



MALLA REDDY VISHWAVIDYAPEETH

SCHOOL OF DIGITAL HEALTH SCIENCES AND TECHNOLOGY

Program

Master of Science (M.Sc.)

Digital Health

2025–26

MALLA REDDY VISHWAVIDYAPEETH
SCHOOL OF DIGITAL HEALTH SCIENCES AND TECHNOLOGY
MASTER OF SCIENCE (M.Sc.) IN DIGITAL HEALTH

VISION

To develop research-capable, industry- and academia-ready postgraduates who can independently design, evaluate, and lead the deployment of advanced digital-health technologies and analytics that transform patient care, health-system efficiency and population-health outcomes.

MISSION

1. Deepen competence in health-systems thinking, national/global digital-health policy (ABDM, national health programmes) and interdisciplinary health knowledge (including AYUSH and occupational health) relevant to advanced practice.
2. Build advanced proficiency in data analytics, predictive modelling, AI/ML and data engineering applied to complex, real-world healthcare datasets.
3. Develop mastery of emerging digital-health technologies – EHR interoperability, telemedicine, AR/VR/MR, digital twins, and IoMT – through specialization electives and dedicated practicals.
4. Cultivate independent research aptitude, critical thinking, market-research and needs-assessment skills, and project-leadership/entrepreneurial competence through an intensive research project/thesis and advanced elective review in the final semester.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Within a few years of graduation, graduates of the M.Sc. Digital Health programme will:

1. Lead the design, development and evaluation of advanced digital-health analytics, applications and emerging-technology solutions in clinical, public-health, government or industry settings.
2. Advance into senior/specialist careers such as Health Data Scientist, Digital Health Product/Programme Manager, Research Associate/Scientist in Health Informatics, Digital Transformation Consultant, or pursue doctoral research (Ph.D.) in digital health or allied fields.
3. Demonstrate advanced professional, ethical, regulatory and data-governance responsibility while designing and deploying AI-enabled and data-intensive digital-health systems.
4. Conduct independent, rigorous research and lead innovation and entrepreneurial ventures that address emerging challenges in digital healthcare delivery, including in rural, under-served and resource-constrained settings.

PROGRAMME OUTCOMES (POs)

On completion of the programme, postgraduates will be able to:

1. Expertise in Advanced Digital Health Analytics: Acquire and apply advanced skills in data analytics, predictive modelling, and forecasting for data-driven healthcare decision-making.
2. Digital Health Technology Design and Development: Design and integrate digital health solutions through UI/UX, rapid prototyping, 3D printing, API integration, and mobile/web application development.
3. Application and System Integration of Emerging Digital Health Technologies: Implement and optimize telemedicine, electronic health records (EHR), digital twins, and AR/VR/MR systems for enhanced healthcare delivery.

4. Healthcare Regulatory, Ethical and Market Insight: Navigate healthcare regulations, national health programmes, ABDM policies, and market research to drive compliance and innovation.
5. Digital Health Research & Innovation: Conduct impactful, ethically sound research, develop critical thinking, and lead digital-health projects to advance healthcare technology and policy.
6. Leadership and Entrepreneurship in Health Technology: Lead multidisciplinary teams and health-technology ventures, applying project-management, market-research and business-planning skills to scale digital-health innovations.
7. Professional Ethics and Lifelong Learning: Demonstrate data-privacy consciousness, professional integrity and a commitment to continuous, independent learning in a rapidly evolving digital-health landscape.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

At the end of the programme, graduates of M.Sc. Digital Health will specifically be able to:

1. Integrate advanced health-systems knowledge (national health programmes, ABDM, AYUSH, occupational health) with sophisticated data-science and computational tools to inform clinical and policy decision-making.
2. Design, evaluate and lead the deployment of advanced digital-health technologies – interoperable EHR systems, telemedicine platforms, AR/VR/MR applications, IoMT systems, and digital twins – for complex, real-world healthcare settings.
3. Apply advanced statistical, machine-learning, predictive-analytics and data-engineering techniques (R, Python, SPSS/STATA/SAS, ML pipelines) to large and complex healthcare datasets for decision support and forecasting.
4. Independently formulate, execute, and defend a research project/thesis or advanced elective review demonstrating original inquiry, market-research competence, and research-ethics compliance in digital health.

MALLA REDDY VISHWAVIDYAPEETH
SCHOOL OF DIGITAL HEALTH SCIENCES AND TECHNOLOGY
MASTER OF SCIENCE (M.Sc.) IN DIGITAL HEALTH
COURSE STRUCTURE

I year I semester

S.NO	SUBJECT	L	T	P	C
1	Introduction to Health Systems	2	-	-	2
2	National Health Programs & ABDM (Ayushman Bharat Digital Mission)	2	-	-	2
3	Introduction to AYUSH	2	-	-	2
4	Occupational Health	2	-	-	2
5	English & Communication Skills	2	-	-	2
6	Computer Foundation	2	-	-	2
7	Understanding Data – Source, Structure, Preparation and Annotation	2	-	-	2
8	Languages for Coding	2	-	-	2
9	Introduction to GitHub	1	-	-	1
10	Digital Health Terminology	2	-	-	2
11	Practicals in Coding	-	-	2	1
	TOTAL	19	-	2	20

I year II semester

S.NO	SUBJECT	L	T	P	C
1	Advanced Data Analytics (R/SPSS/STATA/SAS)	3	-	-	3
2	Predictive Analytics (Prediction and Forecasting)	2	-	-	2
3	UI/UX for Healthcare	2	-	-	2
4	Design Thinking	2	-	-	2
5	Rapid Prototyping and 3D Printing	2	-	-	2
6	Mobile Apps & Web Apps	2	-	-	2
7	API, Plug-in Integration	2	-	-	2
8	Database Features	1	-	-	1
9	Practicals in Advanced Data Analytics (R/SPSS/STATA/SAS)	-	-	4	2
10	Practicals in Predictive Analytics (Prediction and Forecasting)	-	-	4	2
	TOTAL	16	-	8	20

II year III semester

S.NO	SUBJECT	L	T	P	C
1	Electronic Health Records (EHR)	3	-	-	3
2	Telemedicine	3	-	-	3
3	Digital Twins	3	-	-	3
4	AR/VR/MR for Healthcare	3	-	-	3
5	Market Research & Needs Assessment	2	-	-	2
6	Practicals in AR/VR/MR for Healthcare	-	-	6	3
7	Practicals in Internet of Medical Things (IoMT)	-	-	6	3
	TOTAL	14	-	12	20

II year IV semester

S.NO	SUBJECT	L	T	P	C
1	Research Project / Thesis	-	-	-	12
2	Review of Topics / Electives in Digital Health	8	-	-	8
	TOTAL	8	-	-	20

1.1 Post Graduate Programme

Sl. No.	Course	Duration	Eligibility for admission
1	M.Sc. in Digital Health (Two-Year Postgraduate, NEP 2020 / UGC-CCFUP-PG compliant)	2 years (4 semesters)	Candidate must hold a Bachelor's degree (3- or 4-year, NEP 2020 compliant) in Digital Health, Life Sciences, Allied Health Sciences, Nursing, Pharmacy, Computer Science/IT, Biomedical/Biotechnology Engineering, or any other discipline recognised as equivalent by the University, from a recognised university. Minimum aggregate of 50% marks (45% for SC/ST/OBC and other reserved categories as per applicable State/UGC norms) in the qualifying Bachelor's degree. Admission shall be based on merit in the qualifying examination and/or any national/state-level postgraduate entrance test (e.g., CUET-PG or University-conducted entrance test) as notified by the University from time to time, followed by counselling as per Malla Reddy Vishwavidyapeeth admission regulations. Candidates from non-technical/non-life-science backgrounds may be required to complete a bridge module (in coordination with the School) in basic health systems and computing fundamentals during Semester I.

1.2. Medium of Instruction:

English.

1.3 Duration of the Course

2 years (4 semesters). Two semesters per year (odd: July–December; even: January–May), each of minimum 90 working days including internal assessment and examinations.

1.4 Examination Regulations

1.4 Examination Regulations

1.4.1 Attendance:

A minimum of 75% attendance in each course (theory and practical) is mandatory for eligibility to appear in the End-Semester Examination; condonation up to 65% may be granted by the Vice-Chancellor on genuine medical/other grounds as per University rules.

1.4.2 Internal Assessments:

Course Type	Component	Weightage	Description
Theory Courses	Continuous Internal Assessment (CIA)	30%	Two mid-term tests (best of 2 or average), assignments/quizzes, seminars, attendance.
Practical / Laboratory Courses	Continuous Internal Assessment	30%	Lab records, in-lab performance, viva-voce during the semester.

Exam pattern for internal assessment**Theory Courses (Internal Examination, 30 marks, 2 hours)**

Section	Instruction	No. of Questions	Total Marks
A	Very Short Questions	5 × 2 marks	10
B	Short Questions	2 × 5 marks	10
C	Essay Questions	1 × 10 marks	10

Practical Courses (Internal Examination, 30 marks, 2 hours)

Section	Instruction	Total Marks
A	Spotter- Lab practical evaluation	15
B	Viva voce	15
	Total	30

1.4.3 University Examinations (External):

Course Type	Component	Weightage	Description
Theory Courses	End-Semester University Examination (ESE)	70%	Written examination of 3 hours covering the entire syllabus (all units).
Practical / Laboratory Courses	End-Semester Practical Examination	70%	Conduct of experiment/task, output/demo, record and viva-voce by internal + external examiner.

