

**M.Sc. Health Informatics and Analytics**  
**Under Regulations- (R-2022)**  
**(w.e.f. 2022-23 admitted batch)**

# **Course Structure and Syllabus**



**THE APOLLO UNIVERSITY**  
**MURUKAMBATTU - CHITTOOR (Dt) 517127**  
**ANDHRA PRADESH**

## **PROGRAM OUTCOMES (PO)**

**PO 1: Understanding of Health Systems and Policies:** Demonstrate comprehensive knowledge of health systems, healthcare policies, and the regulatory environment impacting health informatics and analytics.

**PO 2: Core Informatics Knowledge:** Acquire foundational knowledge in health informatics concepts, standards, and frameworks such as EHRs, HIEs, CDSS, HL7, ICD-10, and SNOMED CT.

**PO 3: Data Analytics and Statistical Methods:** Master statistical techniques and data analytics methodologies using tools like SQL, R, and Python to analyze and interpret complex healthcare data.

**PO 4: Technical Proficiency:** Develop technical proficiency in health information technologies, including database management, data warehousing, and cloud computing, with hands-on experience in EHR systems like EPIC and Cerner.

**PO 5: Data Management and Quality Assurance:** Implement and manage healthcare data governance and quality assurance practices to ensure data integrity, privacy, and reliability.

**PO 6: Analytical and Problem-Solving Skills:** Apply advanced data analytics techniques to solve healthcare problems and optimize clinical decision-making.

**PO 7: Project Management and Leadership:** Cultivate project management and leadership skills to effectively manage health informatics projects and lead multidisciplinary teams.

**PO 8: Interdisciplinary Collaboration:** Collaborate effectively with healthcare professionals, IT specialists, and stakeholders to develop and implement health informatics solutions.

**PO 9: Ethical and Professional Responsibility:** Adhere to ethical standards and professional responsibilities in the practice of health informatics and analytics.

**PO 10: Innovation and Continuous Improvement:** Foster a mindset of innovation and continuous improvement in health informatics practices to enhance healthcare delivery and outcomes.

## **PROGRAM EDUCATIONAL OBJECTIVES (PEO):**

**PEO1:** Leadership and Innovation: Graduates will excel as leaders, designing and managing advanced health information systems to improve healthcare delivery and drive innovation in the industry.

**PEO 2:** 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.

**PEO 3:** Ethical and Professional Standards: Graduates will uphold the highest ethical standards, ensuring patient confidentiality, data security, and continuous professional development in health informatics.

## **PROGRAM SPECIFIC OUTCOMES (PSO):**

After successful completion of the program the graduates will be able to:

**PSO 1:** Proficiency in Health Data Management: Graduates will master the collection, organization, and secure management of healthcare data, adhering to regulatory standards.

**PSO 2:** Expertise in Health Informatics Systems: Graduates will excel in designing, implementing, and optimizing health informatics systems to support clinical decision-making and healthcare administration.

**PSO 3:** Analytical Competence in Healthcare Data: Graduates will demonstrate advanced analytical skills to interpret healthcare data using statistical and machine learning techniques for improving patient outcomes.

**PSO 4:** Leadership in Health Informatics Strategy: Graduates will lead strategic initiatives to enhance health informatics infrastructure and foster innovation in healthcare delivery and patient care.

# **THE APOLLO UNIVERSITY**

## **ACADEMIC REGULATIONS**

### **SCOPE:**

This Academic regulation provide a framework for the regulatory guidelines of all programs offered by The Apollo University. It includes procedures and practices that are to be followed to ensure academic standards in the University. The regulations are approved by the Academic Council. These regulations may be amended from time to time with the approval of the Academic council for the benefit of students or some times to reflect the changes suggested by the statutory bodies.

Information regarding amendments (if any) to the regulations will be communicated to the students by publishing in the University website. Students must follow the amended regulations as they might impact the process for the award of degree. The decision of the Vice Chancellor shall be the final in case of any discrepancy. These regulations apply to all students, despite the program of study.

### **1. ADMISSION INTO THE PROGRAM**

The University admits the students in two modes. One through the convenor quota as per the Andhra Pradesh Private Universities Act, for which the admissions will be carried out through the convener quota by the Govt of Andhra Pradesh. The other is through University quota for which the following procedure will be followed:

- A. The applicant shall satisfy the entrance requirements specified by The Apollo University and in accordance with guidelines of statutory councils for Under-graduation.
- B. The Applicant shall be qualified in the qualifying examination for a particular program.
- C. The Applicant secures a rank in national level entrance exam or suitable such test conducted by The Apollo University / professional body.
- D. The Applicant qualifies in the specified state or national level examinations prescribed by The Apollo University.

The Apollo University will widely notify the counselling schedule for admissions into the academic programs in the media. The provisional admission will be given to the eligible students during the counseling scheduled by The Apollo University. The selected candidates will be provisionally admitted into the program of his/her choice if the candidate meets the program specific requirements in addition to academic performance qualifying

exam. Admission is purely based on merit and so merely meeting the requirements will not ensure admission. The University does not discriminate based on gender, race, region, religion, disability or nationality. The University reserves the right to make admissions based on various criteria which is specified in the admission brochure.

## **2. ELIGIBILITY CRITERIA**

### **Postgraduate programs**

The qualifying exam eligibility for each program is given Annexure 1. The student should have passed the qualifying exam either in the year the student is seeking admission or the previous year.

**Convener Quota:** The student seeking admission to any program under convener quota shall qualify in the relevant entrance exam conducted by the Government of Andhra Pradesh.

**University Quota:** For getting admission under University quota, percentage of marks obtained in the qualifying exam, the rank obtained in TAU entrance exam or any recognized national level examination in the year of admission will be considered.

### **Counselling**

All the eligible students need to apply for admission and have to attend counselling conducted by TAU as per the schedule for the university quo

## **3. PROGRAMS**

The Apollo University offers variety of programs which includes certificate, undergraduate, postgraduate, and Research. The list of programs on offer for the academic year 2022-23 are annexed in Annexure 2 and those of 2023-24 are annexed in Annexure 3.

### **Minimum duration of the program**

The minimum duration of each program depends on the type of program, viz., undergraduate, postgraduate, integrated programs, etc., and the faculty which offers the program. The maximum duration of the program is N+2 years, where N stands for the minimum duration of the program as mentioned in Annexure 2 and 3. If the student has not obtained the minimum number of credits within the stipulated time, the Vice-Chancellor may extend the maximum duration in extenuating circumstances upon receiving a request along with reasons from the student for not completing the program on time.

#### **4. CHOICE BASED CREDIT SYSTEM**

The choice-based credit system (CBCS) facilitates the education student-centric. It provides the opportunity for the learner to choose the courses from a basket of core, elective, and skill enhanced courses. All programs of study are designed to meet the specified number of credit requirements. The courses taken by the student in each semester as part of program are allotted some credit points based on the number of hours assigned. Upon successful completion of the course, the student secures the number of credits allotted for that course. Once the minimum number of credits of the program is achieved, the degree can be awarded, subject to fulfilment of all other relevant conditions.

#### **5. STRUCTURE OF THE PROGRAM**

The Program structure Consists of

- i) Faculty Courses
  - A. Faculty Core
  - B. Faculty Electives
- ii) Program Courses
  - A. Program Core
  - B. Program electives

Each course\* is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week. (\*one course means one subject)

Core Courses = 3 Credits /4 Credits                      Elective =3 Credits

In general, credits are assigned to the courses as detailed below:

- A classroom lecture/ tutorial of 60 min (1 hr) duration per week, spread over the entire semester, shall be considered as one credit.
- A laboratory session of minimum of 120 min (2 hr) per week shall be considered as one credit.
- A project work/ Internship session of 60 minutes (1 hr) carried out per week shall be considered as one credit.

#### **6. MEDIUM OF INSTRUCTION**

The medium of instruction (including examinations and project reports) shall be English.

## **7. REGISTRATION**

Any of the following student must register for the courses opted in a particular semester during the scheduled registration period.

- i. a new student who enrolls into any program
- ii. an existing student who is continuing on rolls from the preceding regular semester
- iii. a former student, i.e., who has not enrolled in the preceding regular semester or who has availed academic break or detained and got readmission

Each newly admitted student shall attend an induction/ orientation program prior to commencement of the first semester. During this program academic advisors assist the students in choosing the courses. Existing student may register online by using their registration number and mail ID through the Apollo ERP portal. Class schedules are available approximately two weeks before the beginning of every semester for each program. The concerned head of the department must approve class schedule.

## **8. ATTENDANCE REQUIREMENTS**

- Students should earn a minimum of 80% attendance in the current semester to become eligible to write the Semester End Examinations.
- The monthly statement of attendance will be displayed on the Department Notice Board/ Apollo ERP by the respective departments within the first five working days of the following month.
- Candidates who are falling short of 80% attendance will be detained on the recommendation of the HoD and are not eligible to appear for the current semester examinations. The students who are detained in the current semester will not be allowed to register for the next semester and they have to repeat the same semester by paying the tuition fee prescribed. However, they can write arrear subjects, if any.

## **9. EVALUATION**

The assessment of the student's performance in a Theory course shall be based on two components: Continuous Evaluation (40 marks) and Semester-end examination (60 marks). A student has to secure an aggregate of 40% in the course in the two components put together to be declared to have passed the course, subject to the condition that the candidate must have secured a minimum of 24 marks (i.e. 40%) in the theory component at the semester-end

examination. Practical/ Project Work/ Industrial Training/ Viva voce/ Seminar etc. are completely assessed under Continuous Evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 50% to secure Pass Grade. For courses having both theory and practical components, 60% of the weightage will be given for theory component and 40% weightage for practical component. The student must secure 40% (Theory + Practical) with 24 marks minimum in theory to attain pass grade.

Details of Assessment Procedure are furnished below in Table 1.

**Table 1: Assessment Procedure**

S. No.	Component of Assessment	Marks Allotted	Type of Assessment	Scheme of Evaluation
1	Theory	40	Continuous Evaluation	<ul style="list-style-type: none"> <li>i) Twenty (20) marks for mid examinations. Three mid examinations shall be conducted for 20 marks each; average of the best two performances shall be taken into consideration.</li> <li>ii) Ten (10) marks for Quizzes, Assignments and Presentations.</li> <li>iii) Ten (10) marks for periodic evaluation, case studies and projects</li> </ul>
		60	Semester-end Examination	<ul style="list-style-type: none"> <li>iv) Sixty (60) marks for Semester-end examinations</li> </ul>
	<b>Total</b>	<b>100</b>		
2	Laboratory	100	Continuous Evaluation	<ul style="list-style-type: none"> <li>1)80 marks with equal weightage to all experiments subject to conduct of minimum of 10 experiments</li> <li>2)20marks for the end exam (with one of our university teachers as external other than course teacher)</li> </ul>

3	Internship	100	Continuous Evaluation	<p>i) (80) marks for periodic evaluation of Internship report by the Project Supervisor.</p> <p>ii) Twenty (20) marks for final Report presentation and Viva-voce, by a panel of internal examiners.</p> <p>iii) Students shall undergo TWO internships during the course of time and the evaluation shall be done during final semester.</p>
4	Project work	100	Continuous Evaluation	<p>iv) (80) marks for periodic evaluation and technical report writing by the Project Supervisor.</p> <p>ii) Twenty (20) marks for final Report presentation and Viva-voce, by a panel of internal examiners</p>

### GRADING SYSTEM

Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given in Table 2.

**Table 2: Grades & Grade Points**

Sl. No.	Grade	Grade Points	Absolute Marks
1	O(Outstanding)	10	90 and above
2	A+(Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79
4	B+(Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C(Average)	5	45 to 49
7	P(Pass)	4	40 to 44

8	F(Fail)	0	Less than 40
9	Ab. (Absent)	0	-

### SEMESTER GRADEPOINT AVERAGE (SGPA)

A Semester Grade Point Average (SGPA) for the semester will be calculated according to the formula:

$$SGPA = \frac{\sum [C \times G]}{\sum C}$$

Where

C=number of credits for the course,

G=grade points obtained by the student in the course.

A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, and is deemed to have earned the credits assigned to that course.

### CUMULATIVE GRADE POINT AVERAGE (CGPA)

A similar formula is used to arrive at Cumulative Grade Point Average (CGPA), considering the student's performance in all the courses taken in all the semesters up to the particular point of time.

Table 3 shows the CGPA required for the award of class after the successful completion of the program.

**Table3: CGPA required for award of Class**

Class	CGPA Required
First Class with Distinction	≥8.0*
First Class	≥6.5
Second Class	≥5.5
Pass Class	≥5.0

\*In addition to the required CGPA of 8.0 or more, the student must have necessarily passed all the courses of every semester in first attempt.

## 11. REAPPEARANCE

- A student who has secured 'F' grade in a Theory course shall have to reappear at the subsequent Semester end examination held for that course.
- A student who has secured 'F' grade in a Practical course shall have to attend

Special Instruction Classes scheduled by the Department for securing pass.

- c. A student who has secured 'F' Grade in Internship /Project work / Industrial Training etc shall have to reappear for Viva – voce scheduled by the department.
- d. A student who is declared fail (F) in a course/s can apply for revaluation within one week from the date of publication of results with a fee prescribed by the university. The marks /grade awarded in the revaluation is final.

### **11.1 Procedure for revaluation**

- The students who have not satisfied with the marks awarded by the examiner can apply for revaluation of his/her answer script/s
- The students have to apply through proper channel for revaluation and to pay the revaluation fee per paper to the university towards revaluation fee.
- Students have to apply for revaluation within 7 days from the date publication of result.
- The scripts will get valued by second examiner and if the difference is more than 15 marks, they will get valued by the third examiner. The average of the nearest two marks will be declared as the final marks.

### **11.2 ASSESSMENT MECHANISM**

The Apollo University offers a student the benefits of Choice Based Credit System. Every paper is allotted a certain number of credits as per the UGC norms. A student is awarded the specified credits on obtaining a pass in the respective paper.

The Choice Based Credit System (CBCS) has been adopted for PG Course from the year 2021-22 onwards as per the recommendations of the A.P. State Council for Higher Education (APSCHE). The structure of undergraduate programmes provides a wide range of choice for students to opt for courses based on their eligibility, aptitude and career goals.

### **11.3 Semester End Examination**

The End semester examination will be a comprehensive examination of 3 hours duration. Two End Semester examinations are conducted in a year-

Odd semester examinations in November/ December and

Even semester examination in May/June

Practical examination / Project viva will be held 2 weeks prior to the theory semester end examinations.

## Under-Graduation Programs

Course	Continuous Assessment	End semester	Aggregate in End semester Examinations
All PG Courses	No passing minimum	40%	40%

### 11.4 Post Evaluation Programme:

Under the Post Evaluation Programme there are three menus:

- Provision for improvement
- Re-totaling and Revaluation of answer scripts
- Restrictions to appear for the examinations

### 11.5 Provision for improvement

A student who passes a paper in the first attempt can reappear for the same paper in the succeeding End-of-Semester examination only, for improving his/her marks. Re-appearance for improvement is allowed for theory and practical subjects of all semesters, except for the final semester subjects. Revised mark statement will be issued after withdrawing the previous one, if the marks obtained in improvement are higher than the marks awarded earlier. When there is no improvement, there shall not be any change in the original marks already awarded. The improved marks shall be considered for classification but not for ranking.

Provision for Re-totaling and Revaluation of valued answer scripts

- PG candidates may apply for re-totaling / revaluation of valued answer scripts, to the Controller of Examinations through the Heads of Departments and Principal / Dean, in the prescribed forms, remitting the prescribed fee within 7 days from the date of publication of results. Revaluation of answer scripts is permissible only for the current semester papers and not for any arrear paper.
- Those wish to apply for revaluation of final semester papers can do so within five days from the date of publication of results. In re-valuation, the answer papers will be valued by an external examiner and if there is a difference of 15 marks between the two evaluations then the script will be sent for third valuation which is final and the mark awarded by the third examiner will be taken into the account.

- Revised mark statement will be issued after withdrawing the previous one, if the marks obtained in revaluation / retotalling are higher than the marks obtained earlier. In other cases, the original marks obtained earlier will be retained and the matter will be intimated to the student concerned as 'No change'.
- A candidate who applies for revaluation should not apply for retotalling.

