THE APOLLO UNIVERSITY

Murukambattu, Chittoor (Dt) 517127, Andhra Pradesh
School of Health Sciences | Department of Biomedical Sciences

M.Sc. HEALTH INFORAMTICS AND ANALYTICS

(M.Sc. HIA) – 2-Year Programme

Outcome-Based Education (OBE) Curriculum

Course Structure and Syllabi

Regulations R-26 | w.e.f. 2026-27 admitted batch

Prepared in the format required for NAAC accreditation and the UGC Credit Framework (CBCS / NEP-aligned)

PART A: PROGRAMME PROFILE

A1. Vision of the School

To be a global leader in health sciences education, research, and innovation, fostering interdisciplinary excellence to advance healthcare, improve patient outcomes, and address global health challenges through cutting-edge knowledge and technology.

A2. Mission of the School

1. To excel in interdisciplinary education, pioneering research, skill development, and technology-driven healthcare solutions.
2. To foster global collaboration, community engagement, and lifelong learning that advance health sciences and improve patient outcomes.

A3. Preamble & Programme Overview

The Master of Science in Health Informatics and Analytics (M.Sc. HIA) is a specialized 2-year postgraduate programme structured under Choice Based Credit System (CBCS) and Outcome-Based Education (OBE) frameworks. The curriculum bridges clinical practice, computer science, data analytics, artificial intelligence, and healthcare management. It prepares graduates to design, deploy, and manage digital health infrastructure, electronic health records (EHRs), clinical decision support systems (CDSS), and predictive data analytics solutions across modern healthcare delivery systems.

A4. Programme Educational Objectives (PEO)

ID	Objective Title	Description
PEO1	Leadership & Innovation	Graduates will excel as leaders, designing and managing advanced health information systems to improve healthcare delivery and drive innovation in the industry.
PEO2	Data-Driven Decision Making	Graduates will apply advanced data analytics to provide actionable insights, enhancing clinical decision-making and optimizing healthcare outcomes and resource use.
PEO3	Ethical & Professional Standards	Graduates will uphold the highest ethical standards, ensuring patient confidentiality, data security, and continuous professional development in health informatics.

A5. Programme Outcomes (PO)

ID	Programme Outcome	Description
PO1	Understanding of Health Systems & Policies	Demonstrate comprehensive knowledge of health systems, healthcare policies, and regulatory environments impacting health informatics.
PO2	Core Informatics Knowledge	Acquire foundational knowledge in health informatics concepts, standards, and frameworks such as EHRs, HIEs, CDSS, HL7, ICD-10/11, and SNOMED CT.
PO3	Data Analytics & Statistical Methods	Master statistical techniques and data analytics methodologies using SQL, R, and Python to analyze complex healthcare data.
PO4	Technical Proficiency	Develop proficiency in health information technologies, database management, data warehousing, cloud computing, and EHR platforms.
PO5	Data Management & Quality Assurance	Implement healthcare data governance and quality assurance practices ensuring data integrity, privacy, and reliability.
PO6	Analytical & Problem-Solving Skills	Apply advanced data analytics and machine learning techniques to solve healthcare challenges and optimize clinical workflows.
PO7	Project Management & Leadership	Cultivate project management and leadership skills to effectively manage health informatics projects and multidisciplinary teams.
PO8	Interdisciplinary Collaboration	Collaborate effectively with clinicians, IT specialists, and administrative stakeholders to deliver integrated digital health solutions.
PO9	Ethical & Professional Responsibility	Adhere to legal, regulatory, and ethical standards in digital health, data security, and patient privacy (HIPAA, GDPR, ABDM).
PO10	Innovation & Continuous Improvement	Foster a mindset of innovation and continuous improvement in health informatics practices to enhance healthcare delivery.

A6. Programme Specific Outcomes (PSO)

ID	PSO Title	Description
PSO1	Proficiency in Health Data Management	Master the collection, organization, integration, and secure management of healthcare data adhering to national and global standards.
PSO2	Expertise in Health Informatics Systems	Excel in designing, implementing, and optimizing clinical decision support systems, EHRs, and digital health platforms.
PSO3	Analytical Competence in Healthcare Data	Demonstrate advanced analytical skills to interpret clinical, epidemiological, and administrative data using machine learning and AI.
PSO4	Leadership in Health Informatics Strategy	Lead strategic initiatives to enhance health informatics infrastructure, interoperability, and digital transformation in healthcare.

PART B: CREDIT FRAMEWORK AND OBE RULES

B1. Credit Norms (UGC / CBCS Framework)

1 credit = 1 Lecture hour per week (15 hours/semester)
1 credit = 1 Tutorial hour per week (15 hours/semester)
1 credit = 2 Practical/Laboratory hours per week (30 hours/semester)

B2. Credit Summary Across Semesters

Semester	Credits	Remarks / Components
Semester I	24	Core, Elective, Labs & Induction Programme (3 weeks)
Semester II	24	Core, Elective & Advanced Analytics Labs
Semester III	24	Research Methodology, Business Intelligence, Electives & Mini Project (8 credits)
Semester IV	28 (18 Major Project)	Major Research Dissertation / Industry Project (36 hours/week)
Total Credits	90	M.Sc. Health Informatics & Analytics Degree Requirement

B3. Assessment & Grading Scheme

• Theory Courses: Continuous Internal Evaluation (CIE) = 40%, Semester End Examination (SEE) = 60%
• Practical Courses: Continuous Internal Evaluation (CIE) = 50%, Semester End Examination (SEE) = 50%
• Projects / Dissertation: Continuous Internal Review = 40%, Final Dissertation Evaluation & Viva-Voce = 60%

PART C: SEMESTER-WISE COURSE STRUCTURE

Semester I (3-Week Induction Programme)

Code	Course Title	L	T	P	C	Hrs	Category
26HIAT6501	Fundamentals of Clinical Informatics	3	1	0	4	4	Core Theory
26HIAT6502	Foundations of Cloud Computing	3	1	0	4	4	Core Theory
26HIAT6503	Healthcare Data Science	3	1	0	4	4	Core Theory
26HIAT6504	Standards for Digital Health	3	1	0	4	4	Core Theory
26HIAT6601	Program Elective – 1	3	1	0	4	4	Elective Theory
26HIAL6501	Healthcare Data Science Lab	0	0	4	2	4	Laboratory
26HIAL6502	Foundations of Cloud Computing Lab	0	0	4	2	4	Laboratory
--	Non-Credit (Soft Skills, Mentoring, Seminar, Library, Physical Act.)	0	0	0	0	8	Non-Credit
TOTAL	Semester I Total	15	5	8	24	36	