Theory Courses (End-Semester Examination, 70 marks, 3 hours)

Section	Instruction	No. of Questions	Total Marks
A	Very Short Questions	10 × 2 marks	20
B	Short Questions	6 × 5 marks	30
C	Essay Questions	2 × 10 marks	20

Total End-Semester marks = 70 (scaled from the above, or awarded directly out of 70 as per University question-paper template); combined with 30 CIA marks to yield 100.

Practical Courses (End-Semester Examination, 0 marks)

Section	Instruction	Total Marks
A	Spotter- Lab practical evaluation	20
B	Major Practical	10
C	Internal Viva	15
D	External Viva	15
E	Record	10
	Total	70

A student must secure a minimum of 'P' grade (40% aggregate, with at least 40% in ESE) to pass a course. A student who fails in a course may reappear in the subsequent supplementary/arrear examination.

Promotion to the next semester is automatic; however, a student must clear all backlog courses up to Semester IV before being permitted to register for Semester VII, and must clear all UG-level backlogs before the award of degree.

Malpractice in examinations shall be dealt with as per the University's Unfair Means regulations, ranging from cancellation of the concerned examination to debarment.

The Research Project/Dissertation (Semester VIII) must be submitted with a plagiarism similarity index within University-prescribed limits (typically $\leq 10\%$ excluding references) prior to viva-voce.

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5	English & Communication Skills	2	-	-	2
6	Computer Foundation	2	-	-	2
7	Understanding Data – Source, Structure, Preparation and Annotation	2	-	-	2
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9	Introduction to GitHub	1	-	-	1
10	Digital Health Terminology	2	-	-	2
11	Practicals in Coding	-	-	2	1
	TOTAL	19	-	2	20

SEMESTER-I**INTRODUCTION TO HEALTH SYSTEMS**L/T/P/C
2/-/-/2**Learning Outcome:**

1. Describe the structure, components and functions of national and global health systems.
2. Explain the role of primary, secondary and tertiary care in service delivery.
3. Analyse health-system financing, governance and health-workforce planning models.
4. Evaluate the impact of health-system reforms and policy on population-health outcomes.

UNIT-I**EVOLUTION OF HEALTHCARE SYSTEMS (GLOBAL & INDIAN)**

1. Historical perspectives
2. Key reforms in healthcare
3. Comparative global healthcare models

UNIT-II**LEVELS OF HEALTHCARE**

1. Primary, Secondary, Tertiary Care
2. Role of different levels in disease prevention & management

UNIT-III**HEALTHCARE FINANCING & INSURANCE MODELS**

1. Universal Health Coverage (UHC)
2. Public & private insurance schemes
3. Challenges & future trends

UNIT-IV**PUBLIC AND PRIVATE HEALTHCARE SYSTEMS**

1. Structure and roles of public vs. private providers
2. Public-Private Partnerships (PPP) in healthcare

UNIT-V**HEALTH POLICY & GOVERNANCE**

1. National Health Policy
2. Regulatory bodies (WHO, MoHFW, NMC)
3. Health law & ethics

RECOMMENDED TEXT BOOKS

1. Essentials of Global Health – Richard Skolnik
2. Health Policy and Systems Thinking – Thomas Rice
3. Public Health Administration: Principles for Population-Based Management – Leiyu Shi & James A. Johnson
4. Berman, P. (2011). Health Systems Analysis for Developing Countries. World Bank Publications.
5. WHO. (2007). Everybody's Business: Strengthening Health Systems to Improve Health Outcomes. [Link](#)

6. World Bank. (2018). The Role of the World Bank in Health Systems Development.

NATIONAL HEALTH PROGRAMS & ABDM (AYUSHMAN BHARAT DIGITAL MISSION)

L/T/P/C
2/-/-2

Learning Outcome:

1. Explain the objectives, structure and implementation of major national health programmes (RNTCP, NVBDCP, NLEP, NACP, NPCDCS, NMHP).
2. Describe the components of Ayushman Bharat (PMJAY, HWCs) and their role in universal health coverage.
3. Analyse the architecture and ecosystem of the Ayushman Bharat Digital Mission (ABDM).
4. Assess data-interoperability and exchange mechanisms enabled by ABDM for national digital health records.

UNIT-I

INTRODUCTION TO NATIONAL HEALTH PROGRAMS

1. Understanding the burden of communicable & non-communicable diseases in India
2. Role of government initiatives in public health improvement

UNIT-II

KEY NATIONAL HEALTH PROGRAMS – OBJECTIVES, STRUCTURE AND IMPLEMENTATION OF THE PROGRAMS

1. RNTCP (Revised National Tuberculosis Control Program) – TB control strategy.
2. NVBDCP (National Vector Borne Disease Control Program) – Malaria, Dengue, and other vector-borne diseases.
3. NLEP (National Leprosy Eradication Program) – Leprosy control and rehabilitation strategies.

UNIT-III

OVERVIEW OF OTHER NATIONAL HEALTH PROGRAMS

1. National AIDS Control Program (NACP)
2. National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases & Stroke (NPCDCS)
3. National Mental Health Programme (NMHP)
4. Maternal & Child Health Programs

UNIT-IV

AYUSHMAN BHARAT PROGRAM

1. PMJAY (Health Insurance)
2. HWCs (Health & Wellness Centers)

UNIT-V

ABDM ARCHITECTURE & ECOSYSTEM

1. Digital health records
2. Data interoperability & exchange

RECOMMENDED TEXT BOOKS

1. Park, K. (2021). Textbook of Preventive and Social Medicine (26th ed.). M/s Banarsidas Bhanot Publishers.

2. Goel, S. (2017). Public Health Policy and National Health Programs of India. Deep & Deep Publications.
3. Gupta, M. C., & Mahajan, B. K. (2018). Textbook of Preventive and Social Medicine. Jaypee Brothers Medical Publishers.
4. Dhrubajyoti Bhattacharya. (2013). Public Health Policy: Issues, Theories, and Advocacy. Jossey-Bass.

Additional Reading Material

1. Ministry of Health & Family Welfare (MoHFW), Government of India. (2022). National Health Mission Guidelines & Annual Reports. (<https://nhm.gov.in/>)
2. National Digital Health Mission (NDHM) / Ayushman Bharat Digital Mission (ABDM). (2022). Policy & Implementation Guidelines. (<https://abdm.gov.in/>)
3. World Health Organization (WHO). (2017). Primary Health Care Systems (PRIMASYS) India Report. WHO Publications.
4. World Bank. (2018). The Role of the World Bank in Health Systems Development.
5. WHO. (2007). Everybody's Business: Strengthening Health Systems to Improve Health Outcomes. WHO Publications.

INTRODUCTION TO AYUSH

L/T/P/C
2/-/-2

Learning Outcome:

1. Describe the philosophical and theoretical foundations of Ayurveda, Traditional Chinese Medicine and Unani.
2. Explain the core principles, diagnostic approaches and treatment methods of Ayurveda, Siddha, Unani, Yoga, Naturopathy and Homeopathy.
3. Discuss clinical applications and case studies of traditional-medicine therapies for common ailments.
4. Evaluate the role of scientific validation and evidence-based integration of traditional medicine with modern healthcare.

UNIT-I

INTRODUCTION TO TRADITIONAL MEDICINE

1. Definition and scope of traditional medicine
2. Historical context of different traditional medicine systems
3. Philosophical and theoretical foundations of Ayurveda, Traditional Chinese Medicine (TCM), and Unani
4. Cultural and social aspects of traditional medicine practices

UNIT-II

KEY PRINCIPLES OF MAJOR TRADITIONAL SYSTEMS

1. Core concepts, diagnostic approaches, and treatment principles of Ayurveda, Siddha, Unani, Yoga, Naturopathy, and Homeopathy.

UNIT-III

CLINICAL APPLICATION OF TRADITIONAL MEDICINE

1. Common ailments treated with traditional medicine (digestive issues, respiratory problems, skin conditions, pain management)
2. Case studies and clinical applications of traditional medicine therapies

UNIT-IV

RESEARCH IN TRADITIONAL MEDICINE

1. Role of scientific validation and clinical trials in traditional medicine.
2. Understand how traditional medicine is integrated with modern healthcare through evidence-based practice.

RECOMMENDED TEXT BOOKS

1. Mukherjee, P. K. (2015). Evidence-Based Validation of Herbal Medicine. Elsevier.
2. Sharma, P. V. (1995). History of Medicine in India. Indian National Science Academy.
3. Bhattacharya, N. (2012). Traditional Medicine in South East Asia and India. Springer.
4. Warrier, P. K. (1994). Indian Medicinal Plants: A Compendium of 500 Species. Orient Blackswan.
5. World Health Organization. (2013). WHO Traditional Medicine Strategy 2014-2023.

OCCUPATIONAL HEALTH

L/T/P/C
2/-/-2

Learning Outcome:

1. Explain the scope, significance and historical evolution of occupational health and safety.
2. Identify and assess workplace hazards using standard risk-assessment methods.
3. Analyse common occupational diseases/injuries and their prevention, treatment and rehabilitation strategies.
4. Evaluate the role of digital tools (wearables, IoT monitoring, predictive analytics) in workplace-safety surveillance within the applicable regulatory framework (OSHA, Factories Act, ESIC).

