
• To understand quantum dots, Josephson junctions, and hybrid device integration.
• To explore materials science aspects for scalable quantum hardware.

Course Outcomes:
CO1 – Understand quantum device physics and fabrication principles.
CO2 – Explain operation of superconducting and semiconductor qubits.
CO3 – Analyze device integration for scalable architectures.
CO4 – Study materials properties affecting coherence and fidelity.
CO5 – Evaluate recent developments in quantum hardware engineering.

Detailed Syllabus:

Unit 1 – Quantum Device Fundamentals (9 Hours)
Quantum confinement, energy levels, tunneling phenomena.

Unit 2 – Superconducting Qubits (9 Hours)
Josephson junctions, flux and charge qubits.

Unit 3 – Semiconductor Qubits (9 Hours)
Quantum dots, spin qubits, material interfaces.

Unit 4 – Integration Techniques (9 Hours)
Cryogenic CMOS, interconnects, packaging.

Unit 5 – Scalable Hardware Systems (9 Hours)
Hybrid semiconductor-superconductor architectures.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Emerging Frontiers in Quantum Technologies (Quantum Internet, Cloud & Metrology)
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To explore emerging trends and applications in quantum networking, cloud, and metrology
.

• To understand quantum internet architecture and distributed entanglement.
• To study quantum metrology and precision measurement systems.

Course Outcomes:
CO1 – Describe quantum internet concepts and architecture.
CO2 – Explain quantum communication and entanglement distribution.
CO3 – Understand quantum cloud technologies and network security.
CO4 – Apply quantum metrology principles for precision measurements.
CO5 – Analyze global initiatives and industrial developments in quantum frontiers.

Detailed Syllabus:

Unit 1 – Quantum Internet Architecture (9 Hours)
Entanglement distribution, repeaters, network nodes.

Unit 2 – Quantum Networking (9 Hours)
Quantum routing, error correction, security protocols.

Unit 3 – Quantum Cloud (9 Hours)
Multi-node execution, distributed computing, network virtualization.

Unit 4 – Quantum Metrology (9 Hours)
Precision measurement, atomic clocks, interferometry.

Unit 5 – Global Trends (9 Hours)
EU Quantum Flagship, India's NQM, industrial initiatives.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Elective III – Quantum AI
(PE – 3 Credits / 45 Hours)

Course Objectives:
• To integrate artificial intelligence with quantum computing for enhanced learning systems.
• To study quantum neural networks and variational learning approaches.
• To explore applications of quantum AI in optimization, vision, and language models.

Course Outcomes:
CO1 – Understand the concept of quantum AI and hybrid architectures.
CO2 – Design quantum circuits for learning and data representation.
CO3 – Apply variational techniques in AI optimization.
CO4 – Implement quantum neural networks using frameworks like PennyLane and Qiskit.
CO5 – Analyze the potential of quantum AI for real-world applications.

Detailed Syllabus:

Unit 1 – Introduction to Quantum AI (9 Hours)
Quantum advantage in AI, data encoding, hybrid systems.

Unit 2 – Quantum Neural Networks (9 Hours)
QNN architecture, entanglement-based learning, training strategies.

Unit 3 – Quantum Optimization (9 Hours)
Quantum Boltzmann machines, variational optimization.

Unit 4 – Applications (9 Hours)
Quantum AI for image recognition, NLP, finance.

Unit 5 – Tools & Frameworks (9 Hours)
PennyLane, Qiskit ML, TensorFlow Quantum.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Elective IV – Quantum Sensors
(PE – 3 Credits / 45 Hours)

Course Objectives:
- To study quantum mechanical principles of sensing and measurement.
- To explore spin-based and optical quantum sensor technologies.
- To apply quantum sensors in navigation, medical, and industrial applications.

Course Outcomes:
CO1 – Understand the operation principles of quantum sensors.
CO2 – Analyze spin resonance and optical sensing mechanisms.
CO3 – Apply quantum measurement techniques for precision applications.
CO4 – Evaluate sensor performance and noise characteristics.
CO5 – Explore practical applications in metrology and navigation.

Detailed Syllabus:

Unit 1 – Quantum Measurement Basics (9 Hours)
Quantum state projection, Heisenberg limit, measurement precision.

Unit 2 – Spin-Based Sensors (9 Hours)
NV centers in diamond, spin echo methods, magnetometry.

Unit 3 – Optical Quantum Sensors (9 Hours)
Interferometry, atomic clocks, gravitational wave detectors.

Unit 4 – Noise and Decoherence (9 Hours)
Quantum noise sources, sensitivity enhancement.

Unit 5 – Applications (9 Hours)
Medical imaging, navigation, industrial monitoring.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Internship in Quantum Lab / Industry
(PR – 4 Credits / 60 Hours)

Course Objectives:
• To provide hands-on exposure to quantum computing laboratories or industrial projects.
• To develop professional skills in research and technology integration.
• To promote innovation and entrepreneurship through real-world applications.

Course Outcomes:
CO1 – Understand practical operations of quantum systems.
CO2 – Collaborate effectively in interdisciplinary teams.
CO3 – Apply academic knowledge in industrial settings.
CO4 – Prepare technical reports and present findings.
CO5 – Demonstrate professional ethics and responsibility.

Detailed Syllabus:

Unit 1 – Training & Orientation (30 Hours)
Industry exposure, mentor interaction, project planning.

Unit 2 – Documentation & Evaluation (30 Hours)
Final report, presentation, viva-voce.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Major Project Phase I (Product / System Prototype)
(PR – 4 Credits / 60 Hours)

Course Objectives:
• To enable students to initiate research or product development projects in quantum techn ology.
• To integrate multidisciplinary concepts for prototype creation and testing.
• To develop documentation and presentation skills for academic and industrial review.

Course Outcomes:
CO1 – Formulate project goals and scope in quantum applications.
CO2 – Develop system architecture and prototype design.
CO3 – Apply engineering and research principles to implementation.
CO4 – Document progress and results in structured reports.
CO5 – Demonstrate presentation and defense skills in reviews.

Detailed Syllabus:

Unit 1 – Project Definition (15 Hours)
Problem identification, literature survey, objectives.

Unit 2 – Design & Implementation (30 Hours)
Modeling, simulation, prototype testing.

Unit 3 – Reporting & Presentation (15 Hours)
Documentation, review, seminar presentation.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Quantum Computing
Detailed Syllabus – Semester VIII

Tech Entrepreneurship & IPR in Quantum Technologies
(HS – 3 Credits / 45 Hours)

Course Objectives:
• To develop entrepreneurial mindset and innovation skills in the quantum technology doma in.
• To understand the importance of intellectual property rights and technology transfer.
• To explore startup ecosystems and funding strategies for deep-tech ventures.

Course Outcomes:
CO1 – Understand entrepreneurial process and innovation principles.
CO2 – Analyze business models and market strategies for quantum startups.
CO3 – Explain IPR concepts including patents, copyrights, and technology licensing.
CO4 – Prepare a business plan for quantum product or service.
CO5 –
Evaluate government initiatives and global support systems for quantum entrepreneurship.

Detailed Syllabus:

Unit 1 – Entrepreneurship Fundamentals (9 Hours)
Entrepreneurial ecosystem, idea generation, innovation life cycle.

Unit 2 – Business Models & Finance (9 Hours)
Lean canvas, pitch deck, funding stages, venture capital, CSR funding.

Unit 3 – Intellectual Property Rights (9 Hours)
Patents, trademarks, copyrights, trade secrets, technology transfer.

Unit 4 – Innovation Management (9 Hours)
R&D commercialization, startup incubation, spin-off models.

Unit 5 – Case Studies (9 Hours)
Successful quantum and deep-tech startups, policy initiatives (NIDHI, Startup India).

Text Books:
Peter F. Drucker – Innovation and Entrepreneurship.
N.S. Gopalakrishnan & T.G. Agitha – Principles of Intellectual Property.

Reference Books:
WIPO Handbook on Intellectual Property.
AICTE – Startup Policy for Indian Higher Education Institutions.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Major Project Phase II (Capstone with Research Lab / Startup) (PR – 10 Credits / 150 Hours)

Course Objectives:
• To enable students to execute a comprehensive project based on research or product devel opment in quantum technologies.
• To encourage innovation and problem-solving through industry and academic collaboratio n.
• To foster documentation, presentation, and entrepreneurial skills for career readiness.

Course Outcomes:
CO1 – Define project objectives and scope based on identified research problems.
CO2 – Implement hardware, software, or simulation solutions in quantum technologies.
CO3 – Analyze results and validate performance metrics.
CO4 – Prepare technical documentation and presentations for evaluation.
CO5 – Demonstrate leadership and collaborative skills in project execution.

Detailed Syllabus:

Unit 1 – Problem Identification & Design (30 Hours)
Review literature and define objectives for capstone project.

Unit 2 – Development & Implementation (60 Hours)
Design, coding, fabrication, testing, and simulation.

Unit 3 – Evaluation & Presentation (60 Hours)
Thesis preparation, seminar, and viva-voce.

Practical Component:
Students will complete a capstone project either in a research lab or startup environment un der faculty/industry supervision.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Open Elective III – Policy, Ethics & Futuristic Technologies (OE – 2 Credits / 30 Hours)

Course Objectives:
• To introduce students to policy, ethics, and governance of emerging technologies.
• To understand ethical frameworks for AI, quantum, and biotech innovations.
• To explore futuristic technologies and their socio-economic implications.

Course Outcomes:
CO1 – Understand policy frameworks governing emerging technologies.
CO2 – Analyze ethical and legal issues in AI and quantum applications.

CO3 – Evaluate global initiatives in responsible innovation and governance.
CO4 – Discuss impacts of futuristic technologies on society and employment.
CO5 – Formulate ethical guidelines for technology development and deployment.

Detailed Syllabus:

Unit 1 – Technology Governance & Policy (6 Hours)
STI policy, AICTE/UGC policies, global digital ethics frameworks.

Unit 2 – Ethics in AI and Quantum Systems (6 Hours)
Bias, privacy, autonomy, accountability in intelligent systems.

Unit 3 – Futuristic Technologies (6 Hours)
Quantum internet, brain-computer interfaces, nanorobotics.

Unit 4 – Sustainability & SDGs (6 Hours)
Green computing, climate tech, ethical innovation for sustainable future.

Unit 5 – Legal and Socio-Economic Implications (6 Hours)
IP law, data governance, impact on employment and education.

Text Books:
Luciano Floridi – The Ethics of Information.
David Gunkel – The Machine Question: Critical Perspectives on AI and Ethics.

Reference Books:
UNESCO – Recommendation on Ethics of AI (2021).
World Economic Forum – Global Technology Governance Report (2023).

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Viva-Voce / Seminar / Portfolio
(PR – 2 Credits / 30 Hours)

Course Objectives:
- To evaluate students' overall understanding and presentation skills in quantum computing and related domains.
- To encourage technical communication and professional portfolio development.
- To foster self-reflection and lifelong learning attributes in alignment with NEP 2020.

Course Outcomes:
CO1 – Present project outcomes and research findings effectively.
CO2 – Demonstrate communication and public speaking skills.
CO3 – Showcase academic and research portfolio for career advancement.
CO4 – Reflect on skills and competencies acquired during the programme.
CO5 – Engage in continuous learning through feedback and self-evaluation.

Detailed Syllabus:

Unit 1 – Seminar Presentation (15 Hours)
Preparation of presentation on emerging research topics.

Unit 2 – Portfolio Development (15 Hours)
Compilation of academic achievements, projects, and certifications.

Unit 3 – Viva-Voce (15 Hours)
Final oral examination and discussion of career readiness.

Practical Component:
Students will submit a portfolio document and present their major project and research outcomes to an evaluation panel.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Digital Twin Technology
Detailed Syllabus – Semester I

Mathematics I (Calculus & Linear Algebra)
(BS – 4 Credits / 60 Hours)

Course Objectives:
• To develop analytical skills in calculus and linear algebra.
• To apply mathematical concepts to engineering and simulation models.
• To lay the foundation for digital twin data modeling and physical system representation.

Course Outcomes:
CO1 – Understand differential and integral calculus for engineering applications.
CO2 – Apply vector calculus to physical and field problems.
CO3 – Use matrices and determinants to solve linear systems.
CO4 – Analyze eigenvalue problems and diagonalization in dynamic models.
CO5 – Employ mathematical tools in simulation and digital representation of systems.

Detailed Syllabus:

Unit 1 – Differential Calculus (12 Hours)
Limits, continuity, partial differentiation, Jacobian, Taylor series.

Unit 2 – Integral Calculus (12 Hours)
Definite and multiple integrals, applications to areas and volumes.

Unit 3 – Vector Calculus (12 Hours)
Gradient, divergence, curl, line and surface integrals.

Unit 4 – Matrices & Determinants (12 Hours)
Matrix operations, rank, inverse, solutions of linear systems.

Unit 5 – Eigenvalues & Applications (12 Hours)
Eigenvalues, eigenvectors, diagonalization and stability analysis.

Text Books:
B.S. Grewal – Higher Engineering Mathematics.
Erwin Kreyszig – Advanced Engineering Mathematics.

Reference Books:
R.K. Jain & S.R.K. Iyengar – Advanced Engineering Mathematics.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Physics for Engineers (Mechanics, Waves & Optics)
(BS – 4 Credits / 60 Hours)

Course Objectives:
• To provide fundamental understanding of mechanics and wave physics.
• To apply principles of optics and vibrations in engineering systems.
• To connect physical phenomena with digital twin simulation and modeling contexts.

Course Outcomes:
CO1 – Explain laws of motion and energy principles.
CO2 – Analyze harmonic motion and wave phenomena.
CO3 – Describe optical interference, diffraction, and polarization.
CO4 – Apply concepts to measurements and sensor-based systems.
CO5 – Relate physics concepts to virtual and digital twin modeling.

Detailed Syllabus:

Unit 1 – Mechanics (12 Hours)
Newton's laws, work-energy theorem, momentum and rotational motion.

Unit 2 – Oscillations & Waves (12 Hours)
Simple harmonic motion, damped oscillations, wave equation.

Unit 3 – Interference & Diffraction (12 Hours)
Young's double slit, Newton's rings, diffraction grating.

Unit 4 – Polarization & Lasers (12 Hours)
Polarized light, Malus law, introduction to lasers and optical sensors.

Unit 5 – Applications (12 Hours)
Measurement systems for digital twins – optical and vibration sensing.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Chemistry
(BS – 3 Credits / 45 Hours)

Course Objectives:
• To introduce basic chemical principles relevant to materials and nanotechnology.
• To explain bonding, corrosion, and environmental chemistry applications.
• To develop an understanding of materials used in digital twin hardware systems.

Course Outcomes:
CO1 – Understand chemical bonding and molecular structure.
CO2 – Apply concepts of electrochemistry and corrosion control.

CO3 – Analyze polymers, nanomaterials, and composites.
CO4 – Explain environmental effects and green chemistry principles.
CO5 – Correlate chemical properties with engineering material selection.

Detailed Syllabus:

Unit 1 – Chemical Bonding (9 Hours)
Ionic, covalent and metallic bonding; hybridization.

Unit 2 – Electrochemistry (9 Hours)
Electrochemical cells, Nernst equation, battery concepts.

Unit 3 – Corrosion & Prevention (9 Hours)
Mechanisms, protective coatings, surface treatment.

Unit 4 – Polymers & Nanomaterials (9 Hours)
Synthesis, characterization, applications.

Unit 5 – Green Chemistry (9 Hours)
Sustainable chemistry and environmental impacts.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Environmental Science
(BS – 3 Credits / 45 Hours)

Course Objectives:
• To create awareness on environmental issues and sustainable engineering practices.
• To understand ecosystems, biodiversity, and environmental pollution control.
• To integrate sustainability into digital twin applications and smart systems.

Course Outcomes:
CO1 – Explain ecosystem components and biodiversity conservation.
CO2 – Identify pollution types and control technologies.
CO3 – Describe environmental legislation and policy frameworks.
CO4 – Apply sustainable development principles to engineering projects.
CO5 – Promote green engineering in digital twin and smart infrastructure contexts.

Detailed Syllabus:

Unit 1 – Ecosystem Concepts (9 Hours)
Ecosystem structure, function, energy flow, biodiversity.

Unit 2 – Natural Resources (9 Hours)
Water, forest, and energy resource management.

Unit 3 – Pollution Control (9 Hours)
Air, water, soil pollution, waste management.

Unit 4 – Legislation & Policies (9 Hours)
Environmental Protection Act, EIA framework.

Unit 5 – Sustainability & Smart Systems (9 Hours)
Green buildings, SDGs, sustainable digital technologies.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Programming Fundamentals (Python / C)
(ES – 3 Credits / 45 Hours)

Course Objectives:
• To introduce problem-solving and programming techniques using Python or C.
• To develop logical thinking and algorithmic skills for engineering applications.
• To apply basic programming to data handling and simulation in digital twin systems.

Course Outcomes:
CO1 – Write structured programs for basic computation tasks.
CO2 – Apply decision-making and iteration constructs.
CO3 – Use arrays, functions, and structures effectively.
CO4 – Implement file handling and data visualization concepts.
CO5 – Develop simple simulation scripts for digital twin applications.

Detailed Syllabus:

Unit 1 – Introduction to Programming (9 Hours)
Algorithms, flowcharts, syntax, variables.

Unit 2 – Control Structures (9 Hours)
If-else, loops, nested conditions.

Unit 3 – Functions & Arrays (9 Hours)
Parameter passing, recursion, multi-dimensional arrays.

Unit 4 – File Handling (9 Hours)
Reading / writing data, CSV and I/O operations.

Unit 5 – Application in Engineering (9 Hours)
Sensor data simulation and visualization.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Engineering Graphics & CAD
(ES – 3 Credits / 45 Hours)

Course Objectives:
• To develop spatial visualization and technical drawing skills.
• To introduce CAD tools for digital modeling and geometric representation.
• To prepare students for 3D design and digital twin visualization.

Course Outcomes:
CO1 – Interpret engineering drawings and standards.
CO2 – Apply orthographic and isometric projection methods.
CO3 – Use CAD software for 2D and 3D design.
CO4 – Create sectional and assembly drawings.
CO5 – Relate CAD skills to digital twin system representation.

Detailed Syllabus:

Unit 1 – Introduction to Graphics (9 Hours)
Drawing instruments, scales, projections.

Unit 2 – Orthographic Projections (9 Hours)
Projection of points, lines, planes.

Unit 3 – Solids & Sections (9 Hours)
Prisms, pyramids, cylinders, sections.

Unit 4 – Isometric Projections (9 Hours)
Isometric views and dimensions.

Unit 5 – CAD Applications (9 Hours)
Solid modeling and digital rendering using AutoCAD / SolidWorks.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Communication Skills & Professional English
(HS – 2 Credits / 30 Hours)

Course Objectives:
• To enhance verbal and written communication skills for professional contexts.
• To develop team collaboration and presentation abilities.
• To prepare students for industry-ready communication and documentation.

Course Outcomes:
CO1 – Develop effective oral and written communication skills.
CO2 – Use language appropriately in academic and professional situations.

CO3 – Participate in group discussions and presentations.
CO4 – Prepare technical reports and emails professionally.
CO5 – Demonstrate interpersonal communication skills.

Detailed Syllabus:

Unit 1 – Grammar & Vocabulary (6 Hours)
Sentence construction, technical vocabulary.

Unit 2 – Writing Skills (6 Hours)
Emails, letters, paragraphs, technical documents.

Unit 3 – Speaking & Listening (6 Hours)
Presentations, group discussion, interviews.

Unit 4 – Reading Skills (6 Hours)
Comprehension and summarizing technical texts.

Unit 5 – Professional Etiquette (6 Hours)
Body language, cross-cultural communication.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Workshop Practice / Basic Electronics
(ES – 1 Credits / 15 Hours)

Course Objectives:
• To provide hands-on training in fabrication and basic electronic components.
• To develop skills in using tools, equipment, and testing instruments.
• To apply practical knowledge in building simple engineering systems.

Course Outcomes:
CO1 – Use basic tools and equipment for fabrication work.
CO2 – Assemble and test basic electronic circuits.
CO3 – Understand safety procedures in workshops.
CO4 – Demonstrate teamwork and project execution skills.
CO5 – Apply workshop practices to digital hardware prototype development.

Detailed Syllabus:

Unit 1 – Fitting & Welding (9 Hours)
Fabrication of simple components using hand tools.

Unit 2 – Electronics Lab (9 Hours)
Identification of components, breadboard circuits, measurements.

Unit 3 – Soldering & Testing (9 Hours)
PCB soldering, circuit testing using multimeter.

Practical Component:
Hands-on sessions in fabrication, electrical connections, and testing of basic devices used in digital systems.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Digital Twin Technology
Detailed Syllabus – Semester II

Mathematics II (Probability, Statistics & Differential Equations)
(BS – 4 Credits / 60 Hours)

Course Objectives:
• To introduce probability and statistical methods for engineering applications.
• To apply differential equations to model and analyze physical systems.
• To prepare students for data analysis and simulation tasks in digital twin systems.

Course Outcomes:
CO1 – Apply probability theory to engineering events and data sets.
CO2 – Compute mean, variance, and standard deviation for statistical distributions.
CO3 – Solve first- and second-order differential equations in physical contexts.
CO4 – Model dynamic systems using ordinary differential equations.
CO5 – Use statistical methods in digital twin simulation and data validation.

Detailed Syllabus:

Unit 1 – Probability Theory (12 Hours)
Random variables, Bayes theorem, discrete and continuous distributions.

Unit 2 – Statistical Analysis (12 Hours)
Moments, skewness, kurtosis, correlation, regression.

Unit 3 – Differential Equations – I (12 Hours)
First-order ODEs, exact and linear equations.

Unit 4 – Differential Equations – II (12 Hours)
Second-order linear ODEs and applications in vibrations.

Unit 5 – Numerical Methods (12 Hours)
Euler, Runge-Kutta methods and applications in simulation.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Engineering Mechanics & Materials
(ES – 3 Credits / 45 Hours)

Course Objectives:
• To introduce fundamentals of statics, dynamics, and material science.
• To analyze forces, moments, and stress-strain relationships.
• To relate mechanical properties to materials used in digital twin hardware and prototypes.

Course Outcomes:
CO1 – Apply Newtonian mechanics to static and dynamic systems.
CO2 – Calculate centroid, moment of inertia, and frictional forces.
CO3 – Explain properties and testing of engineering materials.
CO4 – Analyze stress, strain, and deformation in mechanical members.
CO5 – Relate mechanics concepts to simulation and digital twin applications.

Detailed Syllabus:

Unit 1 – Statics of Particles & Rigid Bodies (9 Hours)
Equilibrium conditions, free-body diagrams.

Unit 2 – Dynamics & Friction (9 Hours)
Kinematics and kinetics of particles, laws of friction.

Unit 3 – Properties of Materials (9 Hours)
Elasticity, plasticity, hardness, tensile testing.

Unit 4 – Stress & Strain (9 Hours)
Hooke's law, stress–strain curves, Poisson's ratio.

Unit 5 – Engineering Applications (9 Hours)
Material selection for mechanical and IoT systems.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Data Structures & Algorithms
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce data organization and algorithmic techniques for efficient computation.
• To develop problem-solving skills for simulation and data processing.
• To apply DSA concepts in real-time monitoring of digital twin data flows.

Course Outcomes:
CO1 – Understand concepts of data structures and memory management.
CO2 – Implement linked lists, stacks, queues, and trees.
CO3 – Design and analyze sorting and searching algorithms.
CO4 – Apply graph structures for network and path analysis.
CO5 – Integrate data structures with IoT and simulation applications.

Detailed Syllabus:

Unit 1 – Introduction to DSA (9 Hours)
Arrays, structures, complexity analysis.

Unit 2 – Linked Lists & Stacks (9 Hours)
Singly, doubly, circular lists; stack operations.

Unit 3 – Queues & Trees (9 Hours)
Priority queues, binary trees, traversal methods.

Unit 4 – Sorting & Searching (9 Hours)
Quick, merge, heap sort; linear and binary search.

Unit 5 – Graphs & Applications (9 Hours)
Graph representation, BFS, DFS, shortest paths.

Practical Component:
Lab: Implement data structures and algorithms using C/Python; apply to real-time data sets.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Electrical & Electronics Engineering Fundamentals (ES – 3 Credits / 45 Hours)

Course Objectives:
- To introduce basic principles of electrical circuits and electronic devices.
- To apply circuit laws and semiconductor theory to simple systems.
- To develop an understanding of sensor and actuator interfaces for digital twins.

Course Outcomes:
CO1 – Apply Ohm's law and Kirchhoff's laws to DC and AC circuits.
CO2 – Analyze network theorems and transient responses.
CO3 – Explain working of semiconductors, diodes, and transistors.
CO4 – Understand op-amp applications and signal conditioning.
CO5 – Relate electrical concepts to sensor networks and IoT integration.

Detailed Syllabus:

Unit 1 – Electrical Circuits (9 Hours)
KCL, KVL, resistive circuits, AC fundamentals.

Unit 2 – Network Theorems (9 Hours)
Superposition, Thevenin's and Norton's theorems.

Unit 3 – Electronic Devices (9 Hours)
PN junction, Zener diode, BJT, FET characteristics.

Unit 4 – Operational Amplifiers (9 Hours)
Op-amp parameters, filters, amplifiers.

Unit 5 – Sensors & Interfaces (9 Hours)
Signal conditioning and analog-digital conversion.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Introduction to IoT & Emerging Technologies (PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce concepts, architecture, and applications of Internet of Things.
• To integrate IoT systems with cloud, edge, and digital twin technologies.
• To explore emerging trends in AI, AR/VR, and blockchain for smart industry applications.

Course Outcomes:
CO1 – Explain IoT architecture and communication protocols.
CO2 – Design IoT systems using sensors, actuators, and microcontrollers.
CO3 – Integrate IoT devices with cloud and edge platforms for data processing.
CO4 – Understand emerging technologies such as AI, AR/VR, and blockchain.
CO5 – Develop mini IoT applications for digital twin environments.

Detailed Syllabus:

Unit 1 – IoT Fundamentals (9 Hours)
IoT concepts, architecture, IoT stack, applications in smart cities and industry.

Unit 2 – Sensors & Communication Protocols (9 Hours)
Types of sensors, actuators, MQTT, CoAP, HTTP protocols.

Unit 3 – Cloud & Edge Integration (9 Hours)
IoT platforms – AWS, Azure, IBM; data flow to digital twin models.

Unit 4 – Emerging Technologies (9 Hours)
AI, ML, AR/VR, blockchain integration with IoT.

Unit 5 – IoT for Digital Twins (9 Hours)
Real-time data collection, monitoring, and simulation for digital twin applications.

Practical Component:
Mini Project: Implement a simple IoT system to collect sensor data and visualize it on a cloud dashboard using MQTT/HTTP protocols. Demonstrate data connectivity with a digital twin simulation model.

Text Books:
Arshdeep Bahga & Vijay Madisetti – Internet of Things (A Hands-on Approach).
Raj Kamal – Internet of Things: Architecture and Applications.

Reference Books:
Ovidiu Vermesan & Peter Friess –
Internet of Things: Converging Technologies for Smart Environments.
IBM & Microsoft IoT Documentation – Cloud Integration for Digital Twins.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Design Thinking & Innovation
(HS – 3 Credits / 45 Hours)

Course Objectives:
• To cultivate creative problem-solving and design innovation skills.
• To apply user-centered design and prototyping approaches to engineering problems.
• To foster entrepreneurial and multidisciplinary thinking aligned with NEP 2020.

Course Outcomes:
CO1 – Understand the design thinking process and innovation principles.
CO2 – Empathize with users and define real problems for solution design.
CO3 – Ideate and prototype innovative solutions using creativity tools.
CO4 – Test and evaluate prototypes for feasibility and impact.
CO5 – Demonstrate teamwork and communication in innovation projects.

Detailed Syllabus:

Unit 1 – Introduction to Design Thinking (9 Hours)
Phases – Empathize, Define, Ideate, Prototype, Test.

Unit 2 – Creative Problem Solving (9 Hours)
Brainstorming, mind mapping, lateral thinking.

Unit 3 – Prototyping & Testing (9 Hours)
Low-fidelity and digital prototyping tools.

Unit 4 – Innovation Management (9 Hours)
Idea incubation, intellectual property, entrepreneurship.

Unit 5 – Case Studies (9 Hours)
Design-driven solutions in engineering and technology.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Internship I (Industry / Skill Exposure)
(PR – 1 Credits / 15 Hours)

Course Objectives:
• To provide industrial or field exposure relevant to digital technologies.

• To develop professional skills and industry awareness.
• To encourage students to apply theoretical knowledge to practical contexts.

Course Outcomes:
CO1 – Understand basic industry operations and workflow.
CO2 – Apply academic concepts to practical assignments.
CO3 – Collaborate effectively in a team environment.
CO4 – Prepare internship reports with technical observations.
CO5 – Demonstrate professional ethics and communication skills.

Detailed Syllabus:

Unit 1 – Orientation & Observation (6 Hours)
Industrial visit, online training or skill module.

Unit 2 – Report Preparation (9 Hours)
Documentation and presentation of learning outcomes.

Practical Component:
Minimum 2-week internship or certified online training program in digital or IoT domain.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Digital Twin Technology
Detailed Syllabus – Semester III

Signals & Systems
(BS – 3 Credits / 45 Hours)

Course Objectives:
• To introduce the concepts of signals, systems, and their representations.
• To apply Fourier and Laplace transforms for analysis of continuous and discrete systems.
• To provide a foundation for digital signal processing in Digital Twin applications.

Course Outcomes:
CO1 – Represent continuous and discrete signals mathematically.
CO2 – Analyze system characteristics such as linearity, causality, and stability.
CO3 – Apply Fourier and Laplace techniques for system analysis.
CO4 – Use z-transform for discrete-time signal analysis.
CO5 – Relate signal modeling to digital twin simulation systems.

Detailed Syllabus:

Unit 1 – Introduction to Signals (9 Hours)
Signal types, periodicity, energy and power signals.

Unit 2 – System Representation (9 Hours)
System properties – linearity, time-invariance, causality, stability.

Unit 3 – Convolution & Correlation (9 Hours)
Impulse response, convolution sum, cross-correlation.

Unit 4 – Transforms (9 Hours)
Fourier, Laplace, and z-transform applications.

Unit 5 – Applications (9 Hours)
Signal conditioning and sensor data analysis for Digital Twins.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Database Management Systems
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce database concepts and relational data models.
• To develop SQL-based data management and query skills.
• To enable data organization and retrieval for digital twin systems.

Course Outcomes:
CO1 – Design relational schemas using ER models.
CO2 – Develop SQL queries for data manipulation and retrieval.
CO3 – Apply normalization to improve database performance.
CO4 – Manage transactions and ensure data consistency.
CO5 – Integrate databases into IoT and digital twin environments.

Detailed Syllabus:

Unit 1 – Database Concepts (9 Hours)
Data models, DBMS architecture, data independence.

Unit 2 – ER Modeling (9 Hours)
Entity-relationship diagrams, keys, relationships.

Unit 3 – SQL Programming (9 Hours)
DDL, DML, and DCL statements, joins, subqueries.

Unit 4 – Normalization & Transactions (9 Hours)
Normal forms, ACID properties, concurrency control.

Unit 5 – Applications (9 Hours)
Database integration in Digital Twin frameworks.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Computer Networks & Cybersecurity
(PC – 4 Credits / 60 Hours)

Course Objectives:
• To introduce network architectures, protocols, and cybersecurity principles.
• To explain network models for data transfer and secure communication.
• To relate cybersecurity practices to Industrial IoT and digital twin applications.

Course Outcomes:
CO1 – Understand network layers, topologies, and protocols.
CO2 – Configure and manage network devices and routing protocols.
CO3 – Apply encryption and authentication for network security.
CO4 – Analyze common vulnerabilities and prevention techniques.
CO5 – Implement secure data transfer in IoT and digital twin ecosystems.

Detailed Syllabus:

Unit 1 – Network Fundamentals (12 Hours)
OSI and TCP/IP models, addressing, and topologies.

Unit 2 – Data Link & Network Layer (12 Hours)
Switching, routing, and error control.

Unit 3 – Transport & Application Layer (12 Hours)
Flow control, congestion control, HTTP, MQTT, CoAP.

Unit 4 – Cybersecurity Fundamentals (12 Hours)
Encryption, firewalls, IDS, secure network design.

Unit 5 – Industrial IoT Security (12 Hours)
Authentication, secure data transfer in twin networks.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Sensors, Actuators & Embedded Systems
(ES – 3 Credits / 45 Hours)

Course Objectives:
• To introduce sensors and actuators used in Digital Twin and IoT systems.
• To develop skills in embedded programming for real-time control.
• To integrate sensor networks with microcontrollers for data acquisition and simulation.

Course Outcomes:
CO1 – Understand the principles and classifications of sensors and actuators.
CO2 – Interface sensors and actuators with embedded controllers.
CO3 – Design embedded systems using Arduino, Raspberry Pi, or ESP32.
CO4 – Implement real-time data acquisition for digital twin applications.
CO5 – Analyze performance and reliability of embedded twin prototypes.

Detailed Syllabus:

Unit 1 – Introduction to Sensors & Actuators (9 Hours)
Types of sensors (temperature, pressure, proximity, vibration, optical), actuators (DC motor, stepper, servo).

Unit 2 – Sensor Interfacing & Calibration (9 Hours)
Signal conditioning, ADC/DAC, noise reduction, calibration methods.

Unit 3 – Embedded System Fundamentals (9 Hours)
Microcontrollers vs. microprocessors, memory, I/O interfacing, interrupt handling.

Unit 4 – Programming & Communication Protocols (9 Hours)
Embedded C/Python, serial communication (UART, I2C, SPI), wireless protocols (Bluetooth, Wi-Fi, ZigBee).

Unit 5 – Integration for Digital Twins (9 Hours)
Real-time data acquisition, edge processing, cloud connectivity, and case study applications.

Practical Component:
Lab Experiments:
• Interfacing sensors (temperature, motion, ultrasonic) with Arduino/Raspberry Pi.
• Data acquisition and visualization on IoT dashboard.
• Actuator control using PWM.
• Mini-project: Real-time sensor network for digital twin prototype.

Text Books:
Muhammad Ali Mazidi – Microcontrollers and Embedded Systems (8051/PIC).
P. Rajesh & K. Rajasekar – Fundamentals of IoT and Embedded Systems.

Reference Books:
Arshdeep Bahga & Vijay Madisetti – Internet of Things: A Hands-on Approach.
John Catsoulis – Designing Embedded Hardware.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Thermodynamics & Fluid Systems (for Physical Twins)
(ES – 3 Credits / 45 Hours)

Course Objectives:
• To understand the laws of thermodynamics and their applications in engineering systems.
• To analyze fluid mechanics principles for mechanical and thermal twins.
• To apply simulation-based problem solving for physical twin modeling.

Course Outcomes:
CO1 – Understand thermodynamic properties and energy interactions.
CO2 – Apply laws of thermodynamics to closed and open systems.
CO3 – Analyze flow dynamics and heat transfer processes.
CO4 – Perform basic calculations using simulation tools.
CO5 – Correlate thermofluid principles to digital twin design.

Detailed Syllabus:

Unit 1 – Thermodynamic Fundamentals (9 Hours)
System, process, state, energy, and equilibrium.

Unit 2 – Laws of Thermodynamics (9 Hours)
First and second law, entropy, and reversibility.

Unit 3 – Properties of Fluids (9 Hours)
Viscosity, compressibility, surface tension.

Unit 4 – Fluid Dynamics (9 Hours)
Bernoulli’s theorem, laminar and turbulent flow.

Unit 5 – Applications (9 Hours)
Simulation of heat exchangers and turbines in digital twin models.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Humanities Elective (Industrial Psychology / Ethics)
(HS – 3 Credits / 45 Hours)

Course Objectives:
• To develop understanding of industrial psychology, ethics, and human values.
• To enhance teamwork, leadership, and organizational communication.
• To integrate ethical considerations in technology and digital applications.

Course Outcomes:
CO1 – Understand psychological principles in industrial settings.
CO2 – Explain motivation, leadership, and group dynamics.
CO3 – Analyze workplace ethics and professional conduct.
CO4 – Apply ethical frameworks to technology-driven organizations.
CO5 – Demonstrate social responsibility in digital innovation.

Detailed Syllabus:

Unit 1 – Industrial Psychology (9 Hours)
Work behavior, perception, motivation theories.

Unit 2 – Leadership & Communication (9 Hours)
Team dynamics, conflict management, effective communication.

Unit 3 – Ethics & Values (9 Hours)
Ethical theories, professional responsibility, integrity.

Unit 4 – Corporate Governance (9 Hours)
CSR, sustainability, and workplace ethics.

Unit 5 – Case Studies (9 Hours)
Ethical issues in AI, IoT, and digital twin applications.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Internship I (Industry / Skill Exposure)
(PR – 1 Credits / 15 Hours)

Course Objectives:
• To provide exposure to industrial practices in automation or digital technologies.
• To enable practical understanding of IoT or digital system development.
• To build industry awareness and employability skills.

Course Outcomes:
CO1 – Observe industrial or technical workflows.
CO2 – Apply academic knowledge in a professional setting.
CO3 – Demonstrate teamwork and time management.
CO4 – Document tasks and learning outcomes effectively.
CO5 – Communicate technical information in professional formats.

Detailed Syllabus:

Unit 1 – Internship Preparation (6 Hours)
Orientation and mentor allocation.

Unit 2 – Field Work (9 Hours)
Industry visit, online certification, or short-term project.

Practical Component:
Minimum two-week industry internship or equivalent certified training in IoT, embedded systems, or automation domains.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Digital Twin Technology
Detailed Syllabus – Semester IV

Modeling & Simulation Fundamentals
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce modeling principles for physical and cyber systems.
• To understand mathematical and computational models for simulation.
• To relate modeling to digital twin creation and analysis.

Course Outcomes:
CO1 – Explain fundamental concepts of system modeling and abstraction.
CO2 – Develop mathematical models for dynamic systems.
CO3 – Apply numerical and simulation techniques using software tools.
CO4 – Validate and interpret simulation results for real-world systems.
CO5 – Integrate simulation concepts in digital twin development.

Detailed Syllabus:

Unit 1 – Introduction to Modeling (9 Hours)
System representation, model types, assumptions, and simplifications.

Unit 2 – Mathematical Modeling (9 Hours)
Ordinary differential equations, transfer functions, and block diagrams.

Unit 3 – Simulation Concepts (9 Hours)
Discrete-event, continuous, and hybrid simulations.

Unit 4 – Tools and Techniques (9 Hours)
Introduction to MATLAB, Simulink, and Python modeling libraries.

Unit 5 – Applications (9 Hours)
Model validation, optimization, and twin-based scenario analysis.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Control Systems & Automation
(ES – 3 Credits / 45 Hours)

Course Objectives:
• To study feedback control principles and automation techniques.
• To apply control theory to industrial and mechatronic systems.
• To enable understanding of control integration in digital twins.

Course Outcomes:
CO1 – Model control systems using transfer functions and state-space methods.
CO2 – Analyze system response and stability using frequency-domain methods.
CO3 – Design PID controllers for real-time control.
CO4 – Implement automation systems using sensors and actuators.
CO5 – Apply control and automation for digital twin synchronization.

Detailed Syllabus:

Unit 1 – System Modeling (9 Hours)
Transfer functions, block diagram representation.

Unit 2 – Time Response (9 Hours)
Transient and steady-state analysis, error constants.

Unit 3 – Stability Analysis (9 Hours)
Routh-Hurwitz criterion, Bode and Nyquist plots.

Unit 4 – Control Design (9 Hours)
PID controllers, tuning methods.

Unit 5 – Automation Applications (9 Hours)
PLC, SCADA, and twin-based process control.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Cloud Computing & Edge Computing
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce cloud service models and edge computing architectures.
• To understand virtualization, resource management, and data security in clouds.
• To integrate cloud-edge frameworks with digital twin systems.

Course Outcomes:
CO1 – Understand cloud infrastructure and service models.
CO2 – Analyze virtualization and resource allocation mechanisms.
CO3 – Explain edge computing principles and real-time data processing.
CO4 – Integrate IoT, edge, and cloud layers in system design.
CO5 – Apply cloud-edge computing to digital twin applications.

Detailed Syllabus:

Unit 1 – Cloud Concepts (9 Hours)
Service models (IaaS, PaaS, SaaS), virtualization, and orchestration.

Unit 2 – Edge Computing (9 Hours)
Architecture, latency, and local data analytics.

Unit 3 – Cloud Platforms (9 Hours)
AWS, Azure, Google Cloud services for IoT and AI.

Unit 4 – Cloud-Edge Integration (9 Hours)
Hybrid architecture, containerization, Kubernetes, Docker.

Unit 5 – Applications (9 Hours)
Smart manufacturing and predictive maintenance via cloud-edge twins.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Mechatronics & Cyber-Physical Systems (ES – 3 Credits / 45 Hours)

Course Objectives:
• To understand integration of mechanical, electronic, and computational systems.
• To develop knowledge of sensors, actuators, and control logic in automation.
• To study architecture of cyber-physical systems for digital twins.

Course Outcomes:
CO1 – Explain fundamentals of mechatronic and cyber-physical systems.
CO2 – Design embedded control logic for mechatronic systems.
CO3 – Apply system integration concepts using sensors and actuators.
CO4 – Model CPS architecture for data exchange and control.
CO5 – Develop simple CPS prototypes aligned with digital twin frameworks.

Detailed Syllabus:

Unit 1 – Introduction (9 Hours)
Definition, scope, system components.

Unit 2 – Mechanical & Electrical Subsystems (9 Hours)
Actuators, transducers, and interfacing.

Unit 3 – Control Logic (9 Hours)
Feedback, PID, PLC integration.

Unit 4 – CPS Architecture (9 Hours)
Networked embedded systems, IoT layers.

Unit 5 – Applications (9 Hours)
Industry 4.0, robotics, and real-time twin integration.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Open Elective I – AI for Digital Twin Systems
(OE – 3 Credits / 45 Hours)

Course Objectives:
• To introduce the fundamentals of artificial intelligence in engineering systems.
• To apply AI and ML algorithms in predictive and adaptive digital twins.
• To explore real-time data-driven optimization and decision-making.

Course Outcomes:
CO1 – Understand AI concepts, ML models, and neural network basics.
CO2 – Implement supervised and unsupervised learning techniques.
CO3 – Apply AI in anomaly detection, diagnostics, and system prediction.
CO4 – Integrate AI algorithms into digital twin frameworks for decision-making.
CO5 – Analyze ethical and practical implications of AI-driven twins.

Detailed Syllabus:

Unit 1 – AI & ML Foundations (9 Hours)
Introduction to AI, learning paradigms, neural networks.

Unit 2 – Supervised Learning (9 Hours)
Regression, classification, decision trees, SVM.

Unit 3 – Unsupervised Learning (9 Hours)
Clustering, dimensionality reduction, anomaly detection.

Unit 4 – AI for Digital Twins (9 Hours)
Predictive maintenance, fault diagnostics, adaptive control.

Unit 5 – AI Tools (9 Hours)
TensorFlow, PyTorch, Scikit-learn for twin data simulation.

Text Books:
Stuart Russell & Peter Norvig – Artificial Intelligence: A Modern Approach.
Ethem Alpaydin – Introduction to Machine Learning.

Reference Books:
Qiskit Machine Learning Documentation – IBM Quantum.
Ian Goodfellow – Deep Learning.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Laboratory: Simulation Tools (MATLAB, ANSYS, Simulink)
(ES – 4 Credits / 60 Hours)

Course Objectives:
• To provide hands-on experience with modeling and simulation tools.
• To analyze mechanical and electrical systems using computational tools.
• To design and simulate digital twin models with real-world data.

Course Outcomes:
CO1 – Use MATLAB and Simulink for system modeling and analysis.
CO2 – Apply ANSYS for mechanical component simulation.
CO3 – Validate simulation results through experimentation.
CO4 – Integrate simulation results into digital twin frameworks.
CO5 – Document, analyze, and interpret simulation data effectively.

Detailed Syllabus:

Unit 1 – MATLAB Basics (15 Hours)
Introduction to MATLAB environment, matrix operations, basic programming.

Unit 2 – Simulink (15 Hours)
System modeling, control simulation, and dynamic response analysis.

Unit 3 – ANSYS (15 Hours)
Structural, thermal, and flow simulation modules.

Unit 4 – Digital Twin Integration (15 Hours)
Data-driven simulation of smart systems using toolchains.

Unit 5 – Case Study (15 Hours)
Simulation-based predictive analysis for an industrial component.

Practical Component:
List of Experiments:
1. Modeling of a DC motor system in MATLAB.
2. Frequency response analysis using Simulink.
3. Stress analysis of a mechanical component using ANSYS.
4. Thermal simulation and temperature mapping.
5. Integration of real-time sensor data with MATLAB for twin updates.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Internship II (Industry / Skill Exposure)
(PR – 1 Credits / 15 Hours)

Course Objectives:
• To provide industrial or applied learning experience in digital or simulation domains.
• To strengthen understanding of modeling, cloud, or AI applications in real-world setups.
• To promote experiential learning in line with NEP 2020.

Course Outcomes:
CO1 – Apply theoretical knowledge to practical industrial tasks.
CO2 – Document and analyze industrial workflows and systems.
CO3 – Develop skills in simulation and data analysis tools.
CO4 – Demonstrate collaboration and communication skills.
CO5 – Present internship outcomes through a technical report.

Detailed Syllabus:

Unit 1 – Field Work (6 Hours)
Internship in modeling, simulation, or cloud-based companies.

Unit 2 – Reporting (9 Hours)
Prepare report with findings and technical observations.

Practical Component:
Minimum two-week internship or online certification in simulation, automation, or AI domains.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Digital Twin Technology
Detailed Syllabus – Semester V

Digital Twin Architecture & Platforms
(PC – 4 Credits / 60 Hours)

Course Objectives:
• To introduce architectural principles of digital twin systems.
• To understand platforms and frameworks for building digital twins.
• To enable integration of data from IoT, cloud, and AI sources for twin simulation.

Course Outcomes:
CO1 – Explain digital twin architectures and communication layers.
CO2 – Design logical and physical models for twin platforms.
CO3 – Integrate IoT, cloud, and AI components for real-time data flow.
CO4 – Evaluate platforms like Siemens Mindsphere, Azure Digital Twin, and PTC ThingWorx.
CO5 – Develop proof-of-concept digital twin models for industrial systems.

Detailed Syllabus:

Unit 1 – Introduction to Digital Twin Systems (12 Hours)
Concepts, architecture, and layers – data, model, service, visualization.

Unit 2 – Twin Modeling Frameworks (12 Hours)
Twin core model components, state synchronization, digital thread.

Unit 3 – IoT and Cloud Integration (12 Hours)
Real-time data flow using MQTT, REST, OPC UA protocols.

Unit 4 – Platforms & Tools (12 Hours)
Overview of PTC ThingWorx, Azure Digital Twin, Dassault 3DEXPERIENCE.

Unit 5 – Applications & Case Studies (12 Hours)
Manufacturing, energy, aerospace, and smart infrastructure use cases.