Semester II

Code	Course Title	L	T	P	C	Hrs	Category
26HIAT6505	Healthcare Data Engineering	3	1	0	4	4	Core Theory
26HIAT6506	Clinical Decision Support Systems	3	1	0	4	4	Core Theory
26HIAT6507	Healthcare Data Visualization and Analysis	3	1	0	4	4	Core Theory
26HIAT6508	AI in Healthcare	3	1	0	4	4	Core Theory
26HIAT6602	Program Elective – 2	3	1	0	4	4	Elective Theory
26HIAL6503	Healthcare Data Engineering Lab	0	0	4	2	4	Laboratory
26HIAL6504	Healthcare Data Visualization and Analysis Lab	0	0	4	2	4	Laboratory
--	Non-Credit (Soft Skills, Mentoring, Seminar, Library, Physical Act.)	0	0	0	0	8	Non-Credit
TOTAL	Semester II Total	15	5	8	24	36	

Semester III

Code	Course Title	L	T	P	C	Hrs	Category
26HIAT7509	Research Methodology and Ethics in Healthcare	3	1	0	4	4	Core Theory
26HIAT7510	Business Intelligence and Healthcare Management	3	1	0	4	4	Core Theory
26HIAT7603	Program Elective – 3	3	1	0	4	4	Elective Theory

26HIAT7604	Program Elective – 4	3	1	0	4	4	Elective Theory
26HIAP7501	Mini Project	0	0	14	8	16	Project
--	Non-Credit (Mentoring, Physical Activity, Self-Learning)	0	0	0	0	4	Non-Credit
TOTAL	Semester III Total	12	4	14	24	36	

Semester IV

Code	Course Title	L	T	P	C	Hrs	Category
26HIAP7502	Major Project / Research Dissertation	0	0	36	18	36	Research Project
TOTAL	Semester IV Total	0	0	36	18	36	

Program Elective Baskets

Basket Code & Name	Option A	Option B
Program Elective 1 (26HIAT6601)	A. Medical Terminology (HIAT6601A)	B. Mathematical Foundations of Health Informatics (HIAT6601B)
Program Elective 2 (26HIAT6602)	A. Advanced Genomics, Proteomics & CADD (HIAT6602A)	B. Internet of Medical Things - IoMT (HIAT6602B)
Program Elective 3 (26HIAT7603)	A. Deep Learning & Computer Vision (HIAT7603A)	B. Intellectual Property Rights (HIAT7601B) / C. MOOC
Program Elective 4 (26HIAT7604)	A. Agentic AI in Healthcare (HIAT7604A)	B. Pharmacoinformatics (HIAT7602B) / C. MOOC

PART D: DETAILED COURSE SYLLABI (OBE FORMAT)

26HIAT6501: Fundamentals of Clinical Informatics

L-T-P-C	Value	Hours	Value	Sem	Val	Cat	Val
L-T-P-C	3-1-0-4	Teaching Hours	60	Semester	I	Category	Core Theory

Course Description: Provides an integrated understanding of clinical informatics, electronic health records (EHRs), interoperability, clinical decision support systems, data standards, privacy, security, and digital health innovations in precision medicine.

Course Objectives:

1. Explain genomics and proteomics applications in precision medicine.
2. Describe computational drug discovery tools.
3. Understand clinical information system architecture and EHR standards.
4. Analyze interoperability frameworks and CDSS.
5. Evaluate digital health emerging trends.

Unit-wise Syllabus

Unit	Title & Contents	Hours
Unit I: Overview of Clinical Informatics & Genomics	History & scope of clinical informatics; introduction to genomics, DNA sequencing, next-generation sequencing, variant analysis, precision medicine applications.	12
Unit II: Proteomics & Computational Drug Discovery	Proteomics principles, mass spectrometry, protein structure prediction, computer-aided drug design (CADD), molecular docking, virtual screening, bioinformatics databases.	12
Unit III: Clinical Information Systems & EHRs	EHR architecture, Computerized Physician Order Entry (CPOE), clinical documentation, healthcare data standards: ICD-10/11, SNOMED CT, LOINC, CPT.	12
Unit IV: Interoperability, CDSS & Governance	Health Information Exchange (HIE), HL7 v2/v3, FHIR, DICOM standards, Clinical Decision Support Systems (CDSS), evidence-based medicine, HIPAA, GDPR, ABDM compliance.	12
Unit V: Emerging Trends in Clinical Informatics	AI & Machine Learning in clinical practice, predictive analytics, mHealth, IoMT, digital therapeutics, clinical research informatics, future innovations.	12

Course Outcomes (COs)

CO ID	Course Outcome Statement	Bloom Level
CO1	Explain genomic principles, sequencing technologies, and their role in precision medicine.	K2
CO2	Describe proteomics, computational drug design, and bioinformatics tools in drug discovery.	K2
CO3	Understand the architecture of Clinical Information Systems, EHRs, and medical terminologies.	K2
CO4	Apply interoperability standards (HL7/FHIR) and evaluate CDSS and data governance policies.	K3
CO5	Assess AI, mHealth, and digital therapeutics for modern healthcare delivery.	K5

Text & Reference Books:

1. Shortliffe, E. H., & Cimino, J. J. Biomedical Informatics: Computer Applications in Health Care and Biomedicine. Springer.
2. Hoyt, R. E., Yoshihashi, A. K., & Bailey, N. Health Informatics: Practical Guide. Lulu Press.

26HIAT6502: Foundations of Cloud Computing

L-T-P-C	Value	Hours	Value	Sem	Val	Cat	Val
L-T-P-C	3-1-0-4	Teaching Hours	60	Semester	I	Category	Core Theory

Course Description: Introduces cloud architectures, virtualization, IaaS, PaaS, SaaS, cloud security, serverless computing, and cloud-native healthcare data infrastructure on AWS, Azure, and Google Cloud.