UNIT-I

INTRODUCTION TO OCCUPATIONAL HEALTH

1. Definition, scope, and significance of occupational health
2. Historical evolution of workplace health and safety
3. Impact of workplace conditions on employee well-being and productivity

UNIT-II

WORKPLACE HAZARDS AND RISK ASSESSMENT

1. Types of workplace hazards (physical, chemical, biological, ergonomic, psychosocial)
2. Methods for hazard identification and risk assessment
3. Control measures and risk mitigation strategies

UNIT-III

OCCUPATIONAL DISEASES AND INJURIES

1. Common occupational diseases (respiratory illnesses, musculoskeletal disorders, occupational cancers)
2. Workplace factors contributing to occupational illnesses and injuries
3. Prevention, treatment, and rehabilitation strategies

UNIT-IV

HEALTH AND SAFETY REGULATIONS

1. Overview of national and international occupational health regulations (OSHA, Factories Act, ESIC)
2. Employer and employee responsibilities in ensuring workplace safety
3. Compliance strategies and enforcement mechanisms

UNIT-V

DIGITAL HEALTH IN OCCUPATIONAL SAFETY

1. Role of digital tools (wearables, IoT monitoring) in workplace safety
2. AI and predictive analytics for occupational health surveillance
3. Case studies on the effectiveness of workplace safety technologies

RECOMMENDED TEXT BOOKS

1. Friis, R. H. (2015). Occupational Health and Safety for the 21st Century. Jones & Bartlett Learning.
2. LaDou, J., & Harrison, R. J. (2021). Current Occupational & Environmental Medicine (6th ed.). McGraw-Hill Education.

3. Levy, B. S., Wegman, D. H., Baron, S. L., & Sokas, R. K. (2017). Occupational and Environmental Health: Recognizing and Preventing Disease and Injury. Oxford University Press.
4. Fundamental principles of occupational health and safety by Benjamin O. ALLI

Additional Reading

1. International Labour Organization (ILO). (2021). Global Strategy on Occupational Safety and Health. <https://www.ilo.org/>
2. National Institute for Occupational Safety and Health (NIOSH). (2022). Occupational Safety and Health Guidelines. <https://www.cdc.gov/niosh/>
3. World Health Organization (WHO). (2018). Protecting Workers' Health: Global Perspectives. WHO Publications.
4. OSHA (Occupational Safety and Health Administration). (2021). Occupational Safety Standards and Guidelines. <https://www.osha.gov/>

ENGLISH & COMMUNICATION SKILLS

L/T/P/C
2/-/-2

Learning Outcome:

1. Demonstrate effective written and verbal communication in academic and professional healthcare contexts.
2. Apply structured techniques for scientific writing, reporting and presentation.
3. Practice professional etiquette and interpersonal communication with clinicians, technologists and patients.
4. Deliver clear, well-organised oral presentations and participate effectively in group discussions/seminars.

UNIT-I

FUNDAMENTALS OF COMMUNICATION

1. Definition and importance of communication in healthcare and professional settings
2. Types of communication (verbal, non-verbal, written, digital)
3. Barriers to effective communication and overcoming them

UNIT-II

SCIENTIFIC & TECHNICAL WRITING IN HEALTHCARE

1. Structure and format of scientific documents
2. Writing research papers, abstracts, and summaries
3. Citation styles and plagiarism prevention

UNIT-III

GRANT & PROPOSAL WRITING

1. Basics of proposal writing for research and funding
2. Structure of grant proposals and common funding sources
3. Effective writing techniques for securing grants

UNIT-IV

COMMUNICATION FOR HEALTHCARE PROFESSIONALS

1. Effective patient communication and empathy in healthcare
2. Medical terminology and professional interactions
3. Ethical considerations in communication

UNIT-V

PRESENTATION & PUBLIC SPEAKING SKILLS

1. Preparing and delivering impactful presentations
2. Body language, tone, and clarity in speech
3. Handling Q&A sessions confidently

RECOMMENDED TEXT BOOKS

1. Bailey, S. (2018). Academic Writing: A Handbook for International Students. Routledge.
2. Alred, G. J., Brusaw, C. T., & Oliu, W. E. (2012). Handbook of Technical Writing. St. Martin's Press.
3. Huckin, T., & Olsen, L. (1991). Technical Writing and Professional Communication. McGraw-Hill.

4. Additional Readings
5. Turabian, K. L. (2018). A Manual for Writers of Research Papers, Thesis, and Dissertations. University of Chicago Press.
6. Guffey, M. E., & Loewy, D. (2018). Business Communication: Process and Product. Cengage Learning.
7. Chaturvedi, P. D., & Chaturvedi, M. (2011). Business Communication: Concepts, Cases, and Applications. Pearson Education.

COMPUTER FOUNDATIONL/T/P/C
2/-/-/2**Learning Outcome:**

1. Explain fundamental computer hardware, software and operating-system concepts.
2. Demonstrate proficiency in office productivity and internet/collaboration tools.
3. Apply basic digital literacy skills to healthcare information-handling tasks.
4. Describe fundamentals of computer networks and data security relevant to healthcare computing.

UNIT-I**DEFINITION OF COMPUTER**

1. Characteristics of computer
2. Components of Computer Hardware – Input & Output devices
3. Memories – RAM and ROM – MB, GB their conversions
4. Software – Application Software and Systems software
5. Data and Information
6. Different computer languages – Number systems - Binary and decimal conversions.

UNIT-II**TYPING TEXT IN MS WORD**

1. Manipulating text formatting text – using different font sizes, bold, italic – bullets, and numbering – Pictures
2. Aligning the text and justify–choosing paper size– adjusting margins– header and footer
3. Inserting page no's in a doc – printing a file with options– using spell check and grammar – find and replace – mail merge – insert tables in a document.

UNIT-III**CREATING**

1. MS Excel-Cell editing, using formulas and functions, manipulating data with Excel – using the sort function to sort numbers and alphabets– drawing graphs and charts using data in Excel.
2. MS PowerPoint slide transition and animation slides with sounds – inserting clip arts– Pictures, tables, and graphs.

UNIT-IV**INTRODUCTION TO**

1. Computer Network Devices (Hubs, Switches, Routers, Gateway, Bridge, Modems, Wireless Access Points, Firewalls & NIC)
2. Types of Computer Networks (LAN, MAN & WAN),
3. Network Topologies (Star, Ring, Mesh, Tree, Hybrid Topologies)
4. Internet-Based Applications
5. Advantages & Disadvantages of Computer Networks,
6. E-Mail – Components of E-Mail, Attaching Files in E-mail, Different Search Engines.

UNIT-V**AI:**

1. History of AI, Sub Areas of AI
2. Applications of AI in Healthcare

3. Benefits of AI in Health Care
4. Challenges of AI in Healthcare
5. Introduction to Machine Learning
6. Applications of Machine Learning
7. Machine Learning Algorithms
8. Real-world Machine Learning Use Cases

UNIT-VI

PRACTICALS:

1. Peripherals of Computer
2. MS Word
3. MS Excel
4. MS PowerPoint

RECOMMENDED TEXT BOOKS

1. Computer Fundamentals by Goel, Anita Pearson
2. Computer Fundamentals: Concepts, Systems & Applications- 8th Edition by Priti Sinha, Pradeep K., Sinha
3. MS-Office 2010 Training Guide by Prof. Satish Jain, M. Geetha
4. Computer Networks, Andrews S Tanenbaum, 5th Edition, Pearson Education
5. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, Third Edition, Pearson Education
6. Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurelien Geron- Oreilly, 2nd Edition.

UNDERSTANDING DATA – SOURCE, STRUCTURE, PREPARATION AND ANNOTATION

L/T/P/C
2/-/-2

Learning Outcome:

1. Identify diverse healthcare data sources and their structural characteristics.
2. Apply data-cleaning, preparation and annotation techniques to raw healthcare data.
3. Distinguish and handle categorical and numerical health-data variables appropriately.
4. Apply data-privacy and security principles (HIPAA/GDPR) during data preparation and handling.

UNIT-I

HEALTHCARE DATA SOURCES

1. Types of healthcare data (EHR, claims data, registries, surveys)
2. Public health databases and data repositories
3. Data collection methods and challenges

UNIT-II

DATA STANDARDS IN HEALTHCARE

1. HL7, FHIR, SNOMED, ICD coding systems
2. Interoperability and data exchange frameworks
3. Role of standards in digital health ecosystems

UNIT-III

DATA CLEANING & PROCESSING

1. Data quality assessment (missing data, inconsistencies)
2. Normalization and standardization techniques
3. Handling categorical and numerical variables

UNIT-IV

DATA PRIVACY & SECURITY

1. HIPAA, GDPR, and other healthcare data regulations
2. Ethical considerations in data handling
3. Encryption, anonymization, and secure storage practices

RECOMMENDED TEXT BOOKS

1. McDonald, C. J., & Huff, S. M. (2015). Health Data Standards: A Common Language for Data Exchange. Springer.
2. Raghupathi, W., & Raghupathi, V. (2014). Big Data Analytics in Healthcare: Promise and Potential. Health Information Science and Systems.
3. Benson, T., & Grieve, G. (2016). Principles of Health Interoperability: SNOMED CT, HL7, and FHIR. Springer.

LANGUAGES FOR CODING

L/T/P/C
2/-/-2

Learning Outcome:

1. Write Python programs to process and analyse healthcare datasets.
2. Apply Pandas/NumPy for healthcare data cleaning, filtering and numerical analysis.
3. Create visualizations of health trends and outcomes using Matplotlib/Seaborn.
4. Build and evaluate basic machine-learning models for healthcare classification/regression tasks.