Text Books:
Nicholas D. Gallagher – Digital Twin Technology: Concepts and Applications.
John Stark – Digital Twin Driven Smart Manufacturing.

Reference Books:
PTC ThingWorx Documentation – Industrial IoT and Digital Twin Platforms.
Microsoft Azure Digital Twin Developer Guide.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

3D Modeling & Additive Manufacturing (CAD/CAM/3D Printing) (ES – 3 Credits / 45 Hours)

Course Objectives:
- To develop skills in 3D modeling and rapid prototyping.
- To apply additive manufacturing principles in engineering design.
- To relate 3D models to digital twin visualization and simulation.

Course Outcomes:
CO1 – Use CAD tools for solid modeling and assembly.
CO2 – Understand material properties for 3D printing applications.
CO3 – Generate G-code and perform machine setup for prototyping.
CO4 – Apply CAM and CAE integration in product lifecycle design.
CO5 – Correlate 3D models with digital twin representations.

Detailed Syllabus:

Unit 1 – Introduction to 3D Modeling (9 Hours)
CAD tools, parametric modeling, constraints and assemblies.

Unit 2 – Additive Manufacturing Fundamentals (9 Hours)
FDM, SLA, SLS, DMLS process principles.

Unit 3 – Materials and Design (9 Hours)
Polymers, metals, ceramics, composites.

Unit 4 – CAM & G-Code Generation (9 Hours)
Tool path planning, machine operation.

Unit 5 – Applications (9 Hours)
Prototyping for aerospace, biomedical, and smart systems.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Data Analytics & Machine Learning for Digital Twins (PC – 3 Credits / 45 Hours)

Course Objectives:
- To apply data analytics and machine learning techniques for twin data.
- To enable predictive and prescriptive modeling for system optimization.
- To use Python and data platforms for anomaly detection and forecasting.

Course Outcomes:
CO1 – Understand data processing and feature engineering.
CO2 – Implement machine learning models for predictive maintenance.

CO3 – Use Python libraries for data visualization and modeling.
CO4 – Apply ML to real-time data from digital twin systems.
CO5 – Evaluate performance and interpret results for decision-making.

Detailed Syllabus:

Unit 1 – Data Preprocessing (9 Hours)
Data cleaning, feature scaling, dimensionality reduction.

Unit 2 – Exploratory Data Analysis (9 Hours)
Descriptive statistics, visualization with Matplotlib, Seaborn.

Unit 3 – Machine Learning Models (9 Hours)
Regression, classification, clustering, decision trees.

Unit 4 – Predictive Analytics (9 Hours)
Anomaly detection, predictive maintenance models.

Unit 5 – Applications (9 Hours)
Twin data analysis for smart factories and energy systems.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Industrial IoT (IIoT)
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce industrial IoT architecture and communication standards.
• To enable data collection and control of industrial processes using IIoT.
• To integrate IIoT systems into digital twin environments.

Course Outcomes:
CO1 – Describe IIoT architecture and reference models.
CO2 – Configure sensors, actuators, and gateways for industrial communication.
CO3 – Apply protocols like Modbus, OPC UA, MQTT in industrial systems.
CO4 – Integrate data with cloud and analytics platforms.
CO5 – Relate IIoT frameworks to real-time twin synchronization.

Detailed Syllabus:

Unit 1 – IIoT Architecture (9 Hours)
Four-layer architecture, connectivity, edge devices.

Unit 2 – Industrial Communication Protocols (9 Hours)
OPC UA, Modbus, EtherCAT, MQTT.

Unit 3 – Data Acquisition & Control (9 Hours)
Gateways, PLCs, SCADA integration.

Unit 4 – Security & Maintenance (9 Hours)
Industrial cybersecurity and fault tolerance.

Unit 5 – Applications (9 Hours)
Smart factories, energy grids, and predictive operations.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Elective I – Smart Cities Digital Twins
(PE – 3 Credits / 45 Hours)

Course Objectives:
• To understand the concept and architecture of digital twins for urban systems.
• To apply IoT, AI, and data analytics for urban simulation and optimization.
• To design sustainable and data-driven urban twin models.

Course Outcomes:
CO1 – Explain the framework of smart city digital twins and data flows.
CO2 – Model urban infrastructure and mobility systems digitally.
CO3 – Integrate IoT and sensor networks for urban data collection.
CO4 – Analyze data for energy efficiency and resource optimization.
CO5 – Develop prototype digital twin for urban planning or sustainability applications.

Detailed Syllabus:

Unit 1 – Smart Cities Overview (9 Hours)
Urban governance, data driven management, and IoT ecosystem.

Unit 2 – Urban Twin Architecture (9 Hours)
Components, data layers, integration with urban GIS.

Unit 3 – AI & Analytics for Cities (9 Hours)
Predictive traffic control, energy forecasting, waste management.

Unit 4 – Platforms & Standards (9 Hours)
FIWARE, Open Data, ISO standards for urban digital twin design.

Unit 5 – Case Studies (9 Hours)
Singapore, Barcelona, and Indian Smart Cities Mission applications.

Text Books:
Pradeep Kumar – Smart Cities and Digital Twin Technologies.
Michael Batty – Digital Twins for Smart Urban Planning.

Reference Books:
ISO 37120: Sustainable Cities Indicators.
FIWARE Foundation – Urban Data Modeling Guide.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Minor Project I (System-Level Digital Twin Prototype)
(PR – 4 Credits / 60 Hours)

Course Objectives:
- To enable students to develop a working digital twin prototype for a physical system.
- To apply IoT, data analytics, and simulation tools in an integrated project.
- To enhance problem-solving, documentation, and presentation skills.

Course Outcomes:
CO1 – Identify problem statements and define project objectives.
CO2 – Design and develop hardware and software integration for digital twins.
CO3 – Implement data collection, analysis, and visualization modules.
CO4 – Demonstrate working prototype and system simulation accuracy.
CO5 – Prepare project reports and present results professionally.

Detailed Syllabus:

Unit 1 – Phase I – Project Ideation (15 Hours)
Problem definition, literature review, proposal preparation.

Unit 2 – Phase II – Design & Development (30 Hours)
System architecture, hardware selection, data flow design.

Unit 3 – Phase III – Implementation (30 Hours)
Programming, hardware integration, testing.

Unit 4 – Phase IV – Validation (15 Hours)
Simulation comparison, performance metrics evaluation.

Unit 5 – Phase V – Documentation & Presentation (15 Hours)
Report writing, presentation to review committee.

Practical Component:
Project Framework:
- Students will form teams of 3-5 members to design a digital twin prototype for an industria l or urban system.
- Mandatory integration of IoT sensor data and simulation tools (MATLAB / ANSYS / Thing Worx / Azure Twin).
- Deliverables: Project proposal, hardware prototype, code repository, final report, and pres entation.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Digital Twin Technology
Detailed Syllabus – Semester VI

Cloud–Edge Integration for Digital Twins
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To understand architecture and communication between cloud and edge systems.
• To enable real-time data synchronization for digital twin applications.
• To develop hybrid solutions that enhance latency and scalability.

Course Outcomes:
CO1 – Explain cloud and edge computing principles.
CO2 – Design hybrid architectures for real-time data transfer.
CO3 – Implement data pipelines for digital twin platforms.
CO4 – Integrate AI workflows across edge and cloud environments.
CO5 – Evaluate latency and security in edge-cloud deployments.

Detailed Syllabus:

Unit 1 – Introduction to Cloud and Edge Computing (9 Hours)
Architecture, components, benefits and challenges.

Unit 2 – Data Flow Management (9 Hours)
Streaming and batch data processing, APIs and middleware.

Unit 3 – Edge Analytics (9 Hours)
Local data processing, containers, Kubernetes integration.

Unit 4 – Cloud Services for Digital Twins (9 Hours)
AWS IoT Core, Azure Digital Twin, Google Edge TPU.

Unit 5 – Security and Optimization (9 Hours)
Data encryption, fault tolerance, performance tuning.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

AR/VR & XR Interfaces for Twin Visualization
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce principles of augmented, virtual, and extended reality for digital twin visualization.
• To enable 3D interaction and simulation of virtual prototypes.
• To develop immersive interfaces for smart manufacturing and urban applications.

Course Outcomes:
CO1 – Explain AR/VR/XR technologies and frameworks.
CO2 – Design 3D models for interactive twin visualization.
CO3 – Integrate real-time data into virtual environments.
CO4 – Develop applications using Unity / Unreal Engine.
CO5 – Apply XR solutions to digital twin and metaverse scenarios.

Detailed Syllabus:

Unit 1 – Introduction to XR Technologies (9 Hours)
Principles of AR, VR, and MR; hardware and software ecosystems.

Unit 2 – 3D Modeling for XR (9 Hours)
3D object creation and scene building for interactive systems.

Unit 3 – Data Integration (9 Hours)
Sensor and IoT data overlay in XR interfaces.

Unit 4 – Development Tools (9 Hours)
Unity, Unreal Engine, and WebXR platforms.

Unit 5 – Applications (9 Hours)
Industrial training, urban visualization, metaverse integration.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Predictive Maintenance & Asset Management
(PC – 3 Credits / 45 Hours)

Course Objectives:
• To understand strategies for predictive maintenance using data analytics and AI.
• To enable digital monitoring and lifecycle management of assets.
• To integrate maintenance analytics into digital twin ecosystems.

Course Outcomes:
CO1 – Explain maintenance strategies and lifecycle planning.
CO2 – Use machine learning for fault detection and failure prediction.
CO3 – Apply reliability engineering concepts to asset management.
CO4 – Implement data-driven predictive maintenance systems.
CO5 – Evaluate economic and sustainability impacts of maintenance policies.

Detailed Syllabus:

Unit 1 – Maintenance Strategies (9 Hours)
Corrective, preventive, predictive and prescriptive maintenance.

Unit 2 – Data Acquisition & Analytics (9 Hours)
Sensor data collection, feature extraction, ML for fault prediction.

Unit 3 – Reliability Engineering (9 Hours)
MTTF, MTTR, and failure rate modeling.

Unit 4 – Asset Lifecycle Management (9 Hours)
Inventory control, scheduling, and ERP integration.

Unit 5 – Applications (9 Hours)
Smart factories and energy asset management.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Elective II – Energy Systems Digital Twins
(PE – 3 Credits / 45 Hours)

Course Objectives:
• To introduce digital twin applications in energy generation, distribution and storage syste ms.
• To apply AI and data analytics for energy optimization and fault diagnostics.
• To enable integration of renewable energy and smart grid technologies.

Course Outcomes:
CO1 – Explain energy system components and modeling principles.
CO2 – Design digital twin frameworks for power plants and grids.
CO3 – Apply ML and optimization for energy forecasting and efficiency.
CO4 – Simulate renewable energy integration using software tools.
CO5 – Evaluate sustainability and economic impacts of digital energy systems.

Detailed Syllabus:

Unit 1 – Energy System Modeling (9 Hours)
Thermal, solar, and wind energy models for simulation.

Unit 2 – Smart Grid Architecture (9 Hours)
Communication protocols, IoT integration and data management.

Unit 3 – Predictive Analytics (9 Hours)
Load forecasting, demand response, and optimization.

Unit 4 – Simulation Tools (9 Hours)
MATLAB Simulink, HOMER, OpenDSS for energy systems.

Unit 5 – Case Studies (9 Hours)
Digital twins for microgrids and renewable plants.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Open Elective II – Blockchain for Smart Manufacturing Twins (OE – 3 Credits / 45 Hours)

Course Objectives:
• To introduce blockchain principles and its integration in digital twin ecosystems.
• To ensure secure and transparent data transactions for industrial automation.
• To apply smart contracts in supply chain and asset tracking applications.

Course Outcomes:
CO1 – Explain blockchain architecture and consensus mechanisms.
CO2 – Implement smart contracts for industrial applications.
CO3 – Apply blockchain for data security and traceability.
CO4 – Integrate blockchain with IoT and digital twin systems.
CO5 – Evaluate industry case studies in blockchain enabled manufacturing.

Detailed Syllabus:

Unit 1 – Blockchain Fundamentals (9 Hours)
Distributed ledger, cryptography, hash functions.

Unit 2 – Consensus Protocols (9 Hours)
Proof-of-Work, Proof-of-Stake, Hyperledger Fabric.

Unit 3 – Smart Contracts (9 Hours)
Ethereum, Solidity basics, decentralized applications.

Unit 4 – Integration with IoT and Twins (9 Hours)
Secure data transactions, audit trail for twin data.

Unit 5 – Industrial Applications (9 Hours)
Supply chain, asset management and maintenance records.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Minor Project II (Industry Case Study with Simulation Lab) (PR – 5 Credits / 75 Hours)

Course Objectives:
• To enable students to apply digital twin concepts to real industry problems.
• To develop simulation and data integration skills through collaborative projects.
• To enhance reporting and presentation skills based on industrial standards.

Course Outcomes:
CO1 – Analyze an industrial process and identify digital twin requirements.

CO2 – Model and simulate the system using appropriate tools.
CO3 – Integrate sensor data and develop dashboard visualizations.
CO4 – Evaluate system performance based on key metrics.
CO5 – Prepare a comprehensive technical report and presentation.

Detailed Syllabus:

Unit 1 – Phase I – Problem Analysis (15 Hours)
Select industry problem, define objectives and scope.

Unit 2 – Phase II – Model Development (30 Hours)
Simulation model creation and parameter selection.

Unit 3 – Phase III – Data Integration (30 Hours)
IoT connectivity and real-time data validation.

Unit 4 – Phase IV – Analysis and Optimization (15 Hours)
System tuning and result interpretation.

Unit 5 – Phase V – Reporting & Viva (15 Hours)
Project documentation, demonstration and presentation.

Practical Component:
Project Framework:
• Students will collaborate with industry partners or use public datasets for case studies.
• Simulation tools such as MATLAB, ANSYS, or TwinCAT must be used.
• Deliverables: Model report, simulation screenshots, data files, presentation slides and viva documentation.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Digital Twin Technology
Detailed Syllabus – Semester VII

Advanced Digital Twin Applications (Smart Manufacturing, Defence, Healthcare) (PC – 3 Credits / 45 Hours)

Course Objectives:
• To study domain-specific applications of digital twin technologies.
• To analyze interdisciplinary integration in manufacturing, healthcare, and defence systems
.
• To develop problem-solving skills through application-oriented case studies.

Course Outcomes:
CO1 – Explain domain-specific requirements for digital twins.
CO2 – Design application architectures for manufacturing and healthcare systems.
CO3 – Integrate AI and IoT frameworks into real-world applications.
CO4 – Simulate multi-disciplinary systems using twin platforms.
CO5 – Evaluate case studies and emerging technologies for domain deployment.

Detailed Syllabus:

Unit 1 – Smart Manufacturing Twins (9 Hours)
Shop-floor monitoring, machine learning integration, and predictive operations.

Unit 2 – Healthcare Twins (9 Hours)
Patient monitoring, digital biomarkers, AI-based diagnostics.

Unit 3 – Defence & Aerospace Twins (9 Hours)
Mission simulation, autonomous systems, flight control twins.

Unit 4 – Data Fusion & Interoperability (9 Hours)
Integration across CAD, IoT and cloud layers.

Unit 5 – Case Studies (9 Hours)
Rolls Royce jet engine twin, GE healthcare, and Siemens factory twin applications.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

AI-Driven Digital Twin Ecosystems (PC – 3 Credits / 45 Hours)

Course Objectives:
• To integrate artificial intelligence with digital twin ecosystems for autonomous decision-making.
• To understand self-learning models for twin optimization and adaptation.
• To apply reinforcement learning for continuous process improvement.

Course Outcomes:
CO1 – Describe AI frameworks used in digital twin environments.
CO2 – Implement supervised and unsupervised learning for twin optimization.
CO3 – Apply reinforcement learning for adaptive control and automation.
CO4 – Analyze data driven insights from twin ecosystem interactions.
CO5 – Integrate AI decision systems for autonomous digital operations.

Detailed Syllabus:

Unit 1 – Introduction to AI Ecosystems (9 Hours)
AI integration layers within digital twins, data fusion concepts.

Unit 2 – Learning Algorithms (9 Hours)
Regression, clustering, reinforcement learning for process control.

Unit 3 – Adaptive Twins (9 Hours)
Online learning, model self-correction, error feedback loops.

Unit 4 – Optimization Techniques (9 Hours)
Evolutionary algorithms and meta-heuristics in twin systems.

Unit 5 – Case Studies (9 Hours)
AI-enabled production lines, autonomous vehicle twins.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Emerging Trends in Digital Twin (Industry 5.0, Metaverse, Sustainability) (PC – 3 Credits / 45 Hours)

Course Objectives:
• To introduce emerging research directions and technological convergence in digital twin s ystems.
• To understand how Industry 5.0 principles influence twin innovation.
• To analyze ethical, social, and sustainability aspects of digital twin technologies.

Course Outcomes:
CO1 – Identify new technological trends in digital twin applications.
CO2 – Understand the role of human–machine collaboration in Industry 5.0.
CO3 – Explore the integration of metaverse and extended reality in digital twin contexts.
CO4 – Analyze sustainability and circular economy applications using digital twins.
CO5 – Evaluate policy and ethical implications of future twin technologies.

Detailed Syllabus:

Unit 1 – Industry 5.0 and Human-Centric Twins (9 Hours)
Collaboration, personalization, and augmented intelligence.

Unit 2 – Metaverse and Digital Ecosystems (9 Hours)
Virtual collaboration, 3D interoperability, and digital assets.

Unit 3 – Sustainability Integration (9 Hours)
Carbon accounting, energy optimization, resource management.

Unit 4 – Data Ethics and Governance (9 Hours)
Responsible AI, data sovereignty, and cybersecurity.

Unit 5 – Future Directions (9 Hours)
Convergence of quantum computing, edge AI, and cyber-physical clouds.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Elective III – Human Digital Twins
(PE – 3 Credits / 45 Hours)

Course Objectives:
• To understand human physiological and behavioral modeling in digital twin frameworks.
• To develop digital representations of health, performance, and behavior for decision suppo
rt.
• To apply AI and sensor data analytics for personalized twin applications.

Course Outcomes:
CO1 – Explain the concept of human digital twin and its architectural layers.
CO2 – Model physiological parameters using wearable sensors and biometric data.
CO3 – Integrate AI analytics for health and performance prediction.
CO4 – Evaluate ethical issues and privacy in human twin applications.
CO5 – Develop a prototype for healthcare or performance monitoring.

Detailed Syllabus:

Unit 1 – Introduction to Human Digital Twins (9 Hours)
Definition, concepts, and applications in healthcare and sports.

Unit 2 – Data Acquisition (9 Hours)
Wearables, EEG, ECG, motion capture, and biosignals.

Unit 3 – Modeling and Simulation (9 Hours)
Human body and behavioral models for AI integration.

Unit 4 – AI & Analytics (9 Hours)
Predictive health monitoring and anomaly detection.

Unit 5 – Ethics & Privacy (9 Hours)
Data protection laws and governance for personal digital twins.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Elective IV – Cognitive Twins
(PE – 3 Credits / 45 Hours)

Course Objectives:
- To study neuro-symbolic AI and cognitive modeling for autonomous systems.
- To enable self-learning digital twins for complex decision making.
- To understand human–AI collaboration and explainability in cognitive systems.

Course Outcomes:
CO1 – Describe the architecture of cognitive digital twins.
CO2 – Implement cognitive reasoning and knowledge graphs.
CO3 – Integrate natural language and vision data for adaptive twins.
CO4 – Apply cognitive learning for autonomous decision support.
CO5 – Analyze case studies in human–AI collaboration.

Detailed Syllabus:

Unit 1 – Introduction to Cognitive Systems (9 Hours)
Human cognition and AI models for knowledge representation.

Unit 2 – Cognitive Architectures (9 Hours)
ACT-R, SOAR, and hybrid reasoning frameworks.

Unit 3 – Perception and Language (9 Hours)
Integration of NLP and computer vision for context understanding.

Unit 4 – Adaptive Learning (9 Hours)
Reinforcement and neuro-symbolic learning for twin autonomy.

Unit 5 – Applications (9 Hours)
Cognitive assistants, autonomous robots, and AI twin agents.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Internship (2 Months – Industry / Research Lab)
(PR – 4 Credits / 60 Hours)

Course Objectives:
- To gain industry exposure in digital twin development or AI applications.
- To apply academic knowledge to real-world projects under expert guidance.
- To develop professional, technical, and collaborative competencies.

Course Outcomes:
CO1 – Understand industry operations and project management processes.

CO2 – Apply technical knowledge to industry use cases.
CO3 – Collaborate effectively in teams and communicate professionally.
CO4 – Prepare internship reports highlighting achievements and outcomes.
CO5 – Demonstrate professional ethics and career readiness.

Detailed Syllabus:

Unit 1 – Orientation and Project Selection (15 Hours)
Project allocation and mentor guidance.

Unit 2 – Execution Phase (30 Hours)
Industry or lab based project implementation.

Unit 3 – Report and Evaluation (15 Hours)
Final presentation and viva voce.

Practical Component:
Minimum 8-week internship with industry or research organization in digital twin / AI dom ain.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Major Project Phase I (DT Product / System Prototype) (PR – 4 Credits / 60 Hours)

Course Objectives:
• To initiate capstone project development in digital twin and emerging technology domains.
• To develop skills in design thinking, system integration, and project management.
• To prepare students for Phase II execution through structured milestones.

Course Outcomes:
CO1 – Identify problem statement and define scope of the capstone project.
CO2 – Design architecture and workflow for digital twin solution.
CO3 – Develop prototype modules and validate initial results.
CO4 – Document design, progress, and methodology systematically.
CO5 – Present Phase I outcomes to review committee for approval.

Detailed Syllabus:

Unit 1 – Phase I – Problem Identification & Proposal (15 Hours)
Literature review and research gap identification.

Unit 2 – Phase II – Design Architecture (30 Hours)
System modeling, hardware / software planning.

Unit 3 – Phase III – Implementation and Testing (30 Hours)
Prototype module development and validation.

Unit 4 – Phase IV – Documentation (15 Hours)
Project report drafting, progress review submission.

Unit 5 – Phase V – Presentation (15 Hours)
Technical seminar and viva voce for Phase I.

Practical Component:
Project Milestone Framework:
• Proposal submission with problem statement and objectives.
• Design architecture and system model documentation.
• Prototype development of core functional module.
• Progress presentation and internal evaluation report.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

B.Tech – Digital Twin Technology
Detailed Syllabus – Semester VIII

Tech Entrepreneurship, IPR & Innovation Management
(HS – 3 Credits / 45 Hours)

Course Objectives:
• To develop entrepreneurial mindset and leadership skills for technology-driven industries.
• To understand intellectual property rights and innovation management frameworks.
• To create awareness on startup ecosystems and commercialization strategies.

Course Outcomes:
CO1 – Understand concepts of entrepreneurship and startup ecosystems.
CO2 – Apply innovation management principles to technology projects.
CO3 – Explain the role of IPR in protecting technological innovations.
CO4 – Develop a business plan and funding strategy for a tech venture.
CO5 – Evaluate policy and ethical aspects of innovation and entrepreneurship.

Detailed Syllabus:

Unit 1 – Entrepreneurial Foundations (9 Hours)
Entrepreneurial ecosystem, innovation types, design thinking for startups.

Unit 2 – Business Model Development (9 Hours)
Lean canvas, value proposition, market fit and validation.

Unit 3 – Intellectual Property Rights (9 Hours)
Patents, copyrights, trademarks, and licensing strategies.

Unit 4 – Funding and Incubation (9 Hours)
Venture capital, angel funding, incubators and accelerators.

Unit 5 – Innovation Policies and Ethics (9 Hours)
National innovation policies, startup India, ethical entrepreneurship.

Text Books:
Peter F. Drucker – Innovation and Entrepreneurship.
N.S. Gopalakrishnan & T.G. Agitha – Principles of Intellectual Property.

Reference Books:
AICTE Startup Policy for Indian Institutions.
WIPO – Guide to Intellectual Property Rights and Commercialization.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Major Project Phase II (Capstone – Industry / Startup Collaboration)
(PR – 10 Credits / 150 Hours)

Course Objectives:
• To implement a comprehensive project integrating concepts from digital twin and emergin g technologies.
• To encourage collaboration with industry or startup for innovation and commercial applic ation.
• To prepare students for research publication, patent filing, and technology transfer.

Course Outcomes:
CO1 – Plan and execute capstone projects using digital twin principles.
CO2 – Integrate hardware, software, and data analytics for system implementation.
CO3 – Analyze project outcomes using performance metrics and sustainability goals.
CO4 – Publish findings in research journals or present at conferences.
CO5 – Demonstrate project management and entrepreneurial skills.

Detailed Syllabus:

Unit 1 – Phase I – Implementation (45 Hours)
Hardware fabrication, coding, data integration and testing.

Unit 2 – Phase II – Validation & Optimization (45 Hours)
System performance analysis, model validation and error reduction.

Unit 3 – Phase III – Documentation & Dissemination (45 Hours)
Technical report preparation, poster presentation, journal submission.

Unit 4 – Phase IV – Viva Voce (15 Hours)
Final presentation and evaluation by external experts.

Practical Component:
Project Framework:
• Students work individually or in teams to design and implement a functional digital twin so lution.
• Mandatory industry collaboration or startup mentorship.
• Deliverables: Prototype model, technical report, demonstration video, and patent/publicat ion submission.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Open Elective III – Technology Policy, Ethics & Foresight
(OE – 2 Credits / 30 Hours)

Course Objectives:
• To examine policy and ethical implications of emerging technologies.
• To understand governance and regulatory frameworks for digital innovation.
• To analyze futuristic trends in AI, IoT, and digital twin ecosystems through policy foresight.

Course Outcomes:
CO1 – Understand global technology policies and regulatory frameworks.
CO2 – Analyze ethical issues in AI and digital technologies.
CO3 – Evaluate national strategies and innovation governance models.
CO4 – Apply foresight tools for scenario planning and policy design.
CO5 – Propose recommendations for responsible innovation.

Detailed Syllabus:

Unit 1 – Technology Governance (6 Hours)
Global and national technology policies, R&D ecosystems.

Unit 2 – Ethics in Technology (6 Hours)
AI ethics, data privacy, accountability, and human rights.

Unit 3 – Regulation & Law (6 Hours)
Cybersecurity laws, data protection acts, and digital sovereignty.

Unit 4 – Foresight Methods (6 Hours)
Delphi, scenario building, trend analysis for policy innovation.

Unit 5 – Case Studies (6 Hours)
India AI Mission, EU AI Act, and Digital Twin Ethical Guidelines.

Text Books:
Luciano Floridi – The Ethics of Information.
OECD – AI Principles and Policy Guidelines.

Reference Books:
World Economic Forum – Technology Governance Reports (2023).
UNESCO – Recommendation on the Ethics of AI (2021).

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Seminar / Viva-Voce / Portfolio
(PR – 2 Credits / 30 Hours)

Course Objectives:
• To assess students' presentation skills, research acumen, and professional portfolio develo pment.

• To encourage reflective learning and lifelong career readiness.
• To integrate academic achievements into a professional showcase.

Course Outcomes:
CO1 – Prepare and present a seminar on emerging topics in digital technologies.
CO2 – Demonstrate research communication and technical presentation skills.
CO3 – Compile academic and professional achievements in portfolio form.
CO4 – Reflect on learning outcomes and career growth.
CO5 – Participate in viva voce and evaluate peer presentations effectively.

Detailed Syllabus:

Unit 1 – Seminar Preparation (15 Hours)
Selection of topic and literature survey report.

Unit 2 – Presentation Delivery (15 Hours)
PowerPoint presentation and technical discussion.

Unit 3 – Portfolio Development (15 Hours)
Compilation of projects, certifications, and achievements.

Unit 4 – Peer Review and Feedback (15 Hours)
Evaluation and reflection activity.

Practical Component:
Assessment Components:
• Seminar presentation (30 marks)
• Portfolio submission (40 marks)
• Viva voce and peer feedback (30 marks)
Portfolio must include academic records, project summaries, publications, and certifications.

Evaluation Scheme: Continuous Assessment (40%) + End-Semester Examination (60%)

Integrated B.Tech – M.Tech in AI in Healthcare Technology

Comprehensive Detailed Syllabus (Semesters I–X)

Detailed Syllabus – Semester I (20 Credits)

AIH101 - Mathematics I (Calculus & Linear Algebra)

L-T-P: 3-1-0 | Credits: 4 | Total Hours: 60

Course Objectives

• Develop fundamental knowledge in calculus and linear algebra essential for engineering applications.
• Apply mathematical techniques to solve real-world healthcare and AI-related problems.
• Use computational tools to model and analyze systems quantitatively.

Course Outcomes

CO1: Develop fundamental knowledge in calculus and linear algebra essential for engineering applications.
CO2: Apply mathematical techniques to solve real-world healthcare and AI-related problems.
CO3: Use computational tools to model and analyze systems quantitatively.

Detailed Syllabus

Unit I: Differential Calculus – 12 Hours
Limits, continuity, differentiability, mean value theorems, Taylor and Maclaurin series.

Unit II: Integral Calculus – 12 Hours
Definite and indefinite integrals, multiple integrals, applications to area and volume.

Unit III: Vector Calculus – 12 Hours
Gradient, divergence, curl, line and surface integrals, Green's, Stokes' and Gauss' theorems.

Unit IV: Linear Algebra – 12 Hours
Matrices, determinants, eigenvalues and eigenvectors, diagonalization, vector spaces.

Unit V: Differential Equations – 12 Hours
First and second order differential equations, applications to biological systems.

Text / Reference Books

• Grewal, B.S. – Higher Engineering Mathematics, Khanna Publishers.
• Kreyszig, E. – Advanced Engineering Mathematics, Wiley.
• Veerarajan, T. – Engineering Mathematics, Tata McGraw Hill.

AIH102A - Engineering Physics

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives
• Understand physical principles underlying engineering systems.
• Apply optics, quantum mechanics, and semiconductor physics to healthcare technologies.
• Relate material science and electronics to biomedical instrumentation.

Course Outcomes
CO1: Understand physical principles underlying engineering systems.
CO2: Apply optics, quantum mechanics, and semiconductor physics to healthcare technologies.
CO3: Relate material science and electronics to biomedical instrumentation.

Detailed Syllabus

Unit I: Wave Optics – 9 Hours
Interference, diffraction, and polarization principles.

Unit II: Quantum Mechanics – 9 Hours
Photoelectric effect, de Broglie hypothesis, Schrödinger equation.

Unit III: Semiconductors & Lasers – 9 Hours
Energy bands, p–n junctions, laser principles and applications.

Unit IV: Nanomaterials – 9 Hours
Synthesis, properties, and applications in biosensors.

Unit V: Modern Physics in Healthcare – 9 Hours
X-ray, MRI, and optical fiber technologies.

Text / Reference Books
• M.N. Avadhanulu & P.G. Kshirsagar – A Textbook of Engineering Physics, S. Chand.
• Serway & Jewett – Physics for Scientists and Engineers, Cengage.
• Resnick & Halliday – Fundamentals of Physics, Wiley.

AIH102B - Engineering Chemistry
L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives
• Understand chemical principles relevant to materials and environmental sustainability.
• Apply concepts of corrosion, polymers, and water treatment in healthcare industries.
• Relate electrochemistry and nanochemistry to biomedical applications.

Course Outcomes
CO1: Understand chemical principles relevant to materials and environmental sustainability.
CO2: Apply concepts of corrosion, polymers, and water treatment in healthcare industries.
CO3: Relate electrochemistry and nanochemistry to biomedical applications.

Detailed Syllabus

Unit I: Water Technology – 9 Hours
Hardness, desalination, and water treatment methods.

Unit II: Corrosion & Prevention – 9 Hours
Electrochemical corrosion, inhibitors, and coatings.

Unit III: Polymers & Biomaterials – 9 Hours
Classification, synthesis, and applications in medicine.

Unit IV: Electrochemistry – 9 Hours
Cells, batteries, sensors, and fuel cells.

Unit V: Green & Nano Chemistry – 9 Hours
Sustainable synthesis, nanomaterials, and environmental impact.

Text / Reference Books

- Jain & Jain – Engineering Chemistry, Dhanpat Rai.
- Shikha Agarwal – Engineering Chemistry, Cambridge University Press.
- De, A.K. – Environmental Chemistry, Wiley Eastern.

AIH103 - Programming for Problem Solving (Python/C)

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Develop programming logic using structured and modular approaches.
- Implement algorithms to solve computational problems in healthcare contexts.
- Apply debugging, testing, and documentation techniques.

Course Outcomes

CO1: Develop programming logic using structured and modular approaches.
CO2: Implement algorithms to solve computational problems in healthcare contexts.
CO3: Apply debugging, testing, and documentation techniques.

Detailed Syllabus

Unit I: Introduction to Programming – 9 Hours
Algorithms, flowcharts, structure of C/Python programs.

Unit II: Data Types & Control Structures – 9 Hours
Variables, loops, conditional statements, and arrays.

Unit III: Functions & Recursion – 9 Hours
Defining, calling, and recursive functions.

Unit IV: Pointers & File Handling – 9 Hours

Memory management, file operations, and error handling.

Unit V: Applications – 9 Hours
Health data analysis, signal filtering, and real-time computation.

Text / Reference Books

- Balagurusamy, E. – Programming in ANSI C, McGraw Hill.
- Reema Thareja – Python Programming, Oxford University Press.
- Let Us C – Yashavant Kanetkar, BPB Publications.

AIH104 - Human Anatomy & Physiology

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the structure and function of human body systems.
- Relate anatomy and physiology to biomedical and AI healthcare applications.
- Apply physiological principles for diagnostic and therapeutic technologies.

Course Outcomes

CO1: Understand the structure and function of human body systems.
CO2: Relate anatomy and physiology to biomedical and AI healthcare applications.
CO3: Apply physiological principles for diagnostic and therapeutic technologies.

Detailed Syllabus

Unit I: Introduction & Organization – 9 Hours
Cell structure, tissues, and organ systems.

Unit II: Cardiovascular & Respiratory Systems – 9 Hours
Heart anatomy, blood circulation, respiration process.

Unit III: Digestive & Excretory Systems – 9 Hours
Organs, functions, and homeostasis.

Unit IV: Nervous & Musculoskeletal Systems – 9 Hours
Neurons, reflex actions, muscle contraction.

Unit V: Integration with AI – 9 Hours
Biomedical sensors, imaging, and AI-based physiological monitoring.

Text / Reference Books

- Tortora, G.J. – Principles of Anatomy and Physiology, Wiley.
- Ross & Wilson – Anatomy and Physiology in Health and Illness, Elsevier.
- Guyton & Hall – Textbook of Medical Physiology, Elsevier.

AIH105 - Communication Skills / Professional English

L-T-P: 2-0-0 | Credits: 2 | Total Hours: 30

Course Objectives

• Enhance verbal, written, and professional communication skills.
• Develop technical report writing and presentation skills for engineers.
• Improve employability through interpersonal and public speaking abilities.

Course Outcomes

CO1: Enhance verbal, written, and professional communication skills.
CO2: Develop technical report writing and presentation skills for engineers.
CO3: Improve employability through interpersonal and public speaking abilities.

Detailed Syllabus

Unit I: Basics of Communication – 6 Hours
Communication process, types, and barriers.

Unit II: Listening & Speaking Skills – 6 Hours
Pronunciation, active listening, group discussions.

Unit III: Reading & Writing Skills – 6 Hours
Technical writing, email etiquette, report preparation.

Unit IV: Professional Presentations – 6 Hours
Presentation design, body language, and delivery.

Unit V: Soft Skills – 6 Hours
Teamwork, leadership, and conflict resolution.

Text / Reference Books

• Meenakshi Raman & Sangeeta Sharma – Technical Communication, Oxford University Press.
• Muralikrishna & Sunita – Professional Communication, Orient Blackswan.
• Rayudu, C.S. – Communication Skills, Himalaya Publishing House.

AIH106 - Programming Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Develop and test C/Python programs for problem-solving applications.
• Apply control structures, functions, and data structures in code design.

Course Outcomes

CO1: Develop and test C/Python programs for problem-solving applications.
CO2: Apply control structures, functions, and data structures in code design.

Detailed Syllabus

Unit I: Basic Programs – 6 Hours
Input/output, arithmetic, and control flow exercises.

Unit II: Functions & Arrays – 6 Hours
Programs using functions, recursion, and arrays.

Unit III: String & File Handling – 6 Hours
Manipulation of strings and files.

Unit IV: Data Structures – 6 Hours
Lists, stacks, and queues implementation.

Unit V: Mini Project – 6 Hours
Develop small applications using health data processing.

Text / Reference Books

- Python and C Programming Manuals.
- AICTE Model Curriculum Lab Guide (2023).

AIH107 - Basic Sciences Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

- Perform experiments to demonstrate fundamental principles in physics and chemistry.
- Analyze data from scientific experiments relevant to healthcare engineering.

Course Outcomes

CO1: Perform experiments to demonstrate fundamental principles in physics and chemistry.
CO2: Analyze data from scientific experiments relevant to healthcare engineering.

Detailed Syllabus

Unit I: Optics & Waves – 6 Hours
Interference, diffraction, and laser experiments.

Unit II: Material Properties – 6 Hours
Elasticity, viscosity, and conductivity experiments.

Unit III: Chemical Analysis – 6 Hours
Titrations, water hardness, and polymer synthesis.

Unit IV: Spectroscopy – 6 Hours
UV-Visible and FTIR spectroscopy.

Unit V: Mini Project – 6 Hours
Lab-based project applying physics/chemistry concepts in healthcare.

Text / Reference Books

• AICTE Model Curriculum Basic Science Lab Guide (2023).
• Physics and Chemistry Practical Manuals.

AIH108 - Induction / Environmental Studies (MC – Non-Credit)

L-T-P: 0-2-0 | Credits: 0 | Total Hours: 30

Course Objectives

• Understand environmental issues and sustainable practices.

• Develop social responsibility and community engagement skills.

Course Outcomes

CO1: Understand environmental issues and sustainable practices.
CO2: Develop social responsibility and community engagement skills.

Detailed Syllabus

Unit I: Environmental Concepts – 6 Hours
Ecosystems, biodiversity, and natural resource management.

Unit II: Pollution & Control – 6 Hours
Air, water, soil pollution – causes, effects, and control measures.

Unit III: Sustainability & Waste Management – 6 Hours
Renewable energy, solid waste management, and circular economy.

Unit IV: Climate Change & SDGs – 6 Hours
Impact of climate change and sustainable development goals.

Unit V: Field Visit / Project – 6 Hours
Community visit or mini-project on local environmental issues.

Text / Reference Books

• Benny Joseph – Environmental Studies, Tata McGraw Hill.
• Erach Bharucha – Environmental Studies for Undergraduate Courses, UGC.
• AICTE Induction Program Guidelines (2023).

Integrated B.Tech – M.Tech in AI in Healthcare Technology

Detailed Syllabus – Semester II (20 Credits)

AIH201 - Mathematics – II (Probability & Statistics, Differential Equations)

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the concepts of probability, statistics, and differential equations relevant to healthcare data analytics.
• Apply mathematical models to analyze biomedical signals and patient data.
• Develop analytical and computational skills for AI and ML applications.

Course Outcomes

CO1: Understand the concepts of probability, statistics, and differential equations relevant to healthcare data analytics.
CO2: Apply mathematical models to analyze biomedical signals and patient data.
CO3: Develop analytical and computational skills for AI and ML applications.

Detailed Syllabus

Unit I: Probability Theory – 9 Hours
Random variables, probability distributions, mean, variance, Binomial, Poisson, and Normal distributions.

Unit II: Statistical Methods – 9 Hours
Sampling, estimation, hypothesis testing, correlation, and regression analysis.

Unit III: Ordinary Differential Equations – 9 Hours
First and second order ODEs, homogeneous and non-homogeneous equations, applications in population and decay models.

Unit IV: Partial Differential Equations – 9 Hours
Wave, heat, and Laplace equations; boundary conditions and healthcare modeling.

Unit V: Numerical Methods – 9 Hours
Numerical differentiation, integration, and solutions of differential equations using iterative methods.

Text / Reference Books

• Erwin Kreyszig – Advanced Engineering Mathematics, Wiley.
• B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers.
• Miller & Freund – Probability and Statistics for Engineers, Pearson.

AIH202 - Data Structures & Algorithms

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the fundamental data structures and algorithmic techniques used in computer science.

• Implement data structures for efficient data management and retrieval in healthcare systems.
• Analyze algorithm complexity for optimized problem-solving in AI applications.

Course Outcomes
CO1: Understand the fundamental data structures and algorithmic techniques used in computer science.
CO2: Implement data structures for efficient data management and retrieval in healthcare systems.
CO3: Analyze algorithm complexity for optimized problem-solving in AI applications.

Detailed Syllabus

Unit I: Introduction to Data Structures – 9 Hours
Arrays, linked lists, stacks, queues, and their operations.

Unit II: Searching and Sorting Algorithms – 9 Hours
Linear, binary search; Bubble, insertion, merge, and quick sort.

Unit III: Trees and Graphs – 9 Hours
Binary trees, traversals, BST, graphs, BFS, DFS, and adjacency representations.

Unit IV: Algorithm Design Techniques – 9 Hours
Divide and conquer, greedy algorithms, dynamic programming.

Unit V: Applications in Healthcare – 9 Hours
Data organization for patient records, EHR search optimization, and bioinformatics applications.

Text / Reference Books
• Goodrich, Tamassia & Goldwasser – Data Structures and Algorithms in Python, Wiley.
• Narasimha Karumanchi – Data Structures and Algorithms Made Easy, CareerMonk.
• Tenenbaum – Data Structures Using C, PHI.

AIH203 - Principles of Electrical & Electronics Engineering
L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives
• Understand the fundamentals of electrical and electronic circuits used in healthcare devices.
• Analyze and design basic analog and digital circuits for biomedical instrumentation.
• Apply electronics principles in signal sensing and medical device interfaces.

Course Outcomes
CO1: Understand the fundamentals of electrical and electronic circuits used in healthcare devices.
CO2: Analyze and design basic analog and digital circuits for biomedical instrumentation.
CO3: Apply electronics principles in signal sensing and medical device interfaces.

Detailed Syllabus

Unit I: Electrical Circuits – 9 Hours
Ohm's law, Kirchhoff's laws, network theorems, AC/DC circuits, and power calculations.

Unit II: Semiconductor Devices – 9 Hours
PN junctions, diodes, transistors, and operational amplifiers.

Unit III: Digital Electronics – 9 Hours
Logic gates, Boolean algebra, flip-flops, counters, and ADC/DAC converters.

Unit IV: Sensors and Transducers – 9 Hours
Principles and characteristics; Biomedical sensors – temperature, pressure, ECG, and pulse sensors.

Unit V: Applications in Healthcare – 9 Hours
Circuit interfacing with medical systems; examples in ECG, EEG, and wearable monitoring.

Text / Reference Books

- Kothari & Nagrath – Basic Electrical Engineering, McGraw Hill.
- Sedra & Smith – Microelectronic Circuits, Oxford University Press.
- Rizzoni – Principles and Applications of Electrical Engineering, McGraw Hill.

AIH204 - Biochemistry & Medical Biology

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the fundamental biochemical processes of human physiology.
- Apply biochemical knowledge to interpret metabolic and disease mechanisms.
- Correlate biological systems with biomedical engineering and AI applications.

Course Outcomes

CO1: Understand the fundamental biochemical processes of human physiology.
CO2: Apply biochemical knowledge to interpret metabolic and disease mechanisms.
CO3: Correlate biological systems with biomedical engineering and AI applications.

Detailed Syllabus

Unit I: Biomolecules – 9 Hours
Carbohydrates, lipids, proteins, nucleic acids – structure, function, and clinical relevance.

Unit II: Enzymes and Catalysis – 9 Hours
Classification, kinetics, enzyme inhibition, and applications in diagnostics.

Unit III: Metabolism – 9 Hours
Carbohydrate, lipid, and protein metabolism; energy balance and ATP synthesis.

Unit IV: Genetics and Molecular Biology – 9 Hours
DNA replication, transcription, translation, and gene regulation.

Unit V: Clinical Biochemistry – 9 Hours
Biochemical basis of diseases, biomarkers, and bioinformatics databases.

Text / Reference Books

- Satyanarayana & Chakrapani – Biochemistry, Elsevier.
- Lehninger – Principles of Biochemistry, Freeman.
- Harper – Illustrated Biochemistry, McGraw Hill.

AIH205 - Healthcare Systems & Medical Terminology

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the structure and functioning of healthcare systems in India and globally.
- Learn and interpret medical terminology used in healthcare and hospital management.
- Apply health system knowledge to AI-driven medical and administrative solutions.

Course Outcomes

CO1: Understand the structure and functioning of healthcare systems in India and globally.
CO2: Learn and interpret medical terminology used in healthcare and hospital management.
CO3: Apply health system knowledge to AI-driven medical and administrative solutions.

Detailed Syllabus

Unit I: Overview of Healthcare Systems – 9 Hours
Public and private healthcare structures, levels of care, WHO frameworks, and Ayushman Bharat.

Unit II: Hospital Administration – 9 Hours
Departments, workflows, medical records, and healthcare quality standards.

Unit III: Medical Terminology Basics – 9 Hours
Prefixes, suffixes, and roots used in anatomy, pathology, and diagnostics.

Unit IV: Clinical Documentation – 9 Hours
SOAP notes, electronic health records, and standard terminologies (ICD, SNOMED, LOINC).

Unit V: Health Informatics Applications – 9 Hours
Integration of HIS and EHR for AI-based decision-making.

Text / Reference Books

- Chabner, D. – The Language of Medicine, Elsevier.
- WHO – Health Systems Framework, WHO Publications.
- Hoyt & Yoshihashi – Health Informatics: Practical Guide, Informatics Education.

AIH206 - Data Structures Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Implement data structures and algorithms practically using C/Python.
• Analyze performance and optimize solutions for data handling in healthcare systems.

Course Outcomes

CO1: Implement data structures and algorithms practically using C/Python.
CO2: Analyze performance and optimize solutions for data handling in healthcare systems.

Detailed Syllabus

Unit I: Array and String Operations – 6 Hours
Implement insertion, deletion, and search operations.

Unit II: Linked Lists – 6 Hours
Single and doubly linked lists with operations.

Unit III: Stacks and Queues – 6 Hours
Implementation using arrays and linked lists.

Unit IV: Sorting and Searching – 6 Hours
Write programs for sorting and searching techniques.

Unit V: Mini Project – 6 Hours
Develop small application for patient record management.

Text / Reference Books

• Goodrich et al. – Data Structures and Algorithms in Python, Wiley.
• Online C/Python Documentation.

AIH207 - Biology / Biochemistry Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Perform experiments related to biomolecules and enzymatic activities.
• Relate biochemical concepts to physiological and pathological processes.

Course Outcomes

CO1: Perform experiments related to biomolecules and enzymatic activities.
CO2: Relate biochemical concepts to physiological and pathological processes.

Detailed Syllabus

Unit I: Introduction and Safety – 6 Hours
Lab safety, glassware handling, and preparation of reagents.