Course Objectives:

1. Understand cloud computing service and deployment models.
2. Explain virtualization and containerization technologies.
3. Analyze cloud database and storage solutions for healthcare.
4. Evaluate cloud security and compliance.
5. Assess serverless and cloud-native healthcare architectures.

Unit-wise Syllabus

Unit	Title & Contents	Hours
Unit I: Cloud Computing Fundamentals	NIST cloud definition, IaaS, PaaS, SaaS, public/private/hybrid clouds, cloud economics, healthcare cloud migration strategies.	12
Unit II: Virtualization & Containerization	Hypervisors, VMs, Docker containers, Kubernetes orchestration, microservices architecture for health microservices.	12
Unit III: Cloud Storage & Databases	Object storage (S3/Blob), relational & NoSQL cloud databases, cloud data warehousing (Snowflake, BigQuery), EHR data hosting.	12
Unit IV: Cloud Security & Compliance	Cloud IAM, encryption at rest/transit, HIPAA/GDPR cloud compliance, shared responsibility model, audit logging.	12
Unit V: Serverless & Emerging Cloud Tech	AWS Lambda, Azure Functions, edge computing, IoMT cloud integration, multi-cloud strategies in healthcare.	12

Course Outcomes (COs)

CO ID	Course Outcome Statement	Bloom Level

CO1	Explain cloud computing paradigms and deployment models in healthcare settings.	K2
CO2	Apply Docker and Kubernetes for containerizing healthcare applications.	K3
CO3	Design cloud storage and database architectures for electronic health records.	K6
CO4	Evaluate cloud security frameworks and regulatory compliance requirements.	K5
CO5	Develop serverless cloud workflows for real-time healthcare data analytics.	K6

Text & Reference Books:

1. Rajkumar Buyya et al. Mastering Cloud Computing. McGraw-Hill.
2. Barrie Sosinsky. Cloud Computing Bible. Wiley.

26HIAT6503: Healthcare Data Science

L-T-P-C	Value	Hours	Value	Sem	Val	Cat	Val
L-T-P-C	3-1-0-4	Teaching Hours	60	Semester	I	Category	Core Theory

Course Description: Integrates statistical methods, data analytics, machine learning, clinical database querying, data visualization, and predictive modeling for clinical decision support and precision medicine.

Course Objectives:

1. Understand healthcare data sources and biostatistics.
2. Apply data cleaning, EDA, and visualization.
3. Develop machine learning models for clinical analytics.
4. Evaluate data privacy and governance.
5. Assess real-world applications in precision healthcare.

Unit-wise Syllabus

Unit	Title & Contents	Hours
Unit I: Fundamentals of Healthcare Data Science	Healthcare data types (structured, EHR, medical imaging, genomic), data lifecycle, biostatistics, descriptive & inferential statistics.	12
Unit II: Data Preprocessing & Visualization	SQL for healthcare queries, data cleaning, imputation techniques, feature engineering, Tableau & Power BI dashboards.	12
Unit III: Machine Learning for Healthcare	Supervised/unsupervised learning, regression, decision trees, random forests, SVM, clustering, model validation metrics (ROC/AUC, F1).	12
Unit IV: Ethics, Privacy & Governance	Data governance, HIPAA, GDPR, anonymization, de-identification techniques, explainable AI (XAI) in clinical models.	12
Unit V: Advanced Applications	Predictive modeling for patient readmission, disease risk stratification, precision medicine analytics, NLP in clinical notes.	12

Course Outcomes (COs)

CO ID	Course Outcome Statement	Bloom Level

CO1	Explain healthcare data types, statistical methods, and lifecycle management.	K2
CO2	Perform data preprocessing, SQL querying, and interactive visualization.	K3
CO3	Build and validate predictive machine learning models for clinical outcomes.	K6
CO4	Evaluate data security, privacy standards, and ethical AI principles.	K5
CO5	Apply data science pipelines to precision medicine and population health.	K3

Text & Reference Books:

1. Joel Grus. Data Science from Scratch: First Principles with Python. O'Reilly.
2. Trevor Hastie et al. The Elements of Statistical Learning. Springer.

26HIAT6504: Standards for Digital Health

L-T-P-C	Value	Hours	Value	Sem	Val	Cat	Val
L-T-P-C	3-1-0-4	Teaching Hours	60	Semester	I	Category	Core Theory

Course Description: Covers international and national digital health standards enabling secure, interoperable health systems including HL7, FHIR, DICOM, ICD-10/11, SNOMED CT, LOINC, and ABDM.

Course Objectives:

1. Understand digital health interoperability principles.
2. Explain medical terminologies and coding systems.
3. Analyze HL7 and FHIR frameworks.
4. Evaluate cybersecurity and regulatory policies.
5. Assess Ayushman Bharat Digital Mission (ABDM) standards.

Unit-wise Syllabus

Unit	Title & Contents	Hours
Unit I: Introduction to Digital Health Standards	Need for standardization, ISO/TC 215, health information exchange (HIE) models, interoperability levels (technical, syntactic, semantic).	12
Unit II: Clinical Terminologies & Vocabularies	SNOMED CT structure, ICD-10/11 classification, LOINC lab codes, CPT coding, RxNorm, medical ontology mapping.	12
Unit III: Messaging & Data Exchange Standards	HL7 v2/v3 messaging, FHIR resources and APIs, DICOM imaging standards, CDA (Clinical Document Architecture).	12
Unit IV: Privacy, Security & ABDM Framework	ISO 27001/27799, HIPAA, Digital Personal Data Protection (DPDP) Act, ABDM health ID (ABHA), PHR, and Health Facility Registry.	12
Unit V: Emerging Digital Health Standards	AI medical device standards, IoMT communication protocols, telemedicine guidelines, digital therapeutics validation.	12

Course Outcomes (COs)

CO ID	Course Outcome Statement	Bloom Level

CO1	Explain the role and architecture of digital health standards in interoperability.	K2
CO2	Utilize SNOMED CT, ICD, and LOINC for semantic healthcare coding.	K3
CO3	Implement FHIR resources and RESTful APIs for health data exchange.	K3
CO4	Evaluate cybersecurity controls and ABDM national health stack compliance.	K5
CO5	Analyze emerging standards for AI, mHealth, and connected medical devices.	K4

Text & Reference Books:

1. Tim Benson & Grahame Grieve. Principles of Health Interoperability: SNOMED CT, HL7 and FHIR. Springer.
2. Shortliffe, E. H., & Cimino, J. J. Biomedical Informatics. Springer.