UNIT-I

INTRODUCTION TO PROGRAMMING LANGUAGES

1. Basics of Python: syntax, data types, and control structures
2. Importance of Python in healthcare analytics
3. Introduction to Jupyter Notebook and Google Collaboration
4. Handling medical datasets with Python

UNIT-II

DATA ANALYSIS WITH PYTHON

1. Using Pandas for healthcare data processing
2. Data cleaning, filtering and manipulation techniques
3. Applying NumPy for numerical healthcare data analysis
4. Working with real-world health datasets (EHR, Patient records, Clinical Trials)

UNIT-III

DATA VISUALIZATION IN HEALTHCARE

1. Creating charts and graphs using Matplotlib and Seaborn
2. Visualizing health trends, disease spread, and patient outcomes
3. Dashboard creation for healthcare reporting

UNIT-IV

MACHINE LEARNING FOR HEALTHCARE

1. Overview of machine learning in healthcare
2. Applying Scikit-learn for disease prediction
3. Building models for classification (e.g., diabetes prediction) and regression (e.g., patient risk scores)
4. Evaluating healthcare ML models using accuracy, precision, recall

UNIT-V

HEALTHCARE DATA INTEGRATION AND AUTOMATION

1. Introduction to healthcare data interoperability
2. Extracting, transforming, and loading (ETL) healthcare data
3. Automating repetitive healthcare workflows using Python
4. Integration of APIs (FHIR, HL7) for health data exchange

RECOMMENDED TEXT BOOKS

1. Gutttag, J. V. (2016). Introduction to Computation and Programming Using Python. MIT Press.

2. McKinney, W. (2017). Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython. O'Reilly Media.
3. VanderPlas, J. (2016). Python Data Science Handbook. O'Reilly Media.
4. Raschka, S., & Mirjalili, V. (2019). Python Machine Learning. Packt Publishing.
5. Additional Readings
6. Bailey, M. (2021). Healthcare Analytics with Python. Springer.
7. Chakraborty, C., & Banerjee, A. (2020). Machine Learning Techniques for Healthcare Data Analytics. Springer.
8. Faur, D. (2020). Hands-On Healthcare Data: Analyzing Patient Data with Python and Pandas. Packt Publishing.

INTRODUCTION TO GITHUB

L/T/P/C

1/-/-1

Learning Outcome:

1. Explain version-control concepts and the Git/GitHub workflow.
2. Create, manage and collaborate on repositories for health-technology projects.
3. Apply branching, merging and pull-request workflows in team-based development.
4. Document and maintain project code using GitHub best practices.

UNIT-I

VERSION CONTROL & GIT BASICS

1. Introduction to Git and installation
2. Git commands: init, add, commit, status, log
3. Importance of version control in software development

UNIT-II

BRANCHING & MERGING

1. Concept of branches and workflows
2. Creating and switching branches
3. Merging strategies and resolving conflicts

UNIT-III

WORKING WITH GITHUB

1. Setting up a GitHub repository
2. Cloning, pushing, pulling, and forking repositories
3. Collaborating with teams using GitHub

UNIT-IV

GITHUB ACTIONS & AUTOMATION

1. Introduction to GitHub Actions
2. Setting up CI/CD pipelines
3. Automating tasks with GitHub workflows

UNIT-V

BEST PRACTICES & SECURITY

1. Writing good commit messages
2. Protecting branches and repository settings
3. Managing repository permissions and security

RECOMMENDED TEXT BOOKS

1. Loeliger, J., & McCullough, M. (2012). Version Control with Git. O'Reilly Media.
2. Chacon, S., & Straub, B. (2019). Pro Git. Apress.
3. Torres, J. (2021). GitHub for Dummies. Wiley.

DIGITAL HEALTH TERMINOLOGY

L/T/P/C
2/-/-2

Learning Outcome:

1. Define key terminology used across digital-health systems and standards.
2. Explain standard healthcare coding and classification systems (ICD, SNOMED CT, LOINC).
3. Interpret HL7/FHIR terminology in the context of health-data interoperability.
4. Apply correct digital-health terminology in technical documentation and communication.

UNIT-I

INTRODUCTION TO DIGITAL HEALTH TERMINOLOGY

1. Foundational terms and concepts used in digital health, including eHealth, mHealth, telemedicine, and telehealth.

UNIT-II

HEALTH INFORMATION SYSTEMS AND STANDARDS

1. Introduction to key terminology related to health information systems (e.g., EHR, EMR) and health data standards (e.g., HL7, FHIR).

UNIT-III

CLINICAL INFORMATICS

1. Focus on terminology related to the use of information technology in clinical settings, such as decision support systems, patient portals, and clinical workflows.

UNIT-IV

HEALTH DATA AND ANALYTICS

1. Understand terms related to health data types (e.g., structured, unstructured) and analytical methods (e.g., predictive modeling, data mining).

UNIT-V

REGULATIONS AND ETHICS IN DIGITAL HEALTH:

1. Understand terminology related to data privacy laws (e.g., HIPAA, GDPR) and ethical considerations in using digital health technologies

RECOMMENDED TEXT BOOKS

1. Book: Digital Health: A Path to Validation by Homero Rivas and Katarzyna Wac
2. Book: Health Information Management: Concepts, Principles, and Practice by Kathleen M. LaTour and Shirley A. D. Thomas
3. Book: Clinical Informatics: A Practical Approach for Healthcare and Information Technology Professionals by Jon M. N. McCarthy and William L. Hersh

PRACTICALS IN CODING

L/T/P/C
-/-/2/1

Learning Outcome:

1. Write and debug Python programs using core language constructs.
2. Apply data structures and control flow to healthcare-data processing tasks.
3. Read, process and write structured/unstructured health datasets programmatically.
4. Develop a small automated script/workflow for a healthcare data-processing task.

UNIT-I

PYTHON ENVIRONMENT AND BASICS

Environment setup (Jupyter/Google Colab); syntax, variables and data types practice.

UNIT-II

DATA STRUCTURES AND CONTROL FLOW

Lists, dictionaries, loops and conditionals applied to sample healthcare records.

UNIT-III

FILE HANDLING

Reading/writing CSV, JSON and structured health datasets.

UNIT-IV

FUNCTIONS AND SCRIPTING

Building, testing and debugging reusable functions for health-data processing.

UNIT-V

MINI-PROJECT

Automating a basic health-data processing/reporting workflow using Python.

RECOMMENDED TEXT BOOKS

1. Guttag, J. V. (2016). Introduction to Computation and Programming Using Python. MIT Press; McKinney, W. (2017). Python for Data Analysis. O'Reilly Media; official Python and Jupyter documentation.

I year II semester

S.NO	SUBJECT	L	T	P	C
1	Advanced Data Analytics (R/SPSS/STATA/SAS)	3	-	-	3
2	Predictive Analytics (Prediction and Forecasting)	2	-	-	2
3	UI/UX for Healthcare	2	-	-	2
4	Design Thinking	2	-	-	2
5	Rapid Prototyping and 3D Printing	2	-	-	2
6	Mobile Apps & Web Apps	2	-	-	2
7	API, Plug-in Integration	2	-	-	2
8	Database Features	1	-	-	1
9	Practicals in Advanced Data Analytics (R/SPSS/STATA/SAS)	-	-	4	2
10	Practicals in Predictive Analytics (Prediction and Forecasting)	-	-	4	2
	TOTAL	16	-	8	20

SEMESTER-II**ADVANCED DATA ANALYTICS (R/SPSS/STATA/SAS)****L/T/P/C**
3/-/-/3**Learning Outcome:**

1. Apply advanced statistical techniques in R/SPSS/STATA/SAS to healthcare datasets.
2. Perform hypothesis testing, regression and multivariate analysis on health data.
3. Interpret and communicate statistical results for clinical/health-policy decision-making.
4. Evaluate the appropriateness of statistical software and methods for a given healthcare analytics problem.

UNIT-I**INTRODUCTION TO DATA ANALYTICS IN HEALTHCARE**

1. Role of analytics in healthcare
2. Big data and digital health
3. Ethical considerations in health data analysis

UNIT-II**OVERVIEW OF R, SPSS, STATA, AND SAS**

1. Introduction to software environments
2. Interface and functionalities
3. Choosing the right tool for specific analyses

UNIT-III**DATA IMPORTING, CLEANING & TRANSFORMATION**

1. Handling structured and unstructured data
2. Missing value imputation
3. Outlier detection
4. Data normalization

UNIT-IV**EXPLORATORY DATA ANALYSIS (EDA)**

1. Descriptive statistics
2. Data visualization techniques
3. Identifying trends and anomalies in healthcare data

UNIT-V**STATISTICAL ANALYSIS & REGRESSION MODELS**

1. Hypothesis testing (T-tests, ANOVA, Chi-square)
2. Regression models (Linear, Logistic, Cox regression)
3. Time series analysis for patient data trends

RECOMMENDED TEXT BOOKS

1. Data Analysis Using Regression and Multilevel/Hierarchical Models – Andrew Gelman, Jennifer Hill (Cambridge University Press, 2006) - Covers statistical modeling, regression analysis, and hierarchical models using R.