Unit II: Biomolecule Identification – 6 Hours
Qualitative tests for carbohydrates, proteins, and lipids.

Unit III: Enzyme Activity – 6 Hours
Assay of amylase, catalase, or dehydrogenase enzymes.

Unit IV: pH and Buffer Preparation – 6 Hours
Preparation of physiological buffers and pH measurement.

Unit V: Mini Project – 6 Hours
Study of clinical parameter correlation (e.g., glucose vs. enzyme activity).

Text / Reference Books

- Practical Manual – Biochemistry, Elsevier.
- Sadasivam & Manickam – Biochemical Methods, New Age International.

AIH208 - Internship I (Short-Term Industrial/Clinical Exposure)

L-T-P: 0-0-2 | Credits: 1 | Total Hours: 15

Course Objectives

- Gain exposure to healthcare, hospital, or biomedical industry environments.
- Observe workflows, digital tools, and data management processes.

Course Outcomes

CO1: Gain exposure to healthcare, hospital, or biomedical industry environments.
CO2: Observe workflows, digital tools, and data management processes.

Detailed Syllabus

Unit I: Orientation – 3 Hours
Understanding organizational structure and objectives.

Unit II: Observation – 3 Hours
Shadow professionals in clinical, laboratory, or data analytics settings.

Unit III: Documentation – 3 Hours
Maintain daily log and reflective notes on observations.

Unit IV: Mini Project – 3 Hours
Identify and propose digital improvement idea or case study.

Unit V: Presentation – 3 Hours

Submit report and deliver presentation on internship experience.

Text / Reference Books

• AICTE Internship Guidelines (2023).
• Industry Mentor Reference Notes.

AIH209 - Constitution of India / Universal Human Values (MC – Non Credit)

L-T-P: 2-0-0 | Credits: 0 | Total Hours: 30

Course Objectives

• Understand constitutional principles and ethical foundations of professional life.
• Foster human values and social responsibility among students.

Course Outcomes

CO1: Understand constitutional principles and ethical foundations of professional life.
CO2: Foster human values and social responsibility among students.

Detailed Syllabus

Unit I: Introduction to Constitution – 6 Hours
Preamble, fundamental rights, directive principles, duties.

Unit II: Governance – 6 Hours
Union, state, and local governments; judiciary and administration.

Unit III: Human Values – 6 Hours
Truth, compassion, empathy, and self-discipline.

Unit IV: Professional Ethics – 6 Hours
Rights and responsibilities of professionals.

Unit V: Harmony and Global Citizenship – 6 Hours
Tolerance, unity, sustainability, and ethical leadership.

Text / Reference Books

• Basu, D.D. – Introduction to the Constitution of India, LexisNexis.
• R. Subramanian – Professional Ethics, Oxford University Press.

Integrated B.Tech – M.Tech in AI in Healthcare Technology

Detailed Syllabus – Semester III (20 Credits)

AIH301 - Object-Oriented Programming (Java / C++)
L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the principles of object-oriented programming using Java/C++.
- Design and implement modular, reusable, and efficient code for healthcare applications.
- Apply OOP concepts to real-world data handling and simulation problems.

Course Outcomes

CO1: Understand the principles of object-oriented programming using Java/C++.
CO2: Design and implement modular, reusable, and efficient code for healthcare applications.
CO3: Apply OOP concepts to real-world data handling and simulation problems.

Detailed Syllabus

Unit I: Introduction to OOP – 9 Hours
Overview of OOP concepts: Classes, objects, encapsulation, inheritance, polymorphism, abstraction.

Unit II: Control Structures and Functions – 9 Hours
Loops, conditionals, user-defined functions, constructors, and destructors.

Unit III: Inheritance and Polymorphism – 9 Hours
Types of inheritance, function overloading, operator overloading, and virtual functions.

Unit IV: File Handling and Exception Handling – 9 Hours
Reading/writing files, exceptions, templates, and error management.

Unit V: Applications in Healthcare – 9 Hours
Development of OOP-based healthcare data management or simulation tools.

Text / Reference Books

- E. Balagurusamy – Object Oriented Programming with C++, McGraw Hill.
- Herbert Schildt – Java: The Complete Reference, McGraw Hill.
- Bjarne Stroustrup – The C++ Programming Language, Addison-Wesley.

AIH302 - Database Management Systems

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand database concepts and architecture for efficient data management.
- Design and implement relational databases for healthcare systems.
- Apply SQL and normalization principles to medical record management.

Course Outcomes

CO1: Understand database concepts and architecture for efficient data management.
CO2: Design and implement relational databases for healthcare systems.
CO3: Apply SQL and normalization principles to medical record management.

Detailed Syllabus

Unit I: Introduction to Databases – 9 Hours
Data models, DBMS architecture, data independence, ER modeling, and schema design.

Unit II: Relational Model and Algebra – 9 Hours
Relational model, keys, constraints, relational algebra operations.

Unit III: Structured Query Language (SQL) – 9 Hours
DDL, DML, DCL commands, joins, subqueries, transactions, and triggers.

Unit IV: Normalization and Indexing – 9 Hours
Normalization (1NF–3NF, BCNF), indexing, and query optimization.

Unit V: Applications in Healthcare – 9 Hours
Design of EHR databases, patient record systems, and healthcare analytics.

Text / Reference Books

- Elmasri & Navathe – Fundamentals of Database Systems, Pearson.
- Ramakrishnan & Gehrke – Database Management Systems, McGraw Hill.
- Connolly & Begg – Database Systems: A Practical Approach, Pearson.

AIH303 - Biomedical Instrumentation

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the principles and working of biomedical instruments and sensors.
- Apply electronics and signal concepts to measure physiological parameters.
- Analyze data acquisition and instrumentation for AI-based healthcare systems.

Course Outcomes

CO1: Understand the principles and working of biomedical instruments and sensors.
CO2: Apply electronics and signal concepts to measure physiological parameters.
CO3: Analyze data acquisition and instrumentation for AI-based healthcare systems.

Detailed Syllabus

Unit I: Introduction to Biomedical Instrumentation – 9 Hours
Block diagram of a biomedical system, physiological parameters and transducers.

Unit II: Bioelectric Signals and Electrodes – 9 Hours
Origin of bioelectric signals; types of electrodes – surface, needle, microelectrodes.

Unit III: Measurement Systems – 9 Hours
ECG, EEG, EMG, blood pressure, and respiratory monitoring systems.

Unit IV: Signal Conditioning and Amplification – 9 Hours

Operational amplifiers, filters, isolation amplifiers, and safety aspects.

Unit V: Recent Advances – 9 Hours
Wearable devices, wireless sensors, AI-based diagnostics and telemonitoring.

Text / Reference Books

- Rangayyan, R.M. – Biomedical Signal Analysis, Wiley.
- John G. Webster – Medical Instrumentation: Application and Design, Wiley.
- Khandpur, R.S. – Handbook of Biomedical Instrumentation, McGraw Hill.

AIH304 - Signals & Systems

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the mathematical representation and analysis of signals and systems.
- Analyze time and frequency domain behavior of biomedical and physiological signals.
- Apply signal processing techniques in healthcare and AI applications.

Course Outcomes

CO1: Understand the mathematical representation and analysis of signals and systems.
CO2: Analyze time and frequency domain behavior of biomedical and physiological signals.
CO3: Apply signal processing techniques in healthcare and AI applications.

Detailed Syllabus

Unit I: Introduction to Signals – 9 Hours
Continuous and discrete signals, operations on signals, unit step and impulse functions.

Unit II: System Characteristics – 9 Hours
Linearity, time-invariance, causality, and stability of systems.

Unit III: Fourier Analysis – 9 Hours
Fourier series, Fourier transform, and applications to biomedical signals.

Unit IV: Laplace and Z-Transforms – 9 Hours
Transform techniques for analysis of linear systems.

Unit V: Applications in Healthcare – 9 Hours
ECG/EEG signal processing and AI-assisted waveform analysis.

Text / Reference Books

- Oppenheim & Willsky – Signals and Systems, Pearson.
- Nagoor Kani – Signals and Systems, McGraw Hill.
- Rangayyan, R.M. – Biomedical Signal Analysis, Wiley.

AIH305A - Open Elective I (A): Digital Health Entrepreneurship

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the fundamentals of entrepreneurship and innovation in digital health.
• Develop business models for healthcare technology ventures.
• Encourage entrepreneurial mindset for healthcare innovations.

Course Outcomes

CO1: Understand the fundamentals of entrepreneurship and innovation in digital health.
CO2: Develop business models for healthcare technology ventures.
CO3: Encourage entrepreneurial mindset for healthcare innovations.

Detailed Syllabus

Unit I: Introduction to Entrepreneurship – 9 Hours
Entrepreneurship concepts, traits, startup ecosystem, and funding models.

Unit II: Healthcare Innovation Landscape – 9 Hours
Digital health startups, MedTech ecosystem, and global trends.

Unit III: Business Model Canvas – 9 Hours
Value proposition, market segmentation, revenue models, and scalability.

Unit IV: Legal & Ethical Aspects – 9 Hours
Healthcare regulations, intellectual property, and compliance.

Unit V: Case Studies – 9 Hours
Successful digital health startups and lessons learned.

Text / Reference Books

• Hisrich, R. – Entrepreneurship, McGraw Hill.
• Sangram Vajre – Marketing to Serve Entrepreneurs, Wiley.
• Christensen, C. – The Innovator's Prescription, Harvard Business Press.

AIH305B - Open Elective I (B): Biomedical Data Visualization & Dashboards

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Learn principles of data visualization for biomedical and healthcare data.
• Develop interactive dashboards for monitoring and analysis.
• Utilize visualization tools to interpret clinical and operational datasets.

Course Outcomes

CO1: Learn principles of data visualization for biomedical and healthcare data.

CO2: Develop interactive dashboards for monitoring and analysis.
CO3: Utilize visualization tools to interpret clinical and operational datasets.

Detailed Syllabus

Unit I: Introduction to Data Visualization – 9 Hours
Data types, visualization concepts, and importance in healthcare analytics.

Unit II: Tools & Platforms – 9 Hours
Overview of Tableau, Power BI, Python (matplotlib, seaborn, plotly).

Unit III: Design Principles – 9 Hours
Visual perception, storytelling, and dashboard design guidelines.

Unit IV: Healthcare Data Visualization – 9 Hours
Visualization of patient data, EHR analytics, and KPI dashboards.

Unit V: Mini Project – 9 Hours
Develop a prototype healthcare dashboard for hospital analytics.

Text / Reference Books

- Sharma, P. – Healthcare Data Analytics, CRC Press.
- Few, S. – Information Dashboard Design, O'Reilly.
- Provost & Fawcett – Data Science for Business, O'Reilly.

AIH306 - OOP & DBMS Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

- Implement OOP principles and database operations using Java/C++ and SQL.
- Integrate programming and database concepts in mini-projects.

Course Outcomes

CO1: Implement OOP principles and database operations using Java/C++ and SQL.
CO2: Integrate programming and database concepts in mini-projects.

Detailed Syllabus

Unit I: Class & Object Implementation – 6 Hours
Program creation using classes, inheritance, and polymorphism.

Unit II: File & Exception Handling – 6 Hours
Programs for file operations and error handling.

Unit III: Database Creation – 6 Hours
Create, insert, and update operations using SQL.

Unit IV: Queries and Joins – 6 Hours

Execute complex SQL queries, joins, and subqueries.

Unit V: Mini Project – 6 Hours
Integrate OOP and DBMS concepts in a healthcare data system.

Text / Reference Books

- Elmasri & Navathe – Database Systems, Pearson.
- Herbert Schildt – Java: The Complete Reference, McGraw Hill.

AIH307 - Biomedical Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

- Perform experiments related to biomedical sensors and signal measurement.
- Analyze data from physiological systems using laboratory instruments.

Course Outcomes

CO1: Perform experiments related to biomedical sensors and signal measurement.
CO2: Analyze data from physiological systems using laboratory instruments.

Detailed Syllabus

Unit I: Introduction to Biomedical Systems – 6 Hours
Safety, calibration, and data acquisition setup.

Unit II: Sensor Experiments – 6 Hours
Temperature, ECG, and pulse sensor calibration.

Unit III: Signal Analysis – 6 Hours
Noise reduction, filtering, and waveform recording.

Unit IV: System Integration – 6 Hours
Interface sensors with Arduino/Raspberry Pi systems.

Unit V: Mini Project – 6 Hours
Develop simple bio-signal acquisition or monitoring prototype.

Text / Reference Books

- Khandpur, R.S. – Handbook of Biomedical Instrumentation, McGraw Hill.
- John G. Webster – Medical Instrumentation, Wiley.

AIH308 - Internship – Short Industry / Hospital Exposure

L-T-P: 0-0-2 | Credits: 1 | Total Hours: 15

Course Objectives

- Expose students to healthcare or biomedical technology environments.

• Observe workflows, data management, and healthcare operations.

Course Outcomes

CO1: Expose students to healthcare or biomedical technology environments.
CO2: Observe workflows, data management, and healthcare operations.

Detailed Syllabus

Unit I: Orientation – 3 Hours
Introduction to organization and project goals.

Unit II: Observation – 3 Hours
Daily participation in clinical, research, or software tasks.

Unit III: Documentation – 3 Hours
Maintain daily activity log and reflections.

Unit IV: Mini Project – 3 Hours
Identify and analyze a small real-world challenge.

Unit V: Report & Presentation – 3 Hours
Prepare and present internship findings.

Text / Reference Books

• AICTE Internship Guidelines (2023).
• Industry Mentor Manual.

AIH309 - Constitution of India / Universal Human Values (MC – Non Credit)

L-T-P: 2-0-0 | Credits: 0 | Total Hours: 30

Course Objectives

• Understand constitutional values, ethics, and human responsibility in engineering and healthcare domains.
• Develop professional ethics and social consciousness for responsible practice.

Course Outcomes

CO1: Understand constitutional values, ethics, and human responsibility in engineering and healthcare domains.
CO2: Develop professional ethics and social consciousness for responsible practice.

Detailed Syllabus

Unit I: Constitutional Framework – 6 Hours
Preamble, rights, duties, directive principles.

Unit II: Governance – 6 Hours
Union, state, and judiciary structures.

Unit III: Ethics & Values – 6 Hours
Integrity, empathy, accountability, and tolerance.

Unit IV: Professional Responsibility – 6 Hours
Ethical decision-making and codes of conduct.

Unit V: Sustainability & Global Citizenship – 6 Hours
Environment, peace, equality, and social justice.

Text / Reference Books

• Basu, D.D. – Introduction to the Constitution of India, LexisNexis.
• R. Subramanian – Professional Ethics, Oxford University Press.

Integrated B.Tech – M.Tech in AI in Healthcare Technology

Detailed Syllabus – Semester IV (20 Credits)

AIH401 - Operating Systems

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the structure, functions, and components of modern operating systems.
• Analyze process scheduling, memory management, and file handling techniques.
• Apply OS principles to develop efficient healthcare software and embedded systems.

Course Outcomes

CO1: Understand the structure, functions, and components of modern operating systems.
CO2: Analyze process scheduling, memory management, and file handling techniques.
CO3: Apply OS principles to develop efficient healthcare software and embedded systems.

Detailed Syllabus

Unit I: Introduction to Operating Systems – 9 Hours
Overview, structure, and functions; System calls and types of operating systems.

Unit II: Process Management – 9 Hours
Processes, threads, scheduling, synchronization, and deadlocks.

Unit III: Memory Management – 9 Hours
Paging, segmentation, virtual memory, and allocation algorithms.

Unit IV: File and I/O Systems – 9 Hours
File structure, directory systems, disk scheduling, and I/O management.

Unit V: Applications in Healthcare – 9 Hours
Embedded and real-time OS in medical devices, healthcare system integration.

Text / Reference Books
• Silberschatz, A. – Operating System Concepts, Wiley.
• Tanenbaum, A. – Modern Operating Systems, Pearson.
• Stallings, W. – Operating Systems: Internals and Design Principles, Pearson.

AIH402 - Computer Networks & IoT for Healthcare
L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives
• Understand the fundamentals of computer networking and IoT architecture.
• Design IoT-enabled healthcare communication systems and networks.
• Apply network security and data management principles in connected healthcare systems.

Course Outcomes
CO1: Understand the fundamentals of computer networking and IoT architecture.
CO2: Design IoT-enabled healthcare communication systems and networks.
CO3: Apply network security and data management principles in connected healthcare systems.

Detailed Syllabus

Unit I: Basics of Networking – 9 Hours
Network topologies, OSI and TCP/IP models, IP addressing, and protocols.

Unit II: Wireless Communication – 9 Hours
Bluetooth, Wi-Fi, Zigbee, and LoRaWAN for healthcare IoT devices.

Unit III: IoT Architecture – 9 Hours
IoT layers, sensors, microcontrollers (Arduino, Raspberry Pi), and cloud integration.

Unit IV: IoT Data Management – 9 Hours
IoT data acquisition, transmission, and analytics using MQTT, Node-RED, and ThingSpeak.

Unit V: IoT in Healthcare – 9 Hours
Wearable health monitoring, telemedicine integration, and cybersecurity challenges.

Text / Reference Books
• Raj, P. – Internet of Things: Principles and Paradigms, Elsevier.
• James F. Kurose – Computer Networking: A Top-Down Approach, Pearson.
• Berman, F. – IoT and Healthcare, Springer.

AIH403 - Fundamentals of Artificial Intelligence
L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the basic concepts and applications of artificial intelligence.
• Implement knowledge representation, reasoning, and problem-solving algorithms.
• Apply AI techniques in diagnostics, predictive analytics, and robotics.

Course Outcomes

CO1: Understand the basic concepts and applications of artificial intelligence.
CO2: Implement knowledge representation, reasoning, and problem-solving algorithms.
CO3: Apply AI techniques in diagnostics, predictive analytics, and robotics.

Detailed Syllabus

Unit I: Introduction to AI – 9 Hours
History, definitions, intelligent agents, AI applications in healthcare.

Unit II: Problem Solving – 9 Hours
State-space search, uninformed and informed search strategies, A* algorithm.

Unit III: Knowledge Representation – 9 Hours
Logic-based representation, propositional logic, predicate calculus.

Unit IV: Machine Learning Overview – 9 Hours
Supervised, unsupervised, and reinforcement learning basics.

Unit V: AI in Healthcare – 9 Hours
Expert systems, clinical decision support, and medical image interpretation.

Text / Reference Books

• Russell & Norvig – Artificial Intelligence: A Modern Approach, Pearson.
• Goodfellow, I. – Deep Learning, MIT Press.
• Nilsson, N. – Principles of Artificial Intelligence, Morgan Kaufmann.

AIH404 - Medical Imaging Systems

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand physical principles and instrumentation of major medical imaging modalities.
• Analyze image formation, processing, and enhancement techniques.
• Apply AI and data analytics to medical imaging for diagnostics.

Course Outcomes

CO1: Understand physical principles and instrumentation of major medical imaging modalities.
CO2: Analyze image formation, processing, and enhancement techniques.
CO3: Apply AI and data analytics to medical imaging for diagnostics.

Detailed Syllabus

Unit I: Introduction to Medical Imaging – 9 Hours
Principles of image formation and characteristics of imaging modalities.

Unit II: X-ray and CT Imaging – 9 Hours
X-ray production, detectors, computed tomography principles, reconstruction algorithms.

Unit III: Ultrasound Imaging – 9 Hours
Sound propagation, transducers, Doppler imaging, image artifacts.

Unit IV: MRI and Nuclear Imaging – 9 Hours
Magnetic resonance imaging principles, PET, and SPECT systems.

Unit V: Image Processing & AI Integration – 9 Hours
Preprocessing, segmentation, enhancement, and AI-based diagnosis.

Text / Reference Books

• Bushberg, J. – The Essential Physics of Medical Imaging, Wolters Kluwer.
• Sonka, M. – Image Processing, Analysis, and Machine Vision, Cengage.
• Gonzalez & Woods – Digital Image Processing, Pearson.

AIH405A - Open Elective II (A): Ethics, Law & Policy in Artificial Intelligence

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand ethical and legal challenges associated with AI applications.
• Analyze policies governing AI systems in healthcare and other industries.
• Promote responsible AI development and deployment in healthcare.

Course Outcomes

CO1: Understand ethical and legal challenges associated with AI applications.
CO2: Analyze policies governing AI systems in healthcare and other industries.
CO3: Promote responsible AI development and deployment in healthcare.

Detailed Syllabus

Unit I: AI Ethics Foundations – 9 Hours
Moral reasoning, fairness, accountability, transparency in AI.

Unit II: Privacy and Data Protection – 9 Hours
GDPR, HIPAA, data rights, and privacy-preserving AI techniques.

Unit III: AI and Law – 9 Hours
Intellectual property, liability, and algorithmic accountability.

Unit IV: Policy and Governance – 9 Hours

AI policy frameworks (India, EU, OECD, UNESCO).

Unit V: Ethical AI in Healthcare – 9 Hours
Bias, inclusivity, and clinical safety in AI deployment.

Text / Reference Books

- Cath, C. – Artificial Intelligence and Ethics, Oxford University Press.
- Jobin, A. – Global Landscape of AI Ethics Guidelines, Nature Machine Intelligence.
- UNESCO – Ethics of Artificial Intelligence, UNESCO Report.

AIH405B - Open Elective II (B): Healthcare Technology Management & Innovation

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand healthcare technology lifecycle and management strategies.
- Develop innovation and quality assurance processes for medical devices and systems.
- Implement standards for safety, maintenance, and regulatory compliance.

Course Outcomes

CO1: Understand healthcare technology lifecycle and management strategies.
CO2: Develop innovation and quality assurance processes for medical devices and systems.
CO3: Implement standards for safety, maintenance, and regulatory compliance.

Detailed Syllabus

Unit I: Introduction to Healthcare Technology Management – 9 Hours
Concepts, objectives, and importance of technology management in hospitals.

Unit II: Medical Equipment Lifecycle – 9 Hours
Procurement, installation, calibration, and maintenance planning.

Unit III: Innovation and Design Thinking – 9 Hours
Product ideation, design control, and prototype development.

Unit IV: Regulations and Standards – 9 Hours
FDA, CDSCO, ISO 13485, CE marking, and quality systems.

Unit V: Sustainability and Future Trends – 9 Hours
Green healthcare, digital transformation, and public-private partnerships.

Text / Reference Books

- WHO – Medical Equipment Maintenance Manual, WHO Press.
- Handbook of Healthcare Technology Management, Taylor & Francis.
- ISO 13485 – Quality Management Systems for Medical Devices.

AIH406 - AI Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Implement basic AI algorithms using Python and machine learning libraries.
• Apply AI models to solve healthcare-related problems.

Course Outcomes

CO1: Implement basic AI algorithms using Python and machine learning libraries.
CO2: Apply AI models to solve healthcare-related problems.

Detailed Syllabus

Unit I: AI Environment Setup – 6 Hours
Installation of Python, Jupyter, and AI libraries (NumPy, Scikit-learn).

Unit II: Search Algorithms – 6 Hours
Implementation of DFS, BFS, and A* algorithms.

Unit III: Knowledge Representation – 6 Hours
Implement logic-based reasoning and inference engines.

Unit IV: Machine Learning Applications – 6 Hours
Train models on sample healthcare datasets.

Unit V: Mini Project – 6 Hours
Develop a simple AI-based diagnostic or prediction system.

Text / Reference Books

• Russell & Norvig – Artificial Intelligence: A Modern Approach, Pearson.
• Aurélien Géron – Hands-On Machine Learning, O'Reilly.

AIH407 - Imaging & IoT Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Gain hands-on experience in IoT device setup and data communication.
• Perform basic image processing using AI tools.

Course Outcomes

CO1: Gain hands-on experience in IoT device setup and data communication.
CO2: Perform basic image processing using AI tools.

Detailed Syllabus

Unit I: IoT Setup – 6 Hours
Connecting sensors and transmitting data using IoT protocols.

Unit II: Imaging Experiments – 6 Hours
Acquisition of sample medical images and preprocessing.

Unit III: Cloud Integration – 6 Hours
Sending IoT data to cloud platforms (Firebase, ThingSpeak).

Unit IV: Image Analysis – 6 Hours
Apply filters, edge detection, and segmentation techniques.

Unit V: Mini Project – 6 Hours
Develop prototype integrating imaging and IoT monitoring.

Text / Reference Books

- Raj, P. – Internet of Things: Principles and Paradigms, Elsevier.
- Gonzalez & Woods – Digital Image Processing, Pearson.

AIH408 - Mini Project I

L-T-P: 0-0-2 | Credits: 1 | Total Hours: 15

Course Objectives

- Design and develop a small prototype demonstrating AI or IoT concepts in healthcare.
- Enhance problem-solving and interdisciplinary teamwork skills.

Course Outcomes

CO1: Design and develop a small prototype demonstrating AI or IoT concepts in healthcare.
CO2: Enhance problem-solving and interdisciplinary teamwork skills.

Detailed Syllabus

Unit I: Problem Identification – 3 Hours
Select a relevant healthcare challenge or research topic.

Unit II: System Design – 3 Hours
Develop system architecture, data flow, and UI design.

Unit III: Implementation – 3 Hours
Prototype development using available tools and sensors.

Unit IV: Testing – 3 Hours
Validate and troubleshoot prototype performance.

Unit V: Documentation & Presentation – 3 Hours

Prepare final report and demonstrate the project.

Text / Reference Books

- AICTE Project-Based Learning Guidelines, 2023.
- Relevant IEEE and Springer papers in Healthcare AI.

Integrated B.Tech – M.Tech in AI in Healthcare Technology

Detailed Syllabus – Semester V (20 Credits)

AIH501 - Machine Learning

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the fundamental concepts and algorithms of machine learning.
- Apply supervised and unsupervised learning models to real-world data.
- Develop ML solutions for predictive and diagnostic applications in healthcare.

Course Outcomes

CO1: Understand the fundamental concepts and algorithms of machine learning.
CO2: Apply supervised and unsupervised learning models to real-world data.
CO3: Develop ML solutions for predictive and diagnostic applications in healthcare.

Detailed Syllabus

Unit I: Introduction to Machine Learning – 9 Hours
Definition, types of learning, applications, and ML workflow.

Unit II: Supervised Learning – 9 Hours
Linear regression, logistic regression, decision trees, and random forests.

Unit III: Unsupervised Learning – 9 Hours
K-means clustering, hierarchical clustering, PCA, and dimensionality reduction.

Unit IV: Model Evaluation – 9 Hours
Training/testing splits, cross-validation, confusion matrix, and ROC curves.

Unit V: ML in Healthcare – 9 Hours
Case studies: disease prediction, medical imaging, and patient outcome modeling.

Text / Reference Books

- Tom Mitchell – Machine Learning, McGraw Hill.
- Aurélien Géron – Hands-On Machine Learning with Scikit-Learn, O'Reilly.
- Bishop, C.M. – Pattern Recognition and Machine Learning, Springer.

AIH502 - Healthcare Data Analytics

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand data sources and analytical approaches used in healthcare systems.
• Perform data preprocessing, visualization, and statistical analysis for healthcare datasets.
• Apply data-driven methods for decision-making and performance improvement in healthcare.

Course Outcomes

CO1: Understand data sources and analytical approaches used in healthcare systems.
CO2: Perform data preprocessing, visualization, and statistical analysis for healthcare datasets.
CO3: Apply data-driven methods for decision-making and performance improvement in healthcare.

Detailed Syllabus

Unit I: Healthcare Data Sources – 9 Hours
EHR, claims data, sensor data, and clinical trials data.

Unit II: Data Preprocessing – 9 Hours
Cleaning, integration, transformation, and normalization.

Unit III: Descriptive Analytics – 9 Hours
Descriptive statistics, dashboards, and visual summaries.

Unit IV: Predictive Analytics – 9 Hours
Regression, classification, and time-series forecasting in health contexts.

Unit V: Prescriptive Analytics – 9 Hours
Decision support systems, optimization models, and risk analytics.

Text / Reference Books

• Raghupathi & Raghupathi – Big Data Analytics in Healthcare, Springer.
• Bertino, E. – Health Data Analytics, CRC Press.
• Provost & Fawcett – Data Science for Business, O'Reilly.

AIH503 - Cloud Computing for Health Data

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand cloud computing models and architectures applicable to health data management.
• Implement secure storage, sharing, and processing of health data on cloud platforms.

• Evaluate performance, scalability, and compliance of cloud-based healthcare systems.

Course Outcomes

CO1: Understand cloud computing models and architectures applicable to health data management.
CO2: Implement secure storage, sharing, and processing of health data on cloud platforms.
CO3: Evaluate performance, scalability, and compliance of cloud-based healthcare systems.

Detailed Syllabus

Unit I: Cloud Fundamentals – 9 Hours
Cloud concepts, service models, deployment models, and virtualization.

Unit II: Cloud Architecture – 9 Hours
IaaS, PaaS, SaaS, storage systems, and cloud APIs.

Unit III: Cloud Security – 9 Hours
Encryption, authentication, HIPAA compliance, and access control.

Unit IV: Big Data on Cloud – 9 Hours
Hadoop, Spark, and distributed data processing for healthcare.

Unit V: Cloud in Healthcare – 9 Hours
Case studies of cloud-based EHR and telemedicine systems.

Text / Reference Books

• Rajkumar Buyya – Cloud Computing: Principles and Paradigms, Wiley.
• Thomas Erl – Cloud Computing: Concepts, Technology & Architecture, Pearson.
• Kuo, M.H. – Opportunities and Challenges of Cloud Computing to Improve Health Care Services, Springer.

AIH504 - Medical Ethics, Regulations & Standards

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand ethical issues, laws, and global standards governing healthcare technology.
• Apply regulatory frameworks to ensure safety and compliance of AI and medical devices.
• Develop professional responsibility and accountability in healthcare innovation.

Course Outcomes

CO1: Understand ethical issues, laws, and global standards governing healthcare technology.
CO2: Apply regulatory frameworks to ensure safety and compliance of AI and medical devices.
CO3: Develop professional responsibility and accountability in healthcare innovation.

Detailed Syllabus

Unit I: Introduction to Medical Ethics – 9 Hours
Principles of autonomy, beneficence, non-maleficence, and justice.

Unit II: Healthcare Regulations – 9 Hours
Overview of FDA, CDSCO, and WHO regulations.

Unit III: Standards and Certifications – 9 Hours
ISO 13485, IEC 60601, HL7, FHIR, and DICOM.

Unit IV: Legal Framework – 9 Hours
Patient rights, data privacy, consent, and medical negligence.

Unit V: Ethics in AI and Digital Health – 9 Hours
Bias, transparency, accountability, and global best practices.

Text / Reference Books

- Beauchamp & Childress – Principles of Biomedical Ethics, Oxford University Press.
- WHO – Global Model Regulatory Framework for Medical Devices.
- UNESCO – Ethics of Artificial Intelligence, UNESCO Publication.

AIH505A - Professional Elective I (A): AI in Oncology, Cardiology & Neurology

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand AI techniques for disease detection and prediction in key medical domains.
- Apply ML and DL models to analyze cancer, cardiac, and neurological data.
- Evaluate clinical decision support tools based on AI models.

Course Outcomes

CO1: Understand AI techniques for disease detection and prediction in key medical domains.
CO2: Apply ML and DL models to analyze cancer, cardiac, and neurological data.
CO3: Evaluate clinical decision support tools based on AI models.

Detailed Syllabus

Unit I: AI in Oncology – 9 Hours
Tumor detection, radiomics, histopathology image analysis.

Unit II: AI in Cardiology – 9 Hours
ECG-based arrhythmia classification, heart failure prediction.

Unit III: AI in Neurology – 9 Hours
EEG-based epilepsy detection, Parkinson’s and Alzheimer’s prediction.

Unit IV: Clinical Integration – 9 Hours
AI workflow in hospitals, decision support systems.

Unit V: Challenges & Future Trends – 9 Hours
Explainable AI, ethics, and clinical validation.

Text / Reference Books

• Shamim, H. – Artificial Intelligence in Medicine, Springer.
• Krittanawong, C. – Machine Learning in Cardiovascular Medicine, Elsevier.
• Esteva, A. – Deep Learning in Medical Image Analysis, Nature.

AIH505B - Professional Elective I (B): Wearable Devices & Remote Monitoring Systems

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand principles and design of wearable devices used in healthcare.
• Analyze communication and data acquisition techniques in remote monitoring systems.
• Evaluate the role of IoT and AI integration in continuous patient monitoring.

Course Outcomes

CO1: Understand principles and design of wearable devices used in healthcare.
CO2: Analyze communication and data acquisition techniques in remote monitoring systems.
CO3: Evaluate the role of IoT and AI integration in continuous patient monitoring.

Detailed Syllabus

Unit I: Introduction to Wearables – 9 Hours
Types, sensors, form factors, and healthcare applications.

Unit II: Physiological Signal Measurement – 9 Hours
ECG, SpO_2, temperature, and motion sensing technologies.

Unit III: Wireless Communication – 9 Hours
Bluetooth Low Energy, ZigBee, and NFC for wearables.

Unit IV: Remote Monitoring Systems – 9 Hours
Architecture, data transmission, cloud analytics, and feedback systems.

Unit V: AI Integration – 9 Hours
Predictive analytics, anomaly detection, and patient alerting systems.

Text / Reference Books

• Bonato, P. – Wearable Sensors, Springer.
• Sazonov, E. – Wearable Sensors: Fundamentals, Elsevier.

• WHO – mHealth and Remote Patient Monitoring Guidelines.

AIH506 - Machine Learning Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Implement ML algorithms using Python and relevant libraries.
• Analyze healthcare datasets for prediction and classification tasks.

Course Outcomes

CO1: Implement ML algorithms using Python and relevant libraries.
CO2: Analyze healthcare datasets for prediction and classification tasks.

Detailed Syllabus

Unit I: Linear Regression – 6 Hours
Implement linear and multiple regression using Python.

Unit II: Classification Models – 6 Hours
Train and test classification models (KNN, Decision Tree, SVM).

Unit III: Clustering – 6 Hours
Perform K-means and hierarchical clustering on patient data.

Unit IV: Model Evaluation – 6 Hours
Evaluate models using accuracy, precision, recall, and F1-score.

Unit V: Mini Project – 6 Hours
Develop ML-based health prediction or diagnosis project.

Text / Reference Books

• Aurélien Géron – Hands-On Machine Learning, O'Reilly.
• Python ML Documentation – Scikit-Learn & TensorFlow.

AIH507 - Healthcare Data Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Perform data cleaning, visualization, and analysis using real healthcare datasets.
• Use analytics tools like Python, Power BI, and Tableau for data insights.

Course Outcomes

CO1: Perform data cleaning, visualization, and analysis using real healthcare datasets.
CO2: Use analytics tools like Python, Power BI, and Tableau for data insights.

Detailed Syllabus

Unit I: Data Preprocessing – 6 Hours
Handle missing values, outliers, and normalization.

Unit II: Visualization – 6 Hours
Create plots using Python/Power BI/Tableau.

Unit III: Predictive Analytics – 6 Hours
Apply ML models to healthcare data.

Unit IV: Report Generation – 6 Hours
Generate dashboards and analytical reports.

Unit V: Mini Project – 6 Hours
Develop visualization for clinical or hospital dataset.

Text / Reference Books

• Sharma, P. – Healthcare Data Analytics, CRC Press.
• Power BI and Tableau User Manuals.

AIH508 - Minor Project II (AI for Clinical Dataset)

L-T-P: 0-0-2 | Credits: 1 | Total Hours: 15

Course Objectives

• Apply AI algorithms on real or simulated clinical datasets.
• Enhance project development, teamwork, and research documentation skills.

Course Outcomes

CO1: Apply AI algorithms on real or simulated clinical datasets.
CO2: Enhance project development, teamwork, and research documentation skills.

Detailed Syllabus

Unit I: Problem Identification – 3 Hours
Select a problem and define objectives.

Unit II: Data Collection – 3 Hours
Acquire and preprocess clinical datasets.

Unit III: Model Development – 3 Hours
Implement suitable AI/ML model.

Unit IV: Validation – 3 Hours
Analyze results and performance metrics.

Unit V: Report & Presentation – 3 Hours

Prepare report and present findings.

Text / Reference Books

- AICTE Project Guidelines, 2023.
- IEEE Access Journal – Healthcare AI Projects.

Integrated B.Tech – M.Tech in AI in Healthcare Technology
Detailed Syllabus – Semester VI (20 Credits)

AIH601 - Deep Learning

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the architectures and algorithms of deep learning models.
- Implement neural network models for image and text-based data in healthcare.
- Apply deep learning for diagnostics and predictive analytics.

Course Outcomes

CO1: Understand the architectures and algorithms of deep learning models.
CO2: Implement neural network models for image and text-based data in healthcare.
CO3: Apply deep learning for diagnostics and predictive analytics.

Detailed Syllabus

Unit I: Introduction to Neural Networks – 9 Hours
Perceptrons, activation functions, gradient descent, backpropagation.

Unit II: Deep Architectures – 9 Hours
ANNs, CNNs, RNNs, autoencoders, and transfer learning.

Unit III: Training and Optimization – 9 Hours
Batch normalization, dropout, hyperparameter tuning, optimizers.

Unit IV: Deep Learning Frameworks – 9 Hours
TensorFlow, Keras, and PyTorch for healthcare datasets.

Unit V: Applications in Healthcare – 9 Hours
Medical imaging, genomics, and diagnostic predictions using deep networks.

Text / Reference Books

- Goodfellow, I. – Deep Learning, MIT Press.
- Chollet, F. – Deep Learning with Python, Manning.
- Geron, A. – Hands-On Machine Learning, O'Reilly.

AIH602 - Natural Language Processing in Healthcare

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the fundamentals of NLP techniques and language models.
• Apply NLP methods to extract meaningful insights from medical texts and clinical notes.
• Develop AI systems for information retrieval, summarization, and sentiment analysis in healthcare.

Course Outcomes

CO1: Understand the fundamentals of NLP techniques and language models.
CO2: Apply NLP methods to extract meaningful insights from medical texts and clinical notes.
CO3: Develop AI systems for information retrieval, summarization, and sentiment analysis in healthcare.

Detailed Syllabus

Unit I: Introduction to NLP – 9 Hours
Text processing, tokenization, stemming, lemmatization, POS tagging.

Unit II: Feature Extraction – 9 Hours
Bag of words, TF-IDF, word embeddings (Word2Vec, GloVe).

Unit III: Language Models – 9 Hours
n-grams, RNN, LSTM, GRU, and transformer-based models (BERT, GPT).

Unit IV: Applications in Healthcare – 9 Hours
Named entity recognition, clinical report extraction, chatbot design.

Unit V: Ethical Considerations – 9 Hours
Bias, privacy, data confidentiality, and responsible AI in NLP.

Text / Reference Books

• Jurafsky, D. & Martin, J.H. – Speech and Language Processing, Pearson.
• Bird, S. – Natural Language Processing with Python, O'Reilly.
• Lee, J. – Clinical NLP for Healthcare Applications, Springer.

AIH603 - Digital Health & Telemedicine

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the structure, technologies, and regulations governing digital health and telemedicine.
• Implement digital health systems for remote patient care and monitoring.

• Analyze data transmission, security, and clinical workflow integration in telemedicine.

Course Outcomes
CO1: Understand the structure, technologies, and regulations governing digital health and telemedicine.
CO2: Implement digital health systems for remote patient care and monitoring.
CO3: Analyze data transmission, security, and clinical workflow integration in telemedicine.

Detailed Syllabus

Unit I: Introduction to Digital Health – 9 Hours
Overview, ecosystem, benefits, and applications.

Unit II: Telemedicine Technologies – 9 Hours
Communication tools, video conferencing, and remote diagnosis systems.

Unit III: Data Standards & Protocols – 9 Hours
HL7, FHIR, DICOM, and secure data transmission standards.

Unit IV: Regulations and Ethics – 9 Hours
Telemedicine Practice Guidelines (MoHFW, India), licensing, patient consent.

Unit V: AI Integration – 9 Hours
AI-based triage, chatbot systems, and predictive monitoring.

Text / Reference Books
• WHO – Telemedicine: Opportunities and Developments, WHO Publication.
• Hoyt, R.E. – Health Informatics: Practical Guide, Informatics Education.
• Tuckson, R. – Telehealth, NEJM Catalyst.

AIH604 - Biosignal Processing (ECG, EEG, EMG)
L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives
• Understand the fundamentals of biosignal acquisition and analysis.
• Apply digital signal processing techniques to physiological signals.
• Extract features from biosignals for diagnosis and monitoring.

Course Outcomes
CO1: Understand the fundamentals of biosignal acquisition and analysis.
CO2: Apply digital signal processing techniques to physiological signals.
CO3: Extract features from biosignals for diagnosis and monitoring.

Detailed Syllabus

Unit I: Introduction to Biosignals – 9 Hours
Sources, types, and characteristics of biosignals.

Unit II: Signal Acquisition – 9 Hours
ECG, EEG, EMG recording, electrodes, and amplifiers.

Unit III: Signal Processing – 9 Hours
Filtering, FFT, noise removal, and spectral analysis.

Unit IV: Feature Extraction – 9 Hours
Time and frequency domain features, wavelet transforms.

Unit V: Applications – 9 Hours
AI-assisted signal classification and diagnosis systems.

Text / Reference Books

• Rangayyan, R.M. – Biomedical Signal Analysis, Wiley.
• Acharya, U.R. – Advances in Biomedical Signal and Image Analysis, Elsevier.
• Clifford, G.D. – Advanced Methods and Tools for ECG Data Analysis, Artech House.

AIH605A - Professional Elective II (A): AR/VR in Medical Training & Surgery

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the concepts and applications of augmented and virtual reality in healthcare.
• Design immersive simulations for medical training and surgical planning.
• Analyze hardware and software frameworks for AR/VR deployment.

Course Outcomes

CO1: Understand the concepts and applications of augmented and virtual reality in healthcare.
CO2: Design immersive simulations for medical training and surgical planning.
CO3: Analyze hardware and software frameworks for AR/VR deployment.

Detailed Syllabus

Unit I: Introduction to AR/VR – 9 Hours
Definitions, history, and hardware components of AR/VR systems.

Unit II: Software Development – 9 Hours
Unity, Unreal Engine, and SDKs for AR/VR content creation.

Unit III: Applications in Medicine – 9 Hours
Surgical simulation, anatomy visualization, and rehabilitation training.

Unit IV: Human Factors & Evaluation – 9 Hours
User experience, haptic feedback, and performance assessment.

Unit V: Future of AR/VR in Healthcare – 9 Hours
Integration with AI, robotics, and digital twins.

Text / Reference Books

• Burdea, G. & Coiffet, P. – Virtual Reality Technology, Wiley.
• John, N.W. – Virtual Reality in Medicine, Springer.
• WHO – Extended Reality in Healthcare, WHO Report 2022.

AIH605B - Professional Elective II (B): Predictive Analytics for Public Health

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand statistical and ML techniques for predictive modeling in public health.
• Analyze large-scale health datasets to identify patterns and trends.
• Develop data-driven solutions for disease prevention and resource optimization.

Course Outcomes

CO1: Understand statistical and ML techniques for predictive modeling in public health.
CO2: Analyze large-scale health datasets to identify patterns and trends.
CO3: Develop data-driven solutions for disease prevention and resource optimization.

Detailed Syllabus

Unit I: Introduction to Public Health Analytics – 9 Hours
Overview of epidemiology, surveillance data, and predictive analytics.

Unit II: Data Sources & Preprocessing – 9 Hours
Population health datasets, cleaning, and feature engineering.

Unit III: Predictive Modeling – 9 Hours
Regression, decision trees, and ensemble models for health outcomes.

Unit IV: Geospatial Analytics – 9 Hours
GIS-based analysis and visualization for outbreak prediction.

Unit V: Decision Support – 9 Hours
Policy modeling, optimization, and early-warning systems.

Text / Reference Books

• Khoury, M.J. – Big Data and Public Health, Elsevier.
• Sharma, P. – Healthcare Data Analytics, CRC Press.
• Blei, D. – Probabilistic Models in Public Health, Nature.

AIH606 - Deep Learning Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Implement deep learning models using TensorFlow and PyTorch.

• Apply neural networks to medical imaging and biomedical datasets.

Course Outcomes

CO1: Implement deep learning models using TensorFlow and PyTorch.
CO2: Apply neural networks to medical imaging and biomedical datasets.

Detailed Syllabus

Unit I: ANN Implementation – 6 Hours
Develop simple neural networks using Python and Keras.

Unit II: CNN for Imaging – 6 Hours
Build CNNs for image classification and segmentation.

Unit III: RNN for Sequential Data – 6 Hours
Implement LSTM/GRU models for time-series health data.

Unit IV: Transfer Learning – 6 Hours
Apply pre-trained models (VGG, ResNet) to healthcare datasets.

Unit V: Mini Project – 6 Hours
Develop deep learning model for diagnostic application.

Text / Reference Books

• Chollet, F. – Deep Learning with Python, Manning.
• TensorFlow and PyTorch Documentation.

AIH607 - Biosignal Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Record and analyze biosignals using sensors and signal processing tools.
• Develop algorithms for noise reduction and feature extraction.

Course Outcomes

CO1: Record and analyze biosignals using sensors and signal processing tools.
CO2: Develop algorithms for noise reduction and feature extraction.

Detailed Syllabus

Unit I: Signal Acquisition – 6 Hours
Setup biosignal sensors and acquire data (ECG, EEG).

Unit II: Preprocessing – 6 Hours
Remove noise using digital filters.

Unit III: Feature Extraction – 6 Hours
Compute features like RMS, entropy, and spectral components.

Unit IV: Classification – 6 Hours
Implement ML models for signal classification.

Unit V: Mini Project – 6 Hours
Analyze dataset and develop classification model for clinical data.

Text / Reference Books

• Rangayyan, R.M. – Biomedical Signal Analysis, Wiley.
• MATLAB / Python Signal Processing Libraries.

AIH608 - Innovation Lab / Prototype Development

L-T-P: 0-0-2 | Credits: 1 | Total Hours: 15

Course Objectives

• Encourage creative design thinking and innovation in healthcare technology.
• Develop prototype models integrating AI, IoT, and biomedical systems.

Course Outcomes

CO1: Encourage creative design thinking and innovation in healthcare technology.
CO2: Develop prototype models integrating AI, IoT, and biomedical systems.

Detailed Syllabus

Unit I: Idea Generation – 3 Hours
Identify healthcare problems requiring technology solutions.

Unit II: Concept Design – 3 Hours
Design sketches and system architecture.

Unit III: Prototyping – 3 Hours
Develop hardware/software prototype.

Unit IV: Testing – 3 Hours
Validate prototype performance and refine design.

Unit V: Presentation – 3 Hours
Prepare final demo and report.

Text / Reference Books

• AICTE Innovation Cell Handbook (2023).
• Design Thinking for Innovation – Stanford d.school.

Integrated B.Tech – M.Tech in AI in Healthcare Technology
Detailed Syllabus – Semester VII (20 Credits)

AIH701 - AI in Medical Imaging (Radiology, Pathology, Ophthalmology)
L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives
• Understand AI methods applied to radiology, pathology, and ophthalmology imaging.
• Analyze and interpret medical images using deep learning and computer vision techniques.
• Implement AI pipelines for diagnostic support in healthcare systems.

Course Outcomes
CO1: Understand AI methods applied to radiology, pathology, and ophthalmology imaging.
CO2: Analyze and interpret medical images using deep learning and computer vision techniques.
CO3: Implement AI pipelines for diagnostic support in healthcare systems.

Detailed Syllabus

Unit I: Introduction to Medical Imaging AI – 9 Hours
Imaging modalities, image datasets, and AI fundamentals in imaging.

Unit II: Image Processing Techniques – 9 Hours
Preprocessing, enhancement, segmentation, and feature extraction.

Unit III: Deep Learning in Imaging – 9 Hours
CNNs, U-Net, and transfer learning models for medical image analysis.

Unit IV: Applications – 9 Hours
AI for tumor detection, retinal scan analysis, and digital pathology.

Unit V: Regulatory & Ethical Aspects – 9 Hours
Dataset privacy, bias, interpretability, and clinical validation.

Text / Reference Books
• Esteva, A. – Deep Learning in Medical Image Analysis, Nature.
• Lakhani, P. – AI for Radiology, Springer.
• Gonzalez & Woods – Digital Image Processing, Pearson.

AIH702 - Robotics in Surgery & Rehabilitation
L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives
- Understand the design and working of robotic systems used in surgery and rehabilitation.
- Analyze the control and kinematics of surgical and assistive robots.
- Evaluate safety, ethics, and human-robot interaction in medical robotics.

Course Outcomes
CO1: Understand the design and working of robotic systems used in surgery and rehabilitation.
CO2: Analyze the control and kinematics of surgical and assistive robots.
CO3: Evaluate safety, ethics, and human-robot interaction in medical robotics.

Detailed Syllabus

Unit I: Introduction to Medical Robotics – 9 Hours
History, types, and classification of medical robots.

Unit II: Robotic Components – 9 Hours
Sensors, actuators, control systems, and end effectors.

Unit III: Kinematics & Control – 9 Hours
Forward and inverse kinematics, trajectory planning, control algorithms.

Unit IV: Surgical & Rehabilitation Robots – 9 Hours
Da Vinci system, exoskeletons, and robotic prosthetics.

Unit V: Ethics & Future Directions – 9 Hours
Safety, tele-surgery, and AI integration.

Text / Reference Books
- Taylor, R.H. – Medical Robotics and Computer-Integrated Surgery, MIT Press.
- Menciassi, A. – Robotics in Surgery, Springer.
- Aracil, R. – Advances in Medical Robotics, Springer.

AIH703 - Reinforcement Learning for Healthcare Systems
L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives
- Understand reinforcement learning (RL) principles and algorithms.
- Apply RL models for decision-making and adaptive control in healthcare.
- Develop policy-based learning systems for patient treatment and hospital management.

Course Outcomes
CO1: Understand reinforcement learning (RL) principles and algorithms.
CO2: Apply RL models for decision-making and adaptive control in healthcare.
CO3: Develop policy-based learning systems for patient treatment and hospital management.

Detailed Syllabus

Unit I: Basics of Reinforcement Learning – 9 Hours
Markov decision processes, reward systems, and exploration vs exploitation.

Unit II: Dynamic Programming – 9 Hours
Value iteration, policy iteration, and Bellman equations.

Unit III: Model-Free RL – 9 Hours
Monte Carlo, temporal-difference learning, Q-learning, and SARSA.

Unit IV: Deep Reinforcement Learning – 9 Hours
DQN, actor-critic, policy gradients, and applications.

Unit V: RL in Healthcare – 9 Hours
AI-assisted treatment optimization, resource allocation, and ICU management.

Text / Reference Books

• Sutton & Barto – Reinforcement Learning: An Introduction, MIT Press.
• Chandak, Y. – Deep Reinforcement Learning for Healthcare, IEEE.
• Silver, D. – Mastering Reinforcement Learning, DeepMind.

AIH704A - Professional Elective III (A): AI for Genomics & Precision Medicine

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand genomics data structures and computational analysis techniques.
• Apply AI algorithms for gene sequencing, variant detection, and personalized therapy.
• Integrate genomics insights for precision medicine and targeted treatment planning.

Course Outcomes

CO1: Understand genomics data structures and computational analysis techniques.
CO2: Apply AI algorithms for gene sequencing, variant detection, and personalized therapy.
CO3: Integrate genomics insights for precision medicine and targeted treatment planning.

Detailed Syllabus

Unit I: Introduction to Genomics – 9 Hours
DNA sequencing, genome mapping, and omics data sources.

Unit II: Bioinformatics & Data Analysis – 9 Hours
Sequence alignment, BLAST, FASTA, and feature extraction.

Unit III: AI in Genomics – 9 Hours
Deep learning for gene prediction, mutation analysis, and drug design.

Unit IV: Precision Medicine – 9 Hours

Patient stratification, biomarker discovery, and pharmacogenomics.

Unit V: Ethical & Regulatory Aspects – 9 Hours
Data privacy, clinical validation, and consent in genomic research.

Text / Reference Books

• Mount, D.W. – Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Press.
• Lesk, A. – Introduction to Bioinformatics, Oxford University Press.
• Kourou, K. – Machine Learning in Precision Medicine, Elsevier.

AIH704B - Professional Elective III (B): Digital Twins in Healthcare

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the concept of digital twins and their application in healthcare systems.
• Develop virtual models for patient monitoring and hospital management.
• Analyze integration of IoT, AI, and simulation technologies in digital twin frameworks.

Course Outcomes

CO1: Understand the concept of digital twins and their application in healthcare systems.
CO2: Develop virtual models for patient monitoring and hospital management.
CO3: Analyze integration of IoT, AI, and simulation technologies in digital twin frameworks.

Detailed Syllabus

Unit I: Introduction to Digital Twins – 9 Hours
Concepts, architecture, and lifecycle of digital twins.

Unit II: Data Acquisition & Modeling – 9 Hours
Data sources, IoT connectivity, simulation tools, and model calibration.

Unit III: AI-Driven Twins – 9 Hours
Predictive analytics, machine learning integration, and anomaly detection.

Unit IV: Applications – 9 Hours
Patient-specific simulations, hospital asset management, and remote care.

Unit V: Challenges & Future Trends – 9 Hours
Interoperability, scalability, privacy, and ethical issues.

Text / Reference Books

• Grieves, M. – Digital Twin: Manufacturing Excellence through Virtual Factory Replication, Springer.
• Negri, E. – Digital Twin for Healthcare, Elsevier.
• Raj, P. – Digital Twin Technologies, CRC Press.

AIH705A - Open Elective III (A): Bioethics & Health Policy

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand ethical issues, social implications, and policy frameworks in healthcare.
• Evaluate case studies involving bioethics and public health policies.
• Apply ethical reasoning to clinical and technological decision-making.

Course Outcomes

CO1: Understand ethical issues, social implications, and policy frameworks in healthcare.
CO2: Evaluate case studies involving bioethics and public health policies.
CO3: Apply ethical reasoning to clinical and technological decision-making.

Detailed Syllabus

Unit I: Foundations of Bioethics – 9 Hours
Principles, theories, and values in biomedical ethics.

Unit II: Ethical Issues in Clinical Practice – 9 Hours
Consent, confidentiality, end-of-life decisions, and clinical trials.

Unit III: Public Health Policy – 9 Hours
Health policy formulation, regulation, and implementation frameworks.

Unit IV: Global Health Ethics – 9 Hours
Equity, justice, and access to healthcare in global contexts.

Unit V: Technology & Ethics – 9 Hours
AI ethics, data governance, and digital health policy.

Text / Reference Books

• Beauchamp & Childress – Principles of Biomedical Ethics, Oxford University Press.
• WHO – Global Health Ethics, WHO Publications.
• Annas, G.J. – American Bioethics, Oxford University Press.

AIH705B - Open Elective III (B): Entrepreneurship in Healthcare Technology

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand entrepreneurial processes and innovation management in healthcare technology.
• Develop business plans for MedTech and AI-driven healthcare startups.
• Apply financial, legal, and regulatory principles for healthcare entrepreneurship.

Course Outcomes

CO1: Understand entrepreneurial processes and innovation management in healthcare technology.
CO2: Develop business plans for MedTech and AI-driven healthcare startups.
CO3: Apply financial, legal, and regulatory principles for healthcare entrepreneurship.

Detailed Syllabus

Unit I: Introduction to Entrepreneurship – 9 Hours
Entrepreneurial mindset, innovation, and opportunity identification.

Unit II: Healthcare Technology Landscape – 9 Hours
MedTech trends, AI startups, and funding ecosystem.

Unit III: Business Model Development – 9 Hours
Value proposition, revenue streams, and business planning.

Unit IV: Regulations & Compliance – 9 Hours
Legal requirements, certifications, and IP management.

Unit V: Case Studies – 9 Hours
Successful healthcare startups and lessons for entrepreneurs.

Text / Reference Books

- Hisrich, R. – Entrepreneurship, McGraw Hill.
- Christensen, C. – The Innovator's Prescription, Harvard Press.
- WHO – Health Innovation and Entrepreneurship Guidelines.

AIH706 - Healthcare AI Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

- Implement AI models for various healthcare datasets.
- Develop integrated AI pipelines for imaging, signal, and text-based data.

Course Outcomes

CO1: Implement AI models for various healthcare datasets.
CO2: Develop integrated AI pipelines for imaging, signal, and text-based data.

Detailed Syllabus

Unit I: Data Preprocessing – 6 Hours
Prepare and normalize healthcare datasets.

Unit II: Model Implementation – 6 Hours
Train CNN, RNN, or hybrid models on multimodal data.

Unit III: Integration – 6 Hours
Combine AI modules for decision support.

Unit IV: Evaluation – 6 Hours
Test model accuracy, sensitivity, and specificity.

Unit V: Mini Project – 6 Hours
Develop healthcare AI system for clinical decision support.

Text / Reference Books

• Aurélien Géron – Hands-On Machine Learning, O'Reilly.
• TensorFlow & PyTorch Documentation.

AIH707 - Seminar / Technical Writing

L-T-P: 0-2-0 | Credits: 2 | Total Hours: 30

Course Objectives

• Develop research and technical writing skills for academic and industry settings.
• Deliver presentations and reports on current trends in healthcare AI.

Course Outcomes

CO1: Develop research and technical writing skills for academic and industry settings.
CO2: Deliver presentations and reports on current trends in healthcare AI.

Detailed Syllabus

Unit I: Topic Selection – 6 Hours
Identify emerging topics in AI and healthcare.

Unit II: Literature Review – 6 Hours
Survey scholarly papers and technical reports.

Unit III: Paper Writing – 6 Hours
Structure, formatting, referencing (IEEE/APA styles).

Unit IV: Presentation – 6 Hours
Create slides and present findings.

Unit V: Peer Review – 6 Hours
Evaluate and refine papers based on feedback.

Text / Reference Books

• Katz, M.J. – From Research to Manuscript, Springer.
• Day, R. – How to Write and Publish a Scientific Paper, Cambridge University Press.

AIH708 - Mini Project III (Clinical AI Pilot Project)

L-T-P: 0-0-2 | Credits: 1 | Total Hours: 15

Course Objectives

• Design and develop a pilot AI model for a clinical problem.
• Integrate data from imaging, signal, or text for proof-of-concept validation.

Course Outcomes

CO1: Design and develop a pilot AI model for a clinical problem.
CO2: Integrate data from imaging, signal, or text for proof-of-concept validation.

Detailed Syllabus

Unit I: Problem Definition – 3 Hours
Identify clinical challenge and define objectives.

Unit II: Data Collection – 3 Hours
Gather and preprocess relevant datasets.

Unit III: Model Development – 3 Hours
Design, implement, and train an AI model.

Unit IV: Testing & Validation – 3 Hours
Evaluate model performance on test data.

Unit V: Documentation – 3 Hours
Prepare final report and presentation.

Text / Reference Books

• AICTE Project-Based Learning Guidelines, 2023.
• IEEE Access – Healthcare AI Applications Journal.

Integrated B.Tech – M.Tech in AI in Healthcare Technology

Detailed Syllabus – Semester VIII (20 Credits)

AIH801 - Advanced Healthcare Systems & Hospital Management

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the design and functioning of modern healthcare systems and hospitals.
• Apply management principles for healthcare operations, quality assurance, and innovation.
• Analyze case studies on smart hospitals and digital transformation in healthcare.

Course Outcomes

CO1: Understand the design and functioning of modern healthcare systems and hospitals.
CO2: Apply management principles for healthcare operations, quality assurance, and innovation.
CO3: Analyze case studies on smart hospitals and digital transformation in healthcare.

Detailed Syllabus

Unit I: Healthcare System Overview – 9 Hours
Structure, functions, and organization of healthcare delivery systems.

Unit II: Hospital Administration – 9 Hours
Roles of management, HR, finance, and materials management in hospitals.

Unit III: Quality and Accreditation – 9 Hours
NABH, JCI, ISO standards, and continuous quality improvement.

Unit IV: Smart Hospital Systems – 9 Hours
IoT, automation, digital health records, and AI in hospital management.

Unit V: Case Studies – 9 Hours
Best practices in hospital operations and future trends in healthcare.

Text / Reference Books

- WHO – Health Systems Framework, WHO Publications.
- Sakharkar, B.M. – Principles of Hospital Administration and Planning, Jaypee Brothers.
- Hoyt, R.E. – Health Informatics: Practical Guide, Informatics Education.

AIH802 - Cybersecurity & Privacy in Health Data

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand cybersecurity principles, threats, and defense mechanisms in healthcare systems.
- Implement strategies to protect sensitive health data and ensure regulatory compliance.
- Analyze security challenges in cloud and IoT-based healthcare applications.

Course Outcomes

CO1: Understand cybersecurity principles, threats, and defense mechanisms in healthcare systems.
CO2: Implement strategies to protect sensitive health data and ensure regulatory compliance.
CO3: Analyze security challenges in cloud and IoT-based healthcare applications.

Detailed Syllabus

Unit I: Introduction to Cybersecurity – 9 Hours
Basic concepts, CIA triad, and types of cyber threats in healthcare.

Unit II: Data Protection Mechanisms – 9 Hours
Encryption, access control, authentication, and key management.

Unit III: Network & Cloud Security – 9 Hours
Firewalls, intrusion detection, VPNs, and cloud data protection.

Unit IV: Privacy & Compliance – 9 Hours
HIPAA, GDPR, and Indian health data protection regulations.

Unit V: Emerging Challenges – 9 Hours
Blockchain, AI security, and privacy-preserving machine learning.

Text / Reference Books

- Pfleeger, C.P. – Security in Computing, Pearson.
- Sari, A. – Cybersecurity for eHealth, Springer.
- HIPAA Security Rule – U.S. Department of Health & Human Services.

AIH803A - Professional Elective IV (A): AI-Driven Drug Discovery & Personalized Therapy

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the application of AI in drug design, discovery, and development.
- Use computational models for molecular analysis and personalized therapy design.
- Explore the integration of AI, genomics, and pharmacology for precision medicine.

Course Outcomes

CO1: Understand the application of AI in drug design, discovery, and development.
CO2: Use computational models for molecular analysis and personalized therapy design.
CO3: Explore the integration of AI, genomics, and pharmacology for precision medicine.

Detailed Syllabus

Unit I: Drug Discovery Pipeline – 9 Hours
Stages of drug discovery and clinical development process.

Unit II: Computational Drug Design – 9 Hours
Molecular docking, QSAR models, and virtual screening.

Unit III: AI in Drug Discovery – 9 Hours
Machine learning for molecular property prediction and target identification.

Unit IV: Personalized Medicine – 9 Hours
Pharmacogenomics, biomarkers, and patient-specific therapies.

Unit V: Ethics & Regulations – 9 Hours

FDA, CDSCO approvals, and bioethics in drug research.

Text / Reference Books

• Vamathevan, J. – Applications of Machine Learning in Drug Discovery, Nature Reviews.
• Zhavoronkov, A. – Artificial Intelligence in Drug Discovery, Springer.
• Leelananda, S. – Computational Drug Discovery, Wiley.

AIH803B - Professional Elective IV (B): Blockchain in Digital Health Systems

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the fundamentals of blockchain technology and its healthcare applications.
• Design blockchain-based systems for secure and transparent health data exchange.
• Evaluate blockchain architectures for interoperability and data integrity in health informatics.

Course Outcomes

CO1: Understand the fundamentals of blockchain technology and its healthcare applications.
CO2: Design blockchain-based systems for secure and transparent health data exchange.
CO3: Evaluate blockchain architectures for interoperability and data integrity in health informatics.

Detailed Syllabus

Unit I: Introduction to Blockchain – 9 Hours
Concepts of decentralization, distributed ledger, and cryptographic principles.

Unit II: Blockchain Architecture – 9 Hours
Blocks, transactions, consensus algorithms, and smart contracts.

Unit III: Blockchain in Healthcare – 9 Hours
Data sharing, patient consent management, and supply chain transparency.

Unit IV: Integration & Interoperability – 9 Hours
Integration with EHRs, IoT, and AI platforms.

Unit V: Challenges & Future Scope – 9 Hours
Scalability, security, and global healthcare blockchain frameworks.

Text / Reference Books

• Zhang, P. – Blockchain for Healthcare, Springer.
• Dimitrov, D. – Blockchain Applications for Health Care, Frontiers in Blockchain.
• Swan, M. – Blockchain: Blueprint for a New Economy, O'Reilly.

AIH804 - Comprehensive Viva / Qualifying Exam

L-T-P: 0-2-0 | Credits: 2 | Total Hours: 30

Course Objectives

- Assess holistic understanding of core and elective subjects across all semesters.
- Evaluate analytical and communication skills through viva and written examination.
- Prepare students for final year research and M.Tech phase.

Course Outcomes

CO1: Assess holistic understanding of core and elective subjects across all semesters.
CO2: Evaluate analytical and communication skills through viva and written examination.
CO3: Prepare students for final year research and M.Tech phase.

Detailed Syllabus

Unit I: Preparation – 6 Hours
Revision of core subjects and review of research topics.

Unit II: Exam Components – 6 Hours
Written test, oral viva, and problem-solving.

Unit III: Presentation – 6 Hours
Presentation of mini projects or case studies.

Unit IV: Evaluation – 6 Hours
Assessment by internal and external examiners.

Unit V: Feedback & Reflection – 6 Hours
Discuss performance and plan for M.Tech phase.

Text / Reference Books

- Institutional Evaluation Handbook, AICTE Guidelines 2023.
- University Viva Assessment Rubrics.

AIH805 - Major Project – I (Capstone: AI-Healthcare Solution)

L-T-P: 0-0-18 | Credits: 9 | Total Hours: 135

Course Objectives

- Integrate multidisciplinary knowledge to develop an AI-enabled healthcare system or solution.
- Enhance problem-solving, research, and innovation skills through a capstone project.
- Demonstrate teamwork, design thinking, and technical presentation abilities.

Course Outcomes

CO1: Integrate multidisciplinary knowledge to develop an AI-enabled healthcare system or solution.
CO2: Enhance problem-solving, research, and innovation skills through a capstone project.
CO3: Demonstrate teamwork, design thinking, and technical presentation abilities.

Detailed Syllabus

Unit I: Problem Definition & Literature Review – 27 Hours
Identify healthcare challenges, review literature, and finalize problem statement.

Unit II: System Design & Planning – 27 Hours
Architecture design, technology stack selection, and workflow development.

Unit III: Implementation – 27 Hours
Coding, model training, data integration, and system testing.

Unit IV: Evaluation & Documentation – 27 Hours
Performance validation, error analysis, and project documentation.

Unit V: Presentation & Review – 27 Hours
Demonstrate prototype, submit report, and participate in viva.

Text / Reference Books

• AICTE Final Year Project Manual (2023).
• Relevant IEEE & Springer Healthcare AI Research Papers.

Integrated B.Tech – M.Tech in AI in Healthcare Technology

Detailed Syllabus – Semester IX (20 Credits)

AIH901 - Advanced Topics in AI for Healthcare (Precision Medicine, Genomics AI)

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Explore emerging AI techniques for genomics, precision medicine, and predictive analytics.
• Apply machine learning and deep learning methods to high-dimensional biomedical data.
• Understand clinical implications and challenges in implementing advanced AI models.

Course Outcomes

CO1: Explore emerging AI techniques for genomics, precision medicine, and predictive analytics.
CO2: Apply machine learning and deep learning methods to high-dimensional biomedical data.
CO3: Understand clinical implications and challenges in implementing advanced AI models.

Detailed Syllabus

Unit I: Overview of Advanced AI Models – 9 Hours
Transformers, graph neural networks, and generative AI for healthcare.

Unit II: Genomics AI – 9 Hours
Sequence modeling, variant prediction, and genome annotation using AI.

Unit III: Precision Medicine – 9 Hours
Integration of omics, EHR, and lifestyle data for personalized treatments.

Unit IV: AI for Drug Design – 9 Hours
Molecular property prediction, drug repurposing, and simulation models.

Unit V: Challenges and Future Trends – 9 Hours
Explainability, regulation, and integration of clinical AI in hospitals.

Text / Reference Books

• Topol, E. – Deep Medicine: How AI Can Make Healthcare Human Again, Basic Books.
• Goodfellow, I. – Deep Learning, MIT Press.
• Kourou, K. – Machine Learning Applications in Precision Medicine, Elsevier.

AIH902 - AI-Driven Drug Discovery & Personalized Therapy

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand computational and AI-based methods for modern drug discovery.
• Apply AI algorithms in predicting drug efficacy and designing patient-specific treatments.
• Evaluate case studies of AI-driven innovations in pharmaceutical development.

Course Outcomes

CO1: Understand computational and AI-based methods for modern drug discovery.
CO2: Apply AI algorithms in predicting drug efficacy and designing patient-specific treatments.
CO3: Evaluate case studies of AI-driven innovations in pharmaceutical development.

Detailed Syllabus

Unit I: Drug Discovery Framework – 9 Hours
Overview of drug design, virtual screening, and compound optimization.

Unit II: AI Algorithms for Drug Discovery – 9 Hours
Deep learning in molecular docking, QSAR models, and chemical property prediction.

Unit III: Personalized Therapy – 9 Hours
Pharmacogenomics, biomarker discovery, and clinical data integration.

Unit IV: AI Applications – 9 Hours
Case studies in oncology, neurology, and infectious diseases.

Unit V: Ethical & Regulatory Aspects – 9 Hours
Data governance, reproducibility, and global drug regulation.

Text / Reference Books

• Zhavoronkov, A. – Artificial Intelligence in Drug Discovery, Springer.
• Vamathevan, J. – Applications of Machine Learning in Drug Discovery, Nature Reviews.
• Leelananda, S. – Computational Drug Discovery, Wiley.

AIH903 - Research Methodology & Paper Writing

L-T-P: 1-1-0 | Credits: 2 | Total Hours: 30

Course Objectives

• Understand research design, methodology, and ethics for scientific inquiry.
• Develop skills in academic writing, referencing, and publication processes.
• Apply statistical and analytical tools for data interpretation in healthcare AI.

Course Outcomes

CO1: Understand research design, methodology, and ethics for scientific inquiry.
CO2: Develop skills in academic writing, referencing, and publication processes.
CO3: Apply statistical and analytical tools for data interpretation in healthcare AI.

Detailed Syllabus

Unit I: Introduction to Research – 6 Hours
Meaning, objectives, types, and significance of research.

Unit II: Research Design – 6 Hours
Formulating hypotheses, variables, and sampling techniques.

Unit III: Data Collection & Analysis – 6 Hours
Primary and secondary data, statistical analysis using software tools.

Unit IV: Research Ethics – 6 Hours
Plagiarism, informed consent, and responsible research conduct.

Unit V: Technical Writing – 6 Hours
Structure of research papers, referencing styles (IEEE/APA), and submission process.

Text / Reference Books

• Kothari, C.R. – Research Methodology: Methods and Techniques, New Age International.
• Creswell, J. – Research Design: Qualitative, Quantitative, and Mixed Methods, SAGE.
• Day, R.A. – How to Write and Publish a Scientific Paper, Cambridge University Press.

AIH904A - Professional Elective V (A): Digital Therapeutics (DTx)

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the role of digital therapeutics in preventive and personalized healthcare.

• Design and evaluate digital interventions for chronic disease management.
• Explore regulatory, ethical, and market considerations for DTx products.

Course Outcomes

CO1: Understand the role of digital therapeutics in preventive and personalized healthcare.
CO2: Design and evaluate digital interventions for chronic disease management.
CO3: Explore regulatory, ethical, and market considerations for DTx products.

Detailed Syllabus

Unit I: Introduction to DTx – 9 Hours
Definition, difference between wellness apps and digital therapeutics.

Unit II: Therapeutic Areas – 9 Hours
Applications in diabetes, mental health, and cardiovascular diseases.

Unit III: Design & Development – 9 Hours
Software-based treatment design, validation, and clinical trials.

Unit IV: AI & Data Analytics – 9 Hours
Personalized feedback systems and outcome monitoring.

Unit V: Regulatory & Business Models – 9 Hours
FDA, CE approvals, reimbursement, and global adoption.

Text / Reference Books

• Dumont, C. – Digital Therapeutics: Therapeutic Technology for Healthcare, Springer.
• Evidation Health – DTx Landscape Report 2023.
• FDA – Digital Health Innovation Action Plan.

AIH904B - Professional Elective V (B): Robotics & Automation in Rehabilitation

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the fundamentals of robotics and automation used in patient rehabilitation.
• Develop systems integrating AI, sensors, and actuators for physical therapy.
• Analyze safety and control strategies for assistive robotic systems.

Course Outcomes

CO1: Understand the fundamentals of robotics and automation used in patient rehabilitation.
CO2: Develop systems integrating AI, sensors, and actuators for physical therapy.
CO3: Analyze safety and control strategies for assistive robotic systems.

Detailed Syllabus

Unit I: Basics of Rehabilitation Robotics – 9 Hours
Introduction, types, and classification of robotic systems in rehabilitation.

Unit II: Human–Robot Interaction – 9 Hours
Control interfaces, sensors, and feedback mechanisms.

Unit III: Control Systems – 9 Hours
Adaptive and AI-based control for robotic assistance.

Unit IV: Applications – 9 Hours
Robotic gait training, upper limb exoskeletons, and telerehabilitation.

Unit V: Standards & Safety – 9 Hours
ISO standards, ethics, and safety validation.

Text / Reference Books

- Morioka, M. – Rehabilitation Robotics, Elsevier.
- Aracil, R. – Advances in Medical Robotics, Springer.
- WHO – Rehabilitation 2030: A Call for Action.

AIH905A - Open Elective IV (A): Cognitive Science & Human Factors in Healthcare

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand cognitive processes influencing decision-making and perception in healthcare.
- Analyze human factors engineering principles for safe healthcare technology design.
- Apply cognitive modeling to AI-based healthcare systems.

Course Outcomes

CO1: Understand cognitive processes influencing decision-making and perception in healthcare.
CO2: Analyze human factors engineering principles for safe healthcare technology design.
CO3: Apply cognitive modeling to AI-based healthcare systems.

Detailed Syllabus

Unit I: Introduction to Cognitive Science – 9 Hours
Perception, attention, memory, and learning in human cognition.

Unit II: Human–Computer Interaction – 9 Hours
Usability, ergonomics, and interface design for healthcare systems.

Unit III: Human Factors Engineering – 9 Hours
System safety, human error, and performance optimization.

Unit IV: AI & Cognitive Modeling – 9 Hours
Cognitive architectures and AI systems simulating human behavior.

Unit V: Applications – 9 Hours
Human factors in clinical decision support and surgical systems.

Text / Reference Books

- Wickens, C.D. – Engineering Psychology and Human Performance, Pearson.
- Norman, D.A. – The Design of Everyday Things, Basic Books.
- Reason, J. – Human Error, Cambridge University Press.

AIH905B - Open Elective IV (B): Business Analytics in Pharma & Healthcare

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand business analytics tools and methods used in the healthcare and pharma sectors.
- Apply analytical models for operational and strategic decision-making.
- Use predictive and prescriptive analytics for performance improvement.

Course Outcomes

CO1: Understand business analytics tools and methods used in the healthcare and pharma sectors.
CO2: Apply analytical models for operational and strategic decision-making.
CO3: Use predictive and prescriptive analytics for performance improvement.

Detailed Syllabus

Unit I: Overview of Business Analytics – 9 Hours
Data-driven decision-making, descriptive, predictive, and prescriptive analytics.

Unit II: Pharma Analytics – 9 Hours
Market forecasting, R&D analytics, and sales data visualization.

Unit III: Healthcare Operations Analytics – 9 Hours
Hospital resource optimization, patient flow, and service efficiency.

Unit IV: Predictive Modeling – 9 Hours
Regression, classification, and machine learning techniques in healthcare data.

Unit V: Case Studies – 9 Hours
Business analytics implementation in major healthcare organizations.

Text / Reference Books

- Evans, J.R. – Business Analytics, Pearson.
- Sharma, P. – Healthcare Data Analytics, CRC Press.
- Provost & Fawcett – Data Science for Business, O'Reilly.

AIH906 - Major Project – II (Research/Product Development)
L-T-P: 0-0-12 | Credits: 6 | Total Hours: 90

Course Objectives
• Conduct independent research or product development related to AI in healthcare.
• Apply interdisciplinary knowledge to solve complex healthcare challenges.
• Publish findings in conferences or journals and demonstrate prototype solutions.

Course Outcomes
CO1: Conduct independent research or product development related to AI in healthcare.
CO2: Apply interdisciplinary knowledge to solve complex healthcare challenges.
CO3: Publish findings in conferences or journals and demonstrate prototype solutions.

Detailed Syllabus

Unit I: Problem Identification & Review – 18 Hours
Select research topic, define objectives, and review literature.

Unit II: Design & Methodology – 18 Hours
Develop methodology, select algorithms, and design experiments.

Unit III: Implementation – 18 Hours
Execute data collection, analysis, and model implementation.

Unit IV: Results & Discussion – 18 Hours
Interpret results, validate outcomes, and refine models.

Unit V: Documentation & Publication – 18 Hours
Prepare dissertation, present results, and submit research papers.

Text / Reference Books
• AICTE Research Project Handbook (2023).
• Springer & IEEE Conference Paper Writing Guides.

Integrated B.Tech – M.Tech in AI in Healthcare Technology
Detailed Syllabus – Semester X (20 Credits)

AIH1001 - Dissertation / Thesis (Healthcare AI Application)
L-T-P: 0-0-32 | Credits: 16 | Total Hours: 240

Course Objectives
• Undertake independent, original research in an AI application for healthcare or life sciences.
• Apply interdisciplinary knowledge from computing, engineering, and health domains.

• Publish research findings in peer-reviewed conferences or journals and defend through viva-voce.

Course Outcomes
CO1: Undertake independent, original research in an AI application for healthcare or life sciences.
CO2: Apply interdisciplinary knowledge from computing, engineering, and health domains.
CO3: Publish research findings in peer-reviewed conferences or journals and defend through viva-voce.

Detailed Structure / Stages

Stage I: Problem Definition & Literature Review – 48 Hours
Select research problem; review relevant literature; define research gaps and objectives.

Stage II: Design & Methodology – 48 Hours
Develop research design; define algorithms, models, datasets, and experimental plan.

Stage III: Implementation & Experimentation – 48 Hours
Develop and validate prototype or simulation; analyze data and interpret results.

Stage IV: Documentation & Thesis Writing – 48 Hours
Compile report per university format; prepare research papers for publication.

Stage V: Defense & Evaluation – 48 Hours
Present results before expert committee; submit thesis and publication proofs.

Evaluation Criteria / Deliverables
• Continuous evaluation based on progress reviews, innovation, implementation, and documentation.
• Final evaluation through report submission, viva-voce, and publication quality.
• Adherence to AICTE/UGC project guidelines and institutional norms.

Text / Reference Books / Guidelines
• AICTE M.Tech Project / Dissertation Guidelines (2023).
• Creswell, J. – Research Design: Qualitative, Quantitative, and Mixed Methods, SAGE.
• Day, R.A. – How to Write and Publish a Scientific Paper, Cambridge University Press.

AIH1002 - Seminar & Publications
L-T-P: 0-2-0 | Credits: 2 | Total Hours: 30

Course Objectives
• Enhance technical communication and research dissemination skills.
• Present research work in national/international forums and publish findings.
• Develop capability to write review papers, patents, or conference proceedings.

Course Outcomes
CO1: Enhance technical communication and research dissemination skills.

CO2: Present research work in national/international forums and publish findings.
CO3: Develop capability to write review papers, patents, or conference proceedings.

Detailed Structure / Stages

Stage I: Topic Selection & Abstract Writing – 6 Hours
Identify seminar topic aligned with dissertation or emerging AI-health trends.

Stage II: Paper Preparation – 6 Hours
Draft technical paper using IEEE/Elsevier/Springer formats.

Stage III: Presentation – 6 Hours
Deliver oral/poster presentations at institutional or external venues.

Stage IV: Peer Review & Feedback – 6 Hours
Incorporate reviewer suggestions and enhance paper quality.

Stage V: Publication – 6 Hours
Submit research article to indexed journal or conference; file IPR if applicable.

Evaluation Criteria / Deliverables

• Continuous evaluation based on progress reviews, innovation, implementation, and documentation.
• Final evaluation through report submission, viva-voce, and publication quality.
• Adherence to AICTE/UGC project guidelines and institutional norms.

Text / Reference Books / Guidelines

• Katz, M.J. – From Research to Manuscript, Springer.
• Elsevier Author Guidelines (2024).
• IEEE Conference Publishing Standards.

AIH1003 - Clinical / Industry Internship

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Gain hands-on exposure to healthcare or AI industry environments.
• Apply theoretical knowledge to real-world healthcare AI challenges.
• Develop interdisciplinary professional and ethical competencies.

Course Outcomes

CO1: Gain hands-on exposure to healthcare or AI industry environments.
CO2: Apply theoretical knowledge to real-world healthcare AI challenges.
CO3: Develop interdisciplinary professional and ethical competencies.

Detailed Structure / Stages

Stage I: Orientation & Placement – 6 Hours
Join healthcare, biomedical, or AI organization; understand workflow.

Stage II: Work Assignment – 6 Hours
Execute assigned tasks related to AI modeling, analytics, or data integration.

Stage III: Supervised Learning – 6 Hours
Collaborate with mentors for performance feedback and skill enhancement.

Stage IV: Reporting & Review – 6 Hours
Prepare weekly reports, progress documentation, and supervisor feedback.

Stage V: Final Presentation – 6 Hours
Submit internship report and present outcomes before academic panel.

Evaluation Criteria / Deliverables

• Continuous evaluation based on progress reviews, innovation, implementation, and documentation.
• Final evaluation through report submission, viva-voce, and publication quality.
• Adherence to AICTE/UGC project guidelines and institutional norms.

Text / Reference Books / Guidelines

• AICTE Internship Policy 2023.
• Industry/Clinical Internship Logbook Template (University Prescribed).
• WHO – Industry-Academia Collaboration Framework for Health Innovation.

M.Tech in Computational Neuroscience & Artificial Intelligence

Comprehensive Detailed Syllabus (Semesters I–IV)

Detailed Syllabus – Semester I (Foundations, 17 Credits)

CNS 101 - Fundamentals of Neuroscience for Engineers

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the structure and function of the human nervous system relevant to engineering perspectives.
• Analyze neural communication mechanisms, synaptic transmission, and sensory systems.
• Relate brain functions to cognitive processes and computational modeling.

Course Outcomes

CO1: Understand the structure and function of the human nervous system relevant to engineering perspectives.
CO2: Analyze neural communication mechanisms, synaptic transmission, and sensory systems.
CO3: Relate brain functions to cognitive processes and computational modeling.

Detailed Syllabus

Unit I: Overview of Nervous System – 9 Hours
Introduction to central and peripheral nervous systems, neurons, glial cells, and brain organization.

Unit II: Neurophysiology – 9 Hours
Resting potential, action potential, synaptic transmission, and neural signaling pathways.

Unit III: Neuroanatomy & Sensory Systems – 9 Hours
Brain regions, sensory-motor pathways, and cortical organization.

Unit IV: Cognitive & Behavioral Neuroscience – 9 Hours
Perception, attention, learning, and memory mechanisms.

Unit V: Engineering Applications – 9 Hours
Computational models of neurons and introduction to neural engineering interfaces.

Text / Reference Books

• Kandel, E.R. et al. – Principles of Neural Science, McGraw-Hill.
• Bear, Connors & Paradiso – Neuroscience: Exploring the Brain, Wolters Kluwer.
• Dayan, P. & Abbott, L.F. – Theoretical Neuroscience, MIT Press.

CNS 102 - Mathematical Foundations for Neural Computation

L-T-P: 3-1-0 | Credits: 4 | Total Hours: 60

Course Objectives

• Develop mathematical understanding of neural computation and brain-inspired models.
• Apply linear algebra, probability, and differential equations to neural networks.
• Implement mathematical formulations for learning and optimization processes.

Course Outcomes

CO1: Develop mathematical understanding of neural computation and brain-inspired models.
CO2: Apply linear algebra, probability, and differential equations to neural networks.
CO3: Implement mathematical formulations for learning and optimization processes.

Detailed Syllabus

Unit I: Linear Algebra – 12 Hours
Matrices, eigenvalues, eigenvectors, singular value decomposition, and vector spaces.

Unit II: Calculus & Differential Equations – 12 Hours
Gradients, Jacobians, ODEs and PDEs for neural dynamics.

Unit III: Probability & Statistics – 12 Hours
Bayesian inference, Gaussian models, Markov processes, and stochastic modeling.

Unit IV: Optimization Methods – 12 Hours
Gradient descent, stochastic optimization, Lagrange multipliers, convex optimization.

Unit V: Mathematical Modeling of Neurons – 12 Hours
Hodgkin–Huxley, Integrate-and-Fire, and rate-based neural models.

Text / Reference Books

• Simmons, G.F. – Differential Equations, McGraw Hill.
• Strang, G. – Linear Algebra and Its Applications, Cengage Learning.
• Trappenberg, T. – Fundamentals of Computational Neuroscience, Oxford University Press.

CNS 103 - Machine Learning & Deep Learning Techniques

L-T-P: 3-0-2 | Credits: 4 | Total Hours: 60

Course Objectives

• Understand key machine learning and deep learning algorithms and their applications.
• Implement supervised and unsupervised learning techniques using Python or MATLAB.
• Apply neural network architectures for pattern recognition and predictive modeling.

Course Outcomes

CO1: Understand key machine learning and deep learning algorithms and their applications.
CO2: Implement supervised and unsupervised learning techniques using Python or MATLAB.
CO3: Apply neural network architectures for pattern recognition and predictive modeling.

Detailed Syllabus

Unit I: Introduction to Machine Learning – 12 Hours
Supervised, unsupervised, and reinforcement learning paradigms.

Unit II: Regression & Classification – 12 Hours
Linear regression, logistic regression, SVMs, and decision trees.

Unit III: Neural Networks & Deep Learning – 12 Hours
Feedforward networks, backpropagation, CNNs, and RNNs.

Unit IV: Model Evaluation – 12 Hours
Loss functions, regularization, cross-validation, and performance metrics.

Unit V: Applications in Neuroscience – 12 Hours
Pattern recognition in brain imaging, neural decoding, and BCI applications.

Text / Reference Books

• Bishop, C.M. – Pattern Recognition and Machine Learning, Springer.
• Goodfellow, I. – Deep Learning, MIT Press.
• Aurélien Géron – Hands-On Machine Learning with Scikit-Learn & TensorFlow, O'Reilly.

CNS 104 - Neural Signal Processing & Brain Data Analytics

L-T-P: 3-0-2 | Credits: 4 | Total Hours: 60

Course Objectives

• Understand principles of signal processing applied to neural and brain data.
• Perform analysis on EEG, MEG, and fMRI datasets using computational tools.
• Apply machine learning techniques for brain signal decoding and interpretation.

Course Outcomes

CO1: Understand principles of signal processing applied to neural and brain data.
CO2: Perform analysis on EEG, MEG, and fMRI datasets using computational tools.
CO3: Apply machine learning techniques for brain signal decoding and interpretation.

Detailed Syllabus

Unit I: Introduction to Neural Signals – 12 Hours
Electrophysiological signals – EEG, ECoG, MEG, fMRI, and spike trains.

Unit II: Signal Processing Techniques – 12 Hours

Filtering, spectral analysis, time-frequency methods, and feature extraction.

Unit III: Statistical & Machine Learning Methods – 12 Hours
Clustering, classification, PCA, ICA for brain data.

Unit IV: Brain Connectivity & Network Analysis – 12 Hours
Functional connectivity, graph metrics, and dynamic networks.

Unit V: Applications – 12 Hours
BCI, emotion recognition, neurological disorder diagnosis, and neuroinformatics.

Text / Reference Books

• Rangayyan, R.M. – Biomedical Signal Analysis, Wiley.
• Sanei, S. – EEG Signal Processing, Wiley.
• Friston, K. – Statistical Parametric Mapping: The Analysis of Functional Brain Images, Elsevier.

CNS 105 - Neuroscience & AI Simulation Lab (Python/MATLAB/NEURON)

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Implement computational models of neurons using Python/MATLAB/NEURON tools.
• Simulate neural dynamics and AI algorithms applied to neuroscience data.

Course Outcomes

CO1: Implement computational models of neurons using Python/MATLAB/NEURON tools.
CO2: Simulate neural dynamics and AI algorithms applied to neuroscience data.

Detailed Syllabus

Unit I: Simulation Tools Setup – 6 Hours
Introduction to MATLAB, Python (Numpy, SciPy), and NEURON environment.

Unit II: Neuron Modeling – 6 Hours
Implement Integrate-and-Fire and Hodgkin–Huxley models.

Unit III: Signal Processing Experiments – 6 Hours
Analyze EEG/MEG datasets for noise reduction and feature extraction.

Unit IV: Machine Learning Experiments – 6 Hours
Train models for classification and pattern detection in neural data.

Unit V: Mini Project – 6 Hours
Design a small simulation combining neural computation and AI.

Text / Reference Books

• Carnevale, N.T. & Hines, M.L. – The NEURON Book, Cambridge University Press.
• Trappenberg, T. – Fundamentals of Computational Neuroscience, Oxford University Press.
• Aurélien Géron – Hands-On Machine Learning with Scikit-Learn & TensorFlow, O'Reilly.

CNS 106 - Research Methodology & IPR (Audit / Non-Credit)

L-T-P: 2-0-0 | Credits: 0 | Total Hours: 30

Course Objectives

- Understand research design, methodologies, and intellectual property rights.
- Develop skills in report writing, referencing, and publication ethics.

Course Outcomes

CO1: Understand research design, methodologies, and intellectual property rights.
CO2: Develop skills in report writing, referencing, and publication ethics.

Detailed Syllabus

Unit I: Introduction to Research – 6 Hours
Research types, objectives, and design principles.

Unit II: Data Collection & Analysis – 6 Hours
Quantitative and qualitative analysis; tools and software.

Unit III: Technical Writing – 6 Hours
Structure of research papers, reports, and dissertations.

Unit IV: Intellectual Property Rights – 6 Hours
Patents, copyrights, trademarks, and licensing.

Unit V: Ethics & Plagiarism – 6 Hours
Research integrity, plagiarism detection, and open access publishing.

Text / Reference Books

- C.R. Kothari – Research Methodology: Methods and Techniques, New Age International.
- WIPO – Intellectual Property Handbook, WIPO Publication.
- Day, R.A. – How to Write and Publish a Scientific Paper, Cambridge University Press.

M.Tech in Computational Neuroscience & Artificial Intelligence

Detailed Syllabus – Semester II (Cognitive and Computational Models, 18 Credits)

CNS 201 - Cognitive Computing & Brain Modeling

L-T-P: 3-0-2 | Credits: 4 | Total Hours: 60

Course Objectives

- Understand the concepts of cognitive computing and brain-inspired models.
- Develop computational models for perception, reasoning, and learning processes.
- Integrate brain modeling frameworks with AI systems for cognitive architectures.

Course Outcomes

CO1: Understand the concepts of cognitive computing and brain-inspired models.
CO2: Develop computational models for perception, reasoning, and learning processes.
CO3: Integrate brain modeling frameworks with AI systems for cognitive architectures.

Detailed Syllabus

Unit I: Foundations of Cognitive Computing – 12 Hours
Cognition, perception, attention, learning, memory; cognitive architectures (ACT-R, SOAR).

Unit II: Computational Brain Modeling – 12 Hours
Neural dynamics, attractor models, biophysical modeling of neurons and networks.

Unit III: Learning Mechanisms – 12 Hours
Hebbian learning, synaptic plasticity, reinforcement learning in neural circuits.

Unit IV: Cognitive Simulation – 12 Hours
Cognitive task modeling, decision-making systems, and cognitive robotics.

Unit V: Applications – 12 Hours
Cognitive AI, adaptive control, neuro-symbolic reasoning, and brain-inspired computing.

Text / Reference Books

• Anderson, J.R. – Cognitive Psychology and Its Implications, W.H. Freeman.
• Eliasmith, C. – How to Build a Brain: A Neural Architecture for Biological Cognition, Oxford University Press.
• Sun, R. – The Cambridge Handbook of Computational Psychology, Cambridge University Press.

CNS 202 - Artificial Neural Systems & Spiking Neural Networks

L-T-P: 3-0-2 | Credits: 4 | Total Hours: 60

Course Objectives

• Understand architecture and functionality of artificial neural and spiking neural networks.
• Model and simulate neuron spiking dynamics using computational tools.
• Apply SNNs for neuromorphic computing and time-dependent data analysis.

Course Outcomes

CO1: Understand architecture and functionality of artificial neural and spiking neural networks.
CO2: Model and simulate neuron spiking dynamics using computational tools.
CO3: Apply SNNs for neuromorphic computing and time-dependent data analysis.

Detailed Syllabus

Unit I: Introduction to Neural Systems – 12 Hours
Artificial neurons, network architectures, activation functions, and training methods.

Unit II: Spiking Neural Networks – 12 Hours
Leaky Integrate-and-Fire, Izhikevich models, STDP learning rules.

Unit III: Network Dynamics – 12 Hours
Temporal coding, population coding, and spike-timing correlations.

Unit IV: Simulation Tools – 12 Hours
PyNN, NEST, BindsNET, and Loihi-based neuromorphic platforms.

Unit V: Applications – 12 Hours
Pattern recognition, motor control, and energy-efficient neural computing.

Text / Reference Books

• Gerstner, W. & Kistler, W. – Spiking Neuron Models, Cambridge University Press.
• Maass, W. – Networks of Spiking Neurons, Neural Networks Journal.
• Kasabov, N. – Time-Space, Spiking Neural Networks, Springer.

CNS E1 - Program Elective I: Neuromorphic Computing & Edge AI

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand neuromorphic principles and architectures inspired by biological computation.
• Explore AI hardware implementations on edge devices and brain-inspired chips.
• Develop edge AI applications integrating low-power and event-driven processing.

Course Outcomes

CO1: Understand neuromorphic principles and architectures inspired by biological computation.
CO2: Explore AI hardware implementations on edge devices and brain-inspired chips.
CO3: Develop edge AI applications integrating low-power and event-driven processing.