26HIAT6505: Healthcare Data Engineering

L-T-P-C	Value	Hours	Value	Sem	Val	Cat	Val
L-T-P-C	3-1-0-4	Teaching Hours	60	Semester	II	Category	Core Theory

Course Description: Focuses on the architecture, ingestion, storage, ETL pipelines, data lakes, lakehouses, big data technologies (Hadoop, Spark), and cloud platforms for scalable healthcare data engineering.

Course Objectives:

1. Understand data engineering lifecycle in healthcare.
2. Design ETL/ELT pipelines and data warehouses.
3. Utilize Big Data systems (Hadoop, PySpark).
4. Implement data quality and governance.
5. Evaluate modern lakehouse architectures.

Unit-wise Syllabus

Unit	Title & Contents	Hours
Unit I: Fundamentals of Healthcare Data Engineering	Data engineering role, batch vs streaming ingestion, structured/unstructured EHR data feeds, data pipeline architecture.	12
Unit II: Data Warehousing & ETL Pipelines	Dimensional modeling, star/snowflake schemas, ETL toolsets (Airflow), master data management (MDM), FHIR data pipelines.	12
Unit III: Big Data Technologies	Hadoop HDFS, MapReduce, Apache Spark/PySpark distributed processing, Delta Lake, real-time streaming with Kafka.	12
Unit IV: Data Quality, Governance & Security	Data lineage, metadata management, automated data quality testing, role-based access control, HIPAA compliant data vaults.	12
Unit V: Cloud Data Engineering Architectures	AWS Glue, Databricks, Snowflake, Azure Synapse, lakehouse architecture for clinical and genomic data integration.	12

Course Outcomes (COs)

CO ID	Course Outcome Statement	Bloom Level

CO1	Explain data engineering principles and pipeline design patterns in healthcare.	K2
CO2	Design ETL workflows using Apache Airflow and relational/NoSQL databases.	K6
CO3	Process large-scale healthcare datasets using PySpark and distributed systems.	K4
CO4	Implement data quality frameworks and regulatory security governance.	K3
CO5	Construct cloud-native data lakehouse architectures for analytics.	K6

Text & Reference Books:

1. Martin Kleppmann. Designing Data-Intensive Applications. O'Reilly.
2. Ralph Kimball. The Data Warehouse Toolkit. Wiley.

26HIAT6506: Clinical Decision Support Systems

L-T-P-C	Value	Hours	Value	Sem	Val	Cat	Val
L-T-P-C	3-1-0-4	Teaching Hours	60	Semester	II	Category	Core Theory

Course Description: Covers design, rule engines, machine learning integration, clinical workflow optimization, EHR embedding, alert fatigue mitigation, and evaluation of Clinical Decision Support Systems.

Course Objectives:

1. Understand CDSS taxonomy and architecture.
2. Design knowledge-based and AI-driven CDSS.
3. Integrate CDSS into clinical workflows and EHRs.
4. Address alert fatigue and safety issues.
5. Evaluate clinical effectiveness and outcomes.

Unit-wise Syllabus

Unit	Title & Contents	Hours
Unit I: Overview of Clinical Decision Support Systems	History, definition, taxonomy (knowledge-based vs non-knowledge-based), benefits, impact on patient safety and quality.	12
Unit II: Knowledge Representation & Rule Engines	Clinical practice guidelines, Arden Syntax, GELLO, rule-based inference engines, clinical ontologies, Bayesian networks.	12
Unit III: AI & Machine Learning in CDSS	Predictive clinical models, diagnostic algorithms, risk scoring tools (ICU mortality, sepsis prediction), NLP for unstructured clinical notes.	12
Unit IV: Integration & Usability in EHRs	Infobuttons, CDS Hooks, FHIR-based CDSS integration, user interface design, alert fatigue mitigation, workflow alignment.	12
Unit V: Evaluation, Ethics & Regulations	Clinical trials for CDSS, FDA SAMD (Software as a Medical Device) regulations, algorithmic bias, liability, and ethical practice.	12

Course Outcomes (COs)

CO ID	Course Outcome Statement	Bloom Level
CO1	Explain CDSS concepts, architectures, and impact on evidence-based practice.	K2
CO2	Develop knowledge-based rule sets using clinical guidelines.	K6
CO3	Integrate machine learning predictive models into clinical decision support.	K3
CO4	Apply CDS Hooks and FHIR standards for seamless EHR integration.	K3
CO5	Evaluate CDSS performance, usability, alert fatigue, and regulatory compliance.	K5

Text & Reference Books:

1. E. S. Berner. Clinical Decision Support Systems: Theory and Practice. Springer.
2. Shortliffe, E. H., & Cimino, J. J. Biomedical Informatics. Springer.

26HIAT6507: Healthcare Data Visualization and Analysis

L-T-P-C	Value	Hours	Value	Sem	Val	Cat	Val
L-T-P-C	3-1-0-4	Teaching Hours	60	Semester	II	Category	Core Theory

Course Description: Teaches exploratory analysis, statistical graphics, dashboard development, business intelligence tools (Power BI, Tableau), and visual communication of clinical and operational metrics.

Course Objectives:

1. Understand visualization principles and perception.
2. Apply statistical graphics in R/Python.
3. Build executive dashboards in Power BI and Tableau.
4. Analyze clinical and hospital operations metrics.
5. Evaluate visual storytelling for healthcare decision-making.