2. Discovering Statistics Using IBM SPSS Statistics – Andy Field (SAGE Publications, 2017) - A comprehensive guide on statistical analysis using SPSS with real-world examples.
3. A Handbook of Statistical Analyses Using Stata – Brian S. Everitt, Sophia Rabe-Hesketh (Chapman and Hall/CRC, 2014) - Introduces key statistical methods in Stata, including regression and multivariate analysis.
4. SAS Essentials: Mastering SAS for Data Analytics – Alan C. Elliott, Wayne A. Woodward (Wiley, 2019) - Provides practical applications of SAS for healthcare and business analytics.
5. The R Book – Michael J. Crawley (Wiley, 2012) - A detailed reference covering statistical computing, data visualization, and machine learning in R.

PREDICTIVE ANALYTICS (PREDICTION AND FORECASTING)L/T/P/C
2/-/-/2**Learning Outcome:**

1. Explain principles of predictive modelling and forecasting in healthcare.
2. Build predictive models for disease risk, patient outcomes and resource demand.
3. Apply time-series forecasting techniques to healthcare operational data.
4. Evaluate predictive-model performance and validate models for clinical/operational use.

UNIT-I**INTRODUCTION TO PREDICTIVE ANALYTICS IN HEALTHCARE**

1. Role of AI & ML in healthcare
2. EHR (Electronic Health Record) integration for prediction
3. Use cases: Disease risk prediction, readmission forecasting, epidemic spread modelling

UNIT-II**DATA PREPROCESSING & FEATURE ENGINEERING**

1. Handling missing data (mean, median imputation, KNN imputation)
2. Data normalization and standardization
3. Feature selection techniques (PCA, LASSO, Recursive Feature Elimination)

UNIT-III**MACHINE LEARNING MODELS FOR PREDICTION**

1. Regression models (Linear, Logistic, Cox Regression)
2. Decision trees, Random Forests, Gradient Boosting (XGBoost)
3. Neural Networks & Deep Learning for time series forecasting

UNIT-IV**PREDICTIVE MODELING APPLICATIONS IN HEALTHCARE**

1. Predicting chronic disease risks (Diabetes, Cardiovascular Diseases, etc.)

UNIT-V**MODEL DEPLOYMENT & INTERPRETABILITY**

1. Deploying ML models with Flask, FastAPI
2. Model explainability tools (SHAP, LIME)
3. Ethical considerations in AI-driven healthcare

RECOMMENDED TEXT BOOKS

1. Kelleher, J. D., Mac Namee, B., & D'Arcy, A. (2020). Fundamentals of Machine Learning for Predictive Data Analytics. MIT Press.
2. Provost, F., & Fawcett, T. (2013). Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking. O'Reilly Media.
3. Lantz, B. (2019). Machine Learning with R (2nd Ed.). Packt Publishing.
4. Chicco, D., & Jurman, G. (2021). Machine Learning for Biomedical Applications. Springer.
5. Aggarwal, C. C. (2018). Neural Networks and Deep Learning: A Textbook. Springer.

UI/UX FOR HEALTHCARE

L/T/P/C
2/-/-/2

Learning Outcome:

1. Apply user-centred design principles to healthcare application interfaces.
2. Create wireframes, prototypes and usability tests for digital-health products.
3. Evaluate accessibility and patient-safety considerations in healthcare UI/UX design.
4. Design and iterate healthcare app/dashboard interfaces based on user feedback.

UNIT-I

FUNDAMENTALS OF UI/UX IN HEALTHCARE

1. Importance of UI/UX in medical applications
2. Difference between UI and UX
3. Role of cognitive psychology in healthcare UX

UNIT-II

USER RESEARCH & HEALTHCARE PERSONAS

1. Conducting user research for healthcare products
2. Creating patient and provider personas
3. Understanding accessibility needs (elderly, disabled users)

UNIT-III

PRINCIPLES OF HEALTHCARE UI DESIGN

1. Color theory and visual hierarchy
2. Typography and readability in medical applications
3. Designing for different platforms (mobile, web, wearables)

UNIT-IV

UX DESIGN FOR HEALTHCARE APPLICATIONS

1. Wireframing and prototyping healthcare interfaces
2. Navigation and usability principles
3. Data visualization in health dashboards

UNIT-V

TESTING & EVALUATING UI/UX IN HEALTHCARE

1. Usability testing techniques
2. A/B testing and heuristic evaluation
3. Ensuring compliance with accessibility guidelines (WCAG, Section 508)

UNIT-VI

DESIGNING FOR EMERGING TECHNOLOGIES

1. UX for telemedicine and remote patient monitoring
2. UI considerations for AI-powered diagnostics
3. Augmented reality (AR) and virtual reality (VR) UI design in healthcare
4. Preventing dark patterns in medical apps

UNIT-VII

HANDS-ON CASE STUDIES

1. Redesigning a hospital patient portal for better usability
2. Creating a telemedicine platform prototype
3. Improving the UI of an existing medical wearable app

RECOMMENDED TEXT BOOKS

1. Deborah J. Mayhew – The UX Book: Agile UX Design for Healthcare Applications (Elsevier, 2016)
2. Ben Shneiderman – Designing the User Interface: Strategies for Effective Human-Computer Interaction (Pearson, 2016)
3. Aaron Marcus & Hyojin Kim – Design, User Experience, and Usability: UX Research and Design in Healthcare (Springer, 2017)
4. Jesmond Allen & James Chudley – Smashing UX Design: Foundations for Designing Online User Experiences (Wiley, 2012)
5. Patrick W. Jordan – Designing Pleasurable Products: An Introduction to the New Human Factors (CRC Press, 2002)

DESIGN THINKING

Learning Outcome:

1. Apply the design-thinking process (empathize, define, ideate, prototype, test) to healthcare problems.
2. Conduct stakeholder empathy research for digital-health solution design.
3. Generate and prototype innovative digital-health solution concepts.
4. Evaluate prototypes through iterative user testing and feedback.

UNIT-I

INTRODUCTION TO DESIGN THINKING IN HEALTHCARE

1. Principles of design thinking
2. Human-centered design (HCD) in healthcare
3. Role of empathy in healthcare innovation

UNIT-II

IDENTIFYING HEALTHCARE CHALLENGES & USER NEEDS

1. Conducting user research and ethnographic studies
2. Identifying pain points in patient journeys
3. Stakeholder mapping (patients, clinicians, administrators)

UNIT-III

IDEATION AND CONCEPT DEVELOPMENT

1. Brainstorming and creative problem-solving techniques
2. Convergent and divergent thinking
3. Co-designing with healthcare professionals and patients

UNIT-IV

PROTOTYPING HEALTHCARE SOLUTIONS

1. Low-fidelity and high-fidelity prototyping
2. Rapid prototyping tools (paper prototypes, wireframes, 3D models)
3. Iterative design and feedback integration

UNIT-V

IMPLEMENTING DESIGN THINKING IN HEALTHCARE SYSTEMS

1. Case studies of design-driven healthcare innovations
2. Lean startup methodology for healthcare startups
3. Scaling design thinking in large health organizations

UNIT-V

ETHICAL & REGULATORY CONSIDERATIONS

1. Ethical concerns in patient-centered design
2. Regulatory approval for healthcare innovation
3. Risk assessment and mitigation strategies

RECOMMENDED TEXT BOOKS

1. Jeanne Liedtka & Tim Ogilvie – Design Thinking for the Greater Good: Innovation in the Social Sector (Columbia University Press,
2. Tim Brown – Change by Design: How Design Thinking Creates New Alternatives for Business and Society (Harper Business, 2009)
3. Bon Ku & Ellen Lupton – Health Design Thinking: Creating Products and Services for Better Health (MIT Press, 2020)
4. Marc Stickdorn et al. – This is Service Design Thinking (Wiley,
5. IDEO.org – Design Kit: The Human-Centered Design Toolkit (IDEO,
6. Handbook of Design Thinking by Christian Muller Rotenberg
7. Design Thinking: A comprehensive textbook by Shalini Rahul Tiwari and Rohit Rajendra Swarup
8. Design Thinking: Innovative Solutions for a Better World by Gunikhan Sonowal

RAPID PROTOTYPING AND 3D PRINTING

L/T/P/C
2/-/-/2

Learning Outcome:

1. Explain principles of rapid prototyping and additive manufacturing in healthcare.
2. Design 3D models of healthcare devices/aids using CAD tools.
3. Fabricate functional prototypes using FDM/SLA 3D-printing technologies.
4. Evaluate prototypes for functionality, safety and manufacturability in healthcare applications.