Detailed Syllabus

Unit I: Neuromorphic Concepts – 9 Hours
Brain-inspired computation, event-driven architectures, and neural morphology.

Unit II: Hardware Architectures – 9 Hours
IBM TrueNorth, Intel Loihi, SpiNNaker, and memristor-based systems.

Unit III: Edge AI Frameworks – 9 Hours
TinyML, TensorFlow Lite, Edge TPU, and embedded deep learning.

Unit IV: Optimization & Deployment – 9 Hours
Quantization, pruning, federated learning for edge systems.

Unit V: Applications – 9 Hours
Wearables, healthcare IoT, robotics, and real-time inference systems.

Text / Reference Books

- Indiveri, G. – Neuromorphic Computing and Engineering, IOP Publishing.
- Sze, V. – Efficient Processing of Deep Neural Networks, Springer.
- Davies, M. – Loihi: Neuromorphic Hardware for Edge Intelligence, IEEE Micro.

CNS E2 - Program Elective II: Reinforcement Learning & Decision Neuroscience

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand reinforcement learning algorithms and their neural basis.
- Model human and animal decision-making using computational frameworks.
- Apply RL methods to adaptive control and cognitive systems.

Course Outcomes

CO1: Understand reinforcement learning algorithms and their neural basis.
CO2: Model human and animal decision-making using computational frameworks.
CO3: Apply RL methods to adaptive control and cognitive systems.

Detailed Syllabus

Unit I: Foundations of Reinforcement Learning – 9 Hours
Markov decision processes, value functions, policy iteration, Q-learning.

Unit II: Temporal Difference Learning – 9 Hours
TD learning, actor-critic models, and function approximation.

Unit III: Decision Neuroscience – 9 Hours
Reward-based learning, dopamine signaling, and risk-reward processing.

Unit IV: Deep Reinforcement Learning – 9 Hours
DQN, PPO, A3C, and policy gradient methods.

Unit V: Applications – 9 Hours
Cognitive agents, robotic decision-making, and neuroeconomic modeling.

Text / Reference Books

- Sutton, R. & Barto, A. – Reinforcement Learning: An Introduction, MIT Press.
- Doya, K. – Computational Neuroscience of Decision Making, Nature Neuroscience.
- Silver, D. – Mastering Reinforcement Learning, DeepMind Lectures.

CNS 203 - Cognitive-AI Project / Innovation Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

- Integrate cognitive computing and AI tools to design innovative applications.

• Apply interdisciplinary knowledge to develop small prototypes or projects.

Course Outcomes

CO1: Integrate cognitive computing and AI tools to design innovative applications.
CO2: Apply interdisciplinary knowledge to develop small prototypes or projects.

Detailed Syllabus

Unit I: Problem Definition – 6 Hours
Identify a cognitive or AI-driven challenge and define project scope.

Unit II: Design & Architecture – 6 Hours
Plan model, framework, and data requirements.

Unit III: Implementation – 6 Hours
Develop prototype using suitable programming tools.

Unit IV: Testing & Evaluation – 6 Hours
Validate design and evaluate performance.

Unit V: Presentation – 6 Hours
Prepare report and demonstrate project outcomes.

Text / Reference Books

• AICTE Project-Based Learning Manual, 2023.
• IEEE Access – Cognitive Computing Special Issues.

CNS 204 - Technical Seminar / Review Presentation

L-T-P: 0-2-0 | Credits: 2 | Total Hours: 30

Course Objectives

• Develop technical communication and presentation skills in research-oriented topics.
• Engage in literature review, analysis, and discussion of advanced papers.

Course Outcomes

CO1: Develop technical communication and presentation skills in research-oriented topics.
CO2: Engage in literature review, analysis, and discussion of advanced papers.

Detailed Syllabus

Unit I: Topic Identification – 6 Hours
Select seminar topic aligned with current research trends.

Unit II: Literature Review – 6 Hours
Study research papers and summarize findings.

Unit III: Seminar Presentation – 6 Hours
Deliver technical presentation with supporting visuals.

Unit IV: Report Preparation – 6 Hours
Prepare documentation and references in IEEE format.

Unit V: Peer Discussion – 6 Hours
Engage in Q&A and critical review sessions.

Text / Reference Books

- Katz, M.J. – From Research to Manuscript, Springer.
- Day, R.A. – How to Write and Publish a Scientific Paper, Cambridge University Press.

M.Tech in Computational Neuroscience & Artificial Intelligence

Detailed Syllabus – Semester III (Applications & Research Integration, 17 Credits)

CNS 301 - Neuroinformatics & Computational Cognition

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand neuroinformatics principles for organizing and analyzing neuroscience data.
- Apply computational cognitive models to simulate mental processes.
- Develop data-driven cognitive systems integrating AI and neuroscience.

Course Outcomes

CO1: Understand neuroinformatics principles for organizing and analyzing neuroscience data.
CO2: Apply computational cognitive models to simulate mental processes.
CO3: Develop data-driven cognitive systems integrating AI and neuroscience.

Detailed Syllabus

Unit I: Introduction to Neuroinformatics – 9 Hours
Brain data repositories, metadata standards, and data integration techniques.

Unit II: Computational Cognition – 9 Hours
Cognitive modeling, symbolic vs. connectionist approaches.

Unit III: Cognitive Architectures – 9 Hours
ACT-R, SOAR, and Bayesian models of cognition.

Unit IV: Neural Data Analysis – 9 Hours
Multimodal brain data (EEG, fMRI) – preprocessing, feature extraction, and visualization.

Unit V: Applications – 9 Hours
Brain-inspired AI, neuroinformatics in healthcare, and intelligent learning systems.

Text / Reference Books

• Friston, K. – Statistical Parametric Mapping: The Analysis of Functional Brain Images, Elsevier.
• Sporns, O. – Networks of the Brain, MIT Press.
• Anderson, J.R. – Cognitive Psychology and Its Implications, W.H. Freeman.

CNS 302 - Brain–Computer Interfaces & Neural Prosthetics

L-T-P: 3-0-2 | Credits: 4 | Total Hours: 60

Course Objectives

• Understand BCI system design and its components for neural control and communication.
• Analyze signal acquisition, feature extraction, and decoding for brain-computer applications.
• Design BCI and prosthetic systems integrating AI algorithms.

Course Outcomes

CO1: Understand BCI system design and its components for neural control and communication.
CO2: Analyze signal acquisition, feature extraction, and decoding for brain-computer applications.
CO3: Design BCI and prosthetic systems integrating AI algorithms.

Detailed Syllabus

Unit I: Introduction to BCIs – 12 Hours
BCI architecture, invasive and non-invasive systems, EEG/MEG-based interfaces.

Unit II: Signal Processing for BCIs – 12 Hours
Preprocessing, artifact removal, and time-frequency analysis.

Unit III: Feature Extraction & Classification – 12 Hours
PCA, LDA, SVM, CNN for EEG/fNIRS data analysis.

Unit IV: Neural Prosthetics – 12 Hours
Cochlear implants, motor prostheses, and deep brain stimulation systems.

Unit V: Applications – 12 Hours
Assistive communication, neurorehabilitation, and control of robotic limbs.

Text / Reference Books

• He, H. & Wu, D. – Brain–Computer Interfaces: Principles and Practices, CRC Press.
• Wolpaw, J.R. & Wolpaw, E.W. – Brain–Computer Interfaces, Oxford University Press.
• Nam, C.S. – Handbook of BCI Design, CRC Press.

CNS E3A - Program Elective III (A): Biomedical Signal & Image Processing

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand fundamental principles of biomedical signal and image analysis.
• Apply digital signal and image processing techniques for medical applications.
• Implement algorithms for feature extraction, segmentation, and classification of biomedical data.

Course Outcomes

CO1: Understand fundamental principles of biomedical signal and image analysis.
CO2: Apply digital signal and image processing techniques for medical applications.
CO3: Implement algorithms for feature extraction, segmentation, and classification of biomedical data.

Detailed Syllabus

Unit I: Introduction to Biomedical Signals – 9 Hours
Physiological signal acquisition, ECG, EEG, EMG characteristics.

Unit II: Signal Processing Techniques – 9 Hours
Filtering, denoising, Fourier and wavelet transforms.

Unit III: Medical Image Processing – 9 Hours
Image enhancement, segmentation, and registration techniques.

Unit IV: Feature Extraction – 9 Hours
Texture analysis, PCA, ICA, and feature selection methods.

Unit V: Applications – 9 Hours
Disease diagnosis, radiomics, and multimodal data fusion.

Text / Reference Books

• Rangayyan, R.M. – Biomedical Signal Analysis, Wiley.
• Gonzalez & Woods – Digital Image Processing, Pearson.
• Acharya, R. – Biomedical Image Analysis, CRC Press.

CNS E3B - Program Elective III (B): Robotics & Neural Control Systems

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the integration of neural control models with robotic systems.
• Design control algorithms inspired by biological neural systems.
• Apply computational intelligence for adaptive and autonomous robotics.

Course Outcomes

CO1: Understand the integration of neural control models with robotic systems.
CO2: Design control algorithms inspired by biological neural systems.
CO3: Apply computational intelligence for adaptive and autonomous robotics.

Detailed Syllabus

Unit I: Introduction to Neural Control – 9 Hours
Motor control systems, reflex arcs, and central pattern generators.

Unit II: Neural Control Modeling – 9 Hours
Dynamic models for motion control and neuro-motor learning.

Unit III: Robotics Systems – 9 Hours
Sensors, actuators, and robotic architectures.

Unit IV: AI & Neural Control – 9 Hours
Reinforcement learning, adaptive controllers, and hybrid systems.

Unit V: Applications – 9 Hours
Prosthetic control, exoskeletons, and neural-driven autonomous robots.

Text / Reference Books

- Pfeifer, R. & Bongard, J. – How the Body Shapes the Way We Think, MIT Press.
- Spong, M.W. – Robot Dynamics and Control, Wiley.
- Arbib, M.A. – Handbook of Brain Theory and Neural Networks, MIT Press.

CNS OE1A - Open Elective I (A): HealthTech & AI Applications

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Explore AI applications in digital health, diagnostics, and precision medicine.
- Understand data-driven models in healthcare analytics and decision support systems.
- Apply machine learning frameworks to real-world clinical datasets.

Course Outcomes

CO1: Explore AI applications in digital health, diagnostics, and precision medicine.
CO2: Understand data-driven models in healthcare analytics and decision support systems.
CO3: Apply machine learning frameworks to real-world clinical datasets.

Detailed Syllabus

Unit I: AI in Healthcare Overview – 9 Hours
AI for diagnostics, treatment planning, and patient monitoring.

Unit II: Medical Data Analytics – 9 Hours
Data preprocessing, imputation, and normalization in clinical data.

Unit III: Predictive Modeling – 9 Hours
Machine learning for disease risk and prognosis prediction.

Unit IV: AI Ethics & Regulations – 9 Hours
Data privacy, explainable AI, and healthcare compliance frameworks.

Unit V: Case Studies – 9 Hours
Applications in oncology, cardiology, and genomics.

Text / Reference Books

- Topol, E. – Deep Medicine, Basic Books.
- Dey, N. – Smart Healthcare Systems, Elsevier.
- Kumar, A. – AI in Healthcare: Challenges and Applications, CRC Press.

CNS OE1B - Open Elective I (B): Cognitive Robotics & Human Augmentation

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand principles of cognitive robotics and assistive augmentation technologies.
- Design robotic systems capable of adaptive and human-interactive learning.
- Integrate neuroscience-inspired algorithms in augmented intelligence devices.

Course Outcomes

CO1: Understand principles of cognitive robotics and assistive augmentation technologies.
CO2: Design robotic systems capable of adaptive and human-interactive learning.
CO3: Integrate neuroscience-inspired algorithms in augmented intelligence devices.

Detailed Syllabus

Unit I: Introduction to Cognitive Robotics – 9 Hours
Cognitive architectures, perception-action cycle, and sensorimotor control.

Unit II: Human–Robot Interaction – 9 Hours
Speech, gesture, and affective interfaces for communication.

Unit III: Learning & Adaptation – 9 Hours
Reinforcement learning, imitation learning, and transfer learning.

Unit IV: Human Augmentation – 9 Hours
Exoskeletons, neuroprosthetics, and wearable intelligence.

Unit V: Applications – 9 Hours
Assistive technologies, neurorehabilitation, and cognitive enhancement.

Text / Reference Books

- Thrun, S. – Probabilistic Robotics, MIT Press.
- Pfeifer, R. – Understanding Intelligence, MIT Press.

• Chernova, S. – Human–Robot Interaction, Wiley.

CNS 303 - Mini Research Project / Design Studio – I

L-T-P: 0-0-8 | Credits: 4 | Total Hours: 60

Course Objectives

• Undertake research-oriented mini projects integrating neuroscience and AI concepts.
• Apply design thinking to create innovative computational or experimental solutions.

Course Outcomes

CO1: Undertake research-oriented mini projects integrating neuroscience and AI concepts.
CO2: Apply design thinking to create innovative computational or experimental solutions.

Detailed Syllabus

Unit I: Problem Identification – 12 Hours
Select and define research topic aligned with neural and AI systems.

Unit II: Literature Review – 12 Hours
Study and summarize research findings relevant to project.

Unit III: System Design – 12 Hours
Develop conceptual framework and architecture for implementation.

Unit IV: Implementation & Testing – 12 Hours
Execute experiments or simulations, analyze results.

Unit V: Documentation & Presentation – 12 Hours
Prepare report, present outcomes, and plan for publication.

Text / Reference Books

• AICTE Project-Based Learning Manual (2023).
• Springer & IEEE Computational Neuroscience Proceedings.

M.Tech in Computational Neuroscience & Artificial Intelligence

Detailed Syllabus – Semester IV (Dissertation & Capstone, 13 Credits)

CNS 401 - Major Thesis / Dissertation (Phase II)

L-T-P: 0-0-24 | Credits: 12 | Total Hours: 180

Course Objectives

• Undertake an in-depth research project integrating neuroscience and artificial intelligence.
• Apply experimental, computational, or theoretical methods to solve an identified research problem.

- Develop professional research documentation and publishable outcomes.
- Demonstrate independent research ability, innovation, and ethical conduct.

Course Outcomes

CO1: Undertake an in-depth research project integrating neuroscience and artificial intelligence.
CO2: Apply experimental, computational, or theoretical methods to solve an identified research problem.
CO3: Develop professional research documentation and publishable outcomes.
CO4: Demonstrate independent research ability, innovation, and ethical conduct.

Detailed Structure / Stages

Stage I: Problem Definition & Review – 36 Hours
Refinement of research objectives, detailed literature review, and identification of research gaps.

Stage II: Design & Methodology – 36 Hours
Development of experimental/computational models, dataset collection, and workflow design.

Stage III: Implementation – 36 Hours
Execution of research experiments, simulations, or data-driven models.

Stage IV: Analysis & Results – 36 Hours
Interpretation of results, validation of hypotheses, and comparison with existing literature.

Stage V: Thesis Writing & Defense – 36 Hours
Preparation of final report, publication of research paper, and oral presentation/viva.

Evaluation Criteria / Deliverables

- Continuous evaluation based on progress reviews, innovation, implementation, and documentation.
- Final evaluation through report submission, viva-voce, and publication quality.
- Adherence to AICTE/UGC M.Tech dissertation guidelines and institutional norms.

Text / Reference Books / Guidelines

- AICTE M.Tech Project/Dissertation Guidelines (2023).
- Creswell, J. – Research Design: Qualitative, Quantitative, and Mixed Methods, SAGE.
- Day, R.A. – How to Write and Publish a Scientific Paper, Cambridge University Press.
- IEEE & Springer Conference Publication Standards.

CNS 402 - Comprehensive Viva / Publication Seminar

L-T-P: 0-0-0 | Credits: 1 | Total Hours: 15

Course Objectives

- Assess overall subject knowledge acquired across all semesters.
- Evaluate analytical, presentation, and research communication skills.

• Encourage dissemination of research findings through publications or seminars.

Course Outcomes

CO1: Assess overall subject knowledge acquired across all semesters.
CO2: Evaluate analytical, presentation, and research communication skills.
CO3: Encourage dissemination of research findings through publications or seminars.

Detailed Structure / Stages

Stage I: Preparation & Review – 3 Hours
Revision of core courses, electives, and research topics.

Stage II: Seminar Presentation – 3 Hours
Deliver seminar summarizing dissertation work or published papers.

Stage III: Viva Examination – 3 Hours
Comprehensive viva-voce covering program outcomes and research depth.

Stage IV: Evaluation & Feedback – 3 Hours
Panel review of presentation, documentation, and analytical capabilities.

Stage V: Publication Outcome – 3 Hours
Submission or acceptance of research article in indexed journal/conference.

Evaluation Criteria / Deliverables

• Continuous evaluation based on progress reviews, innovation, implementation, and documentation.
• Final evaluation through report submission, viva-voce, and publication quality.
• Adherence to AICTE/UGC M.Tech dissertation guidelines and institutional norms.

Text / Reference Books / Guidelines

• Katz, M.J. – From Research to Manuscript, Springer.
• Elsevier Author & Reviewer Guidelines (2024).
• AICTE Guidelines for M.Tech Comprehensive Viva & Seminar Evaluation (2023).

M.Tech in Health Robotics & Assisted Nursing
Comprehensive Detailed Syllabus (Semesters I–IV)

Detailed Syllabus – Semester I

HRA 101 - Human Anatomy, Physiology & Biomechanics for Engineers
L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives
• Understand human anatomy and physiological functions relevant to biomedical and robotic design.
• Analyze musculoskeletal biomechanics for development of prosthetics, exoskeletons, and assistive robots.
• Apply anatomical knowledge in designing human-centered health robotic systems.

Course Outcomes
CO1: Understand human anatomy and physiological functions relevant to biomedical and robotic design.
CO2: Analyze musculoskeletal biomechanics for development of prosthetics, exoskeletons, and assistive robots.
CO3: Apply anatomical knowledge in designing human-centered health robotic systems.

Detailed Syllabus

Unit I: Introduction to Human Anatomy & Physiology – 9 Hours
Overview of body organization, tissues, organs, and systems; anatomical terminology; applications in robotic surgery and diagnostics.

Unit II: Musculoskeletal System – 9 Hours
Bone structure, joints, muscles; biomechanics of movement and load; robotic arm and exoskeleton motion parallels.

Unit III: Cardiovascular & Respiratory Systems – 9 Hours
Blood circulation, heart physiology, respiration; monitoring using wearable and robotic health sensors.

Unit IV: Nervous & Sensory Systems – 9 Hours
Neuron structure, reflex arcs, proprioception; control strategies for robotic feedback and motion sensing.

Unit V: Biomechanics in Robotics – 9 Hours
Kinetics, kinematics, gait analysis; case studies: robotic prosthetic leg, rehabilitation robotics, and nursing assist devices.

Text / Reference Books
• Tortora & Derrickson – Principles of Anatomy and Physiology, Wiley.

• Nordin & Frankel – Basic Biomechanics of the Musculoskeletal System, Lippincott Williams & Wilkins.
• Humphrey, J.D. – Cardiovascular Solid Mechanics, Springer.

HRA 102 - Fundamentals of Robotics and Mechatronic Systems

L-T-P: 3-1-0 | Credits: 4 | Total Hours: 60

Course Objectives

• Understand basic concepts of robotics, kinematics, and mechatronic systems.
• Develop knowledge of robot motion, sensors, actuators, and control for healthcare applications.
• Apply mechatronic principles to design assistive and nursing robots.

Course Outcomes

CO1: Understand basic concepts of robotics, kinematics, and mechatronic systems.
CO2: Develop knowledge of robot motion, sensors, actuators, and control for healthcare applications.
CO3: Apply mechatronic principles to design assistive and nursing robots.

Detailed Syllabus

Unit I: Introduction to Robotics – 12 Hours
Definition, components, and classification of robots; healthcare and service robots; rehabilitation and nursing robotics overview.

Unit II: Kinematics & Dynamics – 12 Hours
Forward and inverse kinematics, workspaces, degrees of freedom; application to surgical and nursing robots.

Unit III: Actuation Systems – 12 Hours
Motors, pneumatic and hydraulic actuators, joint control; robotic arm design for physiotherapy applications.

Unit IV: Mechatronic System Integration – 12 Hours
Embedded systems, microcontrollers, sensors, and signal interfacing; control logic for assistive robots.

Unit V: Healthcare Applications – 12 Hours
Case studies: robotic rehabilitation, patient-assist robots, robotic drug dispensing systems.

Text / Reference Books

• Craig, J.J. – Introduction to Robotics: Mechanics and Control, Pearson.
• Spong, M.W. – Robot Dynamics and Control, Wiley.
• Bolton, W. – Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson.

HRA 103 - Sensors, Actuators & Control Systems in Healthcare Devices

L-T-P: 3-0-2 | Credits: 4 | Total Hours: 60

Course Objectives

• Understand the working principles of sensors and actuators used in healthcare robots.
• Design control systems for assistive and therapeutic robotic applications.
• Integrate feedback and control strategies for intelligent patient-care systems.

Course Outcomes

CO1: Understand the working principles of sensors and actuators used in healthcare robots.
CO2: Design control systems for assistive and therapeutic robotic applications.
CO3: Integrate feedback and control strategies for intelligent patient-care systems.

Detailed Syllabus

Unit I: Sensors in Healthcare – 12 Hours
Temperature, pressure, motion, force, and biosensors; applications in patient monitoring and rehabilitation devices.

Unit II: Actuators & Transducers – 12 Hours
DC motors, stepper motors, pneumatic actuators; micro-actuators for minimally invasive robotic tools.

Unit III: Control System Basics – 12 Hours
Open-loop and closed-loop control; PID control; system stability; robotic arm and wheelchair control examples.

Unit IV: Advanced Control in Robotics – 12 Hours
Adaptive and fuzzy logic control; human-in-the-loop feedback; nursing robot motion control.

Unit V: System Integration & Safety – 12 Hours
Real-time interfacing, safety standards in medical devices; ISO and IEC compliance in healthcare robotics.

Text / Reference Books

• Kuo, B.C. – Automatic Control Systems, Wiley.
• John G. Webster – Medical Instrumentation: Application and Design, Wiley.
• De Silva, C.W. – Sensors and Actuators: Control System Instrumentation, CRC Press.

HRA 104 - AI & Machine Learning for Health Robotics

L-T-P: 3-0-2 | Credits: 4 | Total Hours: 60

Course Objectives

• Understand core concepts of AI and ML for intelligent healthcare robots.

• Develop ML algorithms for diagnosis, monitoring, and assistive robotic functions.
• Apply neural networks and deep learning to healthcare image and signal data.

Course Outcomes

CO1: Understand core concepts of AI and ML for intelligent healthcare robots.
CO2: Develop ML algorithms for diagnosis, monitoring, and assistive robotic functions.
CO3: Apply neural networks and deep learning to healthcare image and signal data.

Detailed Syllabus

Unit I: Introduction to AI & ML – 12 Hours
Overview of AI in healthcare; supervised, unsupervised, and reinforcement learning; healthcare datasets.

Unit II: Machine Learning Techniques – 12 Hours
Regression, decision trees, clustering, and SVMs; predictive modeling for patient monitoring.

Unit III: Deep Learning Architectures – 12 Hours
CNNs, RNNs, and LSTMs; applications in image-guided robotic surgery and EEG-based control.

Unit IV: AI Integration in Robots – 12 Hours
Speech and gesture recognition, natural language interfaces; intelligent nursing assistance systems.

Unit V: Ethical AI in Healthcare – 12 Hours
Bias, transparency, patient data privacy, and responsible AI frameworks.

Text / Reference Books

• Goodfellow, I. – Deep Learning, MIT Press.
• Bishop, C.M. – Pattern Recognition and Machine Learning, Springer.
• Topol, E. – Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again, Basic Books.

HRA 105 - Health Robotics Simulation & Prototyping Lab (MATLAB / ROS / Arduino / SolidWorks)

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Develop hands-on experience in designing and simulating healthcare robotic systems.
• Use MATLAB, ROS, and SolidWorks for modeling, simulation, and control of assistive robots.

Course Outcomes

CO1: Develop hands-on experience in designing and simulating healthcare robotic systems.

CO2: Use MATLAB, ROS, and SolidWorks for modeling, simulation, and control of assistive robots.

Detailed Syllabus

Unit I: Introduction to Simulation Tools – 6 Hours
Overview of MATLAB, ROS, Arduino IDE, SolidWorks, and sensors integration.

Unit II: Robot Modeling & Kinematics – 6 Hours
Forward and inverse kinematic simulation for robotic arms used in physiotherapy.

Unit III: Sensor Interfacing – 6 Hours
Integration of biosensors and actuators in robotic prototypes; patient vitals monitoring.

Unit IV: Control & Motion Programming – 6 Hours
PID control tuning and motion planning for assistive robots.

Unit V: Prototype Project – 6 Hours
Develop and demonstrate a healthcare robot prototype using simulation platforms.

Text / Reference Books

• Quigley, M. – Programming Robots with ROS, O'Reilly.
• MathWorks – MATLAB Robotics System Toolbox Documentation.
• Bolton, W. – Mechatronics: Control Systems for Engineers, Pearson.

HRA 106 - Research Methodology, Biostatistics & IPR (Audit Course)

L-T-P: 2-0-0 | Credits: 0 | Total Hours: 30

Course Objectives

• Understand research methodology and statistical tools relevant to healthcare and robotics.
• Apply biostatistical analysis for research data in nursing and robotics applications.
• Understand intellectual property rights and research ethics.

Course Outcomes

CO1: Understand research methodology and statistical tools relevant to healthcare and robotics.
CO2: Apply biostatistical analysis for research data in nursing and robotics applications.
CO3: Understand intellectual property rights and research ethics.

Detailed Syllabus

Unit I: Introduction to Research – 6 Hours
Research design, quantitative and qualitative methods, and hypothesis formulation.

Unit II: Biostatistics – 6 Hours
Descriptive statistics, probability, t-tests, ANOVA, and regression in healthcare data.

Unit III: Data Interpretation & Tools – 6 Hours
Use of MATLAB, SPSS, and Python for data analysis and visualization.

Unit IV: Intellectual Property Rights – 6 Hours
Patents, copyrights, trademarks, and case studies in medical robotics IP.

Unit V: Research Ethics – 6 Hours
Plagiarism, informed consent, data protection, and publication ethics.

Text / Reference Books

• C.R. Kothari – Research Methodology: Methods and Techniques, New Age International.
• Rosner, B. – Fundamentals of Biostatistics, Cengage Learning.
• WIPO – Intellectual Property Handbook, WIPO Publication.

M.Tech in Health Robotics & Assisted Nursing

Detailed Syllabus – Semester II

HRA 201 - Rehabilitation Robotics and Human–Robot Interaction

L-T-P: 3-0-2 | Credits: 4 | Total Hours: 60

Course Objectives

• Understand rehabilitation engineering concepts and robotic systems for assisted therapy.
• Design and analyze human–robot interaction (HRI) for physical and cognitive rehabilitation.
• Apply safety and ergonomics principles in developing human-centered rehabilitation robots.

Course Outcomes

CO1: Understand rehabilitation engineering concepts and robotic systems for assisted therapy.
CO2: Design and analyze human–robot interaction (HRI) for physical and cognitive rehabilitation.
CO3: Apply safety and ergonomics principles in developing human-centered rehabilitation robots.

Detailed Syllabus

Unit I: Introduction to Rehabilitation Robotics – 12 Hours
Rehabilitation engineering concepts; robotic therapy devices; upper- and lower-limb rehabilitation systems.

Unit II: Human–Robot Interaction Principles – 12 Hours
Physical HRI and cognitive HRI; perception, communication, and adaptive control for patient interaction.

Unit III: Kinematics and Control in Rehabilitation – 12 Hours

Trajectory planning, impedance control, assist-as-needed algorithms for exoskeletons.

Unit IV: Sensors and Feedback Mechanisms – 12 Hours
Force, EMG, and vision sensors; feedback strategies for therapy outcome monitoring.

Unit V: Clinical Case Studies – 12 Hours
Post-stroke rehabilitation, gait assistance, and robotic physiotherapy systems in nursing contexts.

Text / Reference Books

• Reinkensmeyer, D.J. – Rehabilitation Robotics, CRC Press.
• Nef, T. – Neurorehabilitation Technology, Springer.
• Siciliano & Khatib – Springer Handbook of Robotics, Springer.

HRA 202 - Embedded Systems & IoT for Healthcare Monitoring

L-T-P: 3-0-2 | Credits: 4 | Total Hours: 60

Course Objectives

• Understand architecture and design of embedded systems in healthcare applications.
• Integrate IoT-based devices for patient health monitoring and data analytics.
• Implement communication protocols and cloud-based healthcare data systems.

Course Outcomes

CO1: Understand architecture and design of embedded systems in healthcare applications.
CO2: Integrate IoT-based devices for patient health monitoring and data analytics.
CO3: Implement communication protocols and cloud-based healthcare data systems.

Detailed Syllabus

Unit I: Embedded Systems Basics – 12 Hours
Microcontrollers, ARM architectures, real-time systems, and healthcare device integration.

Unit II: IoT Fundamentals – 12 Hours
Sensors, communication protocols (Bluetooth, ZigBee, Wi-Fi, LoRa); IoT in nursing and patient care.

Unit III: Cloud & Edge Computing – 12 Hours
Healthcare data storage, real-time data analysis, edge AI for medical IoT devices.

Unit IV: Embedded Software Design – 12 Hours
Firmware programming, Arduino/Raspberry Pi applications for vital sign monitoring.

Unit V: IoT Applications in Healthcare – 12 Hours
Remote patient monitoring, ICU automation, smart beds, and wearable health devices.

Text / Reference Books

• Wolf, W. – Computers as Components: Principles of Embedded Computing, Morgan Kaufmann.

• Dey, N. – Smart Healthcare Systems, Elsevier.
• Mahalik, N.P. – Sensor Networks and Configuration, Springer.

HRA 203 - Clinical Nursing Informatics and Patient Safety Systems

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the fundamentals of clinical informatics and healthcare information management.
• Apply informatics tools for patient safety and nursing workflow optimization.
• Design digital systems for safe, efficient, and data-driven nursing practices.

Course Outcomes

CO1: Understand the fundamentals of clinical informatics and healthcare information management.
CO2: Apply informatics tools for patient safety and nursing workflow optimization.
CO3: Design digital systems for safe, efficient, and data-driven nursing practices.

Detailed Syllabus

Unit I: Introduction to Clinical Informatics – 9 Hours
Definition, evolution, and scope; nursing informatics standards (HL7, FHIR).

Unit II: Electronic Health Records – 9 Hours
EHR structure, interoperability, and security; data privacy and ethical compliance.

Unit III: Patient Safety & Risk Management – 9 Hours
Error prevention systems, automated alerts, clinical decision support systems.

Unit IV: Nursing Workflow Optimization – 9 Hours
Mobile informatics tools for nursing documentation and shift management.

Unit V: Analytics for Patient Care – 9 Hours
Data-driven safety analysis, predictive alerts for medication and fall prevention.

Text / Reference Books

• Hebda, T. – Handbook of Informatics for Nurses and Healthcare Professionals, Pearson.
• Hoyt, R.E. – Health Informatics: Practical Guide, Informatics Education.
• Topol, E. – The Patient Will See You Now, Basic Books.

HRA E1A - Elective I (A): Assistive & Companion Robots for Elderly Care

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand social, cognitive, and physical assistance through companion robots.
• Design robotic systems tailored for elderly care and geriatric nursing.

• Analyze ethical and emotional factors in human–robot companionship.

Course Outcomes

CO1: Understand social, cognitive, and physical assistance through companion robots.
CO2: Design robotic systems tailored for elderly care and geriatric nursing.
CO3: Analyze ethical and emotional factors in human–robot companionship.

Detailed Syllabus

Unit I: Introduction to Assistive Robotics – 9 Hours
Classification of assistive robots; social, service, and mobility assistance systems.

Unit II: Human Factors in Elderly Care – 9 Hours
User perception, emotional interaction, and acceptability of robots by elderly patients.

Unit III: Design for Geriatric Assistance – 9 Hours
Mobility, feeding, and communication aid design principles.

Unit IV: AI in Companion Robots – 9 Hours
Emotion recognition, speech interaction, adaptive learning for companionship.

Unit V: Ethics & Case Studies – 9 Hours
Ethical frameworks, privacy, and social acceptance case studies (Pepper, Paro, ElliQ).

Text / Reference Books

• Shibata, T. – Socially Assistive Robots for Elderly Care, Springer.
• Tapus, A. – Companion Robots and Human–Robot Interaction, Elsevier.
• Calo, R. – Robotics and the Lessons of Cyberlaw, California Law Review.

HRA E1B - Elective I (B): Biomedical Signal & Image Processing

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand biomedical signals and imaging systems used in healthcare monitoring.
• Apply signal processing techniques for physiological data analysis.
• Implement image processing algorithms for medical diagnosis and robot-assisted imaging.

Course Outcomes

CO1: Understand biomedical signals and imaging systems used in healthcare monitoring.
CO2: Apply signal processing techniques for physiological data analysis.
CO3: Implement image processing algorithms for medical diagnosis and robot-assisted imaging.

Detailed Syllabus

Unit I: Biomedical Signal Basics – 9 Hours
EEG, ECG, EMG signal characteristics; signal acquisition systems.

Unit II: Preprocessing & Filtering – 9 Hours
Noise removal, digital filters, spectral analysis for healthcare data.

Unit III: Image Processing Fundamentals – 9 Hours
Segmentation, enhancement, and edge detection in medical images.

Unit IV: Feature Extraction – 9 Hours
PCA, ICA, wavelets for pattern recognition in diagnostics.

Unit V: Applications – 9 Hours
Robot-guided surgery imaging, radiomics, and 3D reconstruction.

Text / Reference Books

- Rangayyan, R.M. – Biomedical Signal Analysis, Wiley.
- Gonzalez & Woods – Digital Image Processing, Pearson.
- Acharya, R. – Biomedical Image Analysis, CRC Press.

HRA E2A - Elective II (A): AI in Clinical Decision Support Systems

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand AI-based clinical decision support system design and implementation.
- Apply predictive analytics for diagnostics, treatment, and hospital resource management.
- Integrate ML algorithms for patient risk prediction and outcome evaluation.

Course Outcomes

CO1: Understand AI-based clinical decision support system design and implementation.
CO2: Apply predictive analytics for diagnostics, treatment, and hospital resource management.
CO3: Integrate ML algorithms for patient risk prediction and outcome evaluation.

Detailed Syllabus

Unit I: Overview of CDSS – 9 Hours
Architecture and workflow of CDSS; rule-based and knowledge-based systems.

Unit II: Data Management – 9 Hours
EHR integration, data preprocessing, and standardization (HL7, FHIR).

Unit III: Machine Learning for CDSS – 9 Hours
Supervised and unsupervised models for patient monitoring and disease prediction.

Unit IV: Deep Learning in Clinical Diagnosis – 9 Hours
CNNs for medical imaging and NLP models for report summarization.

Unit V: Ethical AI & Case Studies – 9 Hours
AI bias, transparency, real-world CDSS implementations in hospitals.

Text / Reference Books

• Kawamoto, K. – Clinical Decision Support Systems: Theory and Practice, Springer.
• Dey, N. – Intelligent Healthcare Analytics, Elsevier.
• Topol, E. – Deep Medicine, Basic Books.

HRA E2B - Elective II (B): Robotic Surgery Systems & Haptics

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand robotic surgery architectures and haptic feedback systems.
• Develop control algorithms for precision and safety in surgical robotics.
• Apply haptic technology for tactile feedback in minimally invasive procedures.

Course Outcomes

CO1: Understand robotic surgery architectures and haptic feedback systems.
CO2: Develop control algorithms for precision and safety in surgical robotics.
CO3: Apply haptic technology for tactile feedback in minimally invasive procedures.

Detailed Syllabus

Unit I: Surgical Robotics Overview – 9 Hours
Da Vinci system architecture, teleoperation, and minimally invasive surgery principles.

Unit II: Kinematics & Control – 9 Hours
Manipulator control, precision motion, and constraint-based control for surgery.

Unit III: Haptics Fundamentals – 9 Hours
Force feedback, tactile sensing, and human perception of touch.

Unit IV: Haptic Device Design – 9 Hours
Actuator and sensor design; virtual environments for surgical simulation.

Unit V: Applications – 9 Hours
Case studies: robotic laparoscopic systems, orthopedic surgery robotics, and tele-surgery.

Text / Reference Books

• Tavakoli, M. – Haptics for Teleoperated Surgical Robotic Systems, Springer.
• Howe, R.D. – Haptic Interfaces for Virtual Environments, Wiley.
• Rosen, J. – Surgical Robotics: Systems, Applications, and Visions, Springer.

HRA 204 - Technical Seminar & Case Study on Health Robotics

L-T-P: 0-2-0 | Credits: 2 | Total Hours: 30

Course Objectives

• Develop communication, analytical, and presentation skills in health robotics research.

• Perform literature review and case study analysis on emerging healthcare robotics applications.

Course Outcomes

CO1: Develop communication, analytical, and presentation skills in health robotics research.
CO2: Perform literature review and case study analysis on emerging healthcare robotics applications.

Detailed Syllabus

Unit I: Topic Selection – 6 Hours
Choose current topics in robotics, AI, or nursing informatics for seminar presentation.

Unit II: Literature Review – 6 Hours
Analyze scientific papers and summarize technological trends.

Unit III: Presentation Skills – 6 Hours
Prepare seminar slides, visuals, and research documentation.

Unit IV: Case Study Analysis – 6 Hours
Present case studies on healthcare robotics startups or hospital applications.

Unit V: Evaluation & Discussion – 6 Hours
Q&A, feedback sessions, and report submission.

Text / Reference Books

• Katz, M.J. – From Research to Manuscript, Springer.
• Day, R.A. – How to Write and Publish a Scientific Paper, Cambridge University Press.

M.Tech in Health Robotics & Assisted Nursing

Detailed Syllabus – Semester III

HRA 301 - Intelligent Prosthetics & Exoskeleton Design

L-T-P: 3-0-2 | Credits: 4 | Total Hours: 60

Course Objectives

• Understand biomechanical and control principles for prosthetics and exoskeletons.
• Design intelligent prosthetic systems integrated with sensors, actuators, and AI.
• Analyze gait patterns and develop adaptive control systems for rehabilitation.

Course Outcomes

CO1: Understand biomechanical and control principles for prosthetics and exoskeletons.
CO2: Design intelligent prosthetic systems integrated with sensors, actuators, and AI.
CO3: Analyze gait patterns and develop adaptive control systems for rehabilitation.

Detailed Syllabus

Unit I: Introduction to Prosthetics & Exoskeletons – 12 Hours
History, classification, materials, and design evolution; lower- and upper-limb prostheses; nursing and rehabilitation perspectives.

Unit II: Biomechanics & Human Motion Analysis – 12 Hours
Kinematics and dynamics of walking; gait cycle and motion data analysis using wearable sensors.

Unit III: Sensing & Actuation Mechanisms – 12 Hours
Force, pressure, and EMG sensors; actuators and servo control in exoskeletons.

Unit IV: Control & Intelligence – 12 Hours
PID, adaptive, and neural control; AI-assisted motion prediction for prosthetic automation.

Unit V: Applications & Case Studies – 12 Hours
Clinical case studies – robotic prosthetic legs, stroke recovery exoskeletons, and pediatric rehabilitation devices.

Text / Reference Books

- Dollar, A.M. – Powered Prosthetics and Exoskeletons, CRC Press.
- Herr, H. – Exoskeletons and Rehabilitation Robotics, Springer.
- Pons, J.L. – Wearable Robots: Biomechatronic Exoskeletons, Wiley.

HRA 302 - Tele-Nursing and Remote Assistance Systems

L-T-P: 3-0-2 | Credits: 4 | Total Hours: 60

Course Objectives

- Understand design and deployment of tele-nursing systems for patient monitoring.
- Apply IoT, robotics, and AI to enable remote nursing and clinical assistance.
- Develop knowledge of communication, safety, and data standards in telehealth systems.

Course Outcomes

CO1: Understand design and deployment of tele-nursing systems for patient monitoring.
CO2: Apply IoT, robotics, and AI to enable remote nursing and clinical assistance.
CO3: Develop knowledge of communication, safety, and data standards in telehealth systems.

Detailed Syllabus

Unit I: Introduction to Tele-Nursing – 12 Hours
Concepts, advantages, and limitations; remote healthcare and telenursing applications.

Unit II: System Architecture – 12 Hours
Hardware and software components, communication protocols, and network integration.

Unit III: AI & Robotics in Tele-Assistance – 12 Hours
Autonomous mobile robots, AI chatbots for patient support, virtual nursing assistants.

Unit IV: Data Management & Security – 12 Hours
HIPAA, GDPR, and national telehealth standards for secure patient data exchange.

Unit V: Applications & Case Studies – 12 Hours
Case studies: robotic telepresence, virtual wards, ICU remote monitoring, and home-care nursing robots.

Text / Reference Books

• Tuckson, R.V. – Telemedicine: Changing the Landscape of Healthcare Delivery, NEJM.
• Mahapatra, S. – Telehealth and Nursing Informatics, Elsevier.
• Ryu, S. – Telemedicine: Opportunities and Developments in Member States, WHO Report.

HRA E3A - Program Elective III (A): Wearable Health Devices & Smart Fabrics

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the materials and technologies used in wearable health monitoring devices.
• Design smart fabrics and e-textiles for physiological monitoring.
• Integrate sensor systems and communication modules for continuous healthcare assessment.

Course Outcomes

CO1: Understand the materials and technologies used in wearable health monitoring devices.
CO2: Design smart fabrics and e-textiles for physiological monitoring.
CO3: Integrate sensor systems and communication modules for continuous healthcare assessment.

Detailed Syllabus

Unit I: Introduction to Wearable Technologies – 9 Hours
Overview of wearable sensors and smart textiles in healthcare.

Unit II: Sensors & Materials – 9 Hours
Flexible sensors, conductive fibers, biosignal measurement (ECG, SpO2, EMG).

Unit III: Data Acquisition & Communication – 9 Hours
Signal processing, wireless data transfer (BLE, NFC), and power management.

Unit IV: Smart Fabric Integration – 9 Hours
Textile-based integration techniques, durability, and biocompatibility.

Unit V: Applications – 9 Hours

Postural tracking, fall detection, smart garments for vital monitoring and rehabilitation feedback.

Text / Reference Books

• Stoppa, M. – Wearable Electronics and Smart Textiles, Springer.
• Dunne, L. – Smart Textiles for Health Monitoring, Elsevier.
• Tao, X. – Handbook of Smart Textiles, Springer.

HRA E3B - Program Elective III (B): Cyber-Physical Systems in Healthcare

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the architecture and integration of cyber-physical systems (CPS) in healthcare environments.
• Develop CPS solutions for remote diagnostics and intelligent hospital systems.
• Apply real-time data analytics and control strategies in patient care.

Course Outcomes

CO1: Understand the architecture and integration of cyber-physical systems (CPS) in healthcare environments.
CO2: Develop CPS solutions for remote diagnostics and intelligent hospital systems.
CO3: Apply real-time data analytics and control strategies in patient care.

Detailed Syllabus

Unit I: Introduction to CPS – 9 Hours
Definition, layers, and communication frameworks in CPS; healthcare cybernetics.

Unit II: Sensors & Actuation – 9 Hours
Real-time sensing, actuation, and feedback loops in patient-care systems.

Unit III: Modeling & Control – 9 Hours
Control-theoretic modeling for health monitoring and adaptive response systems.

Unit IV: Security & Privacy – 9 Hours
Risk management, cyber defense, and secure data communication in hospitals.

Unit V: Applications – 9 Hours
Smart ICU systems, robotic logistics, and CPS-enabled hospital automation.

Text / Reference Books

• Lee, E.A. – Introduction to Embedded Systems: A Cyber-Physical Systems Approach, MIT Press.
• Rajkumar, R. – Cyber-Physical Systems, Springer.
• Dey, N. – Smart Healthcare Cyber-Physical Systems, Elsevier.

HRA OE1A - Open Elective I (A): Advanced 3D Printing for Prosthetic Devices

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand additive manufacturing processes for prosthetics and medical implants.
• Design 3D models for patient-specific prosthetic components.
• Integrate material science and simulation for biomedical additive fabrication.

Course Outcomes

CO1: Understand additive manufacturing processes for prosthetics and medical implants.
CO2: Design 3D models for patient-specific prosthetic components.
CO3: Integrate material science and simulation for biomedical additive fabrication.

Detailed Syllabus

Unit I: Introduction to 3D Printing – 9 Hours
Additive manufacturing principles, process classification, and advantages in healthcare.

Unit II: Design & Modeling – 9 Hours
CAD modeling, topology optimization, and design constraints for biomedical use.

Unit III: Materials for Medical Printing – 9 Hours
Biocompatible polymers, metals, and composites; sterilization and durability testing.

Unit IV: Printing Techniques – 9 Hours
FDM, SLS, SLA, and bioprinting technologies for prosthetic development.

Unit V: Applications – 9 Hours
Patient-specific implants, orthotics, surgical guides, and dental prosthetics.

Text / Reference Books

• Gibson, I. – Additive Manufacturing Technologies, Springer.
• Bartolo, P. – Biomedical 3D Printing, Elsevier.
• Sun, J. – Bioprinting in Regenerative Medicine, Springer.

HRA OE1B - Open Elective I (B): AI-Driven Rehabilitation Planning

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Apply AI and data analytics for individualized rehabilitation planning and assessment.
• Develop intelligent rehabilitation frameworks using multimodal patient data.
• Evaluate therapy progress using predictive and adaptive algorithms.

Course Outcomes

CO1: Apply AI and data analytics for individualized rehabilitation planning and assessment.

CO2: Develop intelligent rehabilitation frameworks using multimodal patient data.
CO3: Evaluate therapy progress using predictive and adaptive algorithms.

Detailed Syllabus

Unit I: Introduction to AI in Rehabilitation – 9 Hours
AI models for therapy personalization and recovery trajectory analysis.

Unit II: Data Acquisition & Analysis – 9 Hours
Collection of motion, EMG, and vital signals; preprocessing for AI-based models.

Unit III: Predictive Analytics – 9 Hours
Regression, classification, and time-series forecasting for patient outcomes.

Unit IV: Adaptive Learning Systems – 9 Hours
Reinforcement learning, feedback adaptation, and therapist-in-loop designs.

Unit V: Applications – 9 Hours
Neurorehabilitation, post-stroke recovery, and cognitive therapy optimization.

Text / Reference Books

- Reinkensmeyer, D.J. – Computational Neurorehabilitation, Springer.
- Topol, E. – Deep Medicine, Basic Books.
- Dey, N. – Intelligent Healthcare Analytics, Elsevier.

HRA 303 - Mini Project / Design Studio – I (Prototype Development)

L-T-P: 0-0-8 | Credits: 4 | Total Hours: 60

Course Objectives

- Design and develop healthcare robotic prototypes integrating interdisciplinary knowledge.
- Apply design thinking and project management for healthcare product innovation.

Course Outcomes

CO1: Design and develop healthcare robotic prototypes integrating interdisciplinary knowledge.
CO2: Apply design thinking and project management for healthcare product innovation.

Detailed Syllabus

Unit I: Problem Identification – 12 Hours
Define healthcare or nursing challenge requiring robotic or assistive solution.

Unit II: Conceptual Design – 12 Hours
Develop concept sketches, CAD models, and control logic architecture.

Unit III: Implementation – 12 Hours
Build prototypes using Arduino, sensors, and actuators; integrate control software.

Unit IV: Testing & Validation – 12 Hours
Functional verification, clinical feedback collection, and performance evaluation.

Unit V: Documentation & Presentation – 12 Hours
Prepare report, present design outcomes, and plan for publication or patent.

Text / Reference Books

- AICTE Project-Based Learning Manual (2023).
- Springer Series on Medical Robotics and Applications.
- IEEE Access – Health Robotics Innovation Case Studies.

M.Tech in Health Robotics & Assisted Nursing

Detailed Syllabus – Semester IV

HRA 401 - Major Thesis / Industry-Linked Research Project

L-T-P: 0-0-24 | Credits: 12 | Total Hours: 180

Course Objectives

- Undertake advanced research or an industry-defined problem integrating healthcare robotics and assisted nursing systems.
- Apply design, experimentation, and analytical methodologies to solve real-world challenges in healthcare technology.
- Collaborate with hospitals, startups, or research labs for translational research and innovation.
- Demonstrate competence in project management, ethics, and scientific communication.
- Generate tangible outcomes such as patents, publications, or deployable products.

Course Outcomes

CO1: Undertake advanced research or an industry-defined problem integrating healthcare robotics and assisted nursing systems.
CO2: Apply design, experimentation, and analytical methodologies to solve real-world challenges in healthcare technology.
CO3: Collaborate with hospitals, startups, or research labs for translational research and innovation.
CO4: Demonstrate competence in project management, ethics, and scientific communication.
CO5: Generate tangible outcomes such as patents, publications, or deployable products.

Detailed Structure / Phases

Phase I: Project Definition & Literature Review – 36 Hours
Identify research gaps through literature survey and industry consultation. Define clear objectives, scope, and deliverables.

Phase II: System Design & Methodology – 36 Hours

Develop conceptual models, algorithms, and design specifications for robotic or IoT-based healthcare systems.

Phase III: Implementation & Experimentation – 36 Hours
Fabricate or simulate prototypes; conduct experiments, collect clinical or lab data, and evaluate results.

Phase IV: Analysis, Validation & Optimization – 36 Hours
Data interpretation, statistical validation, performance tuning, and comparison with benchmark studies.

Phase V: Thesis Documentation & Dissemination – 36 Hours
Compile dissertation, prepare technical paper for publication, and defend findings through presentation and viva.

Evaluation Components / Deliverables

- Continuous Evaluation (Internal Guide / Industry Mentor) – 30%
- Mid-Term Progress Review – 20%
- Final Thesis Evaluation (Panel Assessment) – 30%
- Publication / Patent / Prototype Outcome – 10%
- Viva-Voce & Presentation – 10%

Deliverables include: Progress Reports, Working Prototype / Simulation, Research Paper Draft / Patent Disclosure, and Final Thesis Submission.

Text / Reference Books / Guidelines

- AICTE M.Tech Dissertation Guidelines (2023).
- Creswell, J. – Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE.
- Day, R.A. – How to Write and Publish a Scientific Paper, Cambridge University Press.
- IEEE / Springer Author & Publication Ethics Standards.

HRA 402 - Comprehensive Viva / Research Publication Seminar

L-T-P: 0-0-0 | Credits: 1 | Total Hours: 15

Course Objectives

- Assess the cumulative understanding of robotics, AI, and healthcare integration acquired through the program.
- Develop technical presentation, critical analysis, and scientific writing skills.
- Encourage dissemination of research outcomes via indexed publications or conferences.

Course Outcomes

CO1: Assess the cumulative understanding of robotics, AI, and healthcare integration acquired through the program.
CO2: Develop technical presentation, critical analysis, and scientific writing skills.
CO3: Encourage dissemination of research outcomes via indexed publications or conferences.

Detailed Structure / Phases

Phase I: Preparation & Topic Review – 3 Hours
Revise core subjects and specialization areas; select research focus topic.

Phase II: Seminar Presentation – 3 Hours
Present completed or ongoing research to a review panel with Q&A.

Phase III: Viva Examination – 3 Hours
Comprehensive oral exam evaluating technical depth and interdisciplinary integration.

Phase IV: Feedback & Improvement – 3 Hours
Receive evaluative feedback from faculty and industry experts for improvement.

Phase V: Publication Submission – 3 Hours
Submit or present a paper in a Scopus/SCI-indexed journal or national conference.

Evaluation Components / Deliverables

- Continuous Evaluation (Internal Guide / Industry Mentor) – 30%
- Mid-Term Progress Review – 20%
- Final Thesis Evaluation (Panel Assessment) – 30%
- Publication / Patent / Prototype Outcome – 10%
- Viva-Voce & Presentation – 10%

Deliverables include: Progress Reports, Working Prototype / Simulation, Research Paper Draft / Patent Disclosure, and Final Thesis Submission.

Text / Reference Books / Guidelines

- Katz, M.J. – From Research to Manuscript, Springer.
- Elsevier Author & Reviewer Guidelines (2024).
- AICTE Evaluation Framework for M.Tech Viva & Dissertation (2023).

B.Sc. – Digital Health
Detailed Syllabus – Semester I

DH101 - Human Anatomy & Physiology – I
L-T-P: 3-1-0 | Credits: 4 | Total Hours: 60

Course Objectives
• Understand the basic structure and functions of the human body systems.
• Explain the interrelationship between organ systems and homeostasis.
• Demonstrate knowledge of anatomical terminology relevant to healthcare and digital health.

Course Outcomes
CO1: Understand the basic structure and functions of the human body systems.
CO2: Explain the interrelationship between organ systems and homeostasis.
CO3: Demonstrate knowledge of anatomical terminology relevant to healthcare and digital health.

Detailed Syllabus

Unit I: Introduction to Human Body and Cells – 12 Hours
Overview of human body organization; Anatomical terminology; Structure and function of cell and cell organelles; Cell membrane transport; Homeostasis.

Unit II: Tissues and Musculoskeletal System – 12 Hours
Classification of tissues; Structure and function of bones, joints, and muscles; Skeleton types and muscle physiology.

Unit III: Cardiovascular and Lymphatic Systems – 12 Hours
Structure and function of heart, blood vessels; Blood circulation; Composition of blood; Lymphatic system components and functions.

Unit IV: Respiratory and Digestive Systems – 12 Hours
Anatomy of respiratory tract; Mechanism of respiration; Digestive organs and glands; Process of digestion and absorption.

Unit V: Nervous and Sensory Systems – 12 Hours
Structure and functions of CNS and PNS; Neurons, synapse, and reflex arc; Sense organs – eye, ear, tongue, and skin.

Text / Reference Books
• Tortora & Derrickson – Principles of Anatomy and Physiology, Wiley.
• Ross & Wilson – Anatomy and Physiology in Health and Illness, Elsevier.
• Marieb & Hoehn – Human Anatomy and Physiology, Pearson.

DH102 - Introduction to Healthcare Systems

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the structure, components, and functioning of healthcare systems.
- Describe public and private healthcare delivery models in India and globally.
- Recognize digital transformation trends in modern healthcare systems.

Course Outcomes

CO1: Understand the structure, components, and functioning of healthcare systems.
CO2: Describe public and private healthcare delivery models in India and globally.
CO3: Recognize digital transformation trends in modern healthcare systems.

Detailed Syllabus

Unit I: Overview of Healthcare Systems – 9 Hours
Evolution of healthcare systems; Levels of care – primary, secondary, tertiary; Public vs private healthcare.

Unit II: Healthcare Institutions and Stakeholders – 9 Hours
Hospitals, clinics, diagnostics, pharma, insurance, and NGOs; Roles of healthcare professionals.

Unit III: Health Policy and Governance – 9 Hours
National Health Policy; Ayushman Bharat, NHM, WHO structure; Accreditation bodies (NABH, JCI).

Unit IV: Health System Infrastructure and Challenges – 9 Hours
Healthcare financing; Urban vs rural healthcare; Resource allocation and accessibility.

Unit V: Digital Transformation in Healthcare – 9 Hours
Introduction to eHealth, mHealth, telemedicine; Digital health policies; Future of healthcare ecosystems.

Text / Reference Books

- Sundararaman & Muraleedharan – Healthcare Systems in India, Oxford University Press.
- WHO – Health Systems Framework, WHO Publications.
- Dinesh Kumar – Health Informatics and Digital Health, Elsevier.

DH103 - Basics of Computer Science & Digital Technologies

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand fundamental concepts of computer systems and digital technologies.
- Explain hardware, software, and data representation relevant to health informatics.

• Describe emerging technologies used in digital health systems.

Course Outcomes

CO1: Understand fundamental concepts of computer systems and digital technologies.
CO2: Explain hardware, software, and data representation relevant to health informatics.
CO3: Describe emerging technologies used in digital health systems.

Detailed Syllabus

Unit I: Computer Fundamentals – 9 Hours
History and generations of computers; Components – input, output, CPU, memory; Types of computers.

Unit II: Operating Systems and Software – 9 Hours
System and application software; OS functions; Healthcare software overview.

Unit III: Data Representation and Storage – 9 Hours
Binary, octal, hexadecimal systems; Data encoding; Storage media and databases.

Unit IV: Networking and Internet Basics – 9 Hours
LAN, WAN, Internet, IP addressing, cloud computing fundamentals; Network security.

Unit V: Emerging Digital Technologies – 9 Hours
AI, IoT, Big Data, Blockchain, Cloud, and AR/VR – applications in healthcare.

Text / Reference Books

• Peter Norton – Introduction to Computers, McGraw Hill.
• Rajaraman, V. – Fundamentals of Computers, PHI.
• James F. Kurose – Computer Networking: A Top-Down Approach, Pearson.

DH104 - English Communication & Professional Skills

L-T-P: 2-0-0 | Credits: 2 | Total Hours: 30

Course Objectives

• Develop communication skills essential for healthcare professionals.
• Enhance writing, speaking, and interpersonal abilities for clinical and corporate settings.

Course Outcomes

CO1: Develop communication skills essential for healthcare professionals.
CO2: Enhance writing, speaking, and interpersonal abilities for clinical and corporate settings.

Detailed Syllabus

Unit I: Basics of Communication – 6 Hours
Process, types, and importance of communication in healthcare; Barriers and ethics.

Unit II: Grammar and Vocabulary – 6 Hours

Tenses, articles, prepositions, and sentence correction exercises.

Unit III: Writing Skills – 6 Hours
Professional letters, emails, case summaries, and technical documentation.

Unit IV: Oral Communication – 6 Hours
Public speaking, presentations, and patient communication techniques.

Unit V: Soft Skills and Etiquette – 6 Hours
Teamwork, empathy, time management, grooming, and professional conduct.

Text / Reference Books

- Meenakshi Raman & Sangeeta Sharma – Technical Communication, Oxford.
- Lesikar & Pettit – Business Communication, McGraw Hill.
- Robert Bolton – People Skills, Touchstone.

DH105 - Mathematics for Data Analytics

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand mathematical concepts for data analytics and computational modeling.
- Apply linear algebra, calculus, and probability to health data analysis.

Course Outcomes

CO1: Understand mathematical concepts for data analytics and computational modeling.
CO2: Apply linear algebra, calculus, and probability to health data analysis.

Detailed Syllabus

Unit I: Algebra and Matrices – 9 Hours
Matrix operations, determinants, inverse, and systems of linear equations.

Unit II: Differentiation and Integration – 9 Hours
Basic differentiation, maxima-minima, and definite integrals for data trends.

Unit III: Probability and Statistics – 9 Hours
Probability rules, distributions, mean, median, variance, and standard deviation.

Unit IV: Correlation and Regression – 9 Hours
Simple correlation, regression models, and curve fitting.

Unit V: Applications in Health Data – 9 Hours
Mathematical modeling in epidemiology and biomedical analytics.

Text / Reference Books

- Erwin Kreyszig – Advanced Engineering Mathematics, Wiley.
- Gupta & Kapoor – Fundamentals of Mathematical Statistics, Sultan Chand.
- Anthony & Biggs – Mathematics for Computing, Cambridge University Press.

DH106 - Anatomy & Physiology Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Perform experiments to identify anatomical structures and physiological functions.
• Correlate theoretical knowledge with laboratory observations.

Course Outcomes

CO1: Perform experiments to identify anatomical structures and physiological functions.
CO2: Correlate theoretical knowledge with laboratory observations.

Detailed Syllabus

Unit I: Laboratory Safety & Orientation – 6 Hours
Introduction to lab safety rules and instruments.

Unit II: Microscopy & Cell Study – 6 Hours
Use of microscope; Observation of epithelial and muscle tissues.

Unit III: Skeletal System – 6 Hours
Identification of bones and joints.

Unit IV: Circulatory & Respiratory Systems – 6 Hours
Blood grouping; Measurement of pulse rate and respiration rate.

Unit V: Digestive & Nervous Systems – 6 Hours
Study of models and physiological reflex tests.

Text / Reference Books

• Anatomy & Physiology Practical Manual, Elsevier.
• Guyton & Hall – Textbook of Medical Physiology, Elsevier.

DH107 - Computer Fundamentals Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Gain hands-on experience with basic computing and office tools.
• Apply software applications to data handling and digital documentation.

Course Outcomes

CO1: Gain hands-on experience with basic computing and office tools.
CO2: Apply software applications to data handling and digital documentation.

Detailed Syllabus

Unit I: OS and File Management – 6 Hours

Windows/Linux basics; File and folder operations.

Unit II: MS Word – 6 Hours
Document formatting, tables, mail merge, and referencing.

Unit III: MS Excel – 6 Hours
Formulas, charts, data sorting, and pivot tables.

Unit IV: MS PowerPoint – 6 Hours
Creating professional presentations and reports.

Unit V: Internet and Cloud Tools – 6 Hours
Using Google Workspace, drive sharing, and online collaboration.

Text / Reference Books

- Microsoft Office 365 User Guide – Microsoft Press.
- Rajaraman, V. – Fundamentals of Computers, PHI.

DH108 - Environmental Studies (MC – Non Credit)

L-T-P: 2-0-0 | Credits: 0 | Total Hours: 30

Course Objectives

- Create awareness of environmental issues and sustainability.
- Understand the role of individuals and institutions in environmental conservation.

Course Outcomes

CO1: Create awareness of environmental issues and sustainability.
CO2: Understand the role of individuals and institutions in environmental conservation.

Detailed Syllabus

Unit I: Introduction to Environment – 6 Hours
Definition, scope, importance; Components of environment.

Unit II: Ecosystems – 6 Hours
Structure, types, and functions; Energy flow and food chains.

Unit III: Natural Resources – 6 Hours
Forest, water, mineral, energy resources; Conservation methods.

Unit IV: Environmental Pollution – 6 Hours
Air, water, soil, and noise pollution – causes, effects, and control.

Unit V: Sustainable Development – 6 Hours
Environmental laws, SDGs, climate change, and waste management.

Text / Reference Books

- Erach Bharucha – Textbook of Environmental Studies, UGC.

• Raghavan Nair – Environmental Studies, S. Chand.

B.Sc. – Digital Health
Detailed Syllabus – Semester II

DH201 - Human Anatomy & Physiology – II
L-T-P: 3-1-0 | Credits: 4 | Total Hours: 60

Course Objectives
• Understand the structure and functions of human organ systems not covered in Semester I.
• Describe the endocrine, reproductive, urinary, and integumentary systems and their interactions.
• Apply physiological knowledge to healthcare applications and digital health monitoring.

Course Outcomes
CO1: Understand the structure and functions of human organ systems not covered in Semester I.
CO2: Describe the endocrine, reproductive, urinary, and integumentary systems and their interactions.
CO3: Apply physiological knowledge to healthcare applications and digital health monitoring.

Detailed Syllabus

Unit I: Endocrine System – 12 Hours
Structure and functions of endocrine glands – pituitary, thyroid, adrenal, pancreas, gonads; Hormonal regulation and feedback mechanisms.

Unit II: Reproductive System – 12 Hours
Male and female reproductive organs; Gametogenesis; Menstrual cycle; Fertilization and pregnancy physiology.

Unit III: Urinary System – 12 Hours
Structure of kidney and nephron; Urine formation and regulation; Fluid and electrolyte balance.

Unit IV: Integumentary and Immune Systems – 12 Hours
Skin layers and functions; Wound healing; Basics of immunity, antigens, antibodies, and immune responses.

Unit V: Endocrine Disorders & Diagnostics – 12 Hours
Diabetes, hypothyroidism, hormonal imbalances; Diagnostic procedures using health technologies.

Text / Reference Books
• Tortora & Derrickson – Principles of Anatomy and Physiology, Wiley.
• Ross & Wilson – Anatomy and Physiology in Health and Illness, Elsevier.

• Guyton & Hall – Textbook of Medical Physiology, Elsevier.

DH202 - Biochemistry & Pathology Basics

L-T-P: 3-0-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand biochemical processes relevant to human physiology and disease.
• Describe pathological mechanisms of common diseases.
• Interpret biochemical parameters in digital diagnostic systems.

Course Outcomes

CO1: Understand biochemical processes relevant to human physiology and disease.
CO2: Describe pathological mechanisms of common diseases.
CO3: Interpret biochemical parameters in digital diagnostic systems.

Detailed Syllabus

Unit I: Introduction to Biochemistry – 9 Hours
Biomolecules – carbohydrates, proteins, lipids, nucleic acids; Enzymes and their clinical importance.

Unit II: Metabolism and Bioenergetics – 9 Hours
Glycolysis, Krebs cycle, ATP production, lipid and protein metabolism.

Unit III: Acid-Base Balance and Blood Chemistry – 9 Hours
pH regulation, buffers, blood composition, plasma proteins.

Unit IV: Introduction to Pathology – 9 Hours
Cell injury, inflammation, necrosis, repair, and regeneration.

Unit V: Clinical Pathology – 9 Hours
Blood tests, urine analysis, liver and kidney function tests; Automation in pathology labs.

Text / Reference Books

• Harper – Illustrated Biochemistry, McGraw Hill.
• Satyanarayana & Chakrapani – Biochemistry, Elsevier.
• Muir – Pathology Illustrated, Churchill Livingstone.

DH203 - Database Management Systems

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the fundamental concepts of databases and DBMS architecture.
• Design and implement relational database models using SQL.
• Apply database concepts to health information systems.

Course Outcomes

CO1: Understand the fundamental concepts of databases and DBMS architecture.
CO2: Design and implement relational database models using SQL.
CO3: Apply database concepts to health information systems.

Detailed Syllabus

Unit I: Introduction to Databases – 9 Hours
Data, information, database concepts; DBMS advantages; Architecture and data models.

Unit II: Entity-Relationship Modeling – 9 Hours
ER diagrams, keys, relationships, normalization up to 3NF.

Unit III: SQL and Relational Algebra – 9 Hours
DDL, DML, queries, joins, subqueries; Constraints and views.

Unit IV: Transaction Management – 9 Hours
ACID properties, concurrency control, recovery, backup.

Unit V: Health Data Applications – 9 Hours
EHR databases, patient record management, and HL7/FHIR standards.

Text / Reference Books

• Elmasri & Navathe – Fundamentals of Database Systems, Pearson.
• Ramakrishnan & Gehrke – Database Management Systems, McGraw Hill.
• Coronel & Morris – Database Systems: Design, Implementation, Management, Cengage.

DH204 - Health Information Systems & Electronic Health Records (EHR)

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the components and architecture of health information systems (HIS).
• Explain standards and protocols used in EHR and EMR systems.
• Apply knowledge of HIS to design and evaluate digital health solutions.

Course Outcomes

CO1: Understand the components and architecture of health information systems (HIS).
CO2: Explain standards and protocols used in EHR and EMR systems.
CO3: Apply knowledge of HIS to design and evaluate digital health solutions.

Detailed Syllabus

Unit I: Overview of Health Information Systems – 9 Hours
Definition, importance, and evolution; Types of HIS – hospital, clinical, administrative.

Unit II: Electronic Health Records (EHR) – 9 Hours
EHR vs EMR; Components and workflow; Interoperability challenges.

Unit III: Health Data Standards – 9 Hours
HL7, FHIR, ICD, SNOMED CT, DICOM – applications in digital health.

Unit IV: System Implementation – 9 Hours
EHR system development, testing, and deployment; Change management.

Unit V: Privacy, Security, and Ethics – 9 Hours
Patient consent, data sharing, HIPAA compliance, and ethical use of health data.

Text / Reference Books

- Hoyt & Yoshihashi – Health Informatics: Practical Guide, Informatics Education.
- Benson & Grieve – Principles of Health Interoperability HL7 and FHIR, Springer.
- Shortliffe & Cimino – Biomedical Informatics, Springer.

DH205 - Programming Fundamentals (Python / R)

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Learn the basics of programming logic and problem-solving using Python or R.
- Implement data structures and control flow for healthcare data processing.
- Develop small programs for data cleaning and visualization.

Course Outcomes

CO1: Learn the basics of programming logic and problem-solving using Python or R.
CO2: Implement data structures and control flow for healthcare data processing.
CO3: Develop small programs for data cleaning and visualization.

Detailed Syllabus

Unit I: Introduction to Programming – 9 Hours
Concepts of algorithms, flowcharts, pseudocode; Overview of Python/R environment.

Unit II: Data Types and Operators – 9 Hours
Variables, strings, lists, tuples, arrays; Operators and expressions.

Unit III: Control Structures and Functions – 9 Hours
If, while, for loops; Functions, modules, and exception handling.

Unit IV: Data Handling and Visualization – 9 Hours
File I/O, CSV import/export, basic statistics, Matplotlib/ggplot.

Unit V: Applications in Healthcare – 9 Hours
Simple data analysis and visualization of medical data using Python/R.

Text / Reference Books

- Mark Lutz – Learning Python, O'Reilly.
- Wes McKinney – Python for Data Analysis, O'Reilly.

• Hadley Wickham – R for Data Science, O'Reilly.

DH206 - Database Management Systems Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Gain practical experience in database design and implementation using SQL.
• Perform CRUD operations and queries relevant to healthcare databases.

Course Outcomes

CO1: Gain practical experience in database design and implementation using SQL.
CO2: Perform CRUD operations and queries relevant to healthcare databases.

Detailed Syllabus

Unit I: Introduction to DBMS Tools – 6 Hours
Install and configure MySQL/Oracle; Database creation and schema design.

Unit II: Basic SQL Commands – 6 Hours
Create, insert, update, delete; Constraints and keys.

Unit III: Query Operations – 6 Hours
Select, where, group by, order by, aggregate functions.

Unit IV: Joins and Subqueries – 6 Hours
Inner, outer joins, nested queries, views, and indexing.

Unit V: Healthcare Dataset Project – 6 Hours
Build a mini EHR database and perform analysis queries.

Text / Reference Books

• Oracle SQL Developer User Guide.
• Elmasri & Navathe – Database Systems, Pearson.

DH207 - Digital Health Systems Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Develop hands-on experience with digital health applications and data systems.
• Simulate electronic health record workflows and patient data management.

Course Outcomes

CO1: Develop hands-on experience with digital health applications and data systems.
CO2: Simulate electronic health record workflows and patient data management.

Detailed Syllabus

Unit I: Introduction to HIS and EHR Software – 6 Hours
Exploring open-source HIS (OpenMRS, DHIS2).

Unit II: EHR Data Entry and Retrieval – 6 Hours
Patient registration, diagnosis entry, lab results, and discharge summary.

Unit III: Health Data Standards Practice – 6 Hours
Implement HL7/FHIR-based data exchange using demo tools.

Unit IV: Analytics Dashboard – 6 Hours
Create dashboards for health data visualization using Power BI/Tableau.

Unit V: Mini Project – 6 Hours
Develop a prototype digital health record or patient portal application.

Text / Reference Books

• OpenMRS Implementation Guide – OpenMRS Community.
• WHO Digital Health Atlas – User Handbook.

DH208 - Constitution of India / Universal Human Values (MC – Non Credit)

L-T-P: 2-0-0 | Credits: 0 | Total Hours: 30

Course Objectives

• Understand the constitutional framework of India and human values essential for professional ethics.
• Promote responsible citizenship and ethical behavior in healthcare and technology domains.

Course Outcomes

CO1: Understand the constitutional framework of India and human values essential for professional ethics.
CO2: Promote responsible citizenship and ethical behavior in healthcare and technology domains.

Detailed Syllabus

Unit I: Constitutional Framework – 6 Hours
Preamble, fundamental rights, directive principles, and duties.

Unit II: Governance and Citizenship – 6 Hours
Union and state governments, judiciary, and democratic values.

Unit III: Human Values – 6 Hours
Ethics, empathy, compassion, and integrity in professional life.

Unit IV: Professional Responsibility – 6 Hours
Rights and responsibilities of healthcare technologists.

Unit V: National Integration and Global Ethics – 6 Hours
Harmony, tolerance, sustainable living, and global citizenship.

Text / Reference Books

- Basu, D.D. – Introduction to the Constitution of India, LexisNexis.
- R. Subramanian – Professional Ethics, Oxford University Press.

B.Sc. – Digital Health

Detailed Syllabus – Semester III

DH301 - Medical Terminology & Clinical Workflows

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the origin, structure, and application of medical terms.
- Familiarize with clinical workflows in hospital and healthcare settings.
- Interpret medical records, prescriptions, and diagnostic reports accurately.

Course Outcomes

CO1: Understand the origin, structure, and application of medical terms.
CO2: Familiarize with clinical workflows in hospital and healthcare settings.
CO3: Interpret medical records, prescriptions, and diagnostic reports accurately.

Detailed Syllabus

Unit I: Medical Word Building – 9 Hours
Prefixes, suffixes, root words; Common medical abbreviations; Pronunciation and spelling conventions.

Unit II: Body Systems Terminology – 9 Hours
Terminology related to major body systems – cardiovascular, respiratory, digestive, nervous, and musculoskeletal.

Unit III: Diagnostic and Procedural Terms – 9 Hours
Terminology used in lab tests, imaging, and surgical procedures.

Unit IV: Clinical Documentation – 9 Hours
Structure of medical records; SOAP notes; Discharge summaries and prescriptions.

Unit V: Clinical Workflow & Communication – 9 Hours
Patient registration, OP/IP flow, nursing documentation, electronic order entry systems.

Text / Reference Books

- Chabner, D. – The Language of Medicine, Elsevier.

• Ann Ehrlich – Medical Terminology for Health Professions, Cengage.
• Gartee, R. – Electronic Health Records, Pearson.

DH302 - Epidemiology & Public Health Informatics

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the basic principles and methods of epidemiology.
• Apply data-driven approaches in disease surveillance and public health decision-making.
• Use informatics tools for population health management.

Course Outcomes

CO1: Understand the basic principles and methods of epidemiology.
CO2: Apply data-driven approaches in disease surveillance and public health decision-making.
CO3: Use informatics tools for population health management.

Detailed Syllabus

Unit I: Introduction to Epidemiology – 9 Hours
Definitions, scope, history; Measures of disease frequency – incidence, prevalence, mortality.

Unit II: Study Designs – 9 Hours
Descriptive, analytical, and experimental studies; Bias and confounding.

Unit III: Public Health Systems – 9 Hours
Health indicators, surveillance systems, immunization and screening programs.

Unit IV: Public Health Informatics – 9 Hours
Data standards, sources of health data, informatics architecture for public health.

Unit V: Applications in Digital Health – 9 Hours
Epidemiological dashboards, GIS mapping, real-time disease tracking, AI in outbreak prediction.

Text / Reference Books

• Friis & Sellers – Epidemiology for Public Health Practice, Jones & Bartlett.
• Yasnoff, W.A. – Public Health Informatics, Springer.
• WHO – Public Health Surveillance Guidelines.

DH303 - Data Structures & Algorithms

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand fundamental data structures and algorithms for computational efficiency.

• Implement data structures for health data management using Python/R.
• Analyze algorithm performance and optimize digital health applications.

Course Outcomes
CO1: Understand fundamental data structures and algorithms for computational efficiency.
CO2: Implement data structures for health data management using Python/R.
CO3: Analyze algorithm performance and optimize digital health applications.

Detailed Syllabus

Unit I: Introduction to Data Structures – 9 Hours
Arrays, linked lists, stacks, queues, and their operations.

Unit II: Searching and Sorting Algorithms – 9 Hours
Linear, binary search; Bubble, insertion, merge, and quick sort.

Unit III: Trees and Graphs – 9 Hours
Binary trees, traversal methods; Graph representation and traversal (BFS, DFS).

Unit IV: Algorithm Analysis – 9 Hours
Big O notation; Time and space complexity; Recursion and dynamic programming basics.

Unit V: Applications in Healthcare – 9 Hours
Data structures for patient record retrieval, EHR indexing, and diagnostic pattern matching.

Text / Reference Books
• Goodrich, Tamassia & Goldwasser – Data Structures and Algorithms in Python, Wiley.
• Narasimha Karumanchi – Data Structures and Algorithms Made Easy, CareerMonk.
• Tenenbaum – Data Structures Using C, PHI.

DH304 - Telemedicine & Telehealth Platforms
L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives
• Understand the principles and technologies of telemedicine and telehealth systems.
• Explain the architecture, standards, and applications of teleconsultation platforms.
• Evaluate the benefits and challenges of virtual healthcare delivery.

Course Outcomes
CO1: Understand the principles and technologies of telemedicine and telehealth systems.
CO2: Explain the architecture, standards, and applications of teleconsultation platforms.
CO3: Evaluate the benefits and challenges of virtual healthcare delivery.

Detailed Syllabus

Unit I: Introduction to Telemedicine – 9 Hours
Definition, scope, evolution, and applications; Difference between telemedicine and telehealth.

Unit II: Telecommunication Technologies – 9 Hours
Network infrastructure, bandwidth, audio-video transmission, and telecommunication protocols.

Unit III: System Architecture and Standards – 9 Hours
Telemedicine architecture, HL7, DICOM, and FHIR; Data integration and interoperability.

Unit IV: Teleconsultation and Remote Monitoring – 9 Hours
Virtual consultations, telepathology, telecardiology, remote diagnostics and IoT devices.

Unit V: Legal, Ethical, and Operational Aspects – 9 Hours
Telemedicine guidelines (MoHFW, 2020); Data privacy, consent, and liability.

Text / Reference Books

• Wootton, R. – Introduction to Telemedicine, Royal Society of Medicine Press.
• Nayyar, D. – Telemedicine: Principles and Practice, Elsevier.
• WHO – Telemedicine: Opportunities and Developments Report.

DH305A - Open Elective I (A): Digital Entrepreneurship

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the fundamentals of entrepreneurship in digital and healthcare domains.
• Develop business models integrating technology and healthcare solutions.
• Foster innovation and startup mindset through case-based learning.

Course Outcomes

CO1: Understand the fundamentals of entrepreneurship in digital and healthcare domains.
CO2: Develop business models integrating technology and healthcare solutions.
CO3: Foster innovation and startup mindset through case-based learning.

Detailed Syllabus

Unit I: Introduction to Entrepreneurship – 9 Hours
Entrepreneurship concepts; Types of entrepreneurs; Start-up ecosystem in India.

Unit II: Digital Business Models – 9 Hours
E-commerce, SaaS, and digital platforms; Revenue models and scalability.

Unit III: Healthcare Entrepreneurship – 9 Hours
Digital health startups, MedTech ventures, funding, and regulations.

Unit IV: Innovation and Design Thinking – 9 Hours
Ideation, prototyping, MVP, and customer validation in digital healthcare.

Unit V: Business Plan Development – 9 Hours
Pitch deck, financial planning, and funding sources (VC, CSR, grants).

Text / Reference Books

- Hisrich, R. – Entrepreneurship, McGraw Hill.
- Sangram Vajre – Marketing to Serve Entrepreneurs, Wiley.
- Christensen, C. – The Innovator's Dilemma, Harvard Business Press.

DH305B - Open Elective I (B): Health Communication and Behavior Change

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand principles of communication and behavior change theories in public health.
- Develop health education materials using digital tools and social media.
- Implement campaigns for awareness and preventive healthcare.

Course Outcomes

CO1: Understand principles of communication and behavior change theories in public health.
CO2: Develop health education materials using digital tools and social media.
CO3: Implement campaigns for awareness and preventive healthcare.

Detailed Syllabus

Unit I: Introduction to Health Communication – 9 Hours
Definition, scope, and importance; Communication models in health context.

Unit II: Behavior Change Theories – 9 Hours
Health Belief Model, Theory of Planned Behavior, and Social Cognitive Theory.

Unit III: Strategic Communication – 9 Hours
Planning, audience analysis, message design, and dissemination.

Unit IV: Digital Health Campaigns – 9 Hours
Using social media, mobile apps, and infographics for health promotion.

Unit V: Evaluation and Ethics – 9 Hours
Measuring campaign effectiveness, misinformation control, and ethical communication.

Text / Reference Books

- Rimal, R.N. – Health Communication and Behavior Change, Springer.
- Schiavo, R. – Health Communication: From Theory to Practice, Jossey-Bass.
- WHO – Health Promotion and Education Guidelines.

DH306 - Data Structures Lab

L-T-P: 0-0-4 | Credits: 2 | Total Hours: 30

Course Objectives

• Implement data structures and algorithms practically using Python/R.
• Analyze performance and efficiency of implemented programs.

Course Outcomes

CO1: Implement data structures and algorithms practically using Python/R.
CO2: Analyze performance and efficiency of implemented programs.

Detailed Syllabus

Unit I: Array and List Operations – 6 Hours
Implementation of arrays, stacks, and queues.

Unit II: Sorting and Searching – 6 Hours
Code bubble, insertion, merge, and binary search algorithms.

Unit III: Linked Lists – 6 Hours
Single and doubly linked lists with insertion and deletion.

Unit IV: Trees and Graphs – 6 Hours
Binary tree traversals, BFS, and DFS implementations.

Unit V: Mini Project – 6 Hours
Develop a patient record retrieval system using data structures.

Text / Reference Books

• Goodrich et al. – Data Structures in Python, Wiley.
• Online Python Documentation – python.org.

DH307 - Telemedicine Lab

L-T-P: 0-0-6 | Credits: 3 | Total Hours: 45

Course Objectives

• Gain practical experience with telemedicine platforms and communication technologies.
• Simulate virtual consultations and remote monitoring workflows.

Course Outcomes

CO1: Gain practical experience with telemedicine platforms and communication technologies.
CO2: Simulate virtual consultations and remote monitoring workflows.

Detailed Syllabus

Unit I: Introduction to Telemedicine Tools – 9 Hours
Explore open-source telehealth tools (e.g., Jitsi, OpenMRS, DHIS2).

Unit II: Teleconsultation Simulation – 9 Hours
Set up a mock teleconsultation and create documentation.

Unit III: Remote Monitoring – 9 Hours
IoT integration for vital signs data collection and dashboard setup.

Unit IV: Video and Data Transmission – 9 Hours
Configure video calls and secure data transfer protocols.

Unit V: Mini Project – 9 Hours
Design a prototype telehealth platform for chronic disease management.

Text / Reference Books

• Wootton, R. – Introduction to Telemedicine, Royal Society of Medicine.
• OpenMRS Implementation Guide – OpenMRS Community.
• WHO – Telemedicine Implementation Guidelines, 2020.

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Detailed Syllabus – Semester IV

DH401 - Biostatistics & Research Methodology

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand biostatistical concepts and their applications in health sciences.
• Design, conduct, and analyze research using quantitative and qualitative methods.
• Develop research proposals and interpret scientific results statistically.

Course Outcomes

CO1: Understand biostatistical concepts and their applications in health sciences.
CO2: Design, conduct, and analyze research using quantitative and qualitative methods.
CO3: Develop research proposals and interpret scientific results statistically.

Detailed Syllabus

Unit I: Introduction to Biostatistics – 9 Hours
Definition, importance, and scope; Types of data; Presentation of data using tables and graphs.

Unit II: Descriptive Statistics – 9 Hours
Measures of central tendency and dispersion; Probability concepts and distributions.

Unit III: Sampling and Hypothesis Testing – 9 Hours
Sampling methods, sample size determination, t-test, chi-square test, ANOVA.

Unit IV: Research Methodology – 9 Hours

Research design types, data collection tools, questionnaire design, ethical approval.

Unit V: Report Writing and Presentation – 9 Hours
Structure of research report; Referencing, citation styles, and plagiarism check.

Text / Reference Books

- Kothari, C.R. – Research Methodology, New Age International.
- Mahajan, B.K. – Methods in Biostatistics, Jaypee Brothers.
- Gupta, S. – Research Methodology and Biostatistics, Elsevier.

DH402 - Digital Health Devices, IoT & Wearables

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the architecture and components of IoT systems in healthcare.
- Explore wearable device technologies and their biomedical applications.
- Design and analyze sensor-based digital health monitoring systems.

Course Outcomes

CO1: Understand the architecture and components of IoT systems in healthcare.
CO2: Explore wearable device technologies and their biomedical applications.
CO3: Design and analyze sensor-based digital health monitoring systems.

Detailed Syllabus

Unit I: Introduction to IoT and Wearables – 9 Hours
IoT ecosystem; Sensors, actuators, and communication modules; Evolution of wearables.

Unit II: IoT Architecture – 9 Hours
Device layer, communication layer, cloud layer; IoT protocols and data transfer methods.

Unit III: Wearable Sensors and Devices – 9 Hours
Heart rate, ECG, SpO_2, and temperature sensors; Smart watches and fitness bands.

Unit IV: Data Acquisition and Transmission – 9 Hours
Wireless data transfer, Bluetooth, Wi-Fi, LoRaWAN, and MQTT; Real-time data analytics.

Unit V: IoT in Healthcare Applications – 9 Hours
Remote patient monitoring, smart hospital systems, IoMT (Internet of Medical Things) frameworks.

Text / Reference Books

- Raj, P. – Internet of Things: Principles and Paradigms, Elsevier.
- Berman, F. – IoT and Healthcare, Springer.
- Giancarlo Fortino – Wearable Computing: From Modeling to Implementation, Springer.

DH403 - Artificial Intelligence in Healthcare

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the fundamentals of artificial intelligence and machine learning in healthcare.
• Apply AI techniques for diagnosis, prediction, and image analysis.
• Evaluate ethical and regulatory aspects of AI in medicine.

Course Outcomes

CO1: Understand the fundamentals of artificial intelligence and machine learning in healthcare.
CO2: Apply AI techniques for diagnosis, prediction, and image analysis.
CO3: Evaluate ethical and regulatory aspects of AI in medicine.

Detailed Syllabus

Unit I: Introduction to AI and ML – 9 Hours
AI concepts, supervised and unsupervised learning; Applications in healthcare.

Unit II: Data Preparation and Feature Engineering – 9 Hours
Data preprocessing, feature selection, dimensionality reduction techniques.

Unit III: AI Algorithms in Healthcare – 9 Hours
Regression, classification, decision trees, SVM, neural networks.

Unit IV: Medical Imaging and Diagnostics – 9 Hours
AI in radiology, pathology, genomics, and predictive medicine.

Unit V: Ethics and AI Governance – 9 Hours
Bias in AI, explainable AI, regulatory frameworks (FDA, CDSCO), and responsible AI use.

Text / Reference Books

• Davenport & Kalakota – The Potential for AI in Healthcare, Harvard Business Review.
• Jiang, F. et al. – Artificial Intelligence in Healthcare: Past, Present, and Future, Elsevier.
• Goodfellow, I. – Deep Learning, MIT Press.

DH404 - Cybersecurity & Privacy in Health Data

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand cybersecurity principles and challenges in healthcare data management.
• Apply privacy and data protection laws in digital health systems.
• Implement secure practices for data storage and transfer in health informatics.

Course Outcomes

CO1: Understand cybersecurity principles and challenges in healthcare data management.
CO2: Apply privacy and data protection laws in digital health systems.
CO3: Implement secure practices for data storage and transfer in health informatics.

Detailed Syllabus

Unit I: Introduction to Cybersecurity – 9 Hours
Cyber threats, attacks, and vulnerabilities; Security principles – confidentiality, integrity, availability.

Unit II: Network and Data Security – 9 Hours
Encryption, firewalls, intrusion detection, secure authentication systems.

Unit III: Healthcare Data Protection – 9 Hours
HIPAA, GDPR, and Indian IT Act compliance for healthcare systems.

Unit IV: Cybersecurity in IoMT and EHR – 9 Hours
Threats in connected medical devices, ransomware in hospitals, access control.

Unit V: Incident Management and Risk Assessment – 9 Hours
Cyber risk analysis, mitigation strategies, and ethical hacking overview.

Text / Reference Books

• William Stallings – Network Security Essentials, Pearson.
• Amit Sinha – Cybersecurity in Healthcare, CRC Press.
• HIPAA Security Rule Handbook – U.S. Department of Health & Human Services.

DH405A - Open Elective II (A): Health Economics & Policy Analytics

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the economic principles applied to healthcare systems.
• Analyze healthcare financing, insurance, and policy interventions.
• Use data analytics for evidence-based policy decision-making.

Course Outcomes

CO1: Understand the economic principles applied to healthcare systems.
CO2: Analyze healthcare financing, insurance, and policy interventions.
CO3: Use data analytics for evidence-based policy decision-making.

Detailed Syllabus

Unit I: Introduction to Health Economics – 9 Hours
Basic concepts of demand, supply, and elasticity in healthcare; Market failures.

Unit II: Healthcare Financing and Insurance – 9 Hours
Public vs private financing; Insurance models; Ou

t-of-pocket expenditure.

Unit III: Health Policy Frameworks – 9 Hours
National health policy, health equity, and efficiency.

Unit IV: Policy Analytics – 9 Hours
Use of data analytics in policy formulation; Case studies from India and WHO.

Unit V: Economic Evaluation Techniques – 9 Hours
Cost-effectiveness, cost-utility, and cost-benefit analysis.

Text / Reference Books

• Morris, S. – Economic Analysis in Healthcare, Wiley.
• WHO – Health Economics and Financing, WHO Press.
• Bhattacharya, J. – Health Economics, Palgrave Macmillan.

DH405B - Open Elective II (B): AR/VR for Healthcare Training

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand augmented and virtual reality technologies and their applications in healthcare.
• Design and simulate AR/VR-based healthcare training environments.
• Evaluate benefits and limitations of immersive learning in clinical education.

Course Outcomes

CO1: Understand augmented and virtual reality technologies and their applications in healthcare.
CO2: Design and simulate AR/VR-based healthcare training environments.
CO3: Evaluate benefits and limitations of immersive learning in clinical education.

Detailed Syllabus

Unit I: Introduction to AR and VR – 9 Hours
History, evolution, and components of AR/VR systems; Mixed reality concepts.

Unit II: Hardware and Software Platforms – 9 Hours
Headsets, sensors, motion controllers; Software frameworks (Unity, Unreal Engine).

Unit III: Applications in Healthcare – 9 Hours
Surgical simulation, anatomy learning, patient rehabilitation, and therapy.

Unit IV: Designing AR/VR Scenarios – 9 Hours
Storyboard creation, 3D modeling, interaction design, and testing.

Unit V: Evaluation and Future Trends – 9 Hours
Performance metrics, accessibility, ethical considerations, and metaverse in healthcare.

Text / Reference Books

• Craig, A. – Understanding Augmented Reality, Morgan Kaufmann.
• Burdea & Coiffet – Virtual Reality Technology, Wiley.
• Bailenson, J. – Experience on Demand: What Virtual Reality Is, W.W. Norton.

DH406 - AI in Healthcare Lab

L-T-P: 0-0-6 | Credits: 3 | Total Hours: 45

Course Objectives

• Implement AI algorithms for healthcare data analysis using Python/R.
• Develop simple diagnostic and predictive models based on medical datasets.

Course Outcomes

CO1: Implement AI algorithms for healthcare data analysis using Python/R.
CO2: Develop simple diagnostic and predictive models based on medical datasets.

Detailed Syllabus

Unit I: Python/R for AI – 9 Hours
Install libraries (NumPy, pandas, scikit-learn); Basic coding exercises.

Unit II: Data Preprocessing – 9 Hours
Data cleaning, normalization, missing value imputation, and visualization.

Unit III: Classification and Regression Models – 9 Hours
Decision tree, logistic regression, and k-nearest neighbor models.

Unit IV: Image and Text Data Processing – 9 Hours
Implement CNN for medical image classification; NLP for health text analysis.

Unit V: Mini Project – 9 Hours
Build a predictive model for disease risk or image-based diagnosis.

Text / Reference Books

• Wes McKinney – Python for Data Analysis, O'Reilly.
• François Chollet – Deep Learning with Python, Manning.
• Kelleher – Fundamentals of Machine Learning for Predictive Data Analytics, MIT Press.

DH407 - IoT & Wearables Lab

L-T-P: 0-0-8 | Credits: 4 | Total Hours: 60

Course Objectives

• Design and prototype IoT-based digital health monitoring systems.
• Interface sensors and collect physiological data using embedded tools.

Course Outcomes

CO1: Design and prototype IoT-based digital health monitoring systems.
CO2: Interface sensors and collect physiological data using embedded tools.

Detailed Syllabus

Unit I: Sensor Interfacing – 12 Hours
Setup of Arduino/Raspberry Pi; Reading temperature, heart rate, and motion sensors.

Unit II: Data Transmission – 12 Hours
Wireless connectivity setup using Bluetooth/Wi-Fi modules.

Unit III: Cloud Integration – 12 Hours
Send sensor data to cloud platforms (ThingSpeak, Firebase).

Unit IV: Dashboard Development – 12 Hours
Visualize live data using Power BI or web dashboards.

Unit V: Mini Project – 12 Hours
Develop wearable prototype for health parameter tracking (e.g., fitness, ECG).

Text / Reference Books

• Simon Monk – Programming Arduino, McGraw Hill.
• IoT Development Cookbook – Packt Publishing.
• Raj, P. – Internet of Things: Principles and Paradigms, Elsevier.

B.Sc. – Digital Health

Detailed Syllabus – Semester V

DH501 - Cloud Computing & Health Data Storage

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the fundamentals of cloud computing and service models.
• Analyze the role of cloud infrastructure in managing health data.
• Apply cloud storage solutions for scalable and secure health information systems.

Course Outcomes

CO1: Understand the fundamentals of cloud computing and service models.
CO2: Analyze the role of cloud infrastructure in managing health data.
CO3: Apply cloud storage solutions for scalable and secure health information systems.

Detailed Syllabus

Unit I: Introduction to Cloud Computing – 9 Hours
Definition, history, characteristics, and types of clouds (public, private, hybrid).

Unit II: Cloud Service Models – 9 Hours
IaaS, PaaS, SaaS; Cloud deployment and virtualization concepts.

Unit III: Cloud Data Storage – 9 Hours
Data centers, cloud storage architecture, distributed systems, and file systems (HDFS).

Unit IV: Cloud Security and Compliance – 9 Hours
Security mechanisms, HIPAA, GDPR compliance, and access control.

Unit V: Applications in Digital Health – 9 Hours
Case studies of AWS, Azure, and Google Cloud in EHR hosting and data sharing.

Text / Reference Books

• Rajkumar Buyya – Cloud Computing: Principles and Paradigms, Wiley.
• Miller, M. – Cloud Computing: Web-Based Applications, Pearson.
• Amazon Web Services – AWS Cloud Practitioner Essentials.

DH502 - Machine Learning Applications in Healthcare

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand machine learning concepts and their applications in healthcare data.
• Implement ML algorithms for predictive and diagnostic analysis.
• Evaluate the performance of machine learning models using healthcare datasets.

Course Outcomes

CO1: Understand machine learning concepts and their applications in healthcare data.
CO2: Implement ML algorithms for predictive and diagnostic analysis.
CO3: Evaluate the performance of machine learning models using healthcare datasets.

Detailed Syllabus

Unit I: Introduction to Machine Learning – 9 Hours
ML vs AI; Types of learning; ML workflow and applications in healthcare.

Unit II: Data Preprocessing – 9 Hours
Data cleaning, normalization, feature selection, and dimensionality reduction.

Unit III: Supervised Learning – 9 Hours
Regression, classification, decision trees, random forests, and support vector machines.

Unit IV: Unsupervised and Reinforcement Learning – 9 Hours
Clustering, association rules, and reinforcement learning basics.

Unit V: Model Evaluation and Case Studies – 9 Hours
Accuracy, precision, recall, F1-score; ML use cases in disease prediction and diagnostics.

Text / Reference Books

- Alpaydin, E. – Introduction to Machine Learning, MIT Press.
- Kelleher – Fundamentals of Machine Learning for Predictive Data Analytics, MIT Press.
- Aurélien Géron – Hands-On Machine Learning with Scikit-Learn, O'Reilly.

DH503 - Blockchain & Digital Records Management

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand blockchain technology and its role in securing digital health records.
- Apply distributed ledger concepts to healthcare data interoperability.
- Analyze blockchain-based EHR systems and ethical implications.

Course Outcomes

CO1: Understand blockchain technology and its role in securing digital health records.
CO2: Apply distributed ledger concepts to healthcare data interoperability.
CO3: Analyze blockchain-based EHR systems and ethical implications.

Detailed Syllabus

Unit I: Blockchain Fundamentals – 9 Hours
Introduction, architecture, consensus mechanisms, smart contracts.

Unit II: Cryptography and Security – 9 Hours
Hashing, digital signatures, encryption methods, and data immutability.

Unit III: Blockchain Platforms – 9 Hours
Ethereum, Hyperledger, and Corda; Blockchain-as-a-Service models.

Unit IV: Applications in Healthcare – 9 Hours
Medical record sharing, drug supply chain, claims management, and identity verification.

Unit V: Challenges and Future Trends – 9 Hours
Scalability, interoperability, regulatory issues, and integration with AI and IoT.

Text / Reference Books

- Narayanan, A. – Bitcoin and Cryptocurrency Technologies, Princeton University Press.
- Iansiti & Lakhani – The Truth About Blockchain, Harvard Business Review.
- Kamble, S. – Blockchain for Healthcare, CRC Press.

DH504 - Health Data Analytics & Visualization

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand data analytics pipeline and visualization tools for healthcare data.

• Apply statistical and analytical techniques to health datasets.
• Create dashboards and visual reports using BI tools.

Course Outcomes

CO1: Understand data analytics pipeline and visualization tools for healthcare data.
CO2: Apply statistical and analytical techniques to health datasets.
CO3: Create dashboards and visual reports using BI tools.

Detailed Syllabus

Unit I: Introduction to Health Data Analytics – 9 Hours
Data lifecycle, data types in healthcare, structured vs unstructured data.

Unit II: Analytical Methods – 9 Hours
Descriptive, predictive, and prescriptive analytics; Time series and trend analysis.

Unit III: Visualization Tools – 9 Hours
Power BI, Tableau, and Python visualization libraries (matplotlib, seaborn).

Unit IV: Dashboard Design Principles – 9 Hours
KPIs, metrics, interactivity, and storytelling with data.

Unit V: Case Studies in Healthcare Analytics – 9 Hours
Applications in hospital analytics, patient outcomes, and clinical dashboards.

Text / Reference Books

• Provost & Fawcett – Data Science for Business, O'Reilly.
• Davenport, T. – Competing on Analytics, Harvard Business Press.
• Sharma, P. – Healthcare Data Analytics, CRC Press.

DH505A - Professional Elective I (A): AI & Deep Learning in Diagnostics

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand deep learning techniques and architectures used in diagnostics.
• Develop AI models for medical imaging and clinical decision support.
• Evaluate ethical implications of AI-based diagnostic systems.

Course Outcomes

CO1: Understand deep learning techniques and architectures used in diagnostics.
CO2: Develop AI models for medical imaging and clinical decision support.
CO3: Evaluate ethical implications of AI-based diagnostic systems.

Detailed Syllabus

Unit I: Introduction to Deep Learning – 9 Hours
Neural networks, perceptron model, activation functions, backpropagation.

Unit II: Convolutional Neural Networks (CNN) – 9 Hours
Architecture, convolution layers, pooling, and image processing.

Unit III: Recurrent Neural Networks (RNN) – 9 Hours
LSTM, GRU models for sequential and temporal data.

Unit IV: Applications in Diagnostics – 9 Hours
AI in radiology, pathology, dermatology, and ophthalmology.

Unit V: Ethical and Regulatory Frameworks – 9 Hours
Bias in AI, explainable AI, FDA approvals, and compliance.

Text / Reference Books

• Goodfellow, I. – Deep Learning, MIT Press.
• Chollet, F. – Deep Learning with Python, Manning.
• Topol, E. – Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again.

DH505B - Professional Elective I (B): Digital Therapeutics (DTx)

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the principles and applications of digital therapeutics.
• Design digital therapy models for chronic disease management.
• Evaluate clinical validation and regulatory approval pathways for DTx products.

Course Outcomes

CO1: Understand the principles and applications of digital therapeutics.
CO2: Design digital therapy models for chronic disease management.
CO3: Evaluate clinical validation and regulatory approval pathways for DTx products.

Detailed Syllabus

Unit I: Introduction to Digital Therapeutics – 9 Hours
Definition, history, and evolution of DTx; Difference from wellness apps.

Unit II: DTx Ecosystem – 9 Hours
Stakeholders, patient engagement, and behavioral therapy integration.

Unit III: Clinical and Technological Aspects – 9 Hours
Software as a Medical Device (SaMD), clinical trials, and DTx design frameworks.

Unit IV: Regulatory and Business Models – 9 Hours
FDA, CE, and CDSCO guidelines; Market access, reimbursement, and partnerships.

Unit V: Case Studies and Future Trends – 9 Hours
Examples of approved DTx apps; AI, gamification, and global expansion.

Text / Reference Books

- Gerke, S. – Digital Therapeutics: Evidence, Regulation, and Reimbursement, Springer.
- FDA – Software as a Medical Device (SaMD) Framework.
- Dey, S. – Digital Health Innovations for Mental Health, Elsevier.

DH506 - ML in Healthcare Lab

L-T-P: 0-0-6 | Credits: 3 | Total Hours: 45

Course Objectives

- Implement machine learning algorithms using Python/R on medical datasets.
- Evaluate and interpret model outputs for diagnostic and predictive applications.

Course Outcomes

CO1: Implement machine learning algorithms using Python/R on medical datasets.
CO2: Evaluate and interpret model outputs for diagnostic and predictive applications.

Detailed Syllabus

Unit I: Python Setup and Libraries – 9 Hours
Installing and using pandas, numpy, scikit-learn for data analysis.

Unit II: Data Preprocessing – 9 Hours
Handling missing values, normalization, encoding categorical data.

Unit III: Model Development – 9 Hours
Building regression and classification models for healthcare datasets.

Unit IV: Performance Evaluation – 9 Hours
Model validation, confusion matrix, ROC curve, and cross-validation.

Unit V: Mini Project – 9 Hours
Develop ML model for disease prediction or patient readmission risk.

Text / Reference Books

- Wes McKinney – Python for Data Analysis, O'Reilly.
- Aurélien Géron – Hands-On Machine Learning, O'Reilly.

DH507 - Mini Project I (Digital Health Prototype)

L-T-P: 0-0-8 | Credits: 4 | Total Hours: 60

Course Objectives

- Develop an innovative digital health prototype integrating AI, IoT, or analytics.
- Apply multidisciplinary knowledge to solve real-world health problems.

Course Outcomes

CO1: Develop an innovative digital health prototype integrating AI, IoT, or analytics.
CO2: Apply multidisciplinary knowledge to solve real-world health problems.

Detailed Syllabus

Unit I: Problem Identification – 12 Hours
Identify healthcare challenge; define objectives and requirements.

Unit II: System Design – 12 Hours
Prepare conceptual framework, architecture, and workflow diagrams.

Unit III: Implementation – 12 Hours
Develop prototype using chosen technology stack (Python, IoT, Cloud).

Unit IV: Testing and Validation – 12 Hours
Test system for accuracy, reliability, and usability.

Unit V: Documentation and Presentation – 12 Hours
Prepare project report, poster, and final presentation.

Text / Reference Books

• Tanenbaum, A. – Structured Computer Organization, Pearson.
• Relevant research journals and IEEE Digital Health publications.

B.Sc. – Digital Health

Detailed Syllabus – Semester VI

DH601 - Advanced Digital Health Platforms (Smart Hospitals)

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the architecture and components of smart hospital ecosystems.
• Analyze digital transformation technologies applied to healthcare management.
• Evaluate interoperability and data integration across hospital systems.

Course Outcomes

CO1: Understand the architecture and components of smart hospital ecosystems.
CO2: Analyze digital transformation technologies applied to healthcare management.
CO3: Evaluate interoperability and data integration across hospital systems.

Detailed Syllabus

Unit I: Introduction to Smart Hospitals – 9 Hours
Concept, design, and need for digital transformation; Key technologies enabling smart hospitals.

Unit II: Hospital Information Ecosystem – 9 Hours
Integration of HIS, LIS, RIS, PACS, EMR, and IoT devices.

Unit III: Digital Infrastructure and Automation – 9 Hours
IoT, RFID, AI, and robotics in hospital operations and patient flow.

Unit IV: Interoperability & Standards – 9 Hours
FHIR, HL7, DICOM, and IHE frameworks for data exchange.

Unit V: Case Studies – 9 Hours
Implementation models of smart hospitals; Challenges and ROI analysis.

Text / Reference Books

- Hoyt & Yoshihashi – Health Informatics: Practical Guide, Informatics Education.
- Nayar, P. – Smart Healthcare Systems, Springer.
- WHO – Digital Health Transformation Framework, WHO Publications.

DH602 - Mobile Health (mHealth) Applications

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand mobile health technologies and their impact on healthcare delivery.
- Design and evaluate mHealth applications for patient engagement and monitoring.
- Explore regulatory and ethical aspects of mobile-based healthcare.

Course Outcomes

CO1: Understand mobile health technologies and their impact on healthcare delivery.
CO2: Design and evaluate mHealth applications for patient engagement and monitoring.
CO3: Explore regulatory and ethical aspects of mobile-based healthcare.

Detailed Syllabus

Unit I: Introduction to mHealth – 9 Hours
Definition, evolution, and importance; Global initiatives and mHealth programs.

Unit II: mHealth Technologies – 9 Hours
Mobile devices, sensors, SMS-based interventions, mobile apps, and APIs.

Unit III: Application Development – 9 Hours
Frameworks for Android/iOS app design; UI/UX principles in health apps.

Unit IV: Clinical Applications – 9 Hours
Chronic disease management, teleconsultation, medication adherence systems.

Unit V: Data Security and Ethics – 9 Hours
mHealth privacy policies, data encryption, user consent, and regulatory compliance.

Text / Reference Books

• Tomlinson, M. – Mobile Technologies for Health, Springer.
• Free, C. – The Effectiveness of mHealth Technologies, Lancet Digital Health.
• WHO – mHealth: New Horizons for Health Through Mobile Technologies.

DH603 - Predictive Analytics & Precision Medicine

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand predictive analytics principles and their use in personalized healthcare.
• Apply statistical and ML techniques to predict disease risks and treatment outcomes.
• Evaluate the ethical and regulatory dimensions of precision medicine.

Course Outcomes

CO1: Understand predictive analytics principles and their use in personalized healthcare.
CO2: Apply statistical and ML techniques to predict disease risks and treatment outcomes.
CO3: Evaluate the ethical and regulatory dimensions of precision medicine.

Detailed Syllabus

Unit I: Introduction to Predictive Analytics – 9 Hours
Concepts, scope, and data requirements; Role of AI in predictive analytics.

Unit II: Data Sources and Integration – 9 Hours
Clinical, genomic, lifestyle, and imaging data; Data fusion techniques.

Unit III: Modeling and Algorithms – 9 Hours
Regression, ensemble models, clustering, and deep learning in predictions.

Unit IV: Precision Medicine – 9 Hours
Concepts of genomics-based therapy, pharmacogenomics, and targeted treatments.

Unit V: Ethics and Regulation – 9 Hours
Informed consent, genetic data privacy, and international regulations (FDA, EMA).

Text / Reference Books

• Jensen, P.B. – Translational Bioinformatics and Precision Medicine, Elsevier.
• Topol, E. – The Creative Destruction of Medicine, Basic Books.
• Kourou, K. – Machine Learning Applications in Precision Medicine, Elsevier.

DH604 - Hospital Information Systems & Digital Transformation

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand HIS architecture and its role in hospital management and administration.

• Analyze digital transformation strategies for efficient healthcare delivery.
• Implement change management and quality assurance processes in HIS projects.

Course Outcomes

CO1: Understand HIS architecture and its role in hospital management and administration.
CO2: Analyze digital transformation strategies for efficient healthcare delivery.
CO3: Implement change management and quality assurance processes in HIS projects.

Detailed Syllabus

Unit I: Overview of HIS – 9 Hours
Functions, modules, and architecture; Integration of clinical and administrative systems.

Unit II: Workflow Management – 9 Hours
Patient registration, billing, discharge, pharmacy, and laboratory modules.

Unit III: Digital Transformation – 9 Hours
Adoption of EHR, telehealth, and cloud systems; Change management techniques.

Unit IV: Quality and Compliance – 9 Hours
NABH, ISO, HL7, and ICD compliance; Data quality management.

Unit V: HIS Project Implementation – 9 Hours
Steps in system development, testing, training, and evaluation.

Text / Reference Books

• Haux, R. – Health Information Systems: Concepts and Technology, Springer.
• Hoyt, R. – Health Informatics: Practical Guide, Informatics Education.
• WHO – Hospital Information Systems Guidelines.

DH605A - Professional Elective II (A): Robotics in Surgery & Digital Assistance

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

• Understand the principles of robotic surgery and automation in healthcare.
• Explore digital assistance systems used in clinical and surgical environments.
• Evaluate safety, ethics, and future developments in medical robotics.

Course Outcomes

CO1: Understand the principles of robotic surgery and automation in healthcare.
CO2: Explore digital assistance systems used in clinical and surgical environments.
CO3: Evaluate safety, ethics, and future developments in medical robotics.

Detailed Syllabus

Unit I: Introduction to Medical Robotics – 9 Hours
History, classification, and evolution of surgical robots.

Unit II: Robotic System Components – 9 Hours
Sensors, actuators, control systems, and haptic feedback.

Unit III: Robotic Surgery Applications – 9 Hours
Da Vinci surgical system, orthopedic and neurosurgical robots.

Unit IV: Digital Assistants in Healthcare – 9 Hours
AI voice assistants, rehabilitation robots, and robotic nursing aids.

Unit V: Regulations and Future Trends – 9 Hours
Safety standards, FDA approvals, ethics, and tele-robotic surgery.

Text / Reference Books

- Taylor, R.H. – Medical Robotics and Computer-Integrated Surgery, MIT Press.
- Menciassi, A. – Robotics in Surgery, Springer.
- Aracil, R. – Advances in Medical Robotics, Springer.

DH605B - Professional Elective II (B): Genomics & Bioinformatics for Digital Health

L-T-P: 2-1-0 | Credits: 3 | Total Hours: 45

Course Objectives

- Understand the fundamentals of genomics and bioinformatics tools.
- Analyze genetic data for diagnostics and personalized medicine.
- Apply computational biology approaches to healthcare innovations.

Course Outcomes

CO1: Understand the fundamentals of genomics and bioinformatics tools.
CO2: Analyze genetic data for diagnostics and personalized medicine.
CO3: Apply computational biology approaches to healthcare innovations.

Detailed Syllabus

Unit I: Introduction to Genomics – 9 Hours
Genome structure, sequencing technologies, and databases.

Unit II: Bioinformatics Basics – 9 Hours
FASTA, BLAST, sequence alignment, and data mining techniques.

Unit III: Omics Data Analysis – 9 Hours
Transcriptomics, proteomics, and metabolomics integration.

Unit IV: Applications in Digital Health – 9 Hours
Precision medicine, biomarker discovery, and genetic risk prediction.

Unit V: Ethics and Legal Issues – 9 Hours

Data ownership, consent, and bioinformatics data security.

Text / Reference Books

• Mount, D.W. – Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Press.
• Lesk, A. – Introduction to Bioinformatics, Oxford University Press.
• Xiong, J. – Essential Bioinformatics, Cambridge University Press.

DH606 - Digital Health Application Development Lab

L-T-P: 0-0-6 | Credits: 3 | Total Hours: 45

Course Objectives

• Develop full-stack digital health applications integrating databases and APIs.
• Implement secure user interfaces for patients and healthcare providers.

Course Outcomes

CO1: Develop full-stack digital health applications integrating databases and APIs.
CO2: Implement secure user interfaces for patients and healthcare providers.

Detailed Syllabus

Unit I: Setup and Tools – 9 Hours
Web and mobile app frameworks – Django, Flask, Android Studio.

Unit II: Frontend and Backend Design – 9 Hours
UI/UX creation, API development, and database integration.

Unit III: Health Data Integration – 9 Hours
FHIR APIs, HL7 data exchange, and authentication protocols.

Unit IV: Testing and Deployment – 9 Hours
Testing methodologies, debugging, cloud hosting, and version control.

Unit V: Mini Project – 9 Hours
Develop a functional healthcare app prototype with secure login and analytics dashboard.

Text / Reference Books

• Hazzard, E. – Programming Android, O'Reilly.
• Django Project Documentation – djangoproject.com.
• Google FHIR API Developer Guide – Google Health.

DH607 - Research Project / Dissertation

L-T-P: 0-0-8 | Credits: 4 | Total Hours: 60

Course Objectives

• Conduct independent research or applied project in the field of digital health.
• Develop scientific writing and presentation skills through dissertation work.

Course Outcomes
CO1: Conduct independent research or applied project in the field of digital health.
CO2: Develop scientific writing and presentation skills through dissertation work.

Detailed Syllabus

Unit I: Topic Identification – 12 Hours
Select research topic, formulate objectives, and literature review.

Unit II: Research Design – 12 Hours
Define methodology, sampling, and data collection plan.

Unit III: Implementation – 12 Hours
Perform data collection and analysis using statistical or AI tools.

Unit IV: Report Preparation – 12 Hours
Interpret results, prepare findings, and discuss implications.

Unit V: Presentation and Defense – 12 Hours
Prepare dissertation and defend before review panel.

Text / Reference Books
• Kothari, C.R. – Research Methodology, New Age International.
• WHO – Digital Health Research Guidelines.
• Relevant peer-reviewed journals and IEEE publications.

B.Sc. – Digital Health
Detailed Syllabus – Semester VII (Professional Practice – Internship Phase I)

DH701 - Industry/Clinical Internship (6 months)
L-T-P: 0-0-40 | Credits: 20 | Duration: 6 Months (Minimum 24 Weeks)

Course Objectives
• Gain professional exposure to clinical, technological, or industrial settings in digital health.
• Apply academic learning in real-world scenarios involving patient data, EHR, or health informatics.
• Develop industry-ready skills through supervised practical engagement.

Course Outcomes
Upon completion of this course, the student will be able to:
CO1: Gain professional exposure to clinical, technological, or industrial settings in digital health.
CO2: Apply academic learning in real-world scenarios involving patient data, EHR, or health informatics.

CO3: Develop industry-ready skills through supervised practical engagement.

Structure of the Module

Pre-Internship Phase: Selection of organization, internship approval, goal-setting, and orientation.
During Internship: Full-time professional engagement with weekly task documentation and faculty monitoring.
Post-Internship Phase: Preparation of final report, presentation, and viva-voce evaluation.

Weekly/Monthly Activity Plan

Month 1: Induction, orientation, organizational study, understanding workflow and health systems.
Month 2: Project work initiation, participation in live projects, observation of clinical data systems.
Month 3: Data collection, documentation, EHR handling, and interaction with digital platforms.
Month 4: Mid-term review, progress report submission, industry mentor feedback.
Month 5: Advanced project tasks, analytics, report drafting, and validation of data outputs.
Month 6: Final report submission, exit presentation, and certification.

Evaluation Scheme

• Industry Supervisor Evaluation – 40% (professional conduct, attendance, skills).
• Faculty Mentor Evaluation – 30% (weekly progress, report quality).
• Final Presentation & Viva – 20% (clarity, documentation, outcomes).
• Learning Diary & Logbook – 10% (completeness and reflection).

Deliverables

• Internship Approval and Joining Letter.
• Weekly Logbook / Learning Diary.
• Mid-Term Progress Report and Industry Feedback.
• Final Internship Report (60–80 pages).
• Presentation Slides and Completion Certificate.

DH702 - Seminar & Technical Writing

L-T-P: 0-2-0 | Credits: 4 | Duration: 16 Weeks (Concurrent with Internship)

Course Objectives

• Develop technical writing and communication skills for research and professional documentation.
• Present seminar topics on current trends and innovations in digital health.
• Prepare review papers and technical documents using academic referencing formats.

Course Outcomes

Upon completion of this course, the student will be able to:
CO1: Develop technical writing and communication skills for research and professional documentation.
CO2: Present seminar topics on current trends and innovations in digital health.
CO3: Prepare review papers and technical documents using academic referencing formats.

Structure of the Module

Phase I – Topic Selection: Identify seminar topic in consultation with faculty and industry mentor.
Phase II – Research & Writing: Review literature, collect data, and write technical papers with citations.
Phase III – Presentation & Evaluation: Deliver oral seminar presentation and submit report for evaluation.

Weekly/Monthly Activity Plan

Weeks 1–4: Topic identification, proposal submission, and outline preparation.
Weeks 5–8: Collection of secondary data, drafting, and peer review.
Weeks 9–12: Final writing, editing, and formatting using citation tools.
Weeks 13–16: Seminar presentation and final report submission.

Evaluation Scheme

• Seminar Presentation – 40% (delivery, clarity, and innovation).
• Written Report – 30% (structure, language, referencing).
• Viva-Voce – 20% (understanding and responses).
• Participation and Punctuality – 10%.

Deliverables

• Approved Seminar Topic and Outline.
• Technical Paper (8–12 pages, IEEE/APA format).
• Seminar Presentation Slides.
• Faculty Evaluation Sheet and Feedback Form.

B.Sc. – Digital Health

Detailed Syllabus – Semester VIII (Professional Practice – Internship Phase II)

DH801 - Industry/Research Internship (6 months)

L-T-P: 0-0-40 | Credits: 20 | Duration: 6 Months (Minimum 24 Weeks)

Course Objectives

• Gain hands-on experience in advanced digital health research or industry projects.
• Apply interdisciplinary knowledge in AI, data analytics, IoT, and health informatics.
• Collaborate with global or national organizations to develop innovative solutions in digital health.

Course Outcomes

Upon completion of this course, the student will be able to:
CO1: Gain hands-on experience in advanced digital health research or industry projects.
CO2: Apply interdisciplinary knowledge in AI, data analytics, IoT, and health informatics.
CO3: Collaborate with global or national organizations to develop innovative solutions in digital health.

Structure of the Module
Pre-Internship Phase: Approval from organization, finalization of research or project topic, and goal setting.
During Internship: Active participation in live projects, data collection, research, and weekly reporting to faculty mentor.
Post-Internship Phase: Submission of report, presentation, and participation in comprehensive evaluation.

Weekly/Monthly Activity Plan
Month 1: Orientation, role understanding, and review of previous research/project literature.
Month 2: Project initiation – setup, planning, and data collection.
Month 3: Data processing, analytics, software implementation, or field study.
Month 4: Mid-term presentation and progress report submission.
Month 5: Integration of results, testing, validation, and documentation.
Month 6: Final report writing, poster preparation, and submission for evaluation.

Evaluation Scheme
• Industry/Research Supervisor Evaluation – 40% (professional contribution, innovation, skills).
• Faculty Mentor Evaluation – 30% (progress reports, learning outcomes).
• Final Presentation & Viva – 20% (clarity, analysis, communication).
• Learning Diary & Logbook – 10% (documentation and reflection).

Deliverables
• Internship Approval and Joining Letter.
• Weekly Logbook / Learning Diary.
• Mid-Term Review Presentation.
• Final Internship Report (80–100 pages).
• Poster / Technical Presentation.
• Completion Certificate from Organization.

DH802 - Comprehensive Viva & Exit Examination
L-T-P: 0-2-0 | Credits: 4 | Duration: End of Program (2 Weeks)

Course Objectives
• Evaluate the comprehensive understanding of students across the four-year program.
• Assess technical competence, analytical skills, and industry readiness.
• Facilitate reflective learning through portfolio and career planning presentation.

Course Outcomes
Upon completion of this course, the student will be able to:
CO1: Evaluate the comprehensive understanding of students across the four-year program.
CO2: Assess technical competence, analytical skills, and industry readiness.
CO3: Facilitate reflective learning through portfolio and career planning presentation.

Structure of the Module

Phase I – Preparation: Revision of major subjects, research projects, and internship outcomes.
Phase II – Examination: Panel viva-voce, case analysis, and technical discussion.
Phase III – Reflection & Feedback: Presentation of portfolio and feedback from panel for career guidance.

Weekly/Monthly Activity Plan

Week 1: Mock viva and presentation rehearsal with faculty mentors.
Week 2: Final viva-voce with internal and external examiners; submission of portfolio and reports.

Evaluation Scheme

• Comprehensive Viva Panel Evaluation – 60% (knowledge integration, clarity, confidence).
• Portfolio & Project Review – 20% (documentation, quality, presentation).
• Industry Feedback – 10%.
• Professional Conduct – 10%.

Deliverables

• Comprehensive Viva Record Sheet.
• Portfolio (academic, internship, and project compilation).
• Exit Interview Report and Feedback Form.
• Final Evaluation Sheet (signed by panel).

Syllabus for
B.A. (Hons.) Indian Knowledge Systems and Cultural Heritage

Duration: 4 Years (8 Semesters) | **Total Credits:** 160 | **Framework:** NEP-2020 (CBCS / ABC / Multi-Entry-Exit)

Semester I – Foundations (20 Credits)

IKS 101 – Foundations of Indian Knowledge Systems
L-T-P: 3-0-0 | **Credits:** 3

Course Objectives:

1. To introduce students to the origin, scope, and key components of Indian Knowledge Systems (IKS).
2. To understand the interrelation between philosophy, science, culture, and society in ancient India.
3. To explore the epistemological foundations of Indian thought traditions.
4. To familiarize students with classical Indian texts and their contemporary relevance.
5. To build an appreciation for India's holistic worldview integrating spiritual, ecological, and ethical dimensions.

Course Outcomes (COs):
After successful completion, the learner will be able to:

- **CO1:** Explain the concept, scope, and uniqueness of Indian Knowledge Systems.
- **CO2:** Interpret key Indian philosophical and scientific ideas as part of cultural development.
- **CO3:** Identify interconnections between Vedas, Upanishads, and societal structures.
- **CO4:** Analyze the continuity of knowledge traditions and their application to modern contexts.
- **CO5:** Appreciate the inclusive and sustainable worldview inherent in IKS.

Unit	Content	Hours
Unit I: Introduction to IKS	Meaning, scope, and definition of Indian Knowledge Systems; sources – Shruti, Smriti, and Oral traditions; classification of knowledge (Parā / Aparā Vidyā); relevance in contemporary education.	9
Unit II: Philosophical Foundations	Six Darshanas – overview; concepts of Dharma, Karma, and Purusharthas; metaphysical principles of unity and diversity.	9
Unit III: Scientific and Literary Traditions	Contributions in mathematics, astronomy, medicine, and linguistics; role of Panini, Aryabhata, Charaka, Susruta; interaction between science and spirituality.	9
Unit IV: Knowledge Transmission	Gurukula system, Nalanda–Takshashila universities; oral and textual pedagogy; women's role in learning; preservation of knowledge through manuscripts.	9
Unit V: Contemporary Relevance	Integration of IKS into NEP-2020; IKS and sustainability; Indian knowledge for global well-being; case studies in Yoga, Ayurveda, and traditional arts.	9

Textbooks:

1. Kapil Kapoor & Michel Danino (Eds.), Knowledge Traditions and Practices of India, NCERT, 2018.

2. Bal Ram Singh, Foundations of Indian Knowledge System: Yoga, Ayurveda, Science, and Culture, Bharatiya Kala Prakashan, 2021.

References:

1. S.R. Bhatt, Philosophy of Indian Knowledge System, Indian Council of Philosophical Research, 2019.
2. Debiprasad Chattopadhyaya, Science and Society in Ancient India, Research India Press, 2017 (Reprint).
3. Nanditha Krishna, Sacred Plants and Culture in India, Penguin India, 2019.

IKS 102 – Introduction to Sanskrit Language – Level I
L-T-P: 2-1-0 | **Credits:** 3

Course Objectives:

1. To introduce the Sanskrit alphabet, pronunciation, and grammar fundamentals.
2. To build vocabulary relevant to cultural and heritage texts.
3. To enable reading of simple verses and shlokas.
4. To familiarize with classical Sanskrit literature and its themes.
5. To encourage language appreciation through oral recitation.

Course Outcomes:

- **CO1:** Recognize Devanagari script and pronounce Sanskrit sounds correctly.
- **CO2:** Apply basic grammar rules in reading and writing.
- **CO3:** Translate simple sentences from Sanskrit to English and vice versa.
- **CO4:** Appreciate the linguistic richness of Sanskrit literature.
- **CO5:** Recite selected shlokas with proper meter and meaning.

Unit	Content	Hours
Unit I: Phonetics & Script	Devanagari script, vowels & consonants, sandhi rules, pronunciation drills.	6
Unit II: Grammar Fundamentals	Nouns – gender, number, case endings; introduction to verbs and tenses.	6
Unit III: Simple Sentences	Sentence structure, use of pronouns and adjectives; sentence construction exercises.	9
Unit IV: Readings	Short passages from Hitopadesha, Bhagavad Gita (selected shlokas), and Subhashitas.	9
Unit V: Culture & Communication	Conversational Sanskrit; greetings, proverbs, idioms; Sanskrit in Indian sciences.	9

Textbooks:

1. A.V. Shastri, Sanskrit Praveshika, Rashtriya Sanskrit Sansthan, 2020.
2. Madhav Deshpande, Samskrta-Subodhini: A Sanskrit Primer, Michigan University Press, 2016.

References:

1. M.R. Kale, Higher Sanskrit Grammar, Motilal Banarsidass, 2010 (Reprint).
2. Antoine, A Sanskrit Manual, Motilal Banarsidass, 2013.

IKS 103 – Indian History & Civilization – Pre-Vedic to Gupta Era
L-T-P: 3-0-0 | **Credits:** 3

Course Objectives:
1. To trace the evolution of Indian civilization from prehistoric to classical periods.
2. To understand socio-political, economic, and cultural transformations.
3. To explore the role of religion, art, and literature in shaping Indian ethos.
4. To introduce key dynasties, institutions, and thinkers.
5. To interpret historical continuity in contemporary India.

Course Outcomes:
- **CO1:** Identify chronological milestones in early Indian history.
- **CO2:** Describe major cultural and political developments up to the Gupta period.
- **CO3:** Evaluate India's contributions in governance, economy, and education.
- **CO4:** Appreciate unity in diversity in ancient India.
- **CO5:** Analyze how ancient ideas continue to influence modern India.

Unit	Content	Hours
Unit I: Pre-Vedic Period	Indus–Sarasvati Civilization: features, town planning, trade, religion, decline.	9
Unit II: Vedic Age	Early & Later Vedic society; institutions; role of women; yajna culture and polity.	9
Unit III: Rise of Religio-Philosophical Movements	Jainism, Buddhism, Ajivikas; Mauryan polity and Ashoka's Dhamma.	9
Unit IV: Post-Mauryan Developments	Indo-Greek, Kushana, Satavahana contributions; Sangam culture.	9
Unit V: Gupta Period	Political unity, scientific and literary renaissance; education centres; Nalanda.	9

Textbooks:
1. R.S. Sharma, India's Ancient Past, Oxford University Press, 2017.
2. Upinder Singh, A History of Ancient and Early Medieval India, Pearson Education, 2018.

References:
1. Romila Thapar, Early India: From the Origins to AD 1300, Penguin, 2014.
2. D.D. Kosambi, An Introduction to the Study of Indian History, Popular Prakashan, 2016.

AEC 101 – Communication Skills in English
L T P: 2 0 2 | **Credits:** 3

Course Objectives
1. Develop proficiency in reading, writing, listening, and speaking.
2. Strengthen workplace and academic communication.
3. Enhance confidence in group and professional interactions.

Course Outcomes
CO1 Apply principles of effective verbal & written communication.
CO2 Draft reports, letters, and presentations.
CO3 Participate in discussions and interviews with clarity.
CO4 Use grammar and vocabulary accurately in context.

Unit-wise Syllabus (45 Hours)

Unit	Contents	Hours
I	Basics of Communication – process, barriers, non-verbal aspects, listening skills.	9
II	Functional Grammar – tenses, subject-verb agreement, articles, prepositions.	9
III	Writing Skills – paragraphs, emails, notices, CV & cover letters.	9
IV	Oral Communication – presentations, GD, public speaking, interviews.	9
V	Academic Writing – reports, essays, citations, avoiding plagiarism.	9

Text Books
1. Meenakshi Raman & Sangeeta Sharma, Technical Communication: Principles and Practice, Oxford University Press, 2021 (5th Ed.).
2. Raymond Murphy, English Grammar in Use, Cambridge University Press, 2019 (5th Ed.).

Reference Books
1. Andrea J. Rutherford, Basic Communication Skills for Technology, Pearson Education, 2018 (2nd Ed.).
2. Leech & Svartvik, A Communicative Grammar of English, Routledge, 2014 (3rd Ed.).

VAC 101 – Yoga, Wellness and Human Values
L T P: 1 0 2 | **Credits:** 2

Course Objectives
1. Introduce the philosophy and practice of Yoga for holistic health.
2. Integrate Indian ethical values with personal and professional life.
3. Promote physical fitness, mental balance, and emotional stability.

Course Outcomes
CO1 Understand principles of Yoga and value education.
CO2 Demonstrate basic āsanas and prāṇāyāma techniques.
CO3 Apply ethical principles in daily and professional contexts.
CO4 Cultivate self-discipline and positive mental health.

Unit-wise Syllabus (30 Hours)

Unit	Contents	Hours
I	Concept of Yoga – meaning, objectives, schools of Yoga; yogic definition of health.	6
II	Eightfold Path of Patañjali – Yama, Niyama, Āsana, Prāṇāyāma, Pratyāhāra, Dhāraṇā, Dhyāna, Samādhi.	6
III	**Practice Component I** – Sūrya Namaskāra, standing āsanas, relaxation postures.	6
IV	**Practice Component II** – Prāṇāyāma techniques, meditation and mindfulness.	6
V	Human Values – truth, compassion, self-control, service; integration with modern life.	6

Text Books
1. Swami Satyananda Saraswati, Asana Pranayama Mudra Bandha, Yoga Publications Trust, 2013 (Reprint).
2. Swami Sivananda, The Science of Yoga, Divine Life Society, 2017 (Rev. Ed.).

Reference Books
1. T. K. V. Desikachar, The Heart of Yoga, Inner Traditions, 2015.
2. S. Ranganathan, Human Values and Professional Ethics, Oxford University Press, 2018.

MDC 101 – Environmental Studies / Indian Ecology and Sustainability
L T P: 3 0 0 | **Credits:** 3

Course Objectives
1. Introduce environmental concepts through Indian ecological wisdom.
2. Create awareness of sustainable living and resource management.
3. Study environmental ethics in Indian philosophical traditions.

Course Outcomes
CO1 Explain ecosystem structure and biodiversity.
CO2 Discuss environmental issues and policies.
CO3 Analyze traditional Indian approaches to sustainability.
CO4 Adopt eco-friendly practices in daily life.

Unit-wise Syllabus (45 Hours)

Unit	Contents	Hours
I	**Environmental Basics** – ecosystems, biodiversity, food chains and webs.	9
II	**Natural Resources & Management** – land, water, forest, energy; case studies from India.	9
III	**Pollution & Climate Change** – types, causes, effects, mitigation, international agreements.	9
IV	**Indian Environmental Ethics** – concept of ṛta, ahimsa, and ecological balance in Upanishads and Jain-Buddhist thought.	9
V	**Sustainable Development & Policy** – SDGs, Indian policies on environment, community movements (Chipko, Narmada).	9

Text Books
1. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, University Press, 2017 (2nd Ed.).
2. Vandana Shiva, Staying Alive: Women, Ecology and Development, Zed Books, 2016 (Rev. Ed.).

Reference Books
1. Gadgil & Guha, Ecology and Equity: The Use and Abuse of Nature in Contemporary India, Penguin, 2015.
2. S. K. Agarwal, Environmental Studies: Principles and Practices, APH Publishing, 2019 (4th Ed.).

Semester II

IKS 201 – Indian Philosophy (Darśanas & Thinkers)
L T P: 3 0 0 | **Credits:** 3

Course Objectives
1. Introduce the origin, scope & spirit of Indian philosophy.
2. Familiarize students with orthodox (Astika) and heterodox (Nāstika) systems.
3. Explain major thinkers & texts of each Darśana.
4. Relate metaphysical and ethical concepts to life & governance.
5. Build comparative insight with Western thought.

Course Outcomes
After successful completion, learners will –
CO1 Define the nature, branches & scope of Indian philosophy.
CO2 Describe key doctrines of six Darśanas.
CO3 Compare heterodox schools with the orthodox view.
CO4 Interpret philosophical ideas in social & ethical contexts.
CO5 Apply Indian philosophical principles to contemporary issues.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Introduction – meaning of Darśana, Astika–Nāstika classification; common features (Dharma, Karma, Mokṣa).	9
II	Nyāya & Vaiśeṣika – Logic, Epistemology, Categories, God & Liberation.	9
III	Sāṃkhya & Yoga – Dualism of Puruṣa–Prakṛti, Guṇas, Aṣṭāṅga Yoga & Samādhi.	9
IV	Mīmāṃsā & Vedānta – Veda as authority, ritualism vs knowledge, Ātman–Brahman relation, Advaita Śaṅkara.	9
V	Nāstika Schools – Bauddha, Jaina & Cārvāka doctrines; ethical implications and modern relevance.	9

Text Books
1. M. Hiriyanna, Outlines of Indian Philosophy, Motilal Banarsidass, 2017.
2. S. Radhakrishnan & C. A. Moore (eds.), Source Book of Indian Philosophy, Princeton UP, 2019.

References
1. S. N. Dasgupta, A History of Indian Philosophy, MLBD, 2016 (Reprint).
2. T. M. P. Mahadevan, Invitation to Indian Philosophy, Oxford India, 2018.

IKS 202 – Sanskrit Language (Level II)
L T P: 2 1 0 | **Credits:** 3

Objectives
1. Consolidate grammar & syntax from Level I.
2. Build ability to read simple texts & compose short paragraphs.
3. Introduce Samāsa, Tenses & Voice.
4. Encourage spoken Sanskrit practice.
5. Connect language study to IKS terminology.

Outcomes
CO1 Apply grammar rules to reading & writing.
CO2 Translate prose and verses.
CO3 Identify meters and poetic devices.
CO4 Speak basic Sanskrit sentences.
CO5 Use IKS lexicon in context.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Revision of phonetics and Sandhi; types of Samāsa (compounds).	9
II	Declension of special stems; tenses – past (Laṅ), future (Lṛṭ); voice system.	9

Unit	Contents	Hrs
III	Syntax and translation exercises; participles & indeclinables.	9
IV	Reading of selected stories from Pañcatantra & Hitopadeśa; Gītā verses.	9
V	Prosody and Alankāra; spoken practice and recitation.	9

Text Books

1. A. V. Shastri, Sanskrit Praveśikā – Part II, Rashtriya Sanskrit Sansthan, 2021.
2. Madhav Deshpande, Saṃskṛta-Subodhini, U of Michigan Press, 2016.

References

1. M. R. Kale, Higher Sanskrit Grammar, MLBD, 2010.
2. A. A. Macdonell, A Sanskrit Grammar for Students, OUP, 2015.

IKS 203 – Cultural Heritage of India: Art, Architecture & Literature
L T P: 3 0 2 | **Credits:** 4

Objectives

1. Introduce Indian aesthetic and architectural principles.
2. Explain the development of art forms from Indus to medieval periods.
3. Link literary and performing arts with philosophical ideas.
4. Train students in field documentation.
5. Promote heritage conservation awareness.

Outcomes
CO1 Identify styles of Indian art and architecture.
CO2 Interpret symbolism in temple iconography.
CO3 Apply Rasa & Nāṭya theories to literature and art.
CO4 Analyze classical texts on aesthetics.
CO5 Document heritage sites systematically.

Unit-wise Syllabus (60 hrs incl. practice)

Unit	Contents	Hrs
I	Meaning of Heritage; concept of Kala and Saundarya; cultural continuity.	9
II	Art forms – sculpture, painting, dance, music; Ajanta, Ellora, Chola bronzes.	12
III	Architecture – Vedic altars, Buddhist stupas, Nagara and Dravida styles.	12
IV	Literature – Epics, Puranas, Kālidāsa’s drama, Telugu Sangam poetry.	12
V	Field Component – monument visit, heritage mapping & report.	15

Text Books

1. S. Kramrisch, The Art of India, Phaidon, 2016.
2. Kapila Vatsyayan, Classical Indian Dance in Literature and the Arts, Sahitya Akademi, 2019.

References

1. Percy Brown, Indian Architecture (Buddhist and Hindu Period), Taraporevala, 2015.
2. A. L. Basham, The Wonder That Was India, Picador, 2021.

SEC 201 – Digital Tools for Heritage Documentation
L T P: 1 0 2 | **Credits:** 2

Objectives

1. Train students in basic digital methods for cultural documentation.
2. Use GIS and photogrammetry for recording sites and objects.
3. Develop awareness of digital preservation ethics.

Outcomes
CO1 Explain digital archiving concepts.
CO2 Operate basic editing and mapping tools.
CO3 Create a mini digital heritage portfolio.
CO4 Apply ethical standards in data handling.

Unit-wise Syllabus (30 hrs)

Unit	Contents	Hrs
I	Digital heritage concepts; data types & metadata.	6
II	Photography basics and image processing.	6
III	3-D scanning and photogrammetry techniques.	6
IV	GIS mapping – QGIS interface, geo-tagging heritage assets.	6
V	Digital archives & legal framework for preservation.	6

Text Books
1. David J. Pritchard, Digital Heritage: Applying Digital Imaging to Cultural Heritage, Routledge, 2019.
2. K. Denard (ed.), Digital Heritage and the Virtual Past, Springer, 2018.

References
1. Kathryn Weber, Preserving Digital Heritage, Rowman & Littlefield, 2020.
2. QGIS Documentation Manual v3.28, OSGeo Foundation, 2023.

VAC 201 – Indian Logic and Scientific Thought
L T P: 2 0 0 | **Credits:** 2

Objectives
1. Introduce Nyāya and Buddhist logic as scientific reasoning systems.
2. Understand methods of inference and proof in Indian tradition.
3. Correlate logic with scientific method and critical thinking.

Outcomes
CO1 Define Pramāṇa and Prameya concepts.
CO2 Use five-step Nyāya syllogism in argumentation.
CO3 Explain empirical methods in ancient Indian sciences.
CO4 Compare Indian and Western logic approaches.

Unit-wise Syllabus (30 hrs)

Unit	Contents	Hrs
I	Epistemology – Pramā & Pramāṇa; perception and inference.	6
II	Nyāya Logic – five-member syllogism and fallacies.	6
III	Buddhist Logic – Apoha theory, momentariness.	6
IV	Scientific reasoning in Ayurveda, Astronomy, Linguistics.	6
V	Comparative logic – Greek and Modern Scientific Method.	6

Text Books

1. B. K. Matilal, Logic, Language and Reality, MLBD, 2019.
2. Daya Krishna, Indian Philosophy: A Counter Perspective, Oxford India, 2017.

References

1. K. Kunjunni Raja, Indian Logic in the Early Schools, MLBD, 2015.
2. Subhash Kak, The Architecture of Knowledge, MLBD, 2020.

OEC 201 – Comparative Civilizations / Global Heritage Studies
L T P: 3 0 0 | **Credits:** 3

Objectives

1. Provide an overview of world civilizations and their knowledge systems.
2. Compare Indian civilization with other ancient cultures.
3. Understand cross-cultural exchange and heritage conservation globally.
4. Encourage a global perspective of cultural diversity.

Outcomes

CO1 Describe main features of world civilizations.
CO2 Compare philosophical and artistic achievements across cultures.
CO3 Explain global heritage management frameworks (UNESCO etc.).
CO4 Develop inclusive attitude towards cultural plurality.

Unit-wise Syllabus (45 hrs)

Unit	**Contents**	**Hrs**
I	Civilization & Culture – concepts, method of comparative study.	9
II	Ancient Worlds – Mesopotamia, Egypt, China, Greece; art and governance.	9
III	Indian Civilization and Global Interactions – trade, religion, science.	9
IV	Medieval & Modern Contacts – Islamic, European, Asian cross-currents.	9
V	World Heritage and Sustainability – UNESCO conventions, case studies (Ajanta, Pyramids, Great Wall).	9

Text Books

1. Fernand Braudel, A History of Civilizations, Penguin, 2015.
2. John N. Mears, Civilizations Past and Present, Pearson, 2019 (13th Ed.).

References

1. UNESCO, World Heritage Manual Series, Paris, 2020.
2. A. L. Basham et al., World Civilizations: A Comparative Study, Macmillan, 2018.

Semester III

IKS 301 – Vedic and Upanishadic Knowledge Traditions
L T P: 3 0 0 | **Credits:** 3

Course Objectives
1. Introduce Vedic corpus—Samhitā, Brāhmaṇa, Āraṇyaka, Upaniṣad.
2. Examine cosmology, ritual, and philosophical evolution in Vedic literature.
3. Familiarize learners with key Upanishadic concepts (Ātman, Brahman, Mokṣa).
4. Appreciate continuity of spiritual-scientific thinking in India.
5. Relate ancient wisdom to contemporary ethical and ecological concerns.

Course Outcomes
CO1 Describe Vedic literature, chronology and schools.
CO2 Explain principal Upanishadic doctrines and thinkers.
CO3 Interpret hymns symbolically and philosophically.
CO4 Evaluate social, scientific and ecological ideas in Vedic texts.
CO5 Apply Upanishadic insights to holistic living.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Vedic Literature – structure and classification; oral tradition; major Samhitās and commentaries.	9
II	Cosmology & Ritual – creation hymns, sacrifice concept, ecological symbolism.	9
III	Philosophical Transition – from ritual to knowledge; Aranyakas and early Upaniṣads.	9
IV	Doctrines of Major Upaniṣads – Chāndogya, Bṛhadāraṇyaka, Kaṭha, Īśa, Mundaka.	9
V	Relevance – Self-realization, education & ethics; Upanishads and modern science.	9

Text Books
1. S. Radhakrishnan, The Principal Upanishads, HarperCollins, 2017 (Reprint).
2. P. V. Kane, History of Dharmaśāstra Vol I, Bhandarkar Oriental Research Institute, 2016.

References
1. A. C. Das, Rigvedic Culture, MLBD, 2015.
2. R. Panikkar, The Vedic Experience, Motilal Banarsidass, 2019.

IKS 302 – Indian Society, Ethics and Governance
L T P: 3 0 0 | **Credits:** 3

Objectives
1. Understand ethical and social principles in Indian tradition.
2. Study Kautilya's Arthaśāstra and Dharmasūtra governance models.
3. Trace development of institutions—family, guilds, state.
4. Explore justice, gender and environmental ethics.
5. Relate ancient norms to modern public administration.

Outcomes
CO1 Explain core values of Indian social philosophy.
CO2 Analyze texts on statecraft and governance.
CO3 Compare ancient and modern ethical systems.
CO4 Apply principles of Dharma and Lokasaṃgraha to societal issues.
CO5 Demonstrate ethical decision making in governance contexts.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Indian Social Structure – Varna & Āśrama systems; family, guilds, education.	9
II	Concept of Dharma, Artha, Kāma, Mokṣa – Purushārthas and social order.	9
III	Political and Administrative Thought – Arthaśāstra, Manusmṛti, Thirukkural.	9
IV	Ethics in Practice – justice, gender equality, environmental responsibility.	9
V	Modern Governance – Gandhian Sarvodaya, Good Governance & NEP ethics.	9

Text Books
1. Kautilya (Chanakya), Arthaśāstra, trans. R. Shamasastry, Penguin Classics, 2016.
2. P. Prasad, Indian Ethical Systems, PHI Learning, 2019.

References
1. K. C. Pandey, Ethics in Indian Culture, MLBD, 2015.
2. A. Paranjpe, Psychology in Indian Tradition, Springer, 2017.

IKS 303 – Heritage Conservation and Museum Studies
L T P: 2 0 2 | **Credits:** 3

Objectives
1. Introduce principles of cultural heritage management and conservation.
2. Understand museum functions, classification and documentation.
3. Train students in handling heritage objects and curation methods.
4. Explore national and international heritage laws.
5. Encourage community participation in preservation.

Outcomes
CO1 Describe types of heritage and their significance.
CO2 Apply basic conservation techniques.
CO3 Prepare inventory and catalogue entries.
CO4 Explain museum organization and visitor services.
CO5 Identify career avenues in heritage sector.

Unit-wise Syllabus (45 hrs incl. practice)

Unit	Contents	Hrs
I	Definition of Heritage – tangible and intangible; cultural mapping.	9
II	Conservation Principles – preventive vs curative; materials and techniques.	9
III	Museology – history of museums in India; types and functions.	9
IV	Museum Operations – collection, cataloguing, display design, public engagement.	9
V	Heritage Legislation – ASI Acts, UNESCO conventions; field visit report.	9

Text Books
1. G. D. Lewis, Museum Curatorship: A Manual for Museums, Routledge, 2018.
2. A. L. Gupta, Cultural Heritage and Conservation Management in India, APH, 2019.

References
1. UNESCO, Operational Guidelines for World Heritage, Paris, 2021.
2. E. P. Doering, Museums and the Public Sphere, Wiley-Blackwell, 2015.

AEC 301 – Telugu / Sanskrit for Knowledge Texts
L T P: 2 1 0 | **Credits:** 3

Objectives

1. Develop reading skills for classical knowledge texts in Telugu or Sanskrit.
2. Introduce scientific and philosophical terminology in original languages.
3. Enhance translation and interpretation competence.
4. Foster comparative linguistic awareness.
5. Promote interest in primary source study.

Outcomes

CO1 Read and interpret selected Telugu /Sanskrit passages.
CO2 Translate technical terms into English equivalents.
CO3 Analyze textual meaning in context.
CO4 Prepare bilingual glossaries.
CO5 Demonstrate basic philological skills.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Introduction to Telugu/Sanskrit scientific and philosophical literature.	9
II	Terminology in Ethics, Logic and Science.	9
III	Translation techniques and semantic analysis.	9
IV	Text Study – extracts from Upanishads or Sūtras.	9
V	Comparative linguistics and knowledge communication.	9

Text Books

1. Kapil Kapoor, Sanskrit and Knowledge Systems, Centre for Civilizational Studies, 2018.

VAC 301 – Life Skills and Emotional Intelligence
L T P: 1 0 2 | **Credits:** 2

Objectives

1. Strengthen self-awareness and emotional competence.
2. Develop interpersonal communication and stress management skills.
3. Inculcate positive psychology through Indian value framework.
4. Promote teamwork and leadership qualities.

Outcomes

CO1 Recognize personal strengths and emotions.
CO2 Manage stress and conflict effectively.
CO3 Demonstrate teamwork and communication skills.
CO4 Integrate ethical values in decision making.

Unit-wise Syllabus (30 hrs)

Unit	Contents	Hrs
I	Concept of Life Skills – WHO framework; self-awareness.	6

Unit	Contents	Hrs
II	Emotional Intelligence – components and models.	6
III	Communication and Interpersonal Skills – assertiveness training.	6
IV	Stress and Time Management – yogic and mindfulness approach.	6
V	Leadership and Ethics – case studies from Indian texts.	6

Text Books

1. Daniel Goleman, Emotional Intelligence, Bloomsbury, 2018.
2. S. Ranganathan, Human Values and Professional Ethics, Oxford University Press, 2018.

References

1. Swami Sivananda, Thought Power, Divine Life Society, 2016.
2. N. Kumar, Positive Psychology and Well-Being, Sage, 2021.

OEC 301 – Performing Arts, Music and Aesthetics of India
L T P: 3 0 0 | **Credits:** 3

Objectives

1. Familiarize students with theory and philosophy of Indian performing arts.
2. Explain Nāṭya Śāstra principles of Rasa and Bhāva.
3. Trace development of classical music and dance traditions.
4. Promote aesthetic appreciation through demonstration and analysis.

Outcomes

CO1 Explain core concepts of Indian aesthetics.
CO2 Identify forms and styles of music and dance.
CO3 Analyze Nāṭya Śāstra and Raga-Tala theory.
CO4 Appreciate cultural and spiritual dimensions of performing arts.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Introduction to Nāṭya Śāstra – origin, purpose and Rasa theory.	9
II	Classical Dance – Bharatanatyam, Kathak, Odissi, Kuchipudi – technique and expressive aspects.	9
III	Indian Music – Raga, Tala system, Carnatic and Hindustani traditions.	9
IV	Drama and Theatre – classical and folk forms; Abhinaya concepts.	9
V	Aesthetics and Spirituality – Art as Sādhana; Bhakti and Sufi movements.	9

Text Books

1. Kapila Vatsyayan, Indian Classical Dance, Publications Division, 2018.
2. S. R. Bhatt, Indian Aesthetics and Philosophy of Art, MLBD, 2019.

References

1. Rukmini Devi Arundale, Art and Culture of India, Kalakshetra, 2017.
2. A. K. Coomaraswamy, The Transformation of Nature in Art, Harvard UP, 2015.

Semester IV – Indian Sciences & Research (20 Credits)

IKS 401 – Indian Sciences: Ayurveda, Astronomy & Mathematics
L T P: 3 0 0 | **Credits:** 3

Course Objectives
1. Introduce the evolution of scientific thought in ancient India.
2. Familiarize learners with fundamentals of Ayurveda, Jyotiṣa (astronomy), and Ganita (mathematics).
3. Explore philosophical bases of Indian sciences and their empirical orientation.
4. Highlight contributions of major scientists and texts.
5. Relate ancient discoveries to contemporary scientific perspectives.

Course Outcomes
CO1 Identify the epistemic and methodological foundations of Indian sciences.
CO2 Explain principles of Ayurveda, Jyotiṣa, and Ganita.
CO3 Recognize contributions of Indian scholars like Susruta, Āryabhata and Brahmagupta.
CO4 Compare Indian and modern scientific worldviews.
CO5 Appreciate sustainability and holistic health concepts in Indian science.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	**Introduction** – Philosophy of science in India; unity of body, mind & environment; classification of knowledge.	9
II	**Ayurveda** – Tridoṣa theory, Dhātu, Mala, Agni; preventive health & diet; Susruta and Charaka contributions.	9
III	**Astronomy (Jyotiṣa)** – Calendar systems, Nakṣatra and Rāśi; Āryabhata and Varāhamihira; observational methods.	9
IV	**Mathematics (Ganita)** – Decimal system, zero, algebra, geometry; Bhāskara II, Brahmagupta; application in architecture.	9
V	**Legacy & Continuity** – Transmission of Indian science to Arab & Europe; integration with modern STEM education.	9

Text Books
1. Debiprasad Chattopadhyaya, Science and Society in Ancient India, Research India Press, 2017.
2. K. S. Shukla & K. V. Sarma, Āryabhatiya of Āryabhata, Indian National Science Academy, 2015.

References
1. P. C. Ray, History of Hindu Chemistry, Asian Education Services, 2016.
2. K. R. Srikantha Murthy, Foundations of Ayurveda, Chaukhamba, 2018.
3. S. Balachandra Rao, Indian Astronomy: An Introduction, UNESCO–IGNCA, 2020.

IKS 402 – Indian Epics, Purāṇas & Narratives
L T P: 3 0 0 | **Credits:** 3

Course Objectives
1. Explore epic and purāṇic literature as cultural encyclopaedias.
2. Understand philosophical, ethical and historical narratives within them.
3. Interpret symbolism and archetypes in Rāmāyaṇa, Mahābhārata and Purāṇas.
4. Identify societal and gender perspectives within epic traditions.

5. Recognize the continuing influence of these narratives in Indian culture.

Course Outcomes
CO1 Explain structure and purpose of the Itihāsa–Purāṇa genre.
CO2 Interpret ethical and dhārmic themes from epics.
CO3 Analyze myth, history and philosophy interrelation.
CO4 Discuss Purāṇic cosmology and genealogies.
CO5 Appreciate reinterpretations of epics in modern media.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Introduction – Meaning of Itihāsa and Purāṇa; oral and textual traditions; purpose of storytelling.	9
II	Rāmāyaṇa – Valmiki's epic; concept of Dharma, ideal characters, regional versions.	9
III	Mahābhārata – social complexities, Bhagavad Gītā, women and ethics.	9
IV	Purāṇas – cosmology, genealogy of gods and kings; Vishnu, Śiva and Devī Purāṇas.	9
V	Interpretation – Allegory, symbolism, comparative mythology; modern retellings in arts & film.	9

Text Books
1. Romila Thapar, The Past Before Us: Historical Traditions of Early North India, Harvard UP, 2015.
2. P. L. Bhargava, Essentials of Indian Culture, Bharatiya Vidya Bhavan, 2018.

References
1. A. K. Ramanujan, Three Hundred Rāmāyaṇas, OUP, 2016.
2. Devdutt Pattanaik, Indian Mythology, Penguin, 2017.

IKS 403 – Research Methodology in Indian Knowledge Systems
L T P: 2 1 0 | **Credits:** 3

Course Objectives
1. Introduce research foundations and philosophical approaches in IKS.
2. Train learners in qualitative & textual analysis of Indian sources.
3. Develop skills of hypothesis formation, referencing & academic writing.
4. Integrate traditional and modern methods of inquiry.
5. Prepare students for dissertation and field projects.

Course Outcomes
CO1 Explain research design and methodological principles.
CO2 Differentiate between Western and Indian approaches to knowledge.
CO3 Apply tools of data collection and literary analysis.
CO4 Prepare research proposal and annotated bibliography.
CO5 Demonstrate ethical research practice and report writing skills.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Nature of Research – scientific method; types of research; IKS paradigms and epistemology.	9

Unit	Contents	Hrs
II	Research Design – problem identification, objectives, variables, hypothesis.	9
III	Data Collection – field study, textual and archival research; survey tools.	9
IV	Analysis & Interpretation – content analysis, translation methodology, citations.	9
V	Report Writing & Ethics – structure, bibliography styles, plagiarism check.	9

Text Books

1. C. R. Kothari & Gaurav Garg, Research Methodology: Methods and Techniques, New Age, 2022.
2. Kapil Kapoor (ed.), Research in Indian Knowledge Systems, IGNCA, 2020.

References

1. Rajeshwari Panda, Methodological Issues in Indian Studies, ICSSR, 2017.
2. A. K. Singh, Tests Measurements and Research Methods in Behavioral Sciences, BH, 2019.

SEC 401 – Heritage Field Study / Temple Architecture Mapping
L T P: 0 0 4 | **Credits:** 2

Objectives

1. Provide practical exposure to field documentation of heritage sites.
2. Train students in architectural survey and mapping techniques.
3. Develop skills in photography, sketching, and report writing.
4. Promote awareness about conservation and community engagement.

Outcomes
CO1 Conduct field observation and data collection for heritage study.
CO2 Prepare architectural sketches and plans.
CO3 Compile heritage documentation reports.
CO4 Demonstrate ethical practice in heritage work.

Unit-wise Syllabus (30 hrs field/lab)

Unit	Contents	Hrs
I	Orientation to heritage survey tools; planning a field visit.	6
II	Architectural drawing basics – scale, plan, elevation.	6
III	Temple typology – Nagara, Dravida, Vesara styles.	6
IV	Photography and GIS applications for heritage mapping.	6
V	Preparation of report and presentation of findings.	6

Text Books

1. Percy Brown, Indian Architecture (Hindu Period), Taraporevala, 2015.
2. V. Meenakshi, Temple Architecture of South India, IGNCA, 2018.

References

1. R. Nagaswamy, Masterpieces of Chola Art, Govt of Telugu Nadu, 2016.
2. J. Michell, The Hindu Temple: An Introduction to Its Meaning and Forms, Chicago UP, 2019.

OEC 401 – Indian Polity & Legal Traditions
L T P: 3 0 0 | **Credits:** 3

Objectives

1. Examine origins of political and legal thought in ancient India.

2. Study institutions of governance and law from Vedic to medieval periods.
3. Understand justice, rights, and duties in Indian tradition.
4. Trace continuity into modern constitutional ethos.

Outcomes
CO1 Describe ancient Indian systems of law and governance.
CO2 Compare Dharmaśāstra concepts with modern legal ideas.
CO3 Explain citizenship and justice in Indian political thought.
CO4 Analyze constitutional principles derived from traditional values.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Concept of Law (Dharma) and State (Rāṣṭra); sources of law.	9
II	Legal Texts – Manusmṛti, Yājñavalkya Smṛti, Narada Smṛti.	9
III	Judicial and Administrative Systems – Sabha, Samiti, Royal Courts.	9
IV	Rights and Duties – concept of Rajadharma; citizens and king's obligations.	9
V	Continuity – influence on modern Indian Constitution & Human Rights.	9

Text Books
1. L. N. Rangarajan (trans.), Kautilya: The Arthashastra, Penguin, 2015.
2. P. V. Kane, History of Dharmaśāstra, BORI, 2016.

References
1. K. P. Jayaswal, Hindu Polity, Bharatiya Vidya Bhavan, 2017.
2. M. R. Srinivasan, Foundations of Indian Political Thought, PHI Learning, 2019.

VAC 401 – Value Education & Ethics of Governance
L T P: 2 0 0 | **Credits:** 2

Objectives
1. Integrate ethical and value-based decision making in personal and public life.
2. Examine Indian philosophical approaches to values.
3. Promote integrity, transparency and accountability in governance.

Outcomes
CO1 Understand value concepts and ethical frameworks.
CO2 Apply ethical reasoning to governance issues.
CO3 Demonstrate professional responsibility and citizenship.
CO4 Practice empathy, tolerance and non-violence in community settings.

Unit-wise Syllabus (30 hrs)

Unit	Contents	Hrs
I	Nature of Values – types, sources, value education objectives.	6
II	Indian Ethical Traditions – Dharma, Seva, Ahimsa, Satya.	6
III	Professional and Public Ethics – integrity, accountability, conflict of interest.	6
IV	Ethics in Governance – Good Governance principles, citizen charters, case studies.	6
V	Contemporary Value Challenges – corruption, technology ethics, environmental responsibility.	6

Text Books

1. R. R. Gaur, R. Sangal & G. P. Bagaria, Human Values and Professional Ethics, Excel Books, 2018.
2. A. N. Tripathi, Human Values, New Age International, 2016.

References

1. Swami Bhoomananda Tirtha, Values for Life, Chinmaya Publications, 2019.
2. D. Balasubramanian, Ethics and Governance in Public Administration, PHI, 2020.

Semester V

IKS 501 – Indian Knowledge & Modern Science Dialogue
L T P: 3 0 0 | **Credits:** 3

Course Objectives

1. Examine the epistemological foundations of Indian and Western scientific worldviews.
2. Understand the complementarity between traditional wisdom and modern science.
3. Study case examples of knowledge transfer from ancient India to global science.
4. Promote interdisciplinary thinking integrating science, ethics & spirituality.
5. Encourage students to develop a balanced, holistic research perspective.

Course Outcomes

CO1 Describe the Indian holistic view of nature and knowledge.
CO2 Compare methodologies of Indian and modern scientific inquiry.
CO3 Identify historical instances of intercultural scientific exchange.
CO4 Evaluate the role of values in scientific advancement.
CO5 Formulate integrative perspectives for contemporary challenges.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Knowledge & Science – Definitions, epistemic bases, unity of knowledge in Indian thought.	9
II	Science in Civilizational Context – Ancient Indian mathematics, medicine, metallurgy and their global spread.	9
III	Comparative Epistemology – Observation, inference, experiment; contrast with Western empiricism.	9
IV	Ethics of Science – Dharma & Seva as ethical motifs; science without violence.	9
V	Dialogue for Future – Integrating IKS with STEM education, AI & sustainability research.	9

Text Books

1. Bal Ram Singh, Foundations of Indian Knowledge System: Yoga, Ayurveda, Science & Culture, Bharatiya Kala Prakashan, 2021.
2. D. P. Chattopadhyaya (ed.), Science, Philosophy and Culture in Indian Civilization, MLBD, 2018.

References

1. S. Radhakrishnan, Indian Philosophy, Vol. II, Oxford India, 2017.
2. Subhash Kak, The Architecture of Knowledge, MLBD, 2020.

IKS 502 – Indigenous Technologies & Craft Traditions
L T P: 2 0 2 | **Credits:** 3

Course Objectives
1. Document India's traditional technologies in materials, textiles, agriculture, & construction.
2. Understand design principles, ergonomics and sustainability in craft traditions.
3. Encourage appreciation of artisans' knowledge systems.
4. Train students in basic field documentation and product innovation.

Course Outcomes
CO1 Recognize India's indigenous technological heritage.
CO2 Explain eco-friendly craft and design practices.
CO3 Analyze link between technology, aesthetics and community life.
CO4 Apply traditional knowledge to modern design thinking.

Unit-wise Syllabus (45 hrs incl. practice)

Unit	Contents	Hrs
I	Overview of Traditional Technologies – craft clusters and heritage industries.	9
II	Metallurgy and Engineering – Wootz steel, lost-wax casting, iron pillar technology.	9
III	Textile & Handloom Science – natural dyes, weaving structures, Ajrakh and Kanchipuram silks.	9
IV	Architecture & Craftsmanship – Vāstuśāstra, traditional tools, craft guilds (Śilpa Śāstras).	9
V	Field Documentation / Studio Project – study of local craft community, process mapping.	9

Text Books
1. V. Ganapathy, Traditional Indian Crafts and Technologies, IGNCA, 2018.
2. Kapila Vatsyayan, Traditional Indian Craftsmanship, Publications Division, 2019.

References
1. R. Balasubramaniam, Delhi Iron Pillar: New Insights, Foundation Books, 2016.
2. INTACH, Craft Atlas of India, INTACH Publications, 2020.

IKS 503 – Cultural Heritage Management
L T P: 3 0 0 | **Credits:** 3

Course Objectives
1. Introduce theories, policies, and practices in heritage management.
2. Examine the relationship between heritage, community, and tourism.
3. Study legal frameworks and institutional mechanisms (ASI, UNESCO).
4. Equip students with project planning & entrepreneurial skills in heritage sector.

Course Outcomes
CO1 Explain principles of heritage management and conservation ethics.
CO2 Understand institutional structures and heritage laws.
CO3 Design basic heritage tourism and education projects.
CO4 Analyze stakeholder and community participation models.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Concepts – heritage types, value assessment, sustainable management.	9

Unit	Contents	Hrs
II	Policies & Institutions – ASI, INTACH, UNESCO conventions.	9
III	Heritage Tourism – interpretation centres, community benefits, branding.	9
IV	Entrepreneurship & Cultural Industries – start-ups in heritage communication.	9
V	Case Studies – Hampi, Madurai, Ajanta, Khajuraho, UNESCO World Heritage Sites.	9

Text Books

1. Elizabeth Merrill (ed.), Heritage Management Practice, Routledge, 2018.
2. A. L. Gupta, Cultural Heritage and Conservation Management in India, APH, 2019.

References

1. UNESCO, World Heritage Manual Series, 2021.
2. Timothy & Nyaupane, Cultural Heritage and Tourism, Routledge, 2019.

MNE 501 – Multidisciplinary Elective I
L T P: 3 0 0 | **Credits:** 3

(Institutions may choose one of the following tracks based on faculty expertise)

Track A: Archaeology and Material Culture **Track B:** Digital Humanities **Track C:** Indian Environmental Philosophy**
Each track to follow a 5-unit 45 hour framework covering:

1. Concept & Scope 2. Key Methods 3. Case Studies 4. Application & Policy 5. Field/Project Component

Common Outcomes: Multidisciplinary exposure; application of IKS to modern fields; research orientation.

Suggested References

- S. Settar & R. Korisettar, Indian Archaeology in Retrospect, Manohar, 2018.
- T. Burdick, Digital Humanities and Heritage, Routledge, 2020.
- N. Krishna, Ecological Traditions of India, CPR Environment Centre, 2016.

EXP 501 – Internship / Fieldwork in Museum or Cultural Centre
L T P: 0 0 6 | **Credits:** 3

Course Objectives

1. Provide hands-on exposure to museum or heritage-site operations.
2. Integrate classroom learning with real-world professional practice.
3. Develop documentation, communication and teamwork skills.

Course Outcomes

CO1 Apply knowledge of heritage management in field contexts.
CO2 Perform curatorial/documentation tasks under supervision.
CO3 Prepare a professional internship report and presentation.
CO4 Reflect on career roles in museums and cultural industries.

Structure (90 hrs minimum)

Phase	Activities	Hrs
I	Orientation & allocation of mentor/institution.	10
II	On-site training – collections management, visitor handling, events.	50

Phase	Activities	Hrs
III	Project Work – small documentation or education initiative.	20
IV	Report writing & presentation before faculty panel.	10

Assessment
Performance (50%), Report (30%), Viva (20%).

References

- A. Ambrose & C. Paine, Museum Basics, Routledge, 2018.
- UNESCO, Manual for Museum Professionals, Paris, 2020.

VAC 501 – Employability & Career Skills
L T P: 2 0 0 | **Credits:** 2

Objectives
1. Equip students with essential career skills and professional etiquette.
2. Develop resume writing, interview and presentation skills.
3. Build digital literacy and entrepreneurial mindset for cultural industries.

Outcomes
CO1 Prepare effective resumes and cover letters.
CO2 Demonstrate communication and presentation skills in interviews.
CO3 Showcase career readiness through portfolio and networking.
CO4 Apply entrepreneurial principles to self-employment in heritage fields.

Unit-wise Syllabus (30 hrs)

Unit	Contents	Hrs
I	Career Planning & Goal Setting – self-assessment tools.	6
II	Resume Building & Professional Correspondence.	6
III	Interview Techniques – mock sessions, group discussion.	6
IV	Digital Skills – LinkedIn profiles, e-portfolios, virtual interviews.	6
V	Entrepreneurship Basics – idea pitch, business canvas, CSR funding.	6

Text Books
1. Meenakshi Raman & Sangeeta Sharma, Technical Communication, Oxford UP, 2021.
2. B. N. Ghosh, Soft Skills for Professional Success, McGraw Hill, 2019.

References

1. Debasish Biswas, Corporate Soft Skills, Sage, 2020.
2. N. V. R. Naidu, Managerial Skills and Entrepreneurship, I.K. International, 2022.

Semester VI – Application & Outreach (20 Credits)

IKS 601 – Indian Aesthetics & Performing Traditions
L T P: 3 0 0 | **Credits:** 3

Course Objectives
1. Introduce key theories of Indian aesthetics (Rasa, Bhāva, Dhvani, Alankāra).
2. Trace evolution of classical and folk performing arts.

3. Examine Nāṭya Śāstra and its continuing influence on theatre, dance, and music.
4. Explore aesthetic philosophy in spiritual and ethical contexts.
5. Foster creative appreciation through comparative and experiential learning.

Course Outcomes
CO1 Explain aesthetic principles underlying Indian art forms.
CO2 Identify regional and classical performance traditions.
CO3 Analyze Nāṭya Śāstra and aesthetic treatises critically.
CO4 Appreciate spiritual, emotional, and social dimensions of aesthetics.
CO5 Apply aesthetic concepts to creative and research practices.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Indian Aesthetic Philosophy – Rasa theory, Bhāva, Ānanda; Vedic roots of art and beauty.	9
II	Nāṭya Śāstra – origin of drama, Abhinaya, stagecraft, eight Rasas.	9
III	Classical Dance – Bharatanāṭyam, Kathak, Odissi, Mohiniyāṭṭam; Nāṭya and Bhakti.	9
IV	Indian Music – Rāga, Tāla, Nāda; Carnatic and Hindustani systems; devotional genres.	9
V	Comparative Aesthetics – interaction with Western theories; modern Indian thinkers (Coomaraswamy, Tagore).	9

Text Books
1. Kapila Vatsyayan, Indian Classical Dance, Publications Division, 2018.
2. S. R. Bhatt, Indian Aesthetics and Philosophy of Art, MLBD, 2019.

References
1. A. K. Coomaraswamy, The Transformation of Nature in Art, Harvard UP, 2015.
2. Rukmini Devi Arundale, Art and Culture of India, Kalakshetra, 2017.

IKS 602 – Contemporary Relevance of Indian Knowledge Systems
L T P: 3 0 0 | **Credits:** 3

Objectives
1. Assess how IKS principles inform present-day challenges—education, environment, governance.
2. Explore modern applications of traditional medicine, agriculture, and ethics.
3. Encourage interdisciplinary research bridging IKS and contemporary disciplines.
4. Develop analytical skills to reinterpret classical ideas for current policy and innovation.

Outcomes
CO1 Explain contemporary significance of major IKS domains.
CO2 Apply traditional principles to modern sustainability and health.
CO3 Evaluate governmental and institutional IKS initiatives.
CO4 Formulate innovative projects integrating ancient wisdom and technology.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	IKS in Modern India – relevance under NEP 2020, DST and AICTE IKS Division programs.	9
II	Education & Pedagogy – Gurukula vs modern systems; value-based learning.	9

Unit	Contents	Hrs
III	Health & Wellness – Ayurveda, Yoga, Naturopathy; integrative medicine case studies.	9
IV	Ecology & Sustainability – IKS models of biodiversity conservation & agriculture.	9
V	Public Policy & Innovation – IKS start-ups, digital repositories, heritage entrepreneurship.	9

Text Books

1. Bal Ram Singh & K. S. Ramaswamy, Contemporary Relevance of Indian Knowledge System, Bharatiya Kala Prakashan, 2021.
2. Kapil Kapoor & Michel Danino (eds.), Knowledge Traditions and Practices of India, NCERT, 2018.

References

1. D. P. Chattopadhyaya (ed.), Science, Philosophy and Culture in Indian Civilization, MLBD, 2018.
2. Nanditha Krishna, Sacred Plants and Sustainability in India, Penguin, 2019.

IKS 603 – Heritage Laws and Intellectual Property
L T P: 3 0 0 | **Credits:** 3

Objectives

1. Understand the legal framework for heritage protection in India.
2. Introduce basics of Intellectual Property Rights (IPR) and Traditional Knowledge (TK).
3. Examine international conventions and community rights.
4. Build skills for ethical heritage documentation and policy analysis.

Outcomes

CO1 Explain national and international heritage laws.
CO2 Describe IPR types and their implications for TK protection.
CO3 Evaluate ethical issues in digitization and research.
CO4 Apply legal awareness in heritage management projects.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Heritage Laws in India – Ancient Monuments & Archaeological Sites Act (1958); State Acts.	9
II	UNESCO & International Conventions – 1972 World Heritage; 2003 Intangible Heritage.	9
III	Intellectual Property Rights – patent, copyright, GI, TKDL framework.	9
IV	Community Rights & Cultural Property – WIPO treaties, biopiracy cases.	9
V	Policy and Case Studies – Yoga copyright, Ayurvedic formulations, handicraft GI tags.	9

Text Books

1. V. K. Ahuja, Law Relating to Intellectual Property Rights, LexisNexis, 2021.
2. INTACH, Legal Framework for Heritage Protection in India, INTACH Publications, 2019.

References

1. World Intellectual Property Organization (WIPO), Traditional Knowledge and IP, Geneva, 2020.
2. UNESCO, Operational Guidelines for the Implementation of the World Heritage Convention, 2021.

MNE 601 – Multidisciplinary Elective II
L T P: 3 0 0 | **Credits:** 3

(Institutions may offer one elective stream from below depending on faculty expertise)
Option A: Indian Economy & Trade Networks
Option B: Regional Heritage and Cultural Landscape
Option C: Digital Humanities Applications**
Each stream follows a 5-unit framework (45 hrs) including:

1. Concept & Scope 2. Sources & Method 3. Case Studies 4. Field/Project 5. Policy Implications

Common Outcomes: Interdisciplinary competence, application of IKS to modern contexts, project orientation.

Suggested References

- Irfan Habib, Essays in Indian Economic History, Tulika, 2018.
- T. Burden (ed.), Digital Humanities and Cultural Heritage, Routledge, 2020.
- S. Settar & R. Korisettar, Indian Archaeology in Retrospect, Manohar, 2018.

PRJ 601 – Community Heritage Project / Documentation
L T P: 0 0 6 | **Credits:** 3

Objectives

1. Provide experiential learning through community-based heritage documentation.
2. Develop teamwork, field research and project-management skills.
3. Engage with local heritage stakeholders for sustainable development.

Outcomes
CO1 Plan and execute a heritage documentation project.
CO2 Apply field methods and digital tools in data collection.
CO3 Produce a heritage report or multimedia portfolio.
CO4 Demonstrate leadership and social responsibility.

Project Structure (90 hrs minimum)

Phase	Tasks	Hrs
I	Topic selection, proposal submission, mentor approval.	10
II	Fieldwork – surveys, interviews, photography, mapping.	50
III	Data analysis & interpretation; draft report.	20
IV	Final presentation & viva.	10

Assessment
Supervisor Evaluation (40%) + Report (40%) + Viva (20%).

References

1. UNESCO, Community Involvement in Heritage Management, Paris, 2019.
2. INTACH, Manual for Heritage Documentation and Listing, New Delhi, 2018.

VAC 601 – Personality Development and Leadership
L T P: 2 0 0 | **Credits:** 2

Objectives

1. Strengthen leadership qualities and positive personality traits.
2. Enhance communication and team management skills.
3. Foster values-based leadership through Indian philosophical insights.

Outcomes

CO1 Demonstrate confidence and self-motivation.
CO2 Apply leadership styles in group settings.
CO3 Integrate empathy and ethics in decision making.
CO4 Develop time-management and goal-setting competence.

Unit-wise Syllabus (30 hrs)

Unit	Contents	Hrs
I	Personality Concept & Development – self-concept, Johari window.	6
II	Leadership Theories – traits, styles, transformational leadership.	6
III	Communication & Conflict Resolution – group dynamics.	6
IV	Motivation and Goal Setting – Gita-based leadership principles.	6
V	Case Studies – Swami Vivekananda, A. P. J. Abdul Kalam, Mahatma Gandhi.	6

Text Books

1. Stephen R. Covey, The 7 Habits of Highly Effective People, Simon & Schuster, 2020.
2. Swami Sukhabodhananda, Leadership by Consciousness, Prabhat Books, 2019.

References

1. R. K. Narayana, Value-Based Leadership, Sage India, 2021.
2. Swami Vivekananda, The Complete Works, Advaita Ashrama (9 Vols.), 2016.

Semester VII – Advanced Studies (20 Credits)

IKS 701 – Indian Knowledge Systems in Global Context
L T P: 3 0 0 | **Credits:** 3

Course Objectives

1. Understand India's intellectual interactions with other civilizations through history.
2. Analyze comparative knowledge traditions (Greek, Chinese, Islamic, Western).
3. Study global diffusion of Indian sciences, mathematics, medicine, and spirituality.
4. Explore India's role in world knowledge networks and cultural diplomacy.
5. Develop awareness of IKS relevance to 21st-century global challenges.

Course Outcomes

CO1 Trace global exchanges of scientific and philosophical ideas.
CO2 Compare knowledge frameworks across major civilizations.
CO3 Evaluate contributions of Indian scholars to world thought.
CO4 Demonstrate understanding of India's soft-power traditions.
CO5 Apply global perspectives to contemporary research and policy.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	India and the World – ancient trade routes, cultural exchange, translation movements.	9

Unit	Contents	Hrs
II	Comparative Civilizations – Greek, Chinese, Islamic and Indian approaches to science & philosophy.	9
III	Spread of Indian Sciences – mathematics, astronomy, medicine to Arabia and Europe.	9
IV	Global Spiritual Influence – Buddhism, Yoga, Vedanta, and cross-cultural thought.	9
V	Contemporary Relevance – India in global innovation, IKS diplomacy, sustainable development goals.	9

Text Books

1. Debiprasad Chattopadhyaya (ed.), History of Science and Technology in Ancient India, MLBD, 2018.
2. T. R. S. Sarma, India and the World: Intercultural Dialogues, IGNCA, 2019.

References

1. Amartya Sen, The Argumentative Indian, Penguin India, 2017.
2. Kapil Kapoor (ed.), India's Intellectual Tradition in a Global Context, ICSSR, 2020.

IKS 702 – Advanced Sanskrit Texts and Commentaries
L T P: 3 1 0 | **Credits:** 4

Course Objectives

1. Expose students to advanced grammar, prose, and philosophical texts.
2. Train them in interpretation of commentaries (Bhāṣya, Ṭīkā, Vṛtti).
3. Develop capacity for translation, analysis, and critical comparison.
4. Cultivate sensitivity to linguistic nuance and cultural context.

Course Outcomes
CO1 Read and interpret classical Sanskrit prose and śloka texts.
CO2 Identify structure and purpose of commentarial traditions.
CO3 Translate and analyze selected passages critically.
CO4 Apply linguistic and philosophical methods to primary sources.
CO5 Prepare annotated translation or exegetical report.

Unit-wise Syllabus (60 hrs)

Unit	Contents	Hrs
I	Introduction – grammar review; structure of Bhāṣya literature; tools for textual criticism.	12
II	Selections from Śaṅkara's Bhagavad Gītā Bhāṣya – key metaphysical passages.	12
III	Readings from Pāṇini and Patañjali (Mahābhāṣya extracts); linguistic analysis.	12
IV	Commentarial Traditions in Nyāya and Vedānta – structure, argument method.	12
V	Project – translation and presentation of one selected text with commentary.	12

Text Books

1. S. Subrahmanya Iyer (ed.), Selections from Śaṅkara Bhāṣya, Chowkhamba, 2018.
2. M. R. Kale, Higher Sanskrit Grammar, MLBD, 2010.

References

1. George Cardona, Pāṇini: His Work and Its Tradition, MLBD, 2019.
2. K. S. Ramaswami Sastri, The Art of Commentary Writing in Sanskrit, IGNCA, 2020.

IKS 703 – Research Seminar / Thesis Proposal
L T P: 0 2 2 | **Credits:** 3

Course Objectives
1. Guide students to identify a research topic in IKS or Cultural Heritage.
2. Train them in literature review, methodology, and proposal writing.
3. Enhance academic presentation and peer-review skills.
4. Prepare groundwork for Semester VIII Dissertation.

Course Outcomes
CO1 Define research problems with clarity and feasibility.
CO2 Conduct preliminary literature review using primary & secondary sources.
CO3 Prepare research design, objectives, and expected outcomes.
CO4 Present proposal before faculty panel with critical defence.

Unit-wise Structure (45 hrs)

Unit	Contents	Hrs
I	Orientation – research ethics, identifying topics, mentorship assignment.	9
II	Literature Review – database search, citation styles (APA/MLA).	9
III	Research Design – objectives, methods, time-lines, budget.	9
IV	Seminar Presentations – draft proposal defence and peer review.	9
V	Final Submission – revised proposal and annotated bibliography.	9

Text Books
1. C. R. Kothari & Gaurav Garg, Research Methodology: Methods and Techniques, New Age, 2022.
2. A. Bryman, Social Research Methods, Oxford University Press, 2016.

References
1. IGNCA, Manual for IKS Research Projects, New Delhi, 2020.
2. APA Publication Manual, 7th Edition, 2020.

DSE 701 – Discipline Elective (Yoga Science / Comparative Philosophy / Indian Logic)
L T P: 3 0 0 | **Credits:** 3

Option A – Yoga Science

Unit	Contents	Hrs
I	Patañjali Yoga Sūtras – concepts of Citta, Vṛtti and Samādhi.	9
II	Physiology of Yoga – Prāṇa, Nāḍī, Chakras.	9
III	Mind and Meditation Techniques – Kriyā, Dhyāna, Mindfulness.	9
IV	Therapeutic Applications of Yoga for Health & Well-being.	9
V	Contemporary Research & Integration with Modern Science.	9

Option B – Comparative Philosophy – Indian and Western Metaphysics, Ethics and Epistemology.

Option C – Indian Logic (Advanced Nyāya) – Tarka, Anumāna, Fallacies, Debate Structures.

Text Books
1. Swami Vivekananda, Rāja Yoga, Advaita Ashrama, 2016.
2. B. K. Matilal, Logic, Language and Reality, MLBD, 2019.

References

1. E. Frauwallner, History of Indian Philosophy, MLBD, 2017.
2. G. Feuerstein, The Yoga Tradition, Shambhala, 2018.

EXP 701 – Heritage Tourism / Outreach Internship
L T P: 0 0 6 | **Credits:** 3

Course Objectives

1. Expose students to professional environments in heritage tourism or outreach organizations.
2. Apply heritage interpretation, documentation and communication skills.
3. Promote entrepreneurship and community engagement through experiential learning.

Course Outcomes
CO1 Work effectively in tourism or outreach settings.
CO2 Develop heritage interpretation materials (brochures, guided scripts).
CO3 Document and analyze visitor experience.
CO4 Prepare internship report and presentation.

Structure (90 hrs minimum)

Phase	Tasks	Hrs
I	Orientation – allocation of organization & mentor.	10
II	Field Training – heritage tourism operations, visitor services.	50
III	Independent Mini-Project – tourism product design or outreach event.	20
IV	Report Preparation & Viva Voce.	10

Assessment
Internship Performance (50%), Report (30%), Viva (20%).

References

1. B. Timothy & S. Boyd, Cultural Heritage and Tourism, Routledge, 2019.
2. UNWTO, Sustainable Tourism for Development Guidelines, Madrid, 2020.

Semester VIII – Capstone & Professional (20 Credits)

IKS 801 – Dissertation / Major Project on Indian Knowledge Systems & Cultural Heritage
L T P: 0 0 12 | **Credits:** 6

Course Objectives

1. To enable students to conduct independent, supervised research on an IKS-related topic.
2. To integrate interdisciplinary knowledge and research methodologies learned across the program.
3. To develop scholarly writing, analysis, and academic communication skills.
4. To promote contribution to preservation, innovation, or reinterpretation of Indian knowledge traditions.

Course Outcomes
CO1 Formulate a clear research question and objectives based on literature review.
CO2 Apply suitable methodology—textual, field, analytical or comparative—to IKS research.

CO3 Present coherent analysis, findings, and conclusions in an academic format.
CO4 Defend work through seminar/viva with clarity and originality.

Structure & Hours (180 hrs minimum)

Phase	Component	Hrs
I	Topic selection & proposal approval (supervised)	20
II	Literature review & data collection	60
III	Analysis, interpretation & writing	70
IV	Draft submission, presentation & viva	30

Assessment
Proposal (10%) • Progress (20%) • Final Dissertation (50%) • Viva-voce (20%)

Documentation Requirements
Dissertation (10,000–12,000 words) with abstract, objectives, methods, results, bibliography (APA/MLA).

References

1. IGNCA, Manual for IKS Research Projects, 2020.
2. C. R. Kothari & G. Garg, Research Methodology: Methods and Techniques, New Age, 2022.
3. A. Bryman, Social Research Methods, Oxford UP, 2016.

IKS 802 – Entrepreneurship in Culture & Heritage Industries
L T P: 2 0 2 | **Credits:** 3

Course Objectives
1. Introduce entrepreneurial principles for cultural and creative industries.
2. Understand heritage-based business models and start-up ecosystems.
3. Equip students with project-proposal and financial-planning skills.
4. Promote self-employment, social entrepreneurship, and CSR-based opportunities.

Course Outcomes
CO1 Identify entrepreneurship avenues in cultural heritage and tourism.
CO2 Design sustainable business models linking heritage and technology.
CO3 Prepare proposals for funding and incubation.
CO4 Demonstrate ethical, community-oriented enterprise practices.

Unit-wise Syllabus (45 hrs including practicals)

Unit	Contents	Hrs
I	Introduction to Cultural & Creative Industries; entrepreneurial ecosystem in India.	9
II	Heritage-based Start-ups – craft, museum retail, cultural tourism, digital platforms.	9
III	Business Planning – feasibility, marketing, pricing, intellectual property.	9
IV	Funding & Incubation – MSME, CSR, Government schemes (Ministry of Culture, DST-IKS, AICTE).	9
V	Project Work – develop business canvas or pilot proposal.	9

Text Books

1. B. Throsby, Economics and Culture, Cambridge UP, 2016.
2. UNESCO & UNCTAD, Creative Economy Report, 2020.

References

1. Richard Florida, The Rise of the Creative Class, Basic Books, 2019.
2. N. R. K. Sinha, Cultural Entrepreneurship in India, Sage, 2022.

OEC 801 – Indian Knowledge for Sustainable Development
L T P: 3 0 0 | **Credits:** 3

Course Objectives

1. Explore the integration of IKS principles with UN Sustainable Development Goals (SDGs).
2. Study traditional Indian ecological, agricultural, and social sustainability models.
3. Promote community-based and policy-relevant applications of IKS.
4. Build capacity for critical and creative thinking toward Viksit Bharat 2047 vision.

Course Outcomes
CO1 Explain the relationship between IKS and sustainability paradigms.
CO2 Analyze indigenous ecological and resource-management systems.
CO3 Evaluate policy frameworks linking traditional knowledge with SDGs.
CO4 Design proposals for sustainable community initiatives.

Unit-wise Syllabus (45 hrs)

Unit	Contents	Hrs
I	Sustainability in Indian Thought – concept of Ṛta, Dharma, balance of nature.	9
II	Traditional Agriculture & Water Management – tanks, rain-harvesting, organic farming.	9
III	Indigenous Energy & Architecture – eco-housing, temple ecology, renewable models.	9
IV	Policy & Governance – SDGs, National Mission on Traditional Knowledge, Biodiversity Act.	9
V	Case Studies – community forest management, sacred groves, Swachh Bharat integration.	9

Text Books

1. Vandana Shiva, Staying Alive: Women, Ecology and Development, Zed Books, 2016.
2. Nanditha Krishna, Sacred Plants and Sustainable Traditions of India, Penguin, 2019.

References

1. R. Gadgil & M. Guha, Ecology and Equity, Penguin, 2015.
2. IGNCA, IKS for Sustainable Development Compendium, 2021.

VAC 801 – Professional Ethics & Global Citizenship
L T P: 2 0 0 | **Credits:** 2

Course Objectives

1. Cultivate ethical professionalism, integrity, and cross-cultural sensitivity.
2. Familiarize students with global citizenship values, peace, and diversity.
3. Encourage reflective practice and ethical leadership in global contexts.

Course Outcomes
CO1 Demonstrate understanding of professional and social ethics.
CO2 Apply moral reasoning to workplace and global issues.
CO3 Exhibit respect for diversity, inclusivity, and sustainability.
CO4 Engage responsibly as global citizens and change agents.

Unit-wise Syllabus (30 hrs)

Unit	Contents	Hrs
I	Professional Ethics – definitions, codes, accountability, human rights.	6
II	Global Citizenship – concept, multiculturalism, empathy, and collaboration.	6
III	Ethical Dilemmas – case studies from business, media, environment.	6
IV	Peace and Conflict Resolution – UN charter, Gandhian & Buddhist perspectives.	6
V	Value Integration – role of education, community service, and volunteering.	6

Text Books
1. R. R. Gaur et al., Human Values and Professional Ethics, Excel Books, 2018.
2. UNESCO, Education for Global Citizenship: Learning Objectives, 2019.

References
1. Swami Bhoomananda Tirtha, Values for Life, Chinmaya Publications, 2019.
2. M. Velasquez, Business Ethics: Concepts and Cases, Pearson, 2021.

IKS 803 – Comprehensive Viva / Portfolio Presentation
L T P: 0 0 6 | **Credits:** 3

Course Objectives
1. Assess the cumulative knowledge, skills, and competencies acquired across all eight semesters.
2. Encourage reflective documentation of personal academic growth and research contributions.
3. Evaluate ability to synthesize interdisciplinary learning into coherent understanding.
4. Strengthen oral communication and presentation skills for professional readiness.

Course Outcomes
CO1 Demonstrate integrated understanding of IKS domains.
CO2 Present a digital or physical portfolio showcasing research, internships, and creative works.
CO3 Engage confidently in viva discussions and critical reflections.
CO4 Exhibit career preparedness and lifelong-learning orientation.

Structure (90 hrs equivalent)

Component	Description	Hrs
I	Portfolio Compilation – curated works, reflective essays, achievements.	30
II	Seminar Presentation – research overview & public engagement.	30
III	Viva Voce – comprehensive oral examination by panel.	30

Evaluation Pattern
Portfolio (40%) • Presentation (30%) • Viva Voce (30%).

References
1. NAHEP-UGC, Guidelines for Capstone & Exit Assessment, 2021.
2. IGNCA, Model Framework for IKS Undergraduate Research Assessment, 2020.