Unit-wise Syllabus

Unit	Title & Contents	Hours
Unit I: Principles of Healthcare Visualization	Data visualization theory, visual perception (Gestalt principles), chart selection, ethical representation of health data.	12
Unit II: Exploratory Analysis & Statistical Graphics	Distribution plots, time-series analysis, survival curves (Kaplan-Meier), geospatial disease mapping (GIS), ggplot2 & Seaborn.	12
Unit III: Business Intelligence & Dashboard Design	KPI formulation, dashboard wireframing, interactive filters, Microsoft Power BI, Tableau Desktop for clinical reporting.	12
Unit IV: Operational & Clinical Performance Analytics	Hospital length-of-stay dashboards, bed occupancy analytics, readmission tracking, population health monitoring.	12
Unit V: Advanced Visual Analytics & Storytelling	Visual analytics for multi-omics, real-time ICU monitoring displays, visual storytelling techniques for healthcare executives.	12

Course Outcomes (COs)

CO ID	Course Outcome Statement	Bloom Level
CO1	Explain design principles and cognitive perception in data visualization.	K2
CO2	Generate statistical and epidemiological plots using Python and R.	K3
CO3	Create interactive business intelligence dashboards in Power BI and Tableau.	K6
CO4	Analyze hospital operations and clinical quality metrics visually.	K4
CO5	Communicate data insights effectively through visual storytelling.	K6

Text & Reference Books:

1. Claus O. Wilke. Fundamentals of Data Visualization. O'Reilly.
2. Cole Nussbaumer Knaflic. Storytelling with Data. Wiley.

26HIAT6508: AI in Healthcare

L-T-P-C	Value	Hours	Value	Sem	Val	Cat	Val
L-T-P-C	3-1-0-4	Teaching Hours	60	Semester	II	Category	Core Theory

Course Description: Covers machine learning, deep learning, computer vision, NLP, generative AI, medical image processing, and digital health applications while addressing AI ethics, explainability, and regulatory governance.

Course Objectives:

1. Understand AI/ML paradigms in health sciences.
2. Apply deep learning and computer vision to medical imaging.
3. Utilize NLP for clinical notes.
4. Analyze ethical AI, bias, and explainability.
5. Evaluate generative AI and digital health futures.

Unit-wise Syllabus

Unit	Title & Contents	Hours
Unit I: Foundations of AI in Healthcare	History of AI in medicine, supervised/unsupervised ML, neural network architectures, healthcare dataset nuances.	12
Unit II: Deep Learning & Medical Computer Vision	CNNs, ResNet, UNet segmentation for X-Ray, CT, MRI, digital pathology, image classification, object detection.	12
Unit III: Natural Language Processing in Clinical Practice	Clinical text mining, transformers, BioBERT, LLMs for discharge summaries, clinical entity extraction.	12
Unit IV: Responsible AI, Governance & Explainability	Explainable AI (SHAP, LIME), algorithmic fairness, data privacy, FDA AI medical device approval, risk management.	12
Unit V: Generative AI & Next-Gen Healthcare AI	Generative AI for synthetic health data, AI agents, digital twins in surgery, ambient clinical intelligence, future outlook.	12

Course Outcomes (COs)

CO ID	Course Outcome Statement	Bloom Level
CO1	Explain artificial intelligence, machine learning, and deep learning concepts in healthcare.	K2
CO2	Apply CNN architectures to medical image classification and segmentation.	K3
CO3	Utilize NLP models for extracting structured information from clinical narratives.	K3
CO4	Evaluate model explainability, bias, privacy, and regulatory frameworks.	K5
CO5	Assess generative AI and autonomous agents for transforming healthcare operations.	K5

Text & Reference Books:

1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press.
2. Eric Topol. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. Basic Books.

26HIAT7509: Research Methodology and Ethics in Healthcare

L-T-P-C	Value	Hours	Value	Sem	Val	Cat	Val
L-T-P-C	3-1-0-4	Teaching Hours	60	Semester	III	Category	Core Theory

Course Description: Covers scientific inquiry, study designs, biostatistics, literature review, grant proposal preparation, paper writing, research misconduct, ICMR guidelines, and human subject protections.

Course Objectives:

1. Understand healthcare research designs.
2. Apply biostatistical analysis and sampling.
3. Draft research proposals and scientific manuscripts.
4. Evaluate ICMR, GCP, and IEC ethical guidelines.
5. Assess systematic reviews and meta-analysis.

Unit-wise Syllabus

Unit	Title & Contents	Hours
Unit I: Fundamentals of Healthcare Research	Scientific method, observational vs experimental designs, RCTs, cohort studies, case-control studies, systematic literature search.	12
Unit II: Research Methods & Biostatistics	Sampling techniques, sample size estimation, hypothesis testing, ANOVA, multivariate regression, SPSS/R/Python analysis.	12
Unit III: Scientific Writing & Dissemination	Structure of research papers (IMRaD), referencing software (Mendeley, Zotero), grant writing, systematic reviews, PRISMA framework.	12
Unit IV: Research Ethics & Regulatory Frameworks	ICMR ethical guidelines, Declaration of Helsinki, informed consent, Institutional Ethics Committee (IEC), plagiarism, data integrity.	12
Unit V: Emerging Trends in Healthcare Research	Implementation science, real-world evidence (RWE), AI-assisted research, open science, reproducible research practices.	12

Course Outcomes (COs)

CO ID	Course Outcome Statement	Bloom Level

CO1	Explain quantitative and qualitative research methodologies in healthcare.	K2
CO2	Formulate research hypotheses and calculate sample sizes using biostatistics.	K6
CO3	Draft high-quality research proposals and scientific manuscripts.	K6
CO4	Evaluate ethical considerations, ICMR guidelines, and IEC requirements.	K5
CO5	Conduct systematic reviews and meta-analyses following PRISMA guidelines.	K3

Text & Reference Books:

1. C. R. Kothari & G. Garg. Research Methodology: Methods and Techniques. New Age.
2. John W. Creswell. Research Design. Sage.

26HIAT7510: Business Intelligence and Healthcare Management

L-T-P-C	Value	Hours	Value	Sem	Val	Cat	Val
L-T-P-C	3-1-0-4	Teaching Hours	60	Semester	III	Category	Core Theory

Course Description: Combines healthcare administration, strategic decision support, financial analytics, revenue cycle management, supply chain, and Business Intelligence applications for organizational performance.

Course Objectives:

1. Understand healthcare management and BI architecture.
2. Design data warehouses and enterprise KPIs.
3. Analyze hospital operations and financial metrics.
4. Evaluate data governance and strategic planning.
5. Assess digital transformation in healthcare enterprises.