UNIT-I

BASICS OF 3D PRINTING

1. Introduction to Additive Manufacturing
2. Types of 3D Printing Technologies: Fused Deposition Modeling (FDM), Stereolithography (SLA), Selective Laser Sintering (SLS)
3. Differences between additive and subtractive manufacturing

UNIT-II

3D PRINTING MATERIALS

1. Thermoplastics: PLA, ABS, PETG
2. Biocompatible Resins & Medical-Grade Polymers
3. Metal & Ceramic 3D Printing

UNIT-III

3D MODELLING & DESIGN

1. Introduction to CAD Software (AutoCAD, SolidWorks, Fusion 360)
2. Creating STL, OBJ file formats for 3D printing
3. Optimizing designs for printability and reducing material waste

UNIT-IV

PROTOTYPING & TESTING IN HEALTHCARE

1. 3D Printed Medical Applications: Prosthetic limbs, Dental implants, Orthotic devices
2. Bioprinting & Tissue Engineering: Emerging trends
3. Quality assessment and strength testing of printed models

UNIT-V

POST-PROCESSING & FINISHING TECHNIQUES

1. Support Removal, Surface Smoothing, Sterilization Techniques
2. Coating and painting for biocompatibility
3. Sterilization processes in medical applications

UNIT-VI

INDUSTRY APPLICATIONS & FUTURE TRENDS

1. 3D Printing in Surgery & Implants
2. Use in Custom Prosthetics & Assistive Devices
3. Future of Bioprinting and Organ Printing

RECOMMENDED TEXT BOOKS

1. Gibson, I., Rosen, D. W., & Stucker, B. (2021). Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing (2nd Ed.). Springer.
2. Bártolo, P. J. (2011). Stereolithography: Materials, Processes, and Applications. Springer.
3. Chua, C. K., Leong, K. F., & Lim, C. S. (2010). Rapid Prototyping: Principles and Applications (3rd Ed.). World Scientific.
4. Singh, R. (2018). 3D Printing in Biomedical Engineering. Woodhead Publishing.
5. Murr, L. E. (2016). Metallurgy and Design of Alloys with Hierarchical Microstructures. Elsevier.
6. Rapid Prototyping Technology: Selection and Application by Kenneth G. Cooper
7. Rapid Prototyping: Theory and Practice by Ali Kamrani and Emad Abouel Nasr

MOBILE APPS & WEB APPSL/T/P/C
2/-/-/2**Learning Outcome:**

1. Design and develop mobile/web application interfaces for healthcare use cases.
2. Implement core functionality of a health app using appropriate frameworks.
3. Integrate healthcare data and APIs into mobile/web applications.
4. Test and deploy digital-health mobile/web applications.

UNIT-I**INTRODUCTION TO FRONTEND & BACKEND DEVELOPMENT**

1. Overview of full-stack development
2. Frontend and Backend in healthcare applications
3. Introduction to React (Web) and Flutter/Kotlin (Mobile)

UNIT-II**AUTHENTICATION & SECURITY FEATURES**

1. OAuth, JWT, Firebase authentication
2. Role-based access control (RBAC)
3. HIPAA compliance for mobile & web apps

UNIT-III**DATABASE INTEGRATION**

1. Connecting Firebase, PostgreSQL, MySQL
2. Real-time database synchronization
3. NoSQL vs. SQL in healthcare

UNIT-IV**PUSH NOTIFICATIONS & OFFLINE CAPABILITIES**

1. FCM (Firebase Cloud Messaging) for notifications
2. Implementing offline-first applications
3. Optimizing battery and performance for mobile apps

UNIT-V**DEPLOYMENT OF WEB & MOBILE APPS**

1. App Store (iOS) & Play Store (Android) deployment
2. Containerization with Docker & Kubernetes
3. CI/CD pipelines for healthcare applications

RECOMMENDED TEXT BOOKS

1. Pettit, J. (2021). Flutter for Beginners (2nd Ed.). Packt Publishing.
2. Gupta, A. (2020). Full-Stack Web Development with React and Firebase. O'Reilly Media.
3. Fain, Y., & Rasputnis, V. (2019). Modern Web Development with Kotlin. Manning Publications.
4. Steele, K. (2020). The Mobile Application Hacker's Handbook. Wiley.
5. Dimitris, K. (2018). Building Secure and HIPAA-Compliant Healthcare Applications. Springer.

6. Artificial Intelligence and Healthcare: The Impact of Algorithmic Bias on Health Disparities by Javier Cuello & José Vittone
7. MOBILE APPLICATIONS DEVELOPMENT by C. FIRZA AFREEN
8. Handbook of mobile application development: A guide to selecting the right engineering and quality features by Mohamed Sarrab, Hamed Al-Shihi and Naveen Safia
9. Professional mobile application development by Jeff McWherter and Scott Gowell
10. Mobile Application Development: Practice and Experience by Jagannath Singh, Debasish Das, Lov Kumar and Aneesh Krishna

API, PLUG-IN INTEGRATION

L/T/P/C
2/-/-/2

Learning Outcome:

1. Explain principles of API architecture and integration in health-technology systems.
2. Integrate healthcare APIs (FHIR/HL7) into applications for data exchange.
3. Develop and configure plug-ins to extend digital-health application functionality.
4. Test, document and secure API integrations in a healthcare application.

UNIT-I

FUNDAMENTALS OF APIS (REST, SOAP)

1. REST vs. SOAP architecture
2. JSON & XML-based API responses
3. GraphQL introduction

UNIT-II

API AUTHENTICATION & SECURITY

1. OAuth 2.0, API Keys, JWT (JSON Web Token)
2. Role-based access control (RBAC)
3. HIPAA, GDPR compliance in API security

UNIT-III

BUILDING API REQUESTS & RESPONSES

1. GET, POST, PUT, DELETE methods
2. Handling API responses and error codes
3. API documentation using Swagger/OpenAPI

UNIT-IV

INTEGRATING THIRD-PARTY APIS

1. Google Maps API for hospital locations
2. Firebase API for real-time health data storage
3. HL7 & FHIR standards for health data exchange

UNIT-V

WEBHOOKS & EVENT-DRIVEN ARCHITECTURES

1. Webhooks vs. polling methods
2. Using event-driven APIs in telemedicine
3. Asynchronous API requests for real-time monitoring

UNIT-VI

ERROR HANDLING & RATE LIMITING

1. API error handling best practices
2. Throttling and rate-limiting strategies
3. Logging API requests for debugging

UNIT-VII

API SECURITY & COMPLIANCE IN HEALTHCARE

1. Token-based authentication for secure transactions
2. Data encryption (TLS, SSL) in API calls
3. Ensuring API compliance with global health data regulations

RECOMMENDED TEXT BOOKS

1. Meddeb, A. (2018). REST API Development with Node.js. Packt Publishing.
2. Allamaraju, S. (2010). RESTful Web Services Cookbook. O'Reilly Media.
3. Rubino, A. (2021). Hands-on Healthcare API Design with HL7 FHIR. Packt Publishing.
4. Richardson, L., & Amundsen, M. (2020). RESTful Web APIs. O'Reilly Media.
5. Graham, M. (2022). API Security in Action. Manning Publications.

DATABASE FEATURES

L/T/P/C

1/-/-1

Learning Outcome:

1. Explain relational and non-relational database concepts relevant to healthcare data.
2. Design database schemas for storing and managing health records.
3. Query and manipulate healthcare databases using SQL/NoSQL techniques.
4. Apply database security and backup practices to protect sensitive health data.

UNIT-I

DATABASE FUNDAMENTALS (SQL & NOSQL)

1. SQL (PostgreSQL, MySQL) vs. NoSQL (MongoDB, Firebase)
2. Relational vs. non-relational databases
3. Choosing the right database for healthcare applications

UNIT-II

HEALTHCARE DATA MODELS & EMR INTEGRATION

1. Electronic Medical Record (EMR) database design
2. Normalization and de-normalization in healthcare
3. FHIR and HL7 data exchange standards

UNIT-III

QUERY OPTIMIZATION & INDEXING

1. Indexing strategies for large medical datasets
2. SQL query optimization techniques
3. Joins, Views, and Stored Procedures for health data analysis

UNIT-IV

CLOUD DATABASES (AWS, GOOGLE CLOUD, AZURE)

1. Introduction to cloud-based database solutions
2. AWS RDS, Google Firebase, Microsoft Azure SQL

UNIT-V

SECURITY & PRIVACY IN HEALTH DATA MANAGEMENT

1. Data encryption at rest and in transit
2. Access control and user authentication in databases
3. Regulatory compliance (HIPAA, GDPR) in database management

RECOMMENDED TEXT BOOKS

1. Elmasri, R., & Navathe, S. (2017). Fundamentals of Database Systems (7th Ed.). Pearson.
2. Kumar, V. (2018). Big Data Analytics and Machine Learning in Healthcare. Springer.
3. Redmond, E. (2017). Introduction to NoSQL Databases. O'Reilly Media.
4. Ritchie, B. (2021). SQL for Data Analytics (2nd Ed.). Packt Publishing.
5. Gates, R. (2020). Cloud Databases: Deploying Scalable Data Storage Solutions. Wiley.

PRACTICALS IN ADVANCED DATA ANALYTICS (R/SPSS/STATA/SAS)**L/T/P/C**
-/-/4/2**Learning Outcome:**

1. Import, clean and explore healthcare datasets using R/SPSS/STATA/SAS.
2. Perform hypothesis testing and regression analysis on health data.
3. Conduct multivariate/survival analysis relevant to clinical research questions.
4. Present and interpret statistical findings for health-policy or clinical audiences.

UNIT-I

Data import, cleaning and exploratory analysis in R/SPSS/STATA/SAS.

UNIT-II

Hypothesis testing and regression analysis on healthcare datasets.

UNIT-III

Multivariate and survival analysis for clinical data.

UNIT-IV

Report generation and interpretation for health-policy audiences.

UNIT-V

Comparative mini-project applying multiple statistical tools to a healthcare dataset.

RECOMMENDED TEXT BOOKS

1. Field, A. (2018). Discovering Statistics Using IBM SPSS Statistics. Sage; StataCorp documentation; SAS Institute documentation; R Core Team documentation.

PRACTICALS IN PREDICTIVE ANALYTICS (PREDICTION AND FORECASTING) L/T/P/C
-/-/4/2

Learning Outcome:

1. Build classification and regression models for healthcare prediction tasks.
2. Apply time-series forecasting techniques to healthcare operational data.
3. Validate and evaluate predictive-model performance using appropriate metrics.
4. Deploy and present a predictive-analytics solution for a healthcare use case.