### **Restrictions to appear for the examinations**

Candidates who fail in any of the papers in the PG End semester examinations shall complete the paper concerned within N+2 years from the date of admission to the particular course. If they fail to do so, they shall re-register their names and take the examination in the texts/revised regulations/syllabus of the paper prescribed for the subsequent batch of candidates, in force at the time of their reappearance. In the event of removal of that paper consequent to change of regulation and/or curriculum after N+2 years period, the candidate shall have to take up an equivalent paper in the revised syllabus as suggested by the Chairman, Board of Studies concerned.

### **12. BETTERMENT OF GRADES**

A student who has secured only a Pass or Second class and desires to improve his/her Class can appear for Betterment Examinations only in Theory courses of any Semester of his/her choice, conducted in Summer Vacation along with the Special Examinations. Betterment of Grades is permitted 'only once' immediately after completion of the program of study.

### **13. DETENTION AND RE-ADMISSION**

If a student fails to meet the minimum attendance requirement or minimum standards for academic progression, the concerned academic head will recommend for detention and it will be notified by the concerned Dean of the School. The students who are detained in the current semester will not be allowed to register for the next semester and they have to repeat the same semester.

The candidates who are detained or availed academic break or suspended in the previous semester/academic year and want to continue their study shall apply for re-admission to the university. The candidates shall request for re-admission to the respective Head of the Department, with details viz., Full Name, Registration Number, Department, School, Fee payment particulars with proofs and reasons for discontinuations. The concerned academic

head will forward it to the Registrar with specific comments. The Registrar will notify the decision of re-admission which shall include the prescribed fee particulars, semester/ year into which readmission is granted and additional courses to be completed by the student (if any). The candidates should apply for re-admission in advance, that is before the commencement of the semester.

#### **14. GROOMING AND ATTIRE FOR STUDENTS**

Grooming and Etiquette is of great significance in the dynamic of shaping one's Personality. The Apollo University stands by a *Code of Grooming, Attire and Etiquette* that promotes a professional standard: Academic Day; Campus Placements and Non-Academic Hours on Campus.

The Dress Code to be in compliance on academic premises while attending: Formal Functions of the Institution / Lectures / Practicals / Dining Area / Library / Labs / Office Areas.

Students shall follow appropriate attire during Academic and Non-Academic hours on the campus. Students shall wear clean, neat, pressed and presentable clothing, and command respect by dressing in accordance with responsible personal norms. Students shall always wear The Apollo University ID Card with the Lanyard.

##### **Grooming and Formal Wear - Boys:**

Formal Shirts / T-Shirts with a Collar should preferably be tucked in with a Formal pair of Pants Shoes and Socks to complete the Formal Attire. Personal Hygiene should be followed and Hair should be well groomed.

##### **Smart Casuals for Boys:**

Long Kurtas / Formals / Semi-Formal Shirts with Jeans.

##### **Grooming and Formal Wear - Girls:**

Sarees / Salwar Suits / Leggings or Jeggings with Long Kurtis / Long Frocks / Long Skirts / Palazzos. Complement the outfit with proper footwear. Personal Hygiene should be followed and Hair should be well groomed.

##### **Smart Casuals for Girls:**

Jeans with long Kurtis / Long Skirts / Long Frocks.

Attire for Non-Academic Hours On Campus:

The students should be neatly attired during Non-Academic Hours on Campus.

##### **Dress Code for Boys:**

Jeans / Track Suits / T-Shirts / Trousers / Shirts.

**Dress Code for Girls:**

Jeans / T-Shirts or Blouses / Salwar Suits / Palazzos / Leggings or Jeggings with Long Tops / Sarees / Long Skirts / Track Suits.

**DO'S AND DO'NTS FOR BOYS AND GIRL STUDENTS OF THE UNIVERSITY:**

- To wear modest clothing that reflects the essence of good personal grooming standards.
- To refrain from wearing Sleeveless Clothing; Shorts; Short Tops, etc.,

PLEASE NOTE: The decision as to what constitutes Appropriate Attire vests with the Authorities of The Apollo University.

**15. ELIGIBILITY FOR AWARD OF THE DEGREE**

The undergraduate degree will be of 4-years of duration. A student shall be declared as eligible for the award of the degree if the candidate has successfully secured the minimum number of required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated time.

After successful completion of the program, a provisional certificate cum memorandum of grades (PCMG) will be issued to the students. The PCMG includes the secured grades and class achieved in chosen program and specialization if any, along with grades and CGPA secured by the student. The original degree will be presented in the subsequent convocation.

**16. DISCRETION POWER**

Not with-standing anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

**ANNEXURE 1**

**ELIGIBILITY FOR QUALIFYING EXAM FOR POST GRADUATE PROGRAMS**

<b>Program Type</b>	<b>Program Name</b>	<b>Eligibility</b>
<b>Master's</b>	<b>M.Sc Health Informatics and Analytics</b>	Candidates must secure 50% in their Bachelor's Degree and should have completed or qualified the final year of Bachelor courses and should attain 20-21 Years as on 31st December of the preceding calendar year.

**ANNEXURE 2**  
**PROGRAMS OFFERED BY SCHOOL OF HEALTH SCIENCES**  
**FROM ACADEMIC YEAR 2022-23**

<b>Sl. No.</b>	<b>Program</b>	<b>Expanded</b>	<b>Level</b>	<b>Minimum Duration in Years (N)</b>
1	M.Sc HIA	Health Informatics and Analytics	Master's	2

**ANNEXURE 3**  
**PROGRAMS OFFERED BY SCHOOL OF HEALTH SCIENCES**  
**FROM ACADEMIC YEAR 2023-24**

<b>Sl. No.</b>	<b>Program</b>	<b>Expanded</b>	<b>Level</b>	<b>Minimum Duration in Years (N)</b>
1	M.Sc HIA	Health Informatics and Analytics	Master's	2

## I - Semester

<b>3 Week Induction Programme</b>						
<b>Course Code</b>	<b>Course Name</b>	<b>Periods per week</b>			<b>Credits</b>	<b>Hours per week</b>
		<b>L</b>	<b>T</b>	<b>P</b>		
HIAT6501	Fundamentals of Health Informatics	3	1	0	4	4
HIAT6502	Medical Terminology	3	1	0	4	4
HIAT6503	Foundations of Cloud Computing	3	1	0	4	4
HIAT6504	Healthcare Data Science	3	1	0	4	4
HIAT6505	Standards for Digital Health	3	1	0	4	4
HIAL6501	Health Data Science lab	0	0	4	2	4
HIAL6502	Cloud Computing Lab	0	0	4	2	4
--	Soft Skills	0	0	0	0	1
--	Mentoring	0	0	0	0	1
--	Technical Seminar	0	0	0	0	1
--	Library	0	0	0	0	1
--	Physical Activity	0	0	0	0	2
--	Co-curricular activity	0	0	0	0	1
--	Self-Learning	0	0	0	0	1
<b>TOTAL</b>		<b>15</b>	<b>3</b>	<b>8</b>	<b>24</b>	<b>36</b>

## II - Semester

Course Code	Course Name	Periods per week			Credits	Hours per week
		L	T	P		
HIAT6506	Clinical Informatics	3	1	0	4	4
HIAT6507	Clinical Decision Support Systems	3	1	0	4	4
HIAT6508	Artificial Intelligence and Cloud Computing in Healthcare	3	1	0	4	4
HIAT6509	Healthcare Data Visualization and Analysis	3	1	0	4	4
HIAT6510	Legal and Ethical Aspects of Health Informatics	3	1	0	4	4
HIAL6503	Artificial Intelligence and Cloud Computing Lab	0	0	4	2	4
HIAL6504	Data Visualization Lab	0	0	4	2	4
--	Soft Skills	0	0	0	0	1
--	Mentoring	0	0	0	0	1
--	Technical Seminar	0	0	0	0	1
--	Library	0	0	0	0	1
--	Physical Activity	0	0	0	0	2
--	Co-curricular activity	0	0	0	0	1
--	Self-Learning	0	0	0	0	1
<b>TOTAL</b>		<b>15</b>	<b>4</b>	<b>8</b>	<b>24</b>	<b>36</b>

### III - Semester

Course Code	Course Name	Periods per week			Credits	Hours per week
		L	T	P		
HIAT7601	TRACK-1 Elective – 1	3	1	0	4	4
HIAT7602	TRACK-2 Elective – 2	3	1	0	4	4
HIAT7603	TRACK-3 Elective – 3	3	1	0	4	4
HIAT7511	Research Methodology	3	1	0	4	4
HIAP7501	Mini Project	0	0	12	6	12
HIAL7505	Machine Learning Lab	0	0	4	2	4
--	Mentoring	0	0	0	0	1
--	Physical Activity	0	0	0	0	2
--	Self-Learning	0	0	0	0	1
<b>TOTAL</b>		<b>12</b>	<b>4</b>	<b>16</b>	<b>12</b>	<b>36</b>

**For 2022-23 A.Y**

**Track -1 IPR AND SKILL ENHANCEMENT**

- ✓ Intellectual Property Rights
- ✓ Advanced Statistical Methods
- ✓ Healthcare Management

**Track -2 ADVANCED HEALTH ANALYTICS**

- ✓ Machine Learning
- ✓ Data Base Management in Healthcare Sector
- ✓ Prescriptive, Predictive and Diagnostic Analytics in Healthcare

**Track -3 ADVANCED DIGITAL HEALTH ECO-SYSTEM**

- ✓ Internet of Medical Things
- ✓ Imaging Informatics
- ✓ Pharmacoinformatics

From 2023-24 A.Y onwards

**HIAT7601: MEDICAL TECHNOLOGIES**

- ✓ AI in organoids
- ✓ Telehealth strategies
- ✓ Internet of Medical things

**HIAT7602: ADVANCED HEALTH ANALYTICS**

- ✓ Machine Learning in health care
- ✓ Principles and practice of Health care Management
- ✓ Prescriptive, Predictive and Diagnostic Analytics in Healthcare

**HIAT7603: ADVANCED DIGITAL HEALTH ECO-SYSTEM**

- ✓ Precision Medicine
- ✓ Imaging Informatics
- ✓ Pharmacoinformatics

**IV - Semester (From 2023-24 A.Y onwards)**

Course Code	Course Name	Periods per week			Credits	Hours per week
		L	T	P		
HIAT7604	MOOCS Course through (Microsoft)	4	1	0	4	4
HIAT7605	MOOCS Course through (Microsoft)	4	1	0	4	4
HIAP7502	Major Project	0	0	28	14	28
<b>TOTAL</b>		<b>8</b>	<b>2</b>	<b>28</b>	<b>22</b>	<b>36</b>

**I SEMESTER**

**HIAT6501 INTRODUCTION TO HEALTH INFORMATICS L T P C**

**4 0 0 4**

**COURSE DESCRIPTION**

This course provides introduction to health informatics, the field devoted to the optimal use of data, information, and knowledge to advance individual health, health care, public health, and health-related research. Students will learn the application of informatics skills and knowledge to health-related problems.

**Course Objectives**

1. To provide an overview of health informatics, including its history, evolution, and current trends.
2. To learn the principles and practices of health data management, including data collection, storage, retrieval, and analysis.
3. To explore the various types of healthcare information systems (HIS) and their applications in clinical and administrative settings.
4. To examine the ethical, legal, and regulatory issues related to health informatics, including patient privacy, data security, and compliance.
5. To introduce emerging technologies in health informatics, such as telemedicine, electronic health records (EHRs), and mobile health applications..

**UNIT – 1 (10 Hours)**

Overview of Health Informatics, Healthcare Data, Information and Knowledge, Healthcare Data Analytics, Electronic Health Records

**UNIT – 2 (12 Hours)**

Health Information Exchange, Data Standards and Medical Coding, Architectures Of Information Systems, Health Information Privacy And Security, Health Informatics Ethics

**UNIT – 3 (10 Hours)**

Consumer Health Informatics, Mobile Technology, Online Medical Resources, Medical Information Retrieval

**UNIT- 4 (14 Hours)**

Evidence Based Medicine & Clinical Practice Guidelines, Disease Management and Disease Registries, Quality Improvement Strategies, Patient Safety and Health Information

**UNI T- 5 (14 Hours)**

Telemedicine, Medical Imaging Informatics, Bioinformatics, Public Health Informatics, E-Research

### **Course Outcomes –**

Upon successful completion of the course student would be –

1. Able to learn, appreciate, adapt and manage applications of information and communications technologies (ICT) applied to the healthcare sector and Digital Health.
2. Able to understand the roles of informatics and analytics for better health and healthcare outcomes.
3. Able to examine health informatics concepts for the management of health information
4. Able to study compliance requirements throughout health-information life cycle
5. Able to explore and focus on possible areas of further studies and jobs.

### **Text Books**

1. Health Informatics, Practical Guide for Healthcare and Information Technology Professionals, Sixth Edition by Robert E. Hoyt and Ann K. Yoshihashi, 2014
2. Health Care Informatics: An Interdisciplinary Approach, S. P. Englebardt and R. Nelson, Mosby, 2002.

### **Reference Text Books**

1. Health Informatics: A Socio-Technical Perspective, S. Wheton, Oxford Univ. Press, 2005
2. Health informatics: a systems perspective by Gordon D. Brown, Kalyan S. Pasupathy, Timothy B. Patrick, Second edition. Health Administration Press, 2019
3. Health Informatics: An Interprofessional Approach, by Ramona Nelson and Nancy Staggers, ISBN13: 978-0323402316, 2nd Edition

**HIAT6502**

**MEDICAL TERMINOLOGY**

**L T P C**

**4 0 0 4**

**COURSE DESCRIPTION**

The purpose of this course is to develop a student's understanding and use of hospital and medical terminology. There is a focus on understanding the terms commonly used to identify the cause and effects of disease conditions.

**COURSE OBJECTIVES**

1. To provide a foundational understanding of medical terminology, including the origins and structure of medical terms.
2. To learn the terminology related to the anatomy, physiology, and pathology of various body systems.
3. To familiarize students with common medical abbreviations and symbols used in healthcare settings.
4. To instruct on the proper use of medical terminology in medical records and documentation.
5. To enhance students' ability to communicate effectively using medical terminology in both written and verbal forms.

**UNIT – 1**

(9 Hours)

Basics of medical terminology, Specialties in a Hospital, The Human body in health and disease

**UNIT – 2**

(9 Hours)

The Skeletal System, The Muscular System, The lymphatic and immune systems

**UNIT – 3**

(9 Hours)

The Respiratory System, The Circulatory System, The Digestive System, The Urinary System

**UNIT – 4**

(9 Hours)

The Nervous system, Special senses - Eyes and Ears, Skin - The Integumentary system

**UNIT – 5**

(9 Hours)

The Endocrine system, The Reproductive System, Diagnostic procedures, Nuclear Medicine and Pharmacology

**Course Outcomes**

Upon successful completion of the course student would be able to –

1. Demonstrate a strong understanding of the basic principles and components of medical terminology, including prefixes, suffixes, and root words.
2. Accurately use medical terminology related to the anatomy, physiology, and diseases of various body systems.
3. Correctly interpret and use common medical abbreviations and symbols in healthcare communication.

4. Apply medical terminology appropriately in medical records, ensuring accurate and effective documentation.
5. Communicate clearly and professionally using medical terminology in both oral and written healthcare contexts.

### **Text Books**

1. Medical Terminology for Health Professions, 7th Edition by Ann Ehrlich; Carol L Schroeder, ISBN 13: 9781111543297, Published by Delmar Cengage Learning (2013)

2. Workbook for Ehrlich/Schroeder's Medical Terminology for Health Professions, 7th by Carol Schroeder, Ann Ehrlich Published by Delmar Cengage Learning; 7th edition, 2012, ISBN-13 : 978-1111543280

### **Reference Text Books**

1. Quick and Easy Medical Terminology - With Access by Peggy C. Leonard, ISBN13: 978-0323595995, 9th Edition

2. Medical Terminology Systems: A Body Systems Approach - With Access by Barbara A. Gyls, ISBN13: 978-0803658677, 8th Edition

Understanding Medical Terminology by Agnes C. Frenay, ISBN13: 978-0697140586, 9th Edition

**COURSE DESCRIPTION**

This course provides students with a solid foundation in cloud computing by covering key concepts in computer hardware, software, operating systems, virtualization, networking, and cloud computing technologies. Students will gain a comprehensive understanding of the core components that underpin cloud computing and the skills needed to deploy and manage cloud-based solutions.

**Course Objectives**

1. To provide an overview of cloud computing concepts, models, and architectures with a focus on their applications in healthcare.
2. To learn the principles and practices of managing healthcare data in cloud environments, including data storage, retrieval, and analytics.
3. To explore the security, privacy, and compliance requirements for healthcare data in the cloud, including HIPAA and other regulatory standards.
4. To introduce various cloud services and applications relevant to healthcare, such as electronic health records (EHRs), telemedicine, and health information exchanges (HIEs).
5. To provide practical knowledge on implementing and integrating cloud solutions in healthcare settings, including strategies for migration and interoperability.

**Unit 1: Fundamental of Computers**

Introduction to computer, History and Evolution of Computers, Basic concepts of computer model, Advantage and disadvantages of the computers, Hardware and its components, Overview of computer software.

**Unit 2: Operating System Concepts - Linux**

Introduction to operating systems, Mode of operating system, Kernel and its components, Functions of operating system, Types of Operating system, Linux as an open-source operating system, Installation of Linux, Basic Linux commands and file system navigation, User management and permissions in Linux.

**Unit 3: Virtualization**

Understanding virtualization concepts, Virtualization types: full virtualization, para-virtualization, and containerization, Introduction to virtualization platforms like VMware and VirtualBox.

**Unit 4: Networking**

Basic networking concepts, including IP addressing, subnets, and routing, Introduction to network protocols (TCP/IP), Network services and security considerations.

**Unit 5: Introduction to Cloud Computing**

Cloud computing fundamentals and its importance, Cloud service models: IaaS, PaaS, SaaS, Cloud deployment models: public, private, hybrid, and multi-cloud, Major cloud providers (e.g., AWS, Azure, Google Cloud), Overview of cloud services: compute, storage, databases, networking, and more, Demo on cloud provider's platform.

### **Course Outcomes**

Upon successful completion of the course, the student would be able to -

1. Demonstrate a comprehensive understanding of cloud computing principles, models, and architectures, and their relevance to healthcare.
2. Apply cloud computing techniques to manage healthcare data effectively, ensuring secure storage, retrieval, and analysis.
3. Identify and address security, privacy, and compliance challenges related to healthcare data in the cloud, ensuring adherence to relevant regulations.
4. Effectively utilize cloud services and applications to enhance healthcare delivery, including EHRs, telemedicine, and HIEs.
5. Plan and execute the implementation and integration of cloud computing solutions in healthcare environments, ensuring smooth migration and interoperability.

### **Text books:**

1. Rajkumar Buyya, Christian Vecchiola, and S. Thamarai Selvi, Mastering Cloud Computing: Foundations and Applications Programming, 1st Edition, Morgan Kaufmann, 2013, ISBN: 978-0124114548
2. Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, Cloud Computing: Concepts, Technology & Architecture, 1st Edition, Prentice Hall, 2013, ISBN: 978-0133387520

### **Reference Books**

1. Kai Hwang, Geoffrey C. Fox, and Jack J. Dongarra, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, 1st Edition, Morgan Kaufmann, 2011, ISBN: 978-0123858801
2. George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, 1st Edition, O'Reilly Media, 2009, ISBN: 978-0596156367
3. Michael J. Kavis, Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), 1st Edition, Wiley, 2014, ISBN: 978-1118617618

**HIAT6504:**

**HEALTHCARE DATA SCIENCE**

**L T P C**

**4 0 0 4**

## **COURSE DESCRIPTION**

In this course, the student will learn about some of the different types of data and computational methods involved in stratified healthcare and precision medicine.

### **Course Objectives**

1. To provide a comprehensive overview of health data science, including its principles, scope, and importance in modern healthcare.
2. To learn the techniques and best practices for collecting, managing, and curating health data from various sources.
3. To explore statistical methods and data analysis techniques specific to health data, including descriptive and inferential statistics.
4. To introduce machine learning algorithms and predictive modeling techniques used in health data science to identify patterns and make predictions.
5. To examine the ethical considerations and data privacy issues related to health data science, ensuring students understand and adhere to legal and ethical standards.

### **UNIT – 1**

**(12 Hours)**

Defining Data Science and Big data, Benefits and Uses, facets of Data, Data Science Process. The Data Science Process: Overview of the Data Science Process-Setting the research goal, Retrieving Data, Data Preparation, Exploration, Modeling, data Presentation and Automation.

### **UNIT – 2**

**(12 Hours)**

Python: Introduction and Environment Why Learn Python, Installing Python, Installing Anaconda Distribution, Running the Jupyter Notebook, The Building Blocks of Programs, Errors in Python

### **UNIT – 3**

**(12 Hours)**

Basic Python Programming, Datatypes and Operators, Variables, Strings, Lists and Tuples, Dictionary in Python, Conditional Statements, Loops in Python, Functions Classes and Objects File Handling in Python

### **UNIT – 4**

**(12 Hours)**

Biopython, Introduction, Installing Biopython, Biopython Seq Class, Parsing Sequence Files, Writing Files, Pairwise Sequence Alignment, BLAST with Biopython, Multiple Sequence Alignment, Construction of a Phylogenetic Tree, Handling PDB Files

### **UNIT – 5**

**(12 Hours)**

Python for Data Analysis, Introduction, NumPy, NumPy Arrays versus Lists, Two-Dimensional Matrices, Matrix Operations, Comparing Matrices, Generating Data Using NumPy, Speed Test, “Pandas” Data frame, Selecting Rows and Columns, Conditional Filtering in Data frame, Writing CSV Files from Pandas Data frame, Apply() Function, Concatenating and Merging

## **COURSE OUTCOMES**

Upon successful completion of the course student would be able to

1. Recognize the various discipline that contribute to a successful data science effort
2. Understand the processes of data science identifying the problem to be solved, data collection, preparation, modelling, evaluation and visualization.
3. Be aware of the challenges that arise in data sciences.
4. Be able to identify the application of the type of algorithm based on the type of the problem.
5. Be comfortable using commercial and open source tools such as the R/python language and its associated libraries for data analytics and visualization

### **Text Books**

1. Python for Data Science, by Ethan Williams, ISBN13: 978-1687159106
2. Hands on data science for biologists using Python by Yasha Hasija and Rajkumar Chakraborty, First edition. CRC Press, 2021, ISBN 13: 978-0367546786

### **Reference Text Books**

1. Fundamentals of Python: Data Structures, by Kenneth Lambert ISBN13: 978-0357122754, 2nd Edition
2. Data Structures and Algorithms With Python, by Kent D. Lee, ISBN13: 978-3319130712
3. Python Scripting for Computational Science, by Hans Petter Langtangen, ISBN13: 978-3540739159, 3rd Edition

**HIAT6505:**

**STANDARDS OF DIGITAL HEALTH L T P C**

**4 0 0 4**

### **COURSE DESCRIPTION**

This course will help the student to know how to lead digital health projects in public health and the healthcare sector

### **COURSE OBJECTIVES**

- ✓ To list the common standards used for exchange of health information and digital health (Cognitive Domain – Knowledge)
- ✓ To describe the HIT (Health Information Technology) standardization processes and entities (Cognitive Domain – Knowledge)
- ✓ To perform Teamwork to capture the basic standard requirements when developing a functional requirements specification document for the information system for a specific public health and/or healthcare domain (Psychomotor Domain – Manipulation)
- ✓ To tabulate the efforts towards Integration and harmonization of some of the diverse standards used for digital health (Affective Domain – Organization)
- ✓ To Provide a thorough understanding of the various standards and frameworks governing digital health technologies, including interoperability, data exchange, and compliance with regulatory requirements.

#### **Unit 1 Principles of Health Interoperability**

The Health Information Revolution, Why Interoperability is Hard, Role of Standards for achieving interoperability; Health Information Exchange (HIE), Models, UML, BPMN, XML and JSON, Information Governance, Standards Development Organizations

#### **Unit 2 Terminologies and SNOMED CT**

Clinical Terminology, Coding and Classification Schemes, SNOMED CT, SNOMED CT Concept Model, Implementing Terminologies

#### **Unit 3 HL7 and Interchange Formats**

HL7 Version 2, The HL7 v3 RIM, Constrained Information Models, CDA – Clinical Document Architecture, HL7 Dynamic Model, Sharing Documents and IHE XDS

#### **Unit 4 Fast Healthcare Interoperability Resources (FHIR)**

Principles of FHIR, The FHIR RESTful API, FHIR Resources, Conformance and Terminology, Implementing FHIR

#### **Unit 5 Integration and Harmonization**

Need for integration, Data harmonization, integrated and Interoperable systems, and Interoperable technologies in support of the health workforce, harmonization in primary healthcare, IHE Profiles; Continua Design Guidelines (CDG), PCHA, Integration, and harmonization of devices and services.

### **Course Outcomes**

After the completion of this subject, the students will be able to:

- ✓  Understand health information exchanges (HIEs) between clinical and public health data systems.
- ✓  Understand the main categories of HIT standards – data, information content, information exchange, identifier standards.
- ✓  Know in detail some of the Standards –ICD-10 & 11, SNOMED CT, LOINC, HL7 v2, v3 and FHIR, CDA and CCDA, DICOM, and the EHR standards in India.
- ✓  Understand the HIT standardization process.
- ✓  Understand Integration and Harmonization of the various Standards for Digital Health.

### **Textbooks:**

1. Benson Tand Grieve G (2016).Principles of Health Interoperability: SNOMED CT, HL7 and FHIR, Springer-Verlag, London, UK, ISBN: 978-3-319-30368-0
2. Antonio Francesco Maturo Veronica Moretti, Digital Health and The Gamification Of Life: How Apps Can Promote A Positive Medicalization, Emerald Publishing Limited Howard House, Wagon Lane, Bingley BD16 1WA, UK First edition 2018

**List of experiments****Linux Essentials**

1. Gain hands-on experience with Linux commands and file operations.
2. Create and manage users, groups, and permissions in a Linux environment.
3. Disk management and file system concepts.
4. Managing services and processes.

**Virtualization and Networking**

1. Set up and configure a virtualized environment using VirtualBox or VMware.
2. Practice basic networking concepts in a virtual environment.
3. Configuring network interfaces and IP addressing.
4. Introduction to firewall and security settings.

**Introduction to Cloud Platforms**

1. Sign up for a cloud provider account (e.g., AWS, Azure, Google Cloud).
2. Explore the cloud provider's console and services.
3. Launch a virtual machine (VM) in the cloud.

**Data Storage and Management**

1. Set up cloud-based storage solutions (e.g., Amazon S3, Azure Blob Storage).
2. Perform data backup and restoration tasks.

## **STHIA1- L2: BASIC PROGRAMMING FOR HEALTH DATA ANALYTICS LAB**

**L T P C**

**0 0 4 2**

1. Study of data analysis using MS-Excel
2. Study of basic Syntaxes in PYTHON
3. Implementation of vector data objects operations
4. Implementation of matrix, array and factors and perform in PYTHON
5. Implementation and use of data frames in PYTHON
6. Create Sample (Dummy) Data in PYTHON and perform data manipulation with PYTHON
7. Study and implementation of various control structures in PYTHON
8. Data Manipulation with PYTHON
9. Study and implementation of Data Visualization with PYTHON
10. Study and implementation data transpose operations in PYTHON

**II SEMESTER**

**HIAT6506:**

**CLINICAL INFORMATICS**

**L T P C**

**4 0 0 4**

**COURSE DESCRIPTION**

The course provides an overview of the theory, processes and applications of information systems and how they relate to health policy and management. It also provides a basic understanding of data standards and requirements, and the critical concepts and practice in mapping and interpreting health information.

**COURSE OBJECTIVES**

- ✓ To understand the role of IT in clinical management
- ✓ To familiarize with the latest developments in technology with relevance to hospitals
- ✓ To develop the mobile based applications to improve patient care
- ✓ To provide an in-depth understanding of clinical informatics principles, including the role and impact of informatics on clinical practice and healthcare delivery.
- ✓ To examine the ethical and legal considerations in clinical informatics, including patient privacy, data security, and compliance with healthcare regulations.

**UNIT - 1**

**(12 Hours)**

Clinical Informatics: Emergence of a New Profession, The Indian Health System, Clinical Informatics Policy and Regulations

**UNIT – 2**

**(12 Hours)**

Clinical Decision Making/Care Process Improvement – Clinical Decision-Making, Evidence Based Health Care, Clinical Decision Support, Clinical Workflow Analysis, Process Redesign and Quality Improvement

**UNIT - 3**

**(12 Hours)**

Health Information Systems - Information Technology Systems, Health Information Systems and Applications, Healthcare Data Standards and Exchange, Information System Lifecycles in Health Care, Human Factors Engineering and Human–Computer Interaction: Supporting User Performance and Experience

**UNIT – 4**

**(12 Hours)**

Leading and Managing Change - Leadership Models, Processes, and Practices, Effective Interdisciplinary Teams, Project Management, Strategic and Financial Planning for Clinical Information Systems, Change Management for the Successful Adoption of Clinical Information Systems

**UNIT – 5**

**(12 Hours)**

Beyond Clinical Informatics - Consumer Health Informatics: Engaging and Empowering Patients and Families, Public Health Informatics

**COURSE OUTCOMES –**

Upon successful completion of the course student would be –

- ✓ Able to Know about Clinical Informatics and mobile Apps related to healthcare
- ✓ Able to Understand the Fundamentals of Clinical Informatics
- ✓ Able to solve problems as teams for implementing change in a clinical environment
- ✓ Able to Understand and solve problems in the implementation of Hospital Information Systems (HIS)
- ✓ Able to Explore the different types of clinical decision support methodologies and applications.

### **Text Books**

1. Clinical Informatics Study Guide Text and Review, by John T. Finnell and Brian E. Dixon, Springer International Publishing AG Switzerland, ISBN 978-3-319-22753-5
2. Managing Health Care Information Systems, Karen Wager, Frances Lee and John Glaser, Jossy-bass, 2005

### **Reference Text Books**

1. Analysis, Design and Implementation of Information System, Locus, McGraw-Hill, 1985
2. Clinical Decision Support Systems - Theory and Practice, Second Edition, Eta S. Berner, Springer International Publishing AG Switzerland, ISBN-13: 978-0387-33914-6
3. Ramona Nelson and Nancy Staggers. "Health Informatics: An Interprofessional Approach."2nd Edition.

**HIAT6507:**

**CLINICAL DECISION SUPPORT SYSTEMS**

**L T P C**

**4 0 0 4**

**COURSE DESCRIPTION**

This course is designed to provide knowledge in clinical decision support systems for students and it is a comprehensive course which applies computers in medicine.

**COURSE OBJECTIVES**

- To verbalize a clear definition and purpose of Clinical Decision Support Systems (CDSS) tools
- To explore various CDSS tools and recognize application in nursing examples
- To describe how CDSS tools impact quality care and patient safety
- To demonstrate CDSS use through simulation/role play scenario

**UNIT - 1**

**(12 Hours)**

Overview of Clinical Decision Support Systems, Mathematical Foundations of Decision Support Systems

**UNIT - 2**

**(12 Hours)**

Data Mining and Clinical Decision Support Systems, Design and Implementation Issues, Diagnostic Decision Support Systems, Ethical and Legal Issues in Decision Support

**UNIT - 3**

**(12 Hours)**

Clinical Trials of Information Interventions, Clinical Decision Support at Intermountain Healthcare, Case Study - Clinical Decision Support Within the Regenstrief Medical Record System

**UNIT - 4**

**(12 Hours)**

Decision Support During Inpatient Care Provider Order, Entry: The Vanderbilt Experience, Decision Support for Patients

**UNIT – 5**

**(12 Hours)**

Clinical Decision Support Systems Mobile Apps, Optimizing Care Processes with Operational Excellence & Process Mining, Value-Based Health Care Supported by Data Science

**COURSE OUTCOMES –**

**Upon successful completion of the course student would be –**

- ✓ Able to develop a detailed understanding of the history of Knowledge-based systems and clinical decision support and how it's currently implemented at Apollo Hospitals and at other institutions.
- ✓ Able to Become familiar with evidence-based medicine and the use of clinical guidelines and quality of care metrics to support provider decision-making
- ✓ Able to Understand the use and importance of controlled vocabularies in building clinical decision support tools

- ✓ Able to Demonstrate design and usability principles as it relates to the use of clinical decision support tools
- ✓ Able to Employ classical and machine learning models in clinical decision support systems

### **Text Books**

1. Clinical Decision Support Systems: Theory and Practice, Eta S Berner, Springer, 1998
2. Clinical Decision Support System: An Effective Pathway to Reduce Medical Errors and Improve Patient Safety, Chiang S. Jao and Daniel B. Hier, InTech, 2010

### **Reference Text Books**

1. Decision Support System, by Herasymowych, ISBN13: 978-0980881523, 2nd Edition
2. Decision Support Systems for Business Intelligence, by Vicki Lynn Sauter, ISBN13: 978-0470433744, 2nd Edition
3. Foundations of Clinical Research: Applications to Evidence-Based Practice, by Leslie G. Portney, ISBN13: 978-0803661134, 4th Edition

# HIAT6508: ARTIFICIAL INTELLIGENCE AND CLOUD COMPUTING FOR HEALTH INFORMATICS

L T P C  
4 0 0 4

## Course Description:

- ✓ This course will introduce students to the concepts of Artificial Intelligence (AI) and Cloud Computing in the field of Health Informatics. The course will cover the basics of machine learning, natural language processing, and computer vision as applied to healthcare.
- ✓ Students will also learn about cloud computing, including cloud architecture, deployment models, and services such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). The course will focus on the applications of AI and Cloud Computing in healthcare, such as predictive modelling, clinical decision support, population health management, and data analytics.

## Course Objectives:

- Understand the fundamental concepts of Artificial Intelligence and Cloud Computing in healthcare
- Apply AI and Cloud Computing techniques to healthcare data to solve real-world problems
- Evaluate the benefits and risks of using AI and Cloud Computing in healthcare
- Develop skills in data analysis, machine learning, and cloud deployment
- Analyse the ethical and legal implications of AI and Cloud Computing in healthcare

## Course Outline:

### Unit 1: Introduction to AI and Cloud Computing in Healthcare **07 Hours**

Overview of Health Informatics, Introduction to Artificial Intelligence and Cloud Computing, Healthcare data and challenges, Introduction to language models

### Unit 2: Cloud Computing for Health Informatics and Big Data Analytics. **15 Hours**

Cloud architecture and deployment models, Cloud services: IaaS, PaaS, and SaaS, Cloud security and compliance, Data warehousing and data mining, Predictive modelling and decision support, Population health management

### Unit 3: Machine Learning and Natural Language Processing for Health Informatics

**15 Hours**

Supervised and unsupervised learning, Data pre-processing and feature extraction, Model evaluation and selection, Natural language processing (NLP) for machine learning in healthcare, Text classification and sentiment analysis, Named Entity Recognition (NER), Applications of language models in healthcare

### Unit 4: Computer Vision for Health Informatics

**15 Hours**

Image processing and feature extraction, Object detection and recognition, Medical imaging analysis

**Unit 5: AI and Cloud Computing Applications in Healthcare and Ethical and Legal Issues**  
**8 Hours**

Clinical decision support systems, Electronic Health Records (EHR) and telemedicine, Precision medicine and genomics, Privacy, security, and confidentiality, Bias and fairness, Regulatory and compliance issues

**COURSE OUTCOMES –**

**Upon successful completion of the course student would be able to –**

- Demonstrate the ability to apply artificial intelligence (AI) techniques and tools in health informatics to improve diagnostic accuracy, patient outcomes, and operational efficiency.
- Utilize cloud computing services and architectures to manage, store, and analyze large volumes of healthcare data, ensuring scalability and accessibility.
- Implement robust data security and privacy measures within AI and cloud computing frameworks to comply with healthcare regulations and protect patient information.
- Develop and deploy machine learning models to analyze healthcare data, identify patterns, and predict health outcomes, enhancing decision-making in clinical practice.
- Understand and address the ethical and legal implications of using AI and cloud computing in health informatics, ensuring responsible and compliant use of these technologies.

**Text book:**

1. Adam Cheyer and Emily A. Cooper, "AI for Healthcare: A Navigational Guide for Beginners," O'Reilly Media, 2019.
2. Eric Topol, "Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again," Basic Books, 2019.

**Reference Text Books:**

- Joseph Kvedar, "The Internet of Healthy Things," The MIT Press, 2015.
- Ozlem Uzuner and Rebecca S. Crowley, "Natural Language Processing for Clinical Data: A Guide to Systems and Applications," Springer, 2019.

**HIAT6509: HEALTHCARE DATA VISUALIZATION AND ANALYSIS L T P C**  
**4 0 0 4**

**COURSE DESCRIPTION**

This course will provide a rigorous, yet easy to follow, introduction to the main concepts underlying machine learning in healthcare and quantification of the resources needed to learn a given concept.

**COURSE OBJECTIVES**

- How to tell a story from data
- How to marshal the data for storyline
- The ability to develop visualization to tell the story
- The focus is on analysis of data using visualization as a tool
- To demonstrate the data visualization models

**UNIT – 1**

**(12 Hours)**

Introduction to Data Sciences: Concepts of business intelligence and business analytics, Simple data retrieval vs data processing, Role of data scientists vs data analysts, Hidden facts in data, unearthing the facts, Evolution of data science, popular techniques & algorithms, Concepts of predictive and prescriptive analytics, Concepts of data clusters, data distribution, time series data, text processing

**UNIT – 2**

**(12 Hours)**

Python for Data Visualization Introduction, Matplotlib, Matplotlib Functional Method, Matplotlib Object-Oriented Method, Resolution and Saving Figures, Legend, Customization of the Plot Appearance, Scatterplot, Histogram Boxplot, Seaborn, Distribution Plots, Joint Plots, Pairplot, Barplot, Boxplot, Violin Plot, Heatmaps, Cluster Maps, Regression Plot, Plotly – Interactive Data Visualization Geographical Plotting

**UNIT – 3**

**(12 Hours)**

Principal Component Analysis, Introduction, Variance as Information, Data Transformation, Case Study, PCA: Step-by-Step, Standardization of the Features, Obtain the Eigenvectors and Eigenvalues, Choosing Axes with Maximum Variance, Programming Drive, Hands-On Exercises on Differential Gene Expression Analysis, Quality Control, Normalization, Differential Expression Analysis, Cluster Map, Gene Enrichment Analysis, SNP Analysis,

**UNIT – 4**

**(12 Hours)**

Machine Learning and Linear Regression, Introduction to Machine Learning and Its Applications in Biology, Types of Machine Learning Systems Optimization of Models, Challenges in Machine Learning Projects, Linear Regression, General Workflow of a Machine Learning Project, Implementation of Linear Regression Using Scikit-Learn Loading Dataset, Train-Test Split, Training Model, Model Evaluation, Predicting Child Height Based on Parents Height, Predicting the Height of Sons, Predicting the Height of Daughters

**UNIT – 5**

**(12 Hours)**

Logistic Regression, Introduction Implementation of Logistic Regression Using Sklearn, Train-Test Split, Training the Logistic Regression Model, Evaluation of Model, Retrieving Intercept and Coefficient, Data Scaling, Predicting a New Result, Breast Cancer Prediction Using Logistic Regression, Model Evaluation

### **COURSE OUTCOMES –**

Upon successful completion of the course student would be –

- ✓ Able to Discuss the difference between descriptive, predictive and prescriptive analytics
- ✓ Able to Outline the characteristics of “Big Data”
- ✓ Able to Enumerate the necessary skills for a worker in the data analytics field
- ✓ Able to List several limitations of healthcare data analytics
- ✓ Able to learn about the application of visualization tools for health data

### **Text Books**

1. Data Analytics in Healthcare Research - With Access, by David Marc, ISBN13: 978-1584264439
2. Healthcare Data Analytics, edited by Chandan K. Reddy, Charu C. Aggarwal, CRC Press, first edition

### **Reference Text Books**

1. Healthcare Data Analytics and Management, edited by Nilanjan Dey, Amira S. Ashour, Simon James Fong, Chintan Bhatt, Academic Press, Vol. 2
2. Python for data science for dummies by John Paul Mueller, Luca Massaron, Wiley Publishers
3. Programming through Python by M. T. Savaliya, R. K. Maurya, G. M. Magar, STAREDU Solutions

## **HIAT1510: LEGAL AND ETHICAL ASPECTS OF HEALTH INFORMATICS**

**L T P C**  
**3 1 0 4**

### **COURSE DESCRIPTION**

This course introduces students to the workings of the Global legal system and concepts and theories of ethics, examines the legal, ethical, and regulatory issues that impact the protection of confidentiality and integrity of patient information, and, on the other hand, the improvement of accessibility of patient information to enable healthcare providers to make informed decision based on complete patient data.

### **COURSE OBJECTIVES**

- To Identify a complete health record according to organizational policies, external regulations and standards.
- To Apply system security policies according to departmental and organizational data/information standards.
- To Apply policies and procedures surrounding issues of access and disclosure of protected health information.
- To examine the processes for ensuring compliance with legal and ethical standards in health informatics, including risk assessment and management strategies.
- To utilize case studies and real-world scenarios to illustrate the legal and ethical challenges in health informatics and develop practical solutions

### **UNIT – 1 ETHICS IN BIOMEDICAL AND HEALTH INFORMATICS: USERS, STANDARDS, AND OUTCOMES**

**(12 Hours)**

Ethical Issues in Biomedical and Health Informatics, Health-Informatics Applications: Appropriate Use, Users, and Contexts, Privacy, Confidentiality, and Data Sharing, Social Challenges and Ethical Obligations, Legal and Regulatory Matters

### **UNIT – 2 AN OVERVIEW OF ETHICS**

**(12 Hours)**

Ethical Standards, Ethical Decisions and Challenges, Bioethics Issues

### **UNIT - 3 LEGAL AND ETHICAL ISSUES CENTRAL TO HEALTH INFORMATION MANAGEMENT**

**(12 Hours)**

Patient Record Requirements, Confidentiality and Informed Consent, Access to Health Information, Specialized Patient Records

### **UNIT – 4 SPECIALIZED AREAS OF CONCERN IN HEALTH INFORMATION MANAGEMENT**

**(12 Hours)**

Risk Management, Quality Management, and Utilization Management, Information Systems, Health Care Fraud and Abuse, Law and Ethics in the Workplace

**UNIT – 5****(12 Hours)**

Professional ethics for Public health practitioners: Developing empathy, resolving conflicts and building consensus, conflict of interest, issues of integrity, transparency and accountability, communication skills, etc

**COURSE OUTCOMES –**

Upon successful completion of the course student would be able to –

- Demonstrate a comprehensive understanding of the key legal frameworks and regulations that impact health informatics and how they apply to various scenarios.
- Apply ethical principles and theories to make informed and responsible decisions in health informatics, balancing patient rights and public health needs.
- Implement effective data security and privacy measures to protect patient information and comply with legal requirements.
- Identify and manage compliance issues in health informatics, conducting risk assessments and developing mitigation strategies to address potential violations.
- Analyze case studies and practical examples to understand the legal and ethical challenges in health informatics, and propose viable solutions to address these challenges.

**Text Books**

1. Legal and Ethical Aspects of Health Information, by Dana C. Mcway, ISBN13: 978-1285867380, 4th Edition
2. Ethical Health Informatics, by Laurinda Beebe Harman, ISBN13: 978-1284053708, 3rd Edition

**Reference Text Books**

1. Legal and Ethical Aspects of Health Information Management, by Dana C. McWay, ISBN13: 978-0357361542, 5th Edition
2. Fundamentals of Law for Health Informatics and Information Management, Brodnik, McCain, Rinehart-Thompson, and Reynolds, American Health Information Management Association, 2009.
3. Health Information Management Technology: An Applied Approach, ed. by Merida L. Johns, PhD, RHIA, American Health Information Management Association, current edition.

**List of experiments**

1. Write a Python code to calculate the statistical values, such as mean, median, standard deviation, skewness, and kurtosis of a Health care Data Set.
2. Write a Python code to extract the ECG signal features utilizing continuous wavelet transform (CWT).
3. Write a Python code to extract the EEG signal features utilizing discrete wavelet transform (DWT) with 6-level decomposition
4. Write a Python code to extract the ECG signal features utilizing stationary wavelet transform (SWT) with 5-level decomposition
5. Write a program to implement the naïve Bayesian classifier for a sample patient data set stored as a .CSV file.
6. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. Use Java/Python ML library classes/API.
7. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of CKD patients using standard Renal Disease Data Set. Use Java/Python ML library classes/API.
8. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of Malignant Cancer patients using standard Breast Cancer Data Set. Use Java/Python ML library classes/API.
9. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of Diabetes patients using standard Medical Data Set. Use Java/Python ML library classes/API.
10. Write a program to plot a dendrogram of amino acid sequence of human genes. Use divisive clustering in Java/Python ML library classes/API

**List of experiments**

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
4. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
5. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets
6. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
7. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.
8. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
9. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
10. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.
11. Find procedure to run the virtual machine of different configuration. Check how many virtual machines can be utilized at particular time.
12. Find procedure to attach virtual block to the virtual machine and check whether it holds the data even after the release of the virtual machine.
13. Install a C compiler in the virtual machine and execute a sample program.

14. Show the virtual machine migration based on the certain condition from one node to the other.
15. Find procedure to install storage controller and interact with it.
16. Find procedure to set up the one node Hadoop cluster.
17. Mount the one node Hadoop cluster using FUSE.
18. Write a program to use the API's of Hadoop to interact with it.

## **Mini Project**

### **Guidelines**

1. Mini Project may be a theoretical analysis, modelling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
3. Can be individual work or a group project, with a maximum of 3 students.
4. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
5. Carried out inside or outside the university, in any relevant industry or research institution.
6. Publications in the peer reviewed journals / International Conferences will be an added advantage

**III SEMESTER**

**Course Description**

Research Methodology is a course designed to provide students with a comprehensive understanding of the methods and techniques used in scientific research, including qualitative and quantitative approaches. The course covers the entire research process, from formulating research questions and hypotheses to data collection, analysis, and reporting of findings.

**COURSE OBJECTIVES**

1. To understand different definitions in research and research ethics.
2. To Learn how to apply basic research skills in selecting research topic, identifying “keywords”, and designing project aim, objectives, and hypothesis.
3. To understand and plan the proper search and referencing tools that includes scientific databases, open access and other source (papers/proceedings journals, published data/secondary data, thesis/dissertation, poster, abstract, reviewed/refereed articles.
4. To Understand how to Interpret the understanding of scientific research key components by applying it into a small project.
5. To demonstrate various research designs used in health information management

**Unit I Introduction to research**

What is research, Types of research, why do we conduct research, How to turn a project into a business, Ethics in science including plagiarism and animal/ human testing and anonymity.

**Unit II Formulating research problem**

The importance of research problem formulation, your title: What does it reflect, How to define the objectives of your research, Constructing hypothesis, collecting data using primary sources, collecting data using secondary sources

**Unit III Writing a scientific report.**

Structure and components of a scientific report, Introduction, and literature review, what is a research introduction, Developing an outline , Reviewing the literature, How to invest the different resources available for students including textbooks, Google scholar and library, Selecting Methods for data collection, Differences in the methods of data collection in quantitative and qualitative research. Major approaches to information gathering

#### **Unit IV Sample selection**

The differences between sampling in quantitative and qualitative research, Sampling in quantitative research, Sampling in qualitative research, Processing and displaying data Processing data in quantitative and qualitative studies (editing and coding), The role of statistics in Research, Displaying analysed data (text, tables, and graphs)

#### **Unit V Discussion**

Summation of the results, Comparison of data with the existing data, combining of data with the existing data Finding Empirical rules, linking results to the results of others, Conclusion and abstract, Summary of the study, summarizing findings in relation to the literature Surprises: Limitations and unexpected results, Implications of the study, Recommendations for further work, Concluding remarks, Abstract

#### **COURSE OUTCOMES –**

Upon successful completion of the course student would be able to –

- Demonstrate the ability to design a research study, including the formulation of research questions, hypotheses, and selection of appropriate methodologies.
- Apply various data collection techniques, both qualitative and quantitative, ensuring the reliability and validity of the gathered data.
- Analyze and interpret data using suitable statistical and analytical tools, drawing meaningful conclusions from the results.
- Critically evaluate existing research literature, identifying strengths, weaknesses, and gaps in the current knowledge base.
- Effectively communicate research findings through well-structured reports and presentations, adhering to academic and professional standards.

#### **Textbooks/Reference material**

1. Kumar, R., 2011. Research methodology: A step-by-step guide for beginners. Sage.
2. Bryman, A., 2012. Social research methods. Oxford university press.
3. Katz, M., 2009. From research to manuscript. New York: Springer.
4. Roberts, C. and Hyatt, L., n.d. The dissertation journey.

**Course Description**

Machine Learning for Health Data Science is a course designed to equip students with the skills and knowledge necessary to apply machine learning techniques to health data for improved healthcare outcomes. The course covers data preprocessing, model development, evaluation, and practical applications, focusing on real-world health data challenges and ethical considerations.

**COURSE OBJECTIVES**

- ✓ Ability to Work with Healthcare Data: Students should be able to collect, preprocess, and manage healthcare data effectively, addressing issues like missing data and data quality.
- ✓ Machine Learning Skills: Students should be proficient in applying a range of machine learning algorithms to healthcare datasets, with the ability to select appropriate models based on the problem.
- ✓ Ethical and Legal Awareness: Understand the ethical and legal considerations in healthcare data science, and be capable of designing systems that respect patient privacy and comply with regulations.
- ✓ Provide a foundational understanding of machine learning concepts, algorithms, and their applications in health data science.
- ✓ Teach techniques for preprocessing health data and engineering relevant features to improve the performance of machine learning models.

**UNIT I - Fundamentals of Machine Learning****(10 Hours)**

Basics of supervised, unsupervised, and semi-supervised learning. Data preprocessing and feature engineering for health data. Model evaluation metrics for health-related tasks.

**UNIT II - Classical Machine Learning for Health Data****(16 Hours)**

Regression and Classification - Linear regression, logistic regression, and their applications in health data analysis, Model regularisation and feature selection, Modal outcome prediction using regression and classification models, Clustering and Dimensionality Reduction, K-means, hierarchical clustering, and their applications in patient grouping, Principal Component Analysis (PCA) for dimensionality reduction, Exploratory analysis of high-dimensional omics data, Time Series Analysis and Anomaly Detection, Time series forecasting for disease

progression and patient monitoring, Anomaly detection in health data, e.g., detecting irregular patterns in EHR, Case studies on real health data applications.

### **UNIT III: Deep Learning for Health Data (16 Hours)**

Introduction to Deep Learning, Basics of neural networks, activation functions, and architecture types, Training neural networks using gradient descent and back-propagation, Neural network libraries (TensorFlow, PyTorch) for health data applications, Convolutional Neural Networks (CNNs) for Medical Imaging, CNN architecture and its applications in medical image analysis, Image segmentation and classification in radiology and pathology, Transfer learning using pre-trained CNN models, Recurrent Neural Networks (RNNs) for Time Series Data Sequence modelling using RNNs and LSTM networks, Applications in physiological signal analysis and time series forecasting, Challenges in handling irregular and missing time series data.

### **UNIT IV - Generative AI for Health Data (10 Hours)**

Generative Adversarial Networks (GANs) and Variational Auto-encoders (VAEs) GANs for synthetic health data generation and augmentation, VAEs for unsupervised representation learning from health data, Ethical considerations in using generated data for healthcare applications.

### **UNIT V - Capstone project (8 Hours)**

#### **COURSE OUTCOMES**

1. Predictive Modeling: Develop models for healthcare tasks and be able to assess their performance using appropriate metrics.
2. Deep Learning Proficiency: Gain skills in applying deep learning techniques, particularly in the context of medical imaging, natural language processing, and genomics.
3. Interpretability and Explainability: Learn methods to make machine learning models interpretable and explainable, which is essential for gaining trust in clinical settings.
4. Application Development: Create applications and tools that can assist healthcare professionals in decision-making, diagnosis, and treatment planning.
5. Research and Innovation: Be prepared to engage in research in the field of healthcare data science and contribute to advancements in healthcare technology.

**Text books**

1. Machine Learning in Healthcare by Daniel Mietchen and Martin Hofmann-Apitius
2. Healthcare Analytics for Quality and Performance Improvement by Trevor L. Strome
3. Machine Learning for Healthcare: Handling and Managing Medical Data by Antonio Beneti and Adam Wojtuniak

**Reference Books**

1. Pattern Recognition and Machine Learning by Christopher M. Bishop
2. Deep Learning in Medical Image Analysis by Gustavo Carneiro, Bogdan Georgescu, and João Manuel R. S. Tavares

**Course Description**

Advanced Statistics for Health Data Science is a course focused on equipping students with advanced statistical methods and techniques to analyze and interpret complex health data. The course covers topics such as multivariate analysis, longitudinal data analysis, and statistical modeling, emphasizing their applications in health research and data-driven decision-making.

**COURSE OBJECTIVES**

- 1.To Master the Advanced Statistical Techniques used in healthcare setups
- 2.To demonstrate a comprehensive understanding of advanced statistical techniques such as hierarchical models, survival analysis, multilevel modeling, structural equation modeling, and Bayesian statistics.
- 3.To Apply advanced statistical methods to various types of healthcare data, including electronic health records, clinical trials, epidemiological data, and health surveys.
4. To Introduce advanced statistical methods for analyzing relationships among multiple variables simultaneously, crucial for understanding complex interactions in health data.
5. To Teach techniques to analyze data collected over time, enabling students to explore temporal trends and dynamics in health-related phenomena.

**UNIT I - Introduction to Statistics****(12 Hours)**

What is statistics and its importance in data science, Types of data: categorical, numerical, continuous, discrete, Descriptive vs. inferential statistics, Measures of central tendency: mean, median, mode, Measures of dispersion: range, variance, standard deviation, Exploratory Data, Analysis (EDA) and data visualisation using Python libraries

**UNIT II - Probability and Distributions****(12 Hours)**

Basics of probability theory: events, outcomes, sample space, Probability rules: addition, multiplication, conditional probability, Probability distributions: discrete (binomial, Poisson) and continuous (normal, exponential), Exploring data distributions, relationships, and outlier, Central Limit Theorem and its implications, Using Python libraries for probability calculations

**UNIT III - Statistical Inference****(16 Hours)**

Sampling methods: random sampling, stratified sampling, sampling distribution, Point estimates and interval estimates, Hypothesis testing: null and alternative hypotheses, p-values, significance level, One-sample and two-sample t-tests, Chi-squared tests for categorical data, ANOVA (Analysis of Variance) and its applications

#### **UNIT IV - Regression and Correlation**

**(10 Hours)**

Simple linear regression: model, assumptions, interpretation, Multiple linear regression: model building, multicollinearity, interaction terms, Logistic regression for binary classification, Non-linear regression models, Correlation and causation: Pearson correlation, Spearman rank correlation

#### **UNIT V - Advanced Topics in Statistics**

**(10 Hours)**

Time series analysis: components, forecasting, decomposition, Bayesian statistics: Bayes' theorem, posterior distribution, Bayesian inference, Non-parametric methods: Wilcoxon rank-sum test, Kruskal-Wallis test, Introduction to machine learning: supervised vs. unsupervised learning, bias-variance trade-off

#### **COURSE OUTCOMES**

1. Able to develop expertise in research design, including experimental design, observational studies, and clinical trials. Understand the advantages and limitations of different study designs in healthcare research.
2. Able to handle complex and messy healthcare data, including missing data, longitudinal data, and multi-source data integration.
3. Able to Apply multivariate statistical techniques for modeling and analyzing complex healthcare data, including regression analysis, multilevel models, and mixed-effects models.
4. Able to use SEM to model complex relationships in healthcare data, such as causal pathways and latent variables.
5. Able to Apply Bayesian statistical methods to healthcare data, including Bayesian regression, hierarchical Bayesian modeling, and Bayesian network analysis.

#### **Text Books**

1. Applied Longitudinal Data Analysis for Epidemiology: A Practical Guide by Jos W. R. Twisk
2. Bayesian Data Analysis by Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, and Donald B. Rubin
3. Survival Analysis: Techniques for Censored and Truncated Data by John P. Klein and Melvin L. Moeschberger

#### **Reference Books**

1. Multilevel and Longitudinal Modeling Using Stata by Sophia Rabe-Hesketh and Anders Skrondal
2. Structural Equation Modeling: A Second Course by Gregory R. Hancock and Ralph O. Mueller

**Course Description**

Pharmacoinformatics explores the intersection of pharmacology and informatics, focusing on the computational methods used to study drug design, development, and optimization. This course delves into the application of bioinformatics, cheminformatics, and computational modeling techniques to understand drug interactions, mechanisms of action, and pharmacokinetics, aiming to enhance drug discovery processes and therapeutic outcomes.

**COURSE OBJECTIVES**

1. To Gain an understanding of the drug discovery and development process, including target identification, lead compound discovery, preclinical testing, and clinical trials.
2. To Learn the basics of computational chemistry, including molecular modeling, quantum mechanics, molecular dynamics simulations, and cheminformatics techniques.
3. To Provide an overview of the principles and processes involved in drug discovery and development using computational methods.
4. To Teach the use of cheminformatics tools and molecular modeling techniques to predict and analyze drug-receptor interactions.
5. To Explore how pharmacogenomics and personalized medicine can be integrated with informatics to optimize drug therapies based on individual genetic profiles.

**Unit I**

DNA and Protein Sequence databases, Sequence alignment using dynamic programming – Needleman-Wunsch algorithm for global alignment, Smith-Waterman algorithm for local alignment, Substitution score matrices (PAM, BLOSUM), Multiple sequence alignment – methods of multiple sequence alignment, multidimensional dynamic programming

**Unit II**

Molecular phylogenetics: introduction to binary trees. Phylogenetic tree construction using weighted parsimony and Neighbor-joining, Probabilistic models of evolution – Jukes cantor model and Kimura model. Prediction of RNA secondary structure: Nussinov folding algorithm, energy minimization and Zuker folding algorithm, covariance models.

**Unit III**

Prediction of secondary structure from protein sequence – Chou-Fasman rules, Prediction of transmembrane helices. Prediction of protein conformation from protein sequence. Information theoretical methods: Homology and threading. Basic Concepts of prediction using Force fields - Energy minimization, molecular dynamics and simulated annealing

**Unit IV**

Chemoinformatics: Pharmacology databases, structure databases, Molecular descriptors. Molecular similarity. 2D substructure searching. 3D database searching. Pharmacophore keys.

Introduction to database filters, Lipinski Rule of Five, In silico ADMET; QSAR approach, Knowledge - based approach.

### **Unit V**

Principles of ligand-based drug design: SAR, QSAR and 3D-QSAR. Receptor based drug design: Principles of receptor based de novo ligand design. Rigid body molecular Docking. Case study: Structure based design of non-peptide inhibitors specific for HIV1 protease.

### **COURSE OUTCOMES**

1. Able to Develop skills in chemical information retrieval, including the use of chemical databases, literature searches, and data mining for chemical and biological data.
2. Able to use computational tools to design new drugs, perform virtual screening, and predict the binding affinity of molecules to biological targets.
3. Able to apply skills in data analysis and statistical methods as applied to pharmaceutical and biological data, including high-throughput screening data and clinical trial results.
4. Able to Understand the role of genetics and genomics in drug response and the concept of personalized medicine.
5. Able to explain the role of computational techniques in Drug Designing

### **Text Book**

1. Durbin, Eddy, Krogh and Mitchison Biological sequence analysis. Cambridge University Press, 2003.
2. AR Leach and VJ Gillet. An introduction to chemoinformatics. Springer. 2007.

### **Reference text books**

1. M.Rowland and T.N. Tozer Clinical Pharmacokinetics: Concepts and Applications, 3/e, Lea and Febiger publications, 1995.
2. Andrew R. Leach, Molecular modeling, Principles and applications, 2/e, Prentice Hall 2007.

## **HIAP7501 Mini Project**

### **Guidelines**

1. Mini Project may be a theoretical analysis, modelling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
3. Can be individual work or a group project, with a maximum of 3 students.
4. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
5. Carried out inside or outside the university, in any relevant industry or research institution.
6. Publications in the peer reviewed journals / International Conferences will be an added advantage

**For 2022-23 Batch**

**Elective: INTERNET OF MEDICAL THINGS**

**L T P C**

**3 0 0 3**

**Course Description**

The course on Internet of Medical Things (IoMT) explores the integration of connected medical devices and technologies within healthcare systems, focusing on their applications in patient monitoring, diagnostics, and treatment. It covers the design, implementation, and management of IoMT systems, emphasizing their impact on healthcare delivery, patient outcomes, and data security. Students will learn about the interoperability of IoMT devices, regulatory requirements, and ethical considerations in deploying these technologies to enhance medical care and efficiency.

**COURSE OBJECTIVES**

1. To Execute formal training in areas of technology applied to healthcare including computer sciences and IoT technologies to facilitate the deployment of telemedicine.
2. To Understand the basic requirements for the delivery of IoMT services.
3. To Provide an overview of Internet of Medical Things, including its components, technologies, and applications in healthcare.
4. To Explore the design principles and architectures of IoMT systems, focusing on connectivity, data collection, and device interoperability.
5. To Address the challenges and strategies for ensuring data security, patient privacy, and regulatory compliance in IoMT deployments.

**Unit - 1**

Introduction - .Why IoT? , Benefits and impact of IoMT , Classification of IoT Protocols Used in Medical Devices, Security in IoMT Communication Protocols, Secure IoMT Communications: Threat Landscape and Protocol Comparison, Challenges and Open Issues

**Unit - 2**

IoT Based Healthcare Delivery Services to Promote Transparency and Patient Satisfaction in a Corporate Hospital, IoMT Applications, Chronic disease management, Remote assisted living (Tele health), Wellness and preventive care (Lifestyle assessment),. Remote intervention . Improved drug management

**Unit – 3**

Technologies Enduing IoMT Implementation,. Local systems and control layer, Device connectivity and data layer. Analytic solutions layer, Cancer Prediction and Diagnosis Hinged on HCML in IO MT Environment

**Unit – 4**

Market Landscape, Market overview, Key players and current trends in value chain, Local patient systems and control, Device connectivity and data layer, Analytic and solutions layer

### **Unit – 5**

Intellectual Property Perspective. Intellectual Property overview Key players. Milestone innovations

### **Course Outcomes**

Upon successful completion of the course student would be –

- ✓ Able to Understand the technology and standards relating to IoMTs
- ✓ Able to Understand the concepts of the Internet of Medical Things
- ✓ Able to Design IoMT applications in Healthcare domain
- ✓ Able to Analyze basic protocols in wireless sensor network
- ✓ Able to Understand the basic requirements for the delivery of IoMT services.

### **Text Books**

1. Internet of Medical Things: Remote Healthcare Systems and Applications, Hemanth, D. Jude, Anitha, J., Tsihrintzis, George A. (Eds.), Springer 2021
2. Machine Learning and the Internet of Medical Things in Healthcare 1st Edition, Krishna Singh Mohamed Elhoseny Akansha Singh Ahmed Elnga, Elsevier 2021

**Course Description**

Imaging Informatics is a course that focuses on the application of information technology in medical imaging, aiming to enhance the acquisition, management, analysis, and interpretation of medical images. This course covers the principles of imaging modalities, such as X-ray, MRI, CT, and ultrasound, and explores how digital imaging technologies and informatics systems are integrated to improve diagnostic accuracy, treatment planning, and patient care. Students will learn about image processing techniques, picture archiving and communication systems (PACS), and the role of standards and interoperability in imaging informatics, preparing them to navigate the complex landscape of medical imaging technology within healthcare settings.

**COURSE OBJECTIVES**

1. To identify recent advancements in the field of imaging informatics
2. To discuss the Machine Intelligence progress made in medical imaging
3. To describe the interoperability standards in medical imaging
4. To outline specific advancements to measure value in imaging
5. To explain the specific models for imaging analytics

**Unit - 1**

Introduction, Feature Selection and Extraction, Subband Coding and Wavelet Transform The Wavelet Transform in Medical Imaging

**Unit - 2**

Genetic Algorithms, Statistical and Syntactic Pattern Recognition, Foundations of Neural Networks, Transformation and Signal-Separation Neural Networks, Neuro-Fuzzy Classification, Specialized Neural Networks Relevant to Bioimaging, Spatio-Temporal Models in Functional and Perfusion Imaging

**Unit - 3**

Analysis of Dynamic Susceptibility Contrast MRI Time-Series Based on Unsupervised Clustering Methods, Computer-Aided Diagnosis for Diagnostically Challenging Breast Lesions in DCE-MRI

**Unit - 4**

Introduction to Machine Learning for Pattern recognition, Probability Distributions, Linear Models for Regression, Linear Models for Classification

**Unit - 5**

Neural Networks, Kernel methods, Sparse Kernel Machines, Graphical methods, Mixture models, Sequential Data, Sampling methods and Combining models

### **Learning Outcomes**

Upon successful completion of the course student would be –

- ✓ Able to study how information about medical images is exchanged within radiology and throughout the medical enterprise.
- ✓ Able to use picture archiving and communication systems (PACS) effectively.
- ✓ Able to serve the physician better with software knowledge that is designed to meet specific workflow needs.
- ✓ Able to explain the picture archiving and communication systems
- ✓ Able to analyse the picture archiving and communication systems

### **Text Books**

1. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer 2011
2. Pattern Recognition in Medical Imaging, Anke Meyer-Bäse, Elsevier, 2004

**Course Description**

Data Management in Healthcare Analytics focuses on the principles and practices of managing healthcare data to support effective analytics and decision-making processes. This course explores the lifecycle of healthcare data, from collection and storage to integration, cleansing, and analysis. Emphasis is placed on data governance, quality assurance, and ensuring data integrity to derive actionable insights that improve patient outcomes, operational efficiency, and healthcare delivery. Students will gain hands-on experience with healthcare data management tools and techniques, preparing them to address the complexities and challenges of data management in healthcare analytics.

**COURSE OBJECTIVES**

1. To Identify challenges in using population health data sources, including issues related to big data, interoperability, and population segmentation.
2. To Describe the conceptual and practical challenges of developing valid and reliable population health analytic methods.
3. To Teach techniques for collecting, integrating, and aggregating healthcare data from disparate sources, ensuring completeness and accuracy.
4. To Focus on strategies for ensuring data quality, governance, and compliance with regulatory standards such as HIPAA and GDPR.
5. To Introduce database management systems (DBMS) and data warehousing concepts tailored to healthcare settings, emphasizing scalability and performance.

**Unit - 1**

Databases and Their Objectives, Terminology in the Area of Data Bases, Components of databases, File management systems versus database management systems, Related Systems

**Unit - 2**

Scientific Basis for Database Technology, The schema, The data model, Types of database models, Database Operation, Entering data into the database, Data storage, Data organization for retrieval, Data presentation, Database administration

**Unit - 3**

Use of Databases in Health Care, Health Care Settings and the Relevancy of Database Technology, Private solo practice, Group practice, Specialty practice, Hospitals, Clinical research, Non-patient databases

**Unit - 4**

Current Health Care Applications of Databases, Reimbursement databases, Disease-specific shared databases, Databases used in HMO's, Surveillance databases Specialty clinical databases General clinical databases, Databases in research

## **Unit - 5**

The Future Use of Databases in Health Care, Cost-effectiveness issues, Initiatives and innovation due to technology push, The human element, Sharing of information, Privacy in Databases, The Effect of Databases on Health Care Costs, Quality, and Access

### **LEARNING OUTCOMES**

Upon successful completion of the course student would be –

1. Able to Oversee analytical operations and communicate insights to health informaticians
2. Able to Leverage data analysis and modeling techniques to solve problems in the healthcare industry
3. Able to Utilize data and analytical models to inform specific functions and business decisions
4. Able to provide an overview of healthcare data sources, types, and challenges specific to data management in healthcare analytics
5. Able to prepare data for analytics by cleansing, transforming, and structuring it for use in statistical analysis, machine learning, and predictive modeling in healthcare contexts.

### **Text Books**

1. Databases for Health Care, Gio Wiederhold, Springer-Verlag Berlin Heidelberg 1981
2. Data Science for Healthcare Methodologies and Applications, Sergio Consoli, Springer Nature Switzerland AG 2019

**Elective: PRESCRIPTIVE, PREDICTIVE AND DIAGNOSTIC ANALYTICS IN  
HEALTHCARE**

**L T P C**  
**3 0 0 3**

**Course Description**

Prescriptive, Predictive, and Diagnostic Analytics in Healthcare is a course that delves into advanced analytics techniques aimed at improving healthcare outcomes and operational efficiency. It covers the principles and applications of prescriptive analytics for decision-making, predictive analytics for forecasting patient outcomes, and diagnostic analytics for identifying patterns and trends in healthcare data. Students will explore case studies and practical applications to understand how these analytics methods can be leveraged to optimize clinical workflows, enhance patient care, and drive evidence-based decision-making in healthcare settings.

**COURSE OBJECTIVES**

1. To Identify and discuss the developing frontiers in the predictive modeling field
2. To Describe the commonly used case identification/predictive measurement/modeling tools
3. To Discuss the inner workings of commonly used risk adjustment and predictive modeling tools
4. To Explore predictive modeling techniques to forecast patient outcomes, disease trends, and resource needs in healthcare settings.
5. To Provide an overview of prescriptive, predictive, and diagnostic analytics methods and their applications in healthcare.

**Unit - 1**

Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Multiple outputs, Subset selection , Ridge regression, Lasso regression , Linear Discriminant Analysis , Logistic regression , Perception learning algorithm.

**Unit - 2**

Model Assessment and Selection : Bias, Variance, and model complexity, Bias-variance trade off, Optimism of the training error rate ,Estimate of In-sample prediction error, Effective number of parameters, Bayesian approach and BIC, Cross- validation ,Boot strap methods, conditional or expected test error.

**Unit - 3**

Additive Models, Trees,and Boosting: Generalized additive models, Regression and classification trees , Boosting methods-exponential loss and AdaBoost, Numerical Optimization via gradient boosting, Examples (Spam data, California housing , NewZealand fish, Demographic data)

**Unit - 4**

Neural Networks(NN) , Support Vector Machines(SVM),and K-nearest Neighbor: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest –Neighbour classifiers

### **Unit - 5**

Unsupervised Learning and Random forests: Association rules, Cluster analysis, Principal Components, Random forests and analysis. Inferential Statistics and Prescriptive analytics, Assessing Performance of a classification Algorithm (t-test,McNemar's test,Paired ttest,paired F-test),Analysis of Variance, Creating data for analytics through designed experiments.

### **LEARNING OUTCOMES**

Upon successful completion of the course student would be

- ✓ To equip students to critically evaluate business situations and analyze healthcare data for decision making
- ✓ To enable students to synthesize concepts of health data mining and business intelligence
- ✓ To apply specific statistical and regression analysis methods applicable to predictive analytics in the Healthcare industry
- ✓ To Apply prescriptive, predictive, and diagnostic analytics concepts to real-world healthcare scenarios, emphasizing practical implementation and integration into clinical practice and healthcare management.
- ✓ To Explore predictive modeling techniques to forecast patient outcomes, disease trends, and resource needs in healthcare settings

### **Text Books**

1. Healthcare analytics, From Data to Knowledge to Healthcare Improvement, Hui Yang and Eva K. Lee, John Wiley & Sons, Inc. 2016
2. Healthcare Data Analytics, Edited by Chandan K. Reddy and Charu C. Aggarwal, CRC Press 2011

**Course Description**

Project Management in Health Informatics typically covers the principles, tools, and techniques used to effectively manage projects in the context of healthcare information technology.

**COURSE OBJECTIVES**

1. To Take part in system selection processes.
2. To Recommend clinical, administrative, and specialty service applications.
3. To Apply project management techniques to ensure efficient workflow and appropriate outcomes.
4. To Facilitate project management by integrating work efforts
5. To describe project management methodologies specifically within the healthcare sector

**Unit - 1**

Project Management Process, Initiation Phase, Planning Phase, Execution Phase, Control Phase, Closing Phase

**Unit - 2**

Applying the Project Management Process in Healthcare Informatics, Applying the Project Management Process in Healthcare Management

**Unit - 3**

Change Management, Understanding Change Management, Why Do We Resist Change?, Why Do We Resist Change Management, Realization Management, Sponsorship Management, Transformation Management, Training Management, Optimization Management

**Unit - 4**

Managing Project Costs, Estimating Cost, Cost Categories, Direct Costs, Variable Costs, Indirect Costs, Special Case Costs, Capital Costs, Assessing Costs, Allocating Budgeted Costs

**Unit - 5**

Project Quality Management, Project Quality Control, Project Quality Assurance, Basic Statistical Concepts Used in Quality Assessment, The Cost of Quality

**COURSE OUTCOMES**

Upon successful completion of the course student would be –

- ✓ Able to develop project charters, plans, budgets, and schedules with sponsors and stakeholders
- ✓ Able to facilitate team meetings to review progress and teamwork at milestone reviews
- ✓ Able to understand how enterprise resource planning software packages are used within the healthcare field

- ✓ Able to examine the emergence of the empowered patient consumer, changing demands, personal health records, privacy concerns
- ✓ Able to implementation of the successful project management

**Text Books**

1. Project Management for Healthcare, David Shirley, CRC Press, 2011
2. Project Management for Healthcare Information Technology, Scott Coplan and David Masuda, The McGraw-Hill Companies, Inc. 2011

**COURSE OBJECTIVES**

1. To Evaluate capital, operating and/or project budgets using basic accounting principles.
2. To Perform cost-benefit analysis for resource planning and allocation.
3. To Evaluate the stages of the procurement process.

**Unit – 1**

Financial Management – an overview, Nature, scope, functions, goals, sources of finance-an overview

**Unit – 2**

Fundamentals of valuation concepts. Time value of money, Risk & Return-trade off (Elementary idea)

**Unit – 3**

Working Capital Management including Cash Management, Receivables Management, Inventory Management

**Unit – 4**

Investment decisions Capital Budgeting- NPV, IRR, PI, ARR, Cost of Capital-overall vs. specific cost of capital

**Unit – 5**

Dividend decisions-dividend theory, dividend policy, Long term financing-issue of shares, debentures, other modes of financing

**COURSE OUTCOMES**

Upon successful completion of the course student would be –

- ✓ Able to Consolidate knowledge of and apply the technical language and practices of financial management
- ✓ Able to Undertake sophisticated financial analysis with regard to Corporate valuation, interest rate, and currency risk management and present the information in an appropriate format
- ✓ Able to Evaluate, synthesize and apply the contemporary theories and empirical evidence concerning Financial Management to a range of problems and situations

**Text Books**

1. Khan and Jain, Financial management, fourth edition, Tata Mc Graw Hill, New Delhi, 2004.
2. Pandey I.M., Cases in Financial management, Tata Mc Graw Hill, second edition, New Delhi, 20 2003.
3. William N. Zelman, Michael J. McCue, Alan R. Millikan, Alan R. Milikan, Financial Management of Health Care Organizations: An Introduction to Fundamental Tools, Concepts, and Applications, Blackwell Publishers; January 1998.

**From 2023-24 Batch**

**HIAT 7601: MEDICAL TECHNOLOGIES:**

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3 0 0 3**

### **AI in Organoids**

#### **COURSE DESCRIPTION:**

This course explores the intersection of artificial intelligence (AI) and organoids, focusing on how AI techniques can enhance research, modeling, and experimentation in the field of organoid biology. Topics include machine learning algorithms for organoid analysis, AI-driven drug discovery, and the ethical implications of AI in organoid research.

#### **COURSE OBJECTIVES:**

Understand the fundamentals of organoid biology and its significance in biomedical research.

1. Explore various applications of artificial intelligence in organoid research.
2. Gain proficiency in applying machine learning algorithms to analyze organoid data.
3. Critically evaluate the ethical considerations surrounding the use of AI in organoid experimentation.
4. Develop skills in designing AI-driven experiments for organoid research.
5. Explore the concepts of AI in Organ modeling

#### **UNIT – 1 Introduction to Organoid Biology**

Overview of organoid culture techniques, Importance of organoids in disease modeling and regenerative medicine, Fundamentals of Artificial Intelligence, Introduction to machine learning and deep learning, Supervised, unsupervised, and reinforcement learning algorithms

#### **UNIT – 2 AI Applications in Organoid Research**

AI-driven analysis of organoid morphology and structure, Predictive modeling for drug response using AI techniques

#### **UNIT – 3 Ethical Considerations in AI-driven Organoid Research**

Discussion on privacy, consent, and data security, Ethical implications of AI-generated research outcomes

#### **UNIT – 4 Advanced Topics in AI and Organoids**

Integration of multi-omics data for comprehensive analysis, AI-based optimization of organoid culture conditions

### **UNIT – 5 Project Work and Presentations**

Students work on individual or group projects applying AI techniques to organoid research, Presentation of project findings and discussions

### **COURSE OUTCOMES**

By the end of this course, students should be able to:

- Describe the principles of organoid biology and its applications.
- Apply machine learning algorithms to analyze organoid data effectively.
- Evaluate the ethical implications of using AI in organoid research.
- Design and execute experiments using AI techniques in organoid biology.
- Explore the AI mediated organoid synthesis.

### **Textbooks:**

1."Organoids: A Paradigm Shift in Developmental Biology and Medicine" by Joaquim M. Vieira and published by Springer.

2."Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, available freely online.

3."Machine Learning Yearning" by Andrew Ng, available freely online.

4."Ethics of Biomedical Artificial Intelligence" edited by John P. Sadowsky and published by Springer.

## **Telehealth Strategies**

**Course Description:** This course provides an in-depth exploration of telehealth, including its history, technologies, applications, and ethical considerations. Students will examine various telehealth modalities, their implementation, and the impact on healthcare delivery.

### **Course Objectives:**

1. Understand the concept of telehealth and its evolution in healthcare.
2. Explore different telehealth technologies and their applications.
3. Analyze the benefits and challenges of implementing telehealth services.
4. Examine regulatory and ethical issues related to telehealth.
5. Develop skills in designing and implementing telehealth solutions.

### **UNIT 1 Introduction to Telehealth**

Definition and history of telehealth, Overview of telehealth modalities: synchronous vs. asynchronous, real-time vs. store-and-forward

### **UNIT – 2 Telehealth Technologies**

Video conferencing platforms and remote monitoring devices, Wearable technology and mobile health applications

### **UNIT – 3 Applications of Telehealth**

Teleconsultation and remote diagnosis, Telemedicine in specialty care and rural health settings, Benefits and Challenges of Telehealth, Improved access to healthcare services, Privacy, security, and regulatory compliance issues

### **UNIT – 4 Ethics and Legal Considerations in Telehealth**

Patient confidentiality and informed consent, Telehealth reimbursement and licensure requirements

### **UNIT – 5 Future Directions of Telehealth**

Emerging trends and innovations in telehealth, Impact of telehealth on healthcare delivery models

## **Learning Outcomes:**

### **By the end of this course, students should be able to:**

- Define telehealth and discuss its historical development.
- Identify different telehealth technologies and their applications.
- Evaluate the benefits and challenges of implementing telehealth services.
- Analyze ethical and legal considerations in telehealth practice.
- Design and propose telehealth solutions to address specific healthcare needs.

### **Textbooks:**

1."Telemedicine and Telehealth: Principles, Policies, Performance, and Pitfalls" by S. Yunkap Kwankam, published by Springer.

2."Introduction to Telemedicine" by C. William Hanson III, published by CRC Press.

3."Telehealth Nursing: Tools and Strategies for Optimal Patient Care" by Karen S. Kott and Julia A. Eggert, published by Springer Publishing Company.

4."Telehealth and Mobile Health" edited by Scott M. Strayer and published by CRC Press.

## **Internet of Medical Things (IoMT)**

**Course Description:** This course provides an in-depth examination of the Internet of Medical Things (IoMT), including its applications, challenges, and implications for healthcare delivery. Students will explore the integration of connected medical devices, data analytics, and security considerations in the context of patient care.

### **Course Objectives:**

1. Understand the concept of the Internet of Medical Things and its significance in healthcare.
2. Explore different types of medical devices and sensors used in IoMT.
3. Analyze the role of data analytics in leveraging IoMT for improving patient outcomes.
4. Evaluate the challenges and security considerations associated with IoMT implementation.
5. Develop skills in designing and implementing IoMT solutions for healthcare settings.

### **Unit 1: Introduction to IoMT**

Definition and scope of the Internet of Medical Things, Historical development and evolution of IoMT technologies

### **Unit 2: Medical Devices and Sensors**

Overview of connected medical devices and wearables, Types of sensors used in healthcare monitoring and diagnosis

### **Unit 3: Data Analytics in IoMT**

Importance of data analytics for extracting insights from IoMT data, Machine learning algorithms for predictive analytics in healthcare

### **Unit 4: Challenges and Security Considerations**

Regulatory compliance and standards in IoMT, Security risks and privacy concerns associated with IoMT devices and data

### **Unit 5: Implementation and Future Trends**

Case studies of IoMT applications in healthcare delivery, Emerging trends and innovations in IoMT technology

### **LEARNING OUTCOMES:**

By the end of this course, students should be able to:

- Define the Internet of Medical Things and its applications in healthcare.
- Identify different types of medical devices and sensors used in IoMT.
- Apply data analytics techniques to analyze IoMT data for healthcare insights.
- Assess the challenges and security considerations in IoMT implementation.
- Design and propose IoMT solutions to address specific healthcare needs.

**Textbooks:**

1."The Internet of Medical Things" by Arvind Sathi, published by CRC Press.

2."Connected Health: Improving Care, Safety, and Efficiency with Wearables and IoT Solution" by Himanshu Bhatt, published by Apress.

3."Healthcare Sensor Networks: Challenges Toward Practical Implementation" edited by Thomas Falck, published by CRC Press.

4."IoT Applications in Healthcare" edited by Yen-Wei Chen, published by Springer.

**MACHINE LEARNING IN HEALTHCARE**

**COURSE DESCRIPTION:**

This course explores the application of machine learning techniques in healthcare, focusing on how algorithms can analyze medical data to improve diagnosis, treatment, and patient outcomes. Students will learn about various ML models, their implementation, and ethical considerations in healthcare AI.

**Course Objectives:**

1. Understand the fundamentals of machine learning and its applications in healthcare.
2. Explore different types of medical data and their suitability for ML analysis.
3. Analyze the role of ML algorithms in disease diagnosis and prognosis.
4. Evaluate the impact of ML-driven decision support systems on clinical practice.
5. Develop skills in designing and implementing ML models for healthcare applications.

**Unit 1: Introduction to Machine Learning in Healthcare**

Overview of machine learning and its relevance in healthcare, Historical context and evolution of ML applications in medicine

**Unit 2: Medical Data and Feature Engineering**

Types of medical data: structured vs. unstructured, imaging data, electronic health records (EHR), Preprocessing techniques and feature extraction for medical datasets

**Unit 3: ML Models for Healthcare**

Supervised learning algorithms for disease diagnosis and classification, Unsupervised learning techniques for clustering and anomaly detection in healthcare data

**Unit 4: Clinical Decision Support Systems**

Integration of ML models into clinical practice, Ethical considerations and challenges in deploying ML-driven decision support systems

**Unit 5: Applications and Case Studies**

Case studies of ML applications in healthcare, such as image analysis, predictive modeling, and personalized medicine, Emerging trends and future directions in ML-driven healthcare innovation

## **LEARNING OUTCOMESS:**

By the end of this course, students should be able to:

- Describe the principles of machine learning and its applications in healthcare.
- Identify different types of medical data and preprocess them for ML analysis.
- Implement supervised and unsupervised ML models for healthcare tasks.
- Assess the impact of ML-driven decision support systems on clinical practice.
- Design and propose ML solutions to address specific healthcare challenges.

## **Textbooks:**

1."Machine Learning for Healthcare: A Practical Guide for Healthcare Professionals" by Parag K. Mital, published by O'Reilly Media.

2."Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again" by Eric Topol, published by Basic Books.

3."Machine Learning in Medicine: A Complete Overview" by Ton J. Cleophas and Aeilko H. Zwinderman, published by Springer.

4."Healthcare Data Analytics and Management" by Nilanjan Dey et al., published by CRC Press

# **PRINCIPLES AND PRACTICE OF HEALTH CARE MANAGEMENT**

## **COURSE DESCRIPTION:**

This course provides an in-depth understanding of the fundamental principles and practices essential for effective management in the healthcare sector. It covers the core concepts of healthcare administration, including organizational behavior, strategic planning, financial management, and human resources management. The course aims to equip students with the skills and knowledge needed to navigate the complexities of healthcare systems and lead organizations in delivering quality care.

## **COURSE OBJECTIVES:**

- Understand the structure and dynamics of healthcare systems: Analyze the organization, financing, and delivery of health services.
- Develop strategic management skills: Apply strategic planning processes to enhance organizational performance in healthcare settings.
- Master financial management principles: Understand budgeting, financial reporting, and financial decision-making in healthcare organizations.
- Enhance leadership and human resource management: Learn effective leadership styles and human resource practices specific to healthcare.
- Evaluate quality and performance improvement initiatives: Implement and assess quality improvement and performance measurement in healthcare services.
- Navigate legal and ethical issues: Understand the legal, regulatory, and ethical considerations in healthcare management.

## **Unit 1: Introduction to Healthcare Systems and Organizations**

Overview of Healthcare Systems: Types of healthcare systems: public, private, and mixed, Comparative analysis of international healthcare systems, Key stakeholders in healthcare: patients, providers, payers, and regulators.

Healthcare Delivery Models: Primary, secondary, and tertiary care, Ambulatory and acute care services, Integrated delivery systems and accountable care organizations.

Healthcare Policy and Regulation: Role of government in healthcare, Key healthcare policies and regulations, Impact of policy on healthcare organizations.

## **Unit 2: Strategic Management in Healthcare**

Strategic Planning and Analysis: Vision, mission, and values in healthcare organizations, SWOT analysis and environmental scanning, The strategic planning process.

Healthcare Marketing and Competitive Strategy: Market analysis and segmentation, Developing competitive strategies, Branding and marketing in healthcare.

Change Management and Organizational Development: Principles of change management in healthcare, Strategies for managing organizational change, Leadership in organizational development.

### **Unit 3: Financial Management in Healthcare**

Financial Accounting and Reporting: Basics of financial accounting in healthcare, Reading and interpreting financial statements, Key financial performance indicators.

Budgeting and Financial Planning: Types of budgets: operational, capital, and cash flow, Budgeting process and techniques, Financial forecasting and planning.

Healthcare Reimbursement and Funding: Payment models: fee-for-service, capitation, and value-based payments, Revenue cycle management, Financing sources for healthcare organizations.

### **Unit 4: Human Resource Management and Leadership in Healthcare**

Human Resource Management Practices: Recruitment, selection, and retention strategies, Performance management and employee development, Compensation and benefits in healthcare.

Leadership in Healthcare: Leadership theories and styles, Developing leadership skills in healthcare, Ethical leadership and decision-making.

Team Dynamics and Communication: Building and leading effective teams, Communication strategies in healthcare organizations, Conflict resolution and negotiation.

### **Unit 5: Quality, Performance Improvement, and Legal Issues in Healthcare**

Quality Improvement in Healthcare: Concepts of quality in healthcare, Tools and techniques for quality improvement (Six Sigma, Lean), Patient safety and risk management.

Performance Measurement and Management: Key performance indicators in healthcare, Benchmarking and performance analysis, Use of health information systems in performance management.

Legal and Ethical Issues in Healthcare Management: Legal framework and compliance in healthcare, Ethical issues and dilemmas in healthcare management, Privacy, confidentiality, and informed consent.

### **Learning Outcomes:**

By the end of this course, students should be able to:

- Analyze healthcare systems and their impact on organizational management and patient care.
- Apply strategic and financial management principles to solve problems and improve organizational performance in healthcare.
- Demonstrate effective leadership and management skills tailored to the unique challenges of healthcare settings.
- Implement quality and performance improvement strategies to enhance healthcare delivery.
- Assess and respond to legal and ethical issues in the management of healthcare organizations.

**Textbooks:**

1. "Essentials of Healthcare Management: Cases, Concepts, and Skills, Second Edition" by Leigh Cellucci
2. "Shortell & Kaluzny's Health Care Management: Organization Design and Behavior 7th Edition" : by Lawton Burns, Elizabeth Bradley, Bryan Weiner
3. "Quality Management in Health Care: Principles and Methodsystems: Cases, Strategies, and Solutions" by Marion J. Ball et al., published by Springer.

# **PRESCRIPTIVE, PREDICTIVE AND DIAGNOSTIC ANALYTICS IN HEALTHCARE**

## **Course Description**

Prescriptive, Predictive, and Diagnostic Analytics in Healthcare is a course that delves into advanced analytics techniques aimed at improving healthcare outcomes and operational efficiency. It covers the principles and applications of prescriptive analytics for decision-making, predictive analytics for forecasting patient outcomes, and diagnostic analytics for identifying patterns and trends in healthcare data. Students will explore case studies and practical applications to understand how these analytics methods can be leveraged to optimize clinical workflows, enhance patient care, and drive evidence-based decision-making in healthcare settings.

## **COURSE OBJECTIVES**

1. To Identify and discuss the developing frontiers in the predictive modeling field
2. To Describe the commonly used case identification/predictive measurement/modeling tools
3. To Discuss the inner workings of commonly used risk adjustment and predictive modeling tools
4. To Explore predictive modeling techniques to forecast patient outcomes, disease trends, and resource needs in healthcare settings.
5. To Provide an overview of prescriptive, predictive, and diagnostic analytics methods and their applications in healthcare.

### **Unit - 1**

Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Multiple outputs, Subset selection , Ridge regression, Lasso regression , Linear Discriminant Analysis , Logistic regression , Perception learning algorithm.

### **Unit - 2**

Model Assessment and Selection : Bias, Variance, and model complexity, Bias-variance trade off, Optimism of the training error rate ,Estimate of In-sample prediction error, Effective number of parameters, Bayesian approach and BIC, Cross- validation ,Boot strap methods, conditional or expected test error.

### **Unit - 3**

Additive Models, Trees,and Boosting: Generalized additive models, Regression and classification trees , Boosting methods-exponential loss and AdaBoost, Numerical Optimization via gradient boosting, Examples (Spam data, California housing , NewZealand fish, Demographic data)

### **Unit - 4**

Neural Networks(NN) , Support Vector Machines(SVM),and K-nearest Neighbor: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest –Neighbour classifiers

### **Unit - 5**

Unsupervised Learning and Random forests: Association rules, Cluster analysis, Principal Components, Random forests and analysis. Inferential Statistics and Prescriptive analytics, Assessing Performance of a classification Algorithm (t-test,McNemar's test,Paired ttest,paired F-test),Analysis of Variance, Creating data for analytics through designed experiments.

### **LEARNING OUTCOMES**

Upon successful completion of the course student would be

- ✓ To equip students to critically evaluate business situations and analyze healthcare data for decision making
- ✓ To enable students to synthesize concepts of health data mining and business intelligence
- ✓ To apply specific statistical and regression analysis methods applicable to predictive analytics in the Healthcare industry
- ✓ To Apply prescriptive, predictive, and diagnostic analytics concepts to real-world healthcare scenarios, emphasizing practical implementation and integration into clinical practice and healthcare management.
- ✓ To Explore predictive modeling techniques to forecast patient outcomes, disease trends, and resource needs in healthcare settings

### **Text Books**

1. Healthcare analytics, From Data to Knowledge to Healthcare Improvement, Hui Yang and Eva K. Lee, John Wiley & Sons, Inc. 2016
2. Healthcare Data Analytics, Edited by Chandan K. Reddy and Charu C. Aggarwal, CRC Press 2011

**PRECISION MEDICINE**

**Course Description**

This course provides an in-depth exploration of precision medicine, an innovative approach to tailoring medical treatment to the individual characteristics of each patient. Emphasizing the role of genomics, big data, and personalized care, this course aims to equip students with the knowledge and skills necessary to understand and implement precision medicine in clinical and research settings.

**COURSE OBJECTIVES:**

- 1.To understand the fundamental principles and concepts of precision medicine.
- 2.To explore the technological advancements enabling precision medicine.
- 3.To analyze case studies and real-world applications of precision medicine.
- 4.To evaluate ethical, legal, and social implications associated with precision medicine.
- 5.To develop critical thinking and problem-solving skills in the context of precision medicine.

**Unit 1**

Introduction to Precision Medicine:

Definition and historical background, Basic concepts and principles

**UNIT – 2**

Technological Foundations of Precision Medicine

Genomics, transcriptomics, and proteomics, High-throughput sequencing technologies, □Data analytics and bioinformatics tools

**UNIT – 3**

Applications of Precision Medicine

Cancer genomics and targeted therapies, Pharmacogenomics and personalized medicine

Infectious disease management

**UNIT – 4**

## Ethical, Legal, and Social Implications

Privacy and data security concerns, Access and equity in healthcare delivery, Regulatory frameworks and policy considerations

## **UNIT – 5**

### Future Directions and Challenges

Emerging trends in precision medicine, Overcoming barriers to implementation, Global perspectives and collaborative efforts

### **Learning Outcomes:**

By the end of the course, students should be able to:

1. Define precision medicine and explain its significance in healthcare.
2. Identify key technologies driving precision medicine and their applications.
3. Analyze case studies to understand the practical implementation of precision medicine.
4. Evaluate ethical, legal, and social issues associated with precision medicine.
5. Propose solutions to challenges hindering the adoption of precision medicine.

### **Recommended Textbooks:**

1. "Precision Medicine: A Guide to Genomics in Clinical Practice" by Jeanette J. McCarthy and Bryce A. Mendelsohn
2. "Precision Medicine: A Primer" by Eric M. Green
3. "Principles of Precision Medicine" edited by Mukesh Verma
4. "Ethical, Legal, and Social Issues in Precision Medicine" edited by Holly Fernandez Lynch et al.
5. "Genomic and Precision Medicine: Foundations, Translation, and Implementation" edited by Geoffrey S. Ginsburg and Huntington F. Willard

## **Imaging Informatics**

### **Course Description:**

This course provides an overview of imaging informatics, focusing on the acquisition, management, and analysis of medical images. Students will learn about image processing techniques, data integration, and the application of informatics in enhancing diagnostic accuracy and treatment planning. Emphasis will be placed on current technologies and future trends in the field.

### **Course Objectives:**

- 1.To understand the fundamental concepts and principles of imaging informatics.
- 2.To explore various imaging modalities and their applications in healthcare.
- 3.To analyze the role of informatics in image acquisition, storage, retrieval, and analysis.
- 4.To evaluate emerging technologies and trends in imaging informatics.
- 5.To develop practical skills for managing and analyzing medical imaging data.

### **UNIT – 1 Introduction to Imaging Informatics**

Definition and scope of imaging informatics, Historical background and evolution, Role in modern healthcare delivery

### **UNIT – 2 Imaging Modalities and Techniques**

Overview of imaging modalities (e.g., X-ray, MRI, CT, PET), Principles of image acquisition and interpretation, Clinical applications and limitations of each modality

### **UNIT – 3 Informatics Infrastructure for Imaging**

Picture Archiving and Communication Systems (PACS), Radiology Information Systems (RIS), Electronic Health Records (EHR) integration, Data standards and interoperability

### **UNIT – 4 Image Analysis and Processing**

Digital image processing techniques, Computer-aided diagnosis (CAD) systems, Quantitative imaging biomarkers, Machine learning and AI in image analysis

### **UNIT – 5 Advanced Topics in Imaging Informatics**

3D imaging and visualization, Imaging genomics and radiomics. Telemedicine and teleradiology, Regulatory and ethical considerations

### **LEARNING OUTCOMESS:**

By the end of the course, students should be able to:

1. Define imaging informatics and its role in healthcare.
2. Identify different imaging modalities and their clinical applications.
3. Analyze informatics infrastructure for managing medical imaging data.
4. Apply image analysis techniques to extract meaningful information from medical images.
5. Evaluate emerging trends and challenges in imaging informatics.

**Recommended Textbooks:**

1. "Introduction to Imaging" by Wilfried W. de Jong
2. "Fundamentals of Medical Imaging" by Paul Suetens
3. "Informatics in Medical Imaging" by Nilanjan Dey and Amira S. Ashour
4. "Handbook of Medical Imaging: Processing and Analysis" edited by Isaac N. Bankman
5. "Radiology Informatics: Fundamentals of Image Informatics in Radiology" by H. K. Huang and Robert A. C. M. Jacobs

## **Pharmacoinformatics**

### **Course Description:**

This course explores the intersection of pharmacology and informatics, focusing on the use of computational tools to analyze drug data, design new therapeutics, and optimize pharmacotherapy. Students will learn about drug discovery, molecular modeling, and data management techniques to enhance the efficiency and effectiveness of pharmaceutical research and development.

### **COURSE OBJECTIVES:**

- 1.To understand the fundamental principles and concepts of pharmacoinformatics.
- 2.To explore the role of informatics in drug discovery, design, and development.
- 3.To analyze computational methods and tools used in pharmacoinformatics.
- 4.To evaluate the application of pharmacoinformatics in personalized medicine and drug repurposing.
- 5.To develop practical skills for utilizing pharmacoinformatics techniques in pharmaceutical research.

### **UNIT – 1**

Introduction to Pharmacoinformatics, Definition and scope of pharmacoinformatics, Historical development and evolution, Importance in modern drug discovery and development

### **UNIT - 2**

Chemoinformatics: Molecular Modeling and Drug Design, Structure-activity relationship (SAR) studies, Molecular docking and virtual screening, QSAR/QSPR modeling techniques, Ligand-based and structure-based drug design approaches

### **UNIT – 3**

Bioinformatics in Drug Discovery, Sequence analysis and genome mining for drug targets, Protein structure prediction and modeling, Molecular dynamics simulations, Systems biology approaches in drug discovery

### **UNIT – 4**

Pharmacogenomics and Personalized Medicine, Genomic variation and drug response, Pharmacogenomic databases and resources, Predictive modeling for drug efficacy and toxicity, Implementation of pharmacogenomic data in clinical practice

### **UNIT – 5**

Applications and Future Perspectives, Drug repurposing and virtual screening for drug discovery, Network pharmacology and polypharmacology, Big data analytics and machine learning in pharmacoinformatics, Regulatory and ethical considerations in pharmacoinformatics research

### **LEARNING OUTCOMESS:**

By the end of the course, students should be able to:

1. Define pharmacoinformatics and its significance in pharmaceutical research.
2. Identify computational methods and tools used in drug discovery and development.
3. Apply molecular modeling techniques to design and optimize drug candidates.
4. Analyze genomic data to predict drug response and personalize treatment regimens.
5. Evaluate emerging trends and challenges in pharmacoinformatics research.

### **Recommended Textbooks:**

1. "Pharmacoinformatics" by Sandhya Bawa and Gurpreet Singh
2. "Chemoinformatics and Computational Chemical Biology" by Jürgen Bajorath
3. "Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools" by Supratim Choudhuri
4. "Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation" edited by Urs A. Meyer and Hartmut H. Schmidt
5. "Machine Learning in Drug Discovery: Methods and Principles in Medicinal Chemistry" edited by George Karypis

## **Guidelines for Mini-Project**

Designing a mini-project for health informatics can be an engaging and practical way for students to apply their knowledge to real-world scenarios. Here are some guidelines to create such a project:

**Objective:** The objective of this mini-project is to allow students to apply concepts and techniques learned in health informatics to analyze healthcare data and derive actionable insights.

**Project Overview:** Students will work individually or in small groups to complete the following tasks:

1. **Select a Healthcare Dataset:** Students will choose a dataset relevant to healthcare from publicly available sources such as government health agencies, research repositories, or online healthcare platforms. Datasets may include electronic health records (EHR), medical claims data, patient surveys, or public health datasets.

2. **Data Preprocessing:** Students will clean and preprocess the selected dataset to handle missing values, outliers, and inconsistencies. This may involve data cleaning, data transformation, and normalization techniques.

3. **Exploratory Data Analysis (EDA):** Students will conduct exploratory data analysis to gain insights into the dataset. This includes summary statistics, data visualization, and identifying patterns and trends in the data.

4. **Hypothesis Testing (Optional):** Students may formulate hypotheses based on their EDA findings and perform statistical tests to validate or refute these hypotheses. This step is optional but encourages critical thinking and hypothesis-driven analysis.

5. **Predictive Modeling (Optional):** For more advanced projects, students may choose to build predictive models using machine learning algorithms. This could involve tasks such as classification (e.g., predicting disease diagnosis) or regression (e.g., predicting patient length of stay).

6. **Results Interpretation:** Students will interpret their findings and present actionable insights derived from the data analysis. This may include recommendations for healthcare providers, policymakers, or future research directions.

7. **Project Report and Presentation:** Students will write a project report documenting their methodology, findings, and conclusions. They will also deliver a presentation summarizing their project to the class.

**Evaluation Criteria: Projects will be evaluated based on the following criteria:**

- 1.Data Selection and Preprocessing: Appropriateness of dataset selection and effectiveness of data preprocessing techniques.
- 2.Exploratory Data Analysis: Depth and thoroughness of EDA, including insightful visualizations and interpretation of findings.
- 3.Hypothesis Testing (if applicable): Clarity of hypotheses, appropriateness of statistical tests, and interpretation of results.
- 4.Predictive Modeling (if applicable): Model performance, feature selection, and interpretation of model results.
- 5.Results Interpretation: Clarity and significance of insights derived from the data analysis.
- 6.Project Report and Presentation: Quality of written report, clarity of presentation, and effectiveness of communication.

Resources: Provide students with access to relevant resources, including healthcare datasets, software tools (e.g., Python/R for data analysis), tutorials on data preprocessing and analysis, and examples of previous projects or case studies in health informatics.

Timeline: Outline a timeline for the project, including deadlines for dataset selection, data preprocessing, EDA, modeling (if applicable), report writing, and presentation.

Mini-Project Evaluation parameters : Health Informatics

Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)	Inadequate (1)
<b>Problem Identification</b>	Clearly identifies a significant problem in health informatics and provides thorough context.	Identifies a relevant problem in health informatics with adequate context.	Identifies a problem in health informatics but lacks depth in context.	Identifies a vague or unrelated problem in health informatics.	Does not identify a problem in health informatics.
<b>Data Selection and Acquisition</b>	Selects appropriate and relevant data sources with clear justification. Acquires data effectively.	Selects relevant data sources with justification. Acquires data adequately.	Selects somewhat relevant data sources with limited justification. Acquires data with some issues.	Selects irrelevant data sources or lacks justification. Acquires data poorly.	Does not select or acquire relevant data.
<b>Data Preprocessing</b>	Executes comprehensive data preprocessing including cleaning, transformation, and integration effectively.	Performs data preprocessing effectively with minor issues.	Performs data preprocessing but with some errors or omissions.	Data preprocessing is incomplete or ineffective.	No evidence of data preprocessing.
<b>Exploratory Data Analysis (EDA)</b>	Conducts thorough EDA revealing meaningful insights with insightful visualizations.	Conducts EDA effectively with clear visualizations.	Conducts EDA but lacks depth or clarity in insights.	EDA is superficial or unclear.	No evidence of EDA.
<b>Analysis Techniques</b>	Applies appropriate analysis techniques effectively, demonstrating understanding and creativity.	Applies analysis techniques appropriately with minor issues.	Applies analysis techniques but with some errors or limitations.	Misapplies analysis techniques or lacks understanding.	Does not apply appropriate analysis techniques.
<b>Results Interpretation</b>	Interprets results clearly and insightfully, linking findings to the problem statement effectively.	Interprets results clearly, linking findings to the problem statement.	Interprets results but with some lack of clarity or insight.	Results interpretation is unclear or unrelated to the problem statement.	No evidence of results interpretation.

Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)	Inadequate (1)
<b>Project Documentation</b>	Produces a well-organized and comprehensive project report with clear structure and appropriate detail.	Produces a well-organized project report with appropriate detail.	Produces a project report with some organization and detail.	Project report lacks organization or detail.	No project documentation provided.
<b>Presentation Quality</b>	Delivers a clear, engaging, and well-structured presentation effectively communicating key points.	Delivers a clear presentation communicating key points effectively.	Delivers a presentation but with some lack of clarity or engagement.	Presentation lacks clarity or structure.	No presentation provided.
<b>Overall Execution</b>	Demonstrates exceptional execution across all aspects of the mini-project.	Demonstrates good execution across most aspects of the mini-project.	Demonstrates fair execution with some areas needing improvement.	Demonstrates inadequate execution with several areas needing improvement.	Demonstrates poor execution across all aspects of the mini-project.

**Overall Score:**

Score	Description
40 - 45	Exceptional
32 - 39	Good
24 - 31	Fair
16 - 23	Needs Improvement
0 - 15	Inadequate

## Guidelines for Major Project

A capstone project in health informatics and data science is a culminating experience that allows students to apply their knowledge and skills to solve real-world problems in healthcare. Here are some guidelines to create such a project:

**Objective:** The objective of the capstone project is to enable students to demonstrate their proficiency in health informatics and data science by solving a healthcare-related problem using data-driven approaches.

**Project Overview:** Students will work individually or in small teams to complete the following tasks:

1. **Identify a Healthcare Problem:** Students will select a specific healthcare problem or challenge that can be addressed using data science techniques. This could include improving patient outcomes, optimizing healthcare delivery, enhancing population health management, or addressing healthcare disparities.

2. **Data Acquisition:** Students will identify and acquire relevant datasets for their chosen healthcare problem. Datasets may include electronic health records (EHR), medical claims data, patient surveys, genomic data, or public health datasets.

3. **Data Preprocessing:** Students will clean, preprocess, and integrate the acquired datasets to prepare them for analysis. This may involve data cleaning, transformation, normalization, and handling missing values.

4. **Exploratory Data Analysis (EDA):** Students will conduct exploratory data analysis to gain insights into the datasets. This includes summary statistics, data visualization, and identifying patterns and trends in the data.

5. **Feature Engineering:** Students will engineer relevant features from the datasets to capture important information for their analysis. This may involve creating new variables, aggregating data, or extracting meaningful features from raw data.

6. **Predictive Modeling:** Students will develop predictive models using machine learning algorithms to address the healthcare problem. This could include tasks such as classification (e.g., predicting disease diagnosis), regression (e.g., predicting patient outcomes), or clustering (e.g., segmenting patient populations).

7. **Model Evaluation:** Students will evaluate the performance of their predictive models using appropriate evaluation metrics. This may include accuracy, precision, recall, F1-score, ROC-AUC, or other relevant metrics depending on the nature of the problem.

8.Results Interpretation: Students will interpret the results of their analysis and draw actionable insights from the predictive models. This may include identifying risk factors, predicting patient outcomes, optimizing treatment strategies, or informing healthcare policy decisions.

9.Project Report and Presentation: Students will write a comprehensive project report documenting their methodology, findings, and conclusions. They will also deliver a final presentation summarizing their project to the class or a panel of judges.

**Evaluation Criteria: Projects will be evaluated based on the following criteria:**

- 1.Problem Definition: Clarity and significance of the healthcare problem addressed.
- 2.Data Acquisition and Preprocessing: Appropriateness of data sources and effectiveness of data preprocessing techniques.
- 3.Exploratory Data Analysis: Depth and thoroughness of EDA, including insightful visualizations and interpretation of findings.
- 4.Feature Engineering: Relevance and effectiveness of engineered features for the analysis.
- 5.Predictive Modeling: Performance of predictive models and appropriateness of modeling techniques.
- 6.Model Evaluation: Rigor and validity of model evaluation metrics.
- 7.Results Interpretation: Clarity and significance of insights derived from the analysis.
- 8.Project Report and Presentation: Quality of written report, clarity of presentation, and effectiveness of communication.

Resources: Provide students with access to relevant resources, including healthcare datasets, software tools (e.g., Python/R for data analysis), tutorials on data preprocessing and analysis, and examples of previous capstone projects or case studies in health informatics.

Timeline: Outline a timeline for the capstone project, including deadlines for problem selection, data acquisition, preprocessing, analysis, report writing, and presentation.

## Major Project Evaluation parameters: Health Informatics

Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)	Inadequate (1)
<b>Problem Definition</b>					
- Clarity and significance of problem	Clearly defined and highly significant to healthcare.	Well-defined and significant to healthcare.	Adequately defined but could be more significant to healthcare.	Somewhat unclear or lacks significance to healthcare.	Unclear or irrelevant to healthcare.
<b>Data Acquisition and Preprocessing</b>					
- Appropriateness of data sources	Data sources are highly relevant and comprehensive.	Data sources are relevant and sufficient.	Data sources are somewhat relevant but may be lacking.	Data sources are inadequate or irrelevant.	Data sources are missing or not relevant.
- Effectiveness of data preprocessing	Thoroughly cleansed, transformed, and integrated data.	Data preprocessing is effective, with minor issues.	Data preprocessing is somewhat effective but lacks completeness.	Data preprocessing is ineffective or incomplete.	Data preprocessing is missing or poorly done.
<b>Exploratory Data Analysis (EDA)</b>					
- Depth and thoroughness of EDA	Comprehensive EDA with insightful visualizations.	Good EDA with useful visualizations.	Adequate EDA but lacks depth or insight.	Superficial EDA with limited insight.	Minimal or no EDA performed.
<b>Feature Engineering</b>					
- Relevance and effectiveness of features	Features are highly relevant and enhance analysis.	Features are relevant and contribute to analysis.	Features are somewhat relevant but may not fully enhance analysis.	Features are irrelevant or poorly engineered.	Features are missing or poorly engineered.
<b>Predictive Modeling</b>					
- Model Performance	Models perform exceptionally well with high accuracy and robustness.	Models perform well with good accuracy and reliability.	Models perform adequately but may have some limitations.	Models perform poorly with low accuracy or reliability.	Models perform inadequately or not implemented.
<b>Model Evaluation</b>					
- Rigor and validity of evaluation metrics	Evaluation metrics are rigorous and appropriate.	Evaluation metrics are appropriate but may have minor issues.	Evaluation metrics are somewhat appropriate but lack rigor.	Evaluation metrics are inappropriate or not used effectively.	Evaluation metrics are missing or not used.
<b>Results Interpretation</b>					
- Clarity and significance of insights	Insights are clear, significant, and actionable.	Insights are clear and significant.	Insights are somewhat clear and significant.	Insights are unclear or lack significance.	Insights are missing or irrelevant.
<b>Project Report and Presentation</b>					

Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)	Inadequate (1)
- Quality of written report	Report is well-written, organized, and comprehensive.	Report is well-written and organized.	Report is adequately written but may lack organization.	Report is poorly written or lacks detail.	Report is missing or inadequate.
- Clarity of presentation	Presentation is clear, engaging, and effectively communicates key points.	Presentation is clear and effectively communicates key points.	Presentation is somewhat clear but may lack engagement.	Presentation is unclear or lacks coherence.	Presentation is missing or ineffective.

### Overall Score:

Score	Description
23 - 25	Exceptional
19 - 22	Good
15 - 18	Fair
11 - 14	Needs Improvement
0 - 10	Inadequate

This rubric provides a structured framework for evaluating various aspects of a capstone project in health informatics, including problem definition, data acquisition and preprocessing, analysis techniques, and presentation of results. Adjustments can be made based on specific project requirements and COURSE OBJECTIVES.