Unit-wise Syllabus

Unit	Title & Contents	Hours
Unit I: Fundamentals of BI & Healthcare Management	Healthcare organizational structures, management principles, decision support systems, BI architecture in hospital settings.	12
Unit II: Data Warehousing & Healthcare KPIs	ETL processes for hospital databases, OLAP cubes, executive KPI scorecards, balanced scorecard in healthcare.	12
Unit III: Operations & Financial Analytics	Patient flow optimization, bed management, revenue cycle management (RCM), supply chain analytics, cost accounting.	12
Unit IV: Quality, Accreditation & Governance	NABH/JCI accreditation metrics, clinical quality indicators, data governance, risk management, regulatory compliance.	12
Unit V: Digital Transformation & Smart Hospitals	AI-driven business analytics, cloud BI platforms, value-based healthcare delivery, smart hospital management strategies.	12

Course Outcomes (COs)

CO ID	Course Outcome Statement	Bloom Level
CO1	Explain Business Intelligence architecture and healthcare management principles.	K2
CO2	Formulate enterprise KPIs and design data warehouse OLAP models.	K6
CO3	Analyze hospital operational efficiency and revenue cycle performance.	K4
CO4	Apply quality assurance metrics aligned with NABH/JCI accreditation standards.	K3
CO5	Develop strategic digital transformation blueprints for healthcare organizations.	K6

Text & Reference Books:

1. Efraim Turban et al. Business Intelligence, Analytics, and Data Science. Pearson.
2. K. A. Wager et al. Health Care Information Systems. Jossey-Bass.

LABORATORY COURSES SYLLABI

26HIAL6501: Healthcare Data Science Lab

L-T-P-C: 0-0-4-2 | Hours: 60 | Semester: I

List of Practical Experiments:

Expt 1: Data Acquisition & SQL querying on EHR databases.
Expt 2: Data Preprocessing, handling missing clinical values & normalization.
Expt 3: Exploratory Data Analysis (EDA) on patient demographic datasets.
Expt 4: Biostatistical analysis & hypothesis testing using Python/R.
Expt 5: Building Classification models (Logistic Regression, Decision Trees) for disease prediction.
Expt 6: Building Random Forest & SVM models for patient readmission risk.
Expt 7: Clustering patient cohorts using K-Means and Hierarchical clustering.
Expt 8: Model Evaluation (ROC-AUC, Precision, Recall, Confusion Matrix).
Expt 9: Creating Interactive Dashboards using Tableau/Power BI.
Expt 10: Clinical NLP for entity extraction from physician notes.
Expt 11: Deploying a Healthcare Data Science Streamlit web app.
Expt 12: End-to-End Capstone Project on real-world clinical dataset.

26HIAL6502: Foundations of Cloud Computing Lab

L-T-P-C: 0-0-4-2 | Hours: 60 | Semester: I

List of Practical Experiments:

Expt 1: Setting up AWS/Azure cloud environments and IAM security roles.
Expt 2: Configuring Virtual Machines (EC2/Azure VM) and Linux hosting.
Expt 3: Dockerizing a Python Flask/FastAPI healthcare web service.
Expt 4: Deploying containerized microservices on Kubernetes (Minikube).
Expt 5: Configuring Cloud Storage (AWS S3) for medical DICOM images.
Expt 6: Setting up Cloud Relational (RDS PostgreSQL) and NoSQL (MongoDB) databases.
Expt 7: Creating serverless functions (AWS Lambda) for automated HL7 message processing.
Expt 8: Configuring Cloud Security, SSL/TLS, and HIPAA-compliant access controls.
Expt 9: Implementing Automated Data Backup and Cloud Disaster Recovery workflows.
Expt 10: Building Cloud-native BigQuery/Snowflake analytics pipelines.
Expt 11: Infrastructure as Code (IaC) deployment using Terraform.
Expt 12: End-to-End Cloud Healthcare Application deployment.

26HIAL6503: Healthcare Data Engineering Lab

L-T-P-C: 0-0-4-2 | Hours: 60 | Semester: II

List of Practical Experiments:

Expt 1: Designing relational database schemas for hospital information systems.
Expt 2: Developing Python ETL pipelines for ingesting HL7/FHIR JSON messages.
Expt 3: Building Data Warehousing dimensional schemas (Star Schema in PostgreSQL).
Expt 4: Orchestrating ETL workflows using Apache Airflow.

Expt 5: Big Data processing with PySpark on multi-gigabyte EHR datasets.
Expt 6: Real-time streaming data ingestion using Apache Kafka.
Expt 7: Building a Delta Lake architecture for ACID compliance in health data.
Expt 8: Implementing automated data validation and quality checks.
Expt 9: Configuring role-based access control and data masking for HIPAA compliance.
Expt 10: Integrating FHIR APIs with cloud data lakes (AWS Glue / S3).
Expt 11: Optimizing Spark query performance and partition strategies.
Expt 12: End-to-End Healthcare Data Lakehouse Pipeline capstone.

26HIAL6504: Healthcare Data Visualization and Analysis Lab

L-T-P-C: 0-0-4-2 | Hours: 60 | Semester: II

List of Practical Experiments:

Expt 1: Importing and cleaning messy hospital administrative data in Python/R.
Expt 2: Generating statistical graphics (histograms, box plots, scatter) for clinical parameters.
Expt 3: Survival analysis plotting (Kaplan-Meier curves) using lifelines package.
Expt 4: Geospatial disease mapping (GIS) using Folium/Geopandas.
Expt 5: Creating hospital bed occupancy and length-of-stay dashboards in Power BI.
Expt 6: Building interactive clinical quality metrics dashboards in Tableau.
Expt 7: Time-series analysis and forecasting for hospital admission trends.
Expt 8: Design of executive scorecards for healthcare administrators.
Expt 9: Visual analytics for multi-omics and gene expression heatmaps.
Expt 10: Real-time ICU vital signs monitoring dashboard simulation.
Expt 11: Visual data storytelling presentation for clinical stakeholders.
Expt 12: Comprehensive Healthcare BI & Visualization Capstone project.

PROGRAM ELECTIVE COURSES SYLLABI

Course Code: HIAT6601A - Medical Terminology

L-T-P-C: 3-0-0-3 | Hours: 45 | Category: Program Elective

Overview & Key Syllabus Units: Fundamentals of medical root words, prefixes, suffixes, anatomical directional terms, organ system vocabularies, diagnostic terminology, ICD-10/11 coding, and EHR clinical documentation language.