UNIT-I

Building classification models for disease-risk prediction.

UNIT-II

Building regression models for patient-outcome/resource forecasting.

UNIT-III

Time-series forecasting for healthcare demand/operations.

UNIT-IV

Model validation, cross-validation and performance evaluation.

UNIT-V

Deployment/presentation of a predictive-analytics mini-project or dashboard.

RECOMMENDED TEXT BOOKS

1. Raschka, S., & Mirjalili, V. (2019). Python Machine Learning. Packt; Hyndman, R. J., & Athanasopoulos, G. (2021). Forecasting: Principles and Practice. OTexts.

II year III semester

S.NO	SUBJECT	L	T	P	C
1	Electronic Health Records (EHR)	3	-	-	3
2	Telemedicine	3	-	-	3
3	Digital Twins	3	-	-	3
4	AR/VR/MR for Healthcare	3	-	-	3
5	Market Research & Needs Assessment	2	-	-	2
6	Practicals in AR/VR/MR for Healthcare	-	-	6	3
7	Practicals in Internet of Medical Things (IoMT)	-	-	6	3
	TOTAL	14	-	12	20

SEMESTER-III**ELECTRONIC HEALTH RECORDS (EHR)****L/T/P/C**
3/-/-/3**Learning Outcome:**

1. Explain the architecture, standards (HL7/FHIR) and lifecycle of EHR systems.
2. Evaluate EHR interoperability and data-exchange mechanisms across healthcare systems.
3. Assess EHR implementation challenges, workflows and adoption strategies in healthcare organisations.
4. Apply data-privacy and security principles in the design and use of EHR systems.

UNIT-I**INTRODUCTION TO EHR**

1. Definition, Scope and Importance of EHR
2. Evolution of health records
3. Transition from paper to digital

UNIT-II**COMPUTER HARDWARE AND ENABLING TECHNOLOGIES**

1. Basic Computer Architecture for HER
2. Sever vs. Cloud-Based EHR Systems
3. Data Storage and Retrieval Mechanisms
4. Network Infrastructure and Cybersecurity in EHR

UNIT-III**DATABASES, DATA WAREHOUSES, AND DATA REPOSITORIES**

1. Basics of Healthcare Databases (SQL, NoSQL)
2. Data Warehousing Concepts in EHR
3. Electronic Data Interchange (EDI) and HL7 Integration
4. Real-time Data Processing in EHR

UNIT-IV**INTERNET AND INTRANET TECHNOLOGIES**

1. Cloud Computing in EHR
2. Web-based and Mobile EHR Solutions
3. Telemedicine Integration with EHR
4. Security Concerns in Internet-based EHR

UNIT-V**HEALTH INFORMATICS STANDARDS**

1. Standardization Bodies (HL7, SNOMED CT, ICD, DICOM)
2. Interoperability and Data Exchange Standards
3. Regulatory Compliance (HIPAA, GDPR, ONC)

UNIT-VI

UNDERSTANDING CLINICAL PROCESSES & EHR WORKFLOW

1. Patient Data Entry and Management
2. Electronic Prescriptions and Medication Management
3. Physician Order Entry (CPOE) and Integration with Labs
4. Role of EHR in Patient Monitoring and Telehealth

UNIT-VII

PROJECT MANAGEMENT IN EHR IMPLEMENTATION

1. Planning and Budgeting for EHR Deployment
2. Risk Assessment and Change Management
3. Training Healthcare Professionals on EHR
4. Case Study: Large-scale EHR Implementations

RECOMMENDED TEXT BOOKS

1. Electronic Health Records: Understanding and Using Computerized Medical Records – Richard Garte, Pearson (2016) - Covers EHR systems, data management, security, and interoperability.
2. Health Informatics: Practical Guide – William R. Hersh, Lulu.com (2021) - Discusses EHR implementation, clinical decision support, and digital health systems.
3. Biomedical Informatics: Computer Applications in Health Care and Biomedicine – Edward H. Shortliffe, James J. Cimino, Springer (2021) - Focuses on EHR integration, AI applications, and ethical considerations.
4. Electronic Health Records for Dummies – Trenor Williams, Anita Samarth, Wiley (2010) - Beginner-friendly guide on EHR fundamentals and healthcare regulations.
5. Clinical Informatics Study Guide: Text and Review – John T. Finnell, Brian E. Dixon, Springer (2022) - Covers clinical informatics, EHR design, interoperability, and patient safety.
6. Electronic Health Record: Standards, Coding Systems, Frameworks, and Infrastructures by Pradeep Sinha, Gaur Sunder, Prashant Bendale, Manisha Mantri and Atrya Dande
7. Electronic health records and medical big data: Law and Policy by Sharona Hoffman
8. Electronic Health Records: Strategies for Long-Term Success by Michael Fossel and Susan Dorfman

TELEMEDICINE**L/T/P/C**
3/-/-/3**Learning Outcome:**

1. Explain the models, technologies and workflows underlying telemedicine service delivery.
2. Evaluate telemedicine platforms for remote consultation, diagnosis and monitoring.
3. Assess regulatory, ethical and reimbursement considerations in telemedicine practice.
4. Design a telemedicine-enabled care pathway for a specified clinical use case.

UNIT-I**INTRODUCTION TO TELEMEDICINE**

1. Definition & History
2. Understanding the role of telehealth
3. Benefits & Limitations

UNIT-II**TECHNOLOGIES IN TELEMEDICINE**

1. Communication Networks and Services
2. Wireless networks
3. Outdoor operating
4. Environment

UNIT-III**WIRELESS TELEMEDICINE SYSTEM DEPLOYMENT**

1. Planning and deployment considerations
2. Scalability to support future growth
3. Integration with existing IT infrastructure
4. Evaluating IT service and solution provider
5. Quality measurement

UNIT-IV**WIRELESS TECHNOLOGIES IN PATIENT MONITORING**

1. Body area networks
2. Emergency and disaster monitoring
3. In-hospital monitoring

UNIT-V**TECHNOLOGIES IN MEDICAL INFORMATION PROCESSING**

1. Collecting data from patients
2. Bio signal transmission and processing
3. Decision support systems

UNIT-VI**TELEMEDICINE'S IMPACT ON HEALTH CARE DELIVERY**

1. Cost of Care
2. Quality of Care

3. Access to care
4. Relationship with health care providers
5. Market for telehealth services

UNIT-VII

REGULATIONS & COMPLIANCE – GUIDELINES FOR ELECTRONIC FLOW OF HEALTH INFORMATION AND RECORDS

1. Licensing & reimbursement policies
2. Data security & HIPAA compliance

UNIT-VIII

FUTURE TRENDS IN TELEMEDICINE

1. AI & machine learning in telehealth
2. 5G & IoT integration

RECOMMENDED TEXT BOOKS

1. Telemedicine: Technology and Applications (MHealth, TeleHealth and EHealth) – R.S. Khandpur, PHI Learning (2017) - Covers fundamentals of telemedicine, remote diagnostics, and mHealth applications.
2. Telemedicine Technologies: Information Technologies in Medicine and Telehealth – Hemanth D. Jude, Elsevier (2019) - Focuses on emerging telemedicine technologies, AI integration, and security aspects.
3. Understanding Telehealth – Karen Schuller Rheuban, Elizabeth Krupinski, McGraw Hill (2017) - Explains clinical applications, legal considerations, and telehealth implementation.
4. Digital Health: Scaling Healthcare to the World – Homero Rivas, Katarzyna Wac, Springer (2018) - Discusses telehealth scalability, patient engagement, and IoT applications.
5. Telemedicine and E-Health Law – L. Camille Hébert, Bloomberg Law (2020) - Covers legal, ethical, and policy frameworks governing telemedicine practices.
6. Telemedicine technology and application (MHealth, telehealth and e-health) by R.S Khandpur
7. Fundamentals of telemedicine and telehealth by Shashi Gogia

DIGITAL TWINS**L/T/P/C**
3/-/-/3**Learning Outcome:**

1. Explain the concept, components and evolution of digital twins in healthcare.
2. Analyse applications of digital twins in patient monitoring, simulation and hospital operations.
3. Identify data sources (IoT, EHR, imaging) required to build a healthcare digital twin.
4. Evaluate the ethical concerns, data-security challenges and future directions of digital twins in healthcare.

UNIT-I**CONCEPT OF DIGITAL TWINS**

1. Definition & evolution
2. Components of Digital Twin

UNIT-II**APPLICATIONS IN HEALTHCARE**

1. Patient Monitoring and Management
2. Medical Simulations and Training
3. Hospital Digital Twins

UNIT-III**DATA SOURCES FOR DIGITAL TWINS**

1. IoT-enabled devices
2. EHR Data, Radiological Images

UNIT-IV**CHALLENGES & ETHICAL CONCERNS**

1. Data security
2. Ethical dilemmas in predictive modeling

UNIT-V**FUTURE OF DIGITAL TWINS IN HEALTHCARE**

1. AI & deep learning integration
2. Next-gen predictive models

RECOMMENDED TEXT BOOKS

1. Digital Twin Technologies and Smart Cities – Mokhtar Awang, Asif Iqbal, CRC Press (2021) - Covers digital twin fundamentals, applications in healthcare, and real-world implementations.
2. Digital Twin: The Next Wave of Digital Transformation – Rajiv Ranjan, Pethuru Raj, Springer (2022) - Explores digital twin concepts, AI integration, and use cases in medicine.
3. Digital Twin Technologies for Healthcare 4.0 – Sukanta Kumar Barik, P. V. Suresh, Springer (2023) - Focuses on digital twins for predictive healthcare, diagnostics, and personalized medicine.
4. Healthcare Digital Twins: The Convergence of Digital Health, AI, and IoT – Carmelo Ardito, Springer (2023) - Discusses digital twins for patient monitoring, disease modeling, and telemedicine applications.

5. The Digital Twin Paradigm for Smarter Systems and Environments: The Industry Use Cases – Hassan Raja, Elsevier (2020) - Covers industrial and medical applications of digital twins, including remote patient monitoring.
6. Digital twins in healthcare: Transforming patient care through intelligent digital simulation by Manjeet Kaur

AR/VR/MR FOR HEALTHCARE**L/T/P/C**
3/-/-/3**Learning Outcome:**

1. Explain the principles and technologies underlying AR/VR/MR systems in healthcare.
2. Evaluate applications of AR/VR/MR in clinical training, surgery and patient rehabilitation.
3. Design an AR/VR/MR-based solution/prototype for a healthcare training or care scenario.
4. Assess the technical, ethical and adoption challenges of immersive technologies in clinical settings.

UNIT-I**INTRODUCTION TO AR, VR AND MR**

1. AR
2. VR
3. MR

UNIT-II**APPLICATIONS OF AR/VR/MR:**

1. Medical Training and Education
2. Pain Management and Therapy
3. Mental Health Treatment
4. Patient Engagement and Education
5. Remote Consultation and Monitoring

UNIT-III**SOFTWARE FOR AR/VR/MR:**

1. AR (Microsoft HoloLens Development Studio, Unity 3D)
2. VR (Oculus SDK, Engage VR)
3. MR (Holo Anatomy, Microsoft Dynamics 365 Remote Assist)

UNIT-IV**HARDWARE FOR AR/VR/MR**

1. AR (Microsoft HoloLens2, Google Glass Enterprise Edition)
2. VR (Oculus Rift S/ Oculus Quest 2, HTC Vive Pro)
3. MR (Microsoft HoloLens 2, Oculus Quest 2)

UNIT-V**TYPES OF DATA SETS FOR AR/VR/MR:**

1. EMR Data sets
2. Sensing data sets
3. Image data sets
4. Video data set

RECOMMENDED TEXT BOOKS

1. Augmented Reality in Healthcare: Applications, Technologies, and Challenges by Amir H. Alavi and Seyedali S. Jafari
2. Virtual Reality and Augmented Reality: Myths and Realities by Steven A. Brown

3. Mixed Reality and 3D Technologies in Medicine by André Biedenkapp, Javier García, and Eduardo R. P. de Souza

MARKET RESEARCH & NEEDS ASSESSMENT**L/T/P/C**
2/-/-/2**Learning Outcome:**

1. Apply market-research methods (surveys, focus groups) to digital-health product development.
2. Conduct a healthcare needs assessment to identify gaps in patient/provider services.
3. Perform competitive analysis and evaluate business models of existing digital-health solutions.
4. Analyse emerging trends and investment patterns to inform digital-health product strategy.

UNIT-I**INTRODUCTION TO MARKET RESEARCH**

1. Types of market research
2. Importance in digital health

UNIT-II**DATA COLLECTION & ANALYSIS**

1. Surveys & focus groups
2. Statistical analysis

UNIT-III**NEEDS ASSESSMENT IN HEALTHCARE**

1. Identifying gaps in Healthcare
2. Evaluating patient & provider needs

UNIT-IV**COMPETITIVE ANALYSIS & BUSINESS MODELS**

1. Analyzing existing digital health solutions
2. Business strategies in healthcare

UNIT-V**TRENDS & FUTURE SCOPE**

1. Emerging technologies
2. Investment trends in digital health

RECOMMENDED TEXT BOOKS

1. Essentials of Marketing Research – William G. Zikmund, Barry J. Babin (Cengage Learning, 2018) - Covers qualitative and quantitative research methods, data collection, and analysis techniques.
2. Marketing Research: An Applied Orientation – Naresh K. Malhotra (Pearson, 2019) - A comprehensive guide on market research methodologies, survey design, and consumer insights.
3. The Handbook of Market Research for Life Science Companies – Jean-Francois Denault (Springer, 2021) - Focuses on market research strategies for healthcare, biotech, and life sciences industries.
4. Marketing Research for the Health Sector: Insights and Innovations – John Whittaker (Routledge, 2020) - Discusses market research methods specific to healthcare products, medical devices, and pharmaceuticals.
5. Needs Assessment: Analysis and Prioritization – David Royse, Thomas Badger (Oxford University Press, 2019) - Covers needs assessment frameworks, stakeholder engagement, and data-driven decision-making in healthcare and social services.

PRACTICALS IN AR/VR/MR FOR HEALTHCARE**L/T/P/C**
-/-/6/3**Learning Outcome:**

1. Set up and configure AR/VR/MR development environments and SDKs.
2. Develop a basic immersive clinical-training or patient-education module.
3. Integrate health data into an AR/VR/MR healthcare application.
4. Evaluate the usability and clinical relevance of an AR/VR/MR prototype.

UNIT-I

Setting up the VR/AR development environment (Unity 3D, HoloLens/Oculus SDK).

UNIT-II

Building a basic VR clinical-training simulation module.

UNIT-III

Developing an AR overlay for anatomy visualization or patient education.

UNIT-IV

Integrating patient/health data into an immersive application.

UNIT-V

Usability testing and evaluation of the AR/VR/MR prototype.

RECOMMENDED TEXT BOOKS

1. Vendor SDK documentation (Unity 3D, HoloLens, Oculus); Brown, S. A. Virtual Reality and Augmented Reality: Myths and Realities.

PRACTICALS IN INTERNET OF MEDICAL THINGS (IOMT)**L/T/P/C**
-/-/6/3**Learning Outcome:**

1. Explain IoMT architecture, protocols and device categories used in healthcare.
2. Configure and interface medical sensors with microcontroller platforms (Arduino/Raspberry Pi).
3. Implement data-acquisition and cloud-transmission pipelines for IoMT devices.
4. Evaluate security, privacy and regulatory considerations for IoMT deployment in clinical settings.

UNIT-I**INTRODUCTION TO IOMT**

architecture, sensor categories and connectivity protocols (BLE, Zigbee, MQTT).

UNIT-II

Wearable and remote patient-monitoring device integration.

UNIT-III

Data acquisition, transmission and cloud integration for IoMT devices.

UNIT-IV

Hands-on development using Arduino/Raspberry Pi with medical sensors.

UNIT-V

Security, privacy and regulatory considerations (FDA/CDSCO) for IoMT devices.

RECOMMENDED TEXT BOOKS

1. Rodrigues, J. J. P. C. (Ed.). Internet of Things for Healthcare Technologies. Springer; Arduino/Raspberry Pi Foundation official documentation.

II year IV semester

S.NO	SUBJECT	L	T	P	C
1	Research Project / Thesis	-	-	-	12
2	Review of Topics / Electives in Digital Health	8	-	-	8
	TOTAL	8	-	-	20

SEMESTER-IV**RESEARCH PROJECT / THESIS****L/T/P/C**
-/-/-/12

This is a Research Advisory Committee (RAC)-supervised, thesis-based course requiring each student to independently identify a digital-health research problem, conduct a literature review, obtain Institutional Ethics Committee clearance where human/patient data is involved, and execute original research culminating in a written thesis and open viva-voce defence, evaluated as detailed in Section 11.3. Indicative phases:

Phase I – Proposal Development: Problem identification, literature review, research-question/hypothesis formulation, and Proposal Defence before the RAC.

Phase II – Methodology and Ethics Clearance: Finalising research design, data-collection instruments, sampling, and obtaining Institutional Ethics Committee approval where applicable.

Phase III – Data Collection and Analysis: Fieldwork/experimentation, data collection, statistical/qualitative analysis, and Mid-term Progress Review before the RAC.

Phase IV – Thesis Writing and Defence: Compilation of the written thesis, Pre-submission Review, plagiarism screening, and final open viva-voce/defence before a committee including an external expert.

RECOMMENDED TEXT BOOKS

1. Discipline-specific peer-reviewed literature identified during the review process; University Research Project/Thesis Handbook and Institutional Ethics Committee guidelines.

REVIEW OF TOPICS / ELECTIVES IN DIGITAL HEALTH**L/T/P/C**
8/-/-8

This is a seminar/review-based elective course allowing each student, in consultation with the course coordinator, to select one or more advanced digital-health topics beyond the core curriculum for an in-depth literature/technology review, evaluated as detailed in Section 11.3. Indicative elective topics (illustrative, not exhaustive):

1. Artificial Intelligence and Generative AI in Clinical Decision Support
2. Health Policy, Economics and Insurance Analytics
3. Robotics, Exoskeletons and Assistive Technologies in Healthcare
4. Cybersecurity and Data Governance for Digital Health
5. Digital Health Entrepreneurship and Start-up Strategy
6. Global Health Informatics Standards and Interoperability
7. Public Health Surveillance and Epidemiological Modelling

RECOMMENDED TEXT BOOKS

1. Recent peer-reviewed journal articles, conference proceedings and technical/policy reports (WHO, ABDM, HIMSS, HL7) relevant to the topic selected by the student and approved by the course coordinator.