ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY

(AUTONOMOUS)

(Anjugramam-Kanyakumari Main Road, Palkulam,Variyoor P.O.-629 401, K.K.Dist.)

Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai

Accredited with A+ Grade by NAAC

Minor Degree Course

PRECISION HEALTH TECHNOLOGY

Curriculum & Syllabus

(*2024-2025 Admitted Students Onwards*)

CREDIT INFO		
Sl.No	**Category**	**Credits**
1	**Minor Courses**	**18**

CREDIT DISTRIBUTION

Course Category	**Credit/Semester**								**No. of Credits**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
Minor Courses					**6**	**6**	**6**	**-**	**18**

PROGRAMS ELIGIBLE FOR HONOUS-BME PROGRAMS ELIGIBLE FOR MINOR-ALL OTHER UG BRANCHES							
Sl.no	Course Code	Course Title	Course Type	L	T	P	Credit
1.	24PH501	Introduction to Precision Health Technologies	PEC	3	0	0	3
2.	24PH502	Human Anatomy & Physiology for Engineers	PEC	3	0	0	3
3.	24PH601	Medical Sensors and Wearable Devices	PEC	2	0	2	3
4.	24PH602	Biomedical Signal Processing & Health Data Analytics	PEC	3	0	0	3
5.	24PH701	Artificial Intelligence and Machine Learning in Healthcare	PEC	3	0	0	3
6.	24PH702	Precision Health Project	PEC	0	0	6	3

Course Code:	24PH501	Course Title:	Introduction to Precision Health Technologies
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

1. Understand the concepts, scope, and evolution of Precision Health Technologies.
2. Explain the role of genomics, biomedical engineering, AI, IoT, and wearable technologies in personalized healthcare.
3. Apply engineering principles to solve healthcare problems using digital technologies.
4. Analyze healthcare datasets and digital health systems considering ethics, privacy, and regulatory requirements.
5. Design innovative technology-enabled healthcare solutions addressing current industrial and societal challenges.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Interactive lectures with multimedia demonstrations
2. Flipped classroom
3. Case-based learning using hospital and industrial case studies
4. Problem-Based Learning (PBL)
5. Design Thinking workshops
6. Hands-on demonstrations of wearable devices
7. AI healthcare software demonstrations
8. Guest lectures from hospitals, MedTech industries, startups, and research organizations
9. Mini projects
10. Industry expert seminars
11. Simulation using open-source healthcare datasets
12. Team discussions and presentations

UNIT I: Introduction to Precision Health Technologies	**[9 hours]**
Evolution of healthcare systems, Conventional healthcare and precision healthcare, Precision medicine, Personalized healthcare, Digital health ecosystem, Healthcare 4.0 and Industry 5.0, Healthcare value chain, Role of engineering in healthcare, Emerging healthcare technologies, Global healthcare challenges and opportunities.	

UNIT II: Biomedical Devices and Connected Healthcare	[9 hours]
Human physiological parameters, Biomedical sensors, Biosensors, Wearable health devices, Smart medical devices, Internet of Medical Things (IoMT), Remote patient monitoring, Telemedicine, Mobile health (mHealth), Smart hospitals, Connected healthcare infrastructure.	

UNIT III: Artificial Intelligence and Healthcare Analytics	[9 hours]
Artificial Intelligence in healthcare, Machine learning fundamentals, Deep learning applications, Medical image analysis, Electronic Health Records (EHR), Clinical Decision Support Systems (CDSS), Healthcare data analytics, Predictive healthcare analytics, Preventive healthcare, Digital twins in healthcare.	

UNIT IV: Genomics and Personalized Healthcare	[9 hours]
Human genomics, Precision medicine, Pharmacogenomics, Biomarkers, Multi-omics technologies, Personalized disease prevention, Personalized therapeutics, Digital therapeutics, Drug discovery, Future trends in precision medicine	

UNIT-V Healthcare Security, Ethics and Standards	[9 hours]
Healthcare cybersecurity, Medical data privacy, Healthcare data governance, HIPAA and GDPR overview, AI ethics in healthcare, Explainable Artificial Intelligence (XAI), Medical device regulations, Healthcare standards (HL7, FHIR, DICOM, ISO 13485), Interoperability in healthcare systems, Digital biomarkers, Smart hospitals, Robotics in healthcare, Augmented Reality (AR) and Virtual Reality (VR) in medicine, Healthcare innovation ecosystem, HealthTech startups, Future trends in Precision Health Technologies	

Course outcomes:

On completion of the course, the student will have the ability to:

CO No.	Course Outcome	Highest Cognitive Level
CO1	Apply precision health concepts to identify suitable technology solutions for personalized healthcare problems.techniques in biomedical measurement systems.	K2
CO2	Demonstrate the use of wearable sensors, IoT devices, and biomedical data for continuous patient monitoring.	K2
CO3	Analyze healthcare data using AI and digital health tools to support clinical decision-making..	K2
CO4	Develop engineering solutions considering ethical, cybersecurity, interoperability, and regulatory requirements in healthcare.	K2
CO5	Design an innovative prototype or conceptual solution addressing an industrial healthcare challenge using precision health technologies.	K2

COs and POs Mapping:

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	2	1	1	2	---	---	---	---	---	---	1
CO2	3	2	2	2	1	1	---	---	---	---	---	1
CO3	3	2	1	2	1	1	---	---	---	---	---	1
CO4	3	1	2	1	2	2	---	---	---	---	---	1
CO5	2	1	1	2	1	1	---	---	---	---	---	2

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE) - Theory	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Jameson, J. L., *Precision Medicine: A Guide to Genomics in Clinical Practice*, McGraw-Hill.
2. Rifat Latifi, *Telemedicine for Healthcare Systems*, Springer.
3. Joseph D. Bronzino, *Biomedical Engineering Fundamentals*, CRC Press.
4. David D. Feng (Ed.), *Biomedical Information Technology*, Academic Press.
5. Bernhard Preim and Dirk Bartz, *Visualization in Medicine*, Morgan Kaufmann.

Reference Books:

1. Eric Topol, *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*, Basic Books.
2. Arthur Andreassi, *Psychophysiology: Human Behavior and Physiological Response*, Routledge.
3. John D. Enderle and Susan Blanchard, *Introduction to Biomedical Engineering*, Academic Press.

4. Kevin Murphy, *Probabilistic Machine Learning: An Introduction*, MIT Press.
5. N. H. Lovell (Ed.), *Wearable Monitoring Systems*, Springer.
6. Mark Braunstein, *Health Informatics on FHIR*, Springer.
7. R. S. H. Istepanian and Bryan Woodward, *M-Health: Fundamentals and Applications*, Wiley.

Industry-Oriented Skill Development Activities

Students shall complete any five:

1. Wearable device performance analysis
2. Healthcare mobile app evaluation
3. Medical sensor demonstration
4. Electronic Health Record data visualization
5. AI healthcare case study
6. Telemedicine workflow analysis
7. Smart hospital visit
8. Healthcare startup case study
9. Literature survey on Precision Medicine
10. Mini healthcare innovation project

Course Code:	24PH502	Course Title:	Human Anatomy & Physiology for Engineers
Credits:	**3**	**L – T – P**	**3-0-0**

Course objectives:

To impart knowledge on the

- Understand the structure and functions of major human organ systems relevant to engineering applications.
- Explain physiological principles underlying human health, disease, and biomedical measurements.
- Apply engineering concepts to analyze physiological signals and healthcare technologies.
- Interpret the relationship between human anatomy, physiology, biomedical devices, and digital health systems.
- Develop interdisciplinary