Course Code: HIAT6601B - Mathematical Foundations of Health Informatics

L-T-P-C: 3-0-0-3 | Hours: 45 | Category: Program Elective

Overview & Key Syllabus Units: Linear algebra, matrix operations, eigenvalues, differential/integral calculus, optimization algorithms, probability distributions, Bayes theorem, and statistical inference for health data analytics.

Course Code: HIAT6602A - Advanced Genomics, Proteomics & CADD

L-T-P-C: 3-0-0-3 | Hours: 45 | Category: Program Elective
Overview & Key Syllabus Units: NGS genomic analysis, variant calling, mass spec proteomics, structural bioinformatics, molecular modeling, virtual screening, docking algorithms, and AI-driven drug discovery.

Course Code: HIAT6602B - Internet of Medical Things (IoMT)

L-T-P-C: 3-0-0-3 | Hours: 45 | Category: Program Elective
Overview & Key Syllabus Units: IoMT architecture, medical sensors, wearable health monitors, wireless protocols (BLE, Zigbee, MQTT), remote patient monitoring, edge AI, and IoMT cybersecurity.

Course Code: HIAT7603A - Deep Learning and Computer Vision

L-T-P-C: 3-0-0-3 | Hours: 45 | Category: Program Elective
Overview & Key Syllabus Units: Convolutional Neural Networks (CNNs), ResNet, UNet, vision transformers, medical image segmentation (CT/MRI/X-Ray), object detection, and generative adversarial networks (GANs) in radiology.

Course Code: HIAT7601B - Intellectual Property Rights

L-T-P-C: 3-0-0-3 | Hours: 45 | Category: Program Elective
Overview & Key Syllabus Units: Patents, copyrights, trademarks, trade secrets, software patents in digital health, patent searching, technology transfer, licensing, and global IPR frameworks (TRIPS, WIPO).

Course Code: HIAT7604A - Agentic AI in Healthcare

L-T-P-C: 3-0-0-3 | Hours: 45 | Category: Program Elective
Overview & Key Syllabus Units: Autonomous AI agents, Large Language Models, Retrieval-Augmented Generation (RAG), multi-agent systems, clinical task automation, AI copilots, and human-AI teaming in clinical care.

Course Code: HIAT7602B - Pharmacoinformatics

L-T-P-C: 3-0-0-3 | Hours: 45 | Category: Program Elective
Overview & Key Syllabus Units: Cheminformatics, pharmaceutical databases (DrugBank, PubChem), QSAR modeling, pharmacogenomics, adverse drug reaction (ADR) mining, pharmacovigilance, and AI in precision medicine.

MBTP7502 → MSHIA7502: Major Project / Dissertation

1. Course information

Component	Proposed details
Course Code	MSHIA7502 (proposed; confirm against the approved coding scheme)
Course Title	Major Project / Dissertation
Learning (L)	0
Tutorial (T)	0
Practical / Project (P)	36
Credits (C)	18
Duration	15 weeks (480 hours)
Semester	IV
Evaluation	300 marks (240 Internal + 60 External)

2. Project guidelines and work breakdown

The Major Project provides an intensive 15-week research experience in which students identify a relevant healthcare problem, formulate a research question, acquire or access appropriate health data, conduct analytical or computational investigations, interpret findings, and present a dissertation with practical relevance to healthcare delivery, clinical decision-making, or health systems improvement.

Phase	Activity and focus area	Timeline	Allocated hours
Phase 1	Problem Identification: Identify a focused healthcare problem in clinical informatics, health data analytics, digital health, healthcare quality, epidemiology, or AI-enabled healthcare.	Weeks 1–2	30
Phase 2	Literature Review and Research Question: Critically review scientific literature, identify research gaps, formulate objectives and hypotheses, and define measurable outcomes.	Weeks 3–4	50
Phase 3	Research Design and Data Acquisition: Develop the study protocol; identify, obtain, or access clinical, public health, hospital information system, or open-source datasets, subject to appropriate ethical approval and data permissions.	Weeks 5–6	90

Phase 4	Data Preprocessing and Analytical Execution: Perform data cleaning, coding, harmonisation, missing-data assessment, exploratory data analysis, statistical analysis, and/or implementation of computational workflows.	Weeks 7–10	110
Phase 5	Model Validation and Results Interpretation: Evaluate analytical findings or predictive models using suitable validation strategies, performance metrics, statistical tests, and comparison with published evidence.	Weeks 11–12	80
Phase 6	Dissertation and Manuscript Preparation: Prepare the dissertation, document methods and results, discuss limitations and implications, and draft a manuscript or research communication where appropriate.	Weeks 13–14	60
Phase 7	Final Presentation and Defense: Present the research findings, demonstrate the analytical workflow where applicable, and defend the conclusions before departmental faculty and an external expert.	Week 15	60
Total		15 weeks	480 hours

3. Project course outcomes (COs)

On successful completion of the Major Project / Dissertation, students will be able to:

- CO1: Formulate a relevant and ethically sound healthcare research question through critical literature review and identification of research gaps.
- CO2: Design and implement a health informatics research study using appropriate clinical, public health, hospital, or digital health data, adhering to ethical, privacy, confidentiality, and data-security requirements.
- CO3: Acquire, clean, preprocess, manage, and analyse healthcare data using appropriate statistical, computational, bioinformatics, or machine-learning techniques.
- CO4: Develop or evaluate analytical models and interpret results using appropriate statistical methods, validation procedures, and healthcare-relevant performance metrics.
- CO5: Prepare a comprehensive dissertation, communicate findings effectively, and defend evidence-based conclusions and their implications for healthcare practice, research, or health systems.

4. Suggested project domains



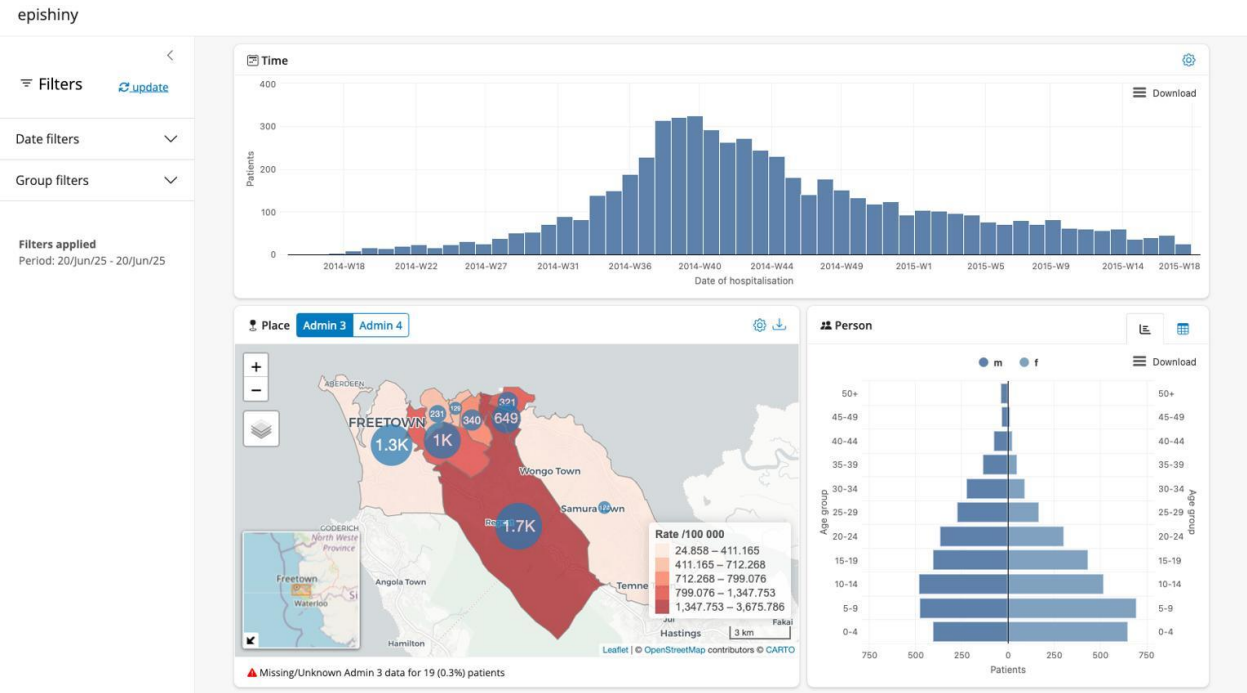
1. Clinical and Hospital Data Analytics

Hospital information systems, electronic health records, clinical outcomes, readmission risk, length of stay, and healthcare quality indicators.



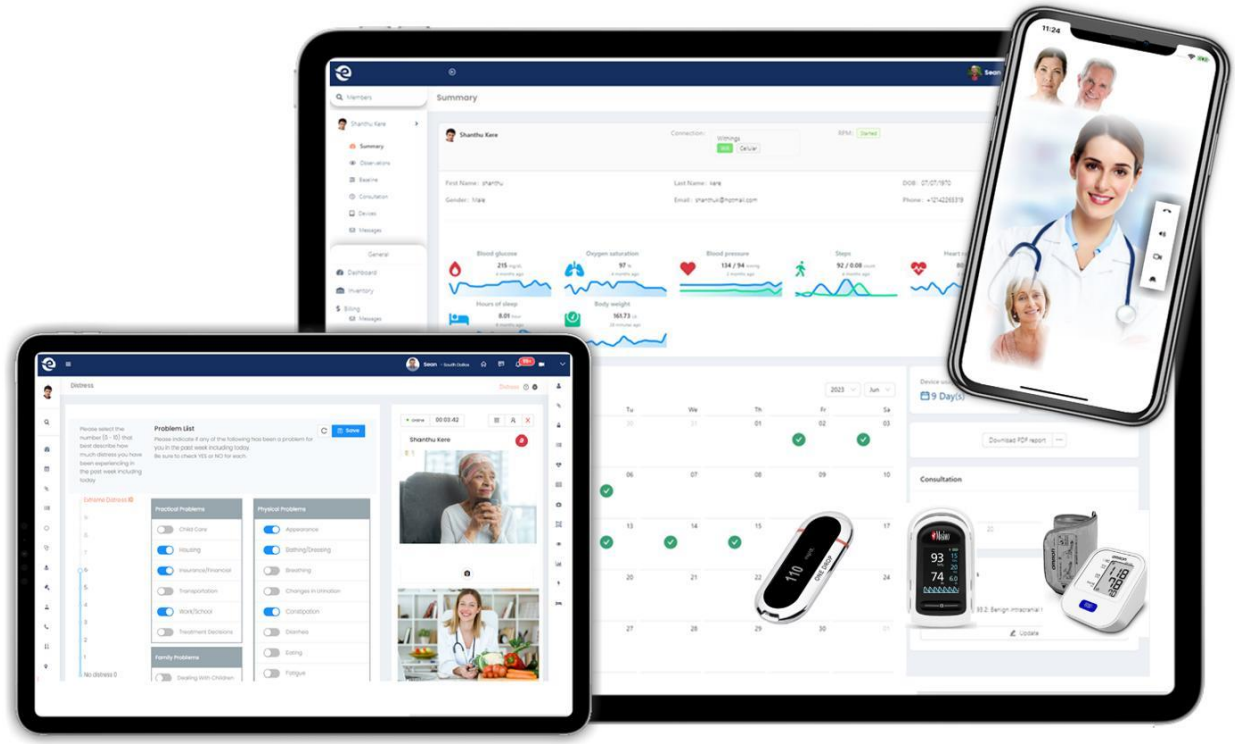
2. Artificial Intelligence and Predictive Analytics

Disease-risk prediction, clinical decision support, model interpretability, risk stratification, and evaluation of predictive algorithms.



3. Public Health and Epidemiological Informatics

Disease surveillance, population-health analytics, health disparities, epidemiological modelling, and healthcare utilisation.



4. Digital Health and Health Systems

Telemedicine, remote patient monitoring, digital health adoption, workflow analytics, and evaluation of digital healthcare interventions.



5. Health Information Management and Interoperability

Data quality, healthcare data standards, health information exchange, clinical coding, and information-system usability.

5. Important evaluation clarification

The proposed 300 marks (240 internal + 60 external) may be retained if this matches the approved programme regulations. A suggested internal assessment framework is:

Internal assessment component	**Marks**
Research proposal and literature review	30
Research design, ethics and data management	30
Data analysis / model development and implementation	70
Progress review and interpretation of findings	40
Dissertation quality and documentation	40
Research presentation and communication	30
Total internal	240
External evaluation and viva voce	60
Grand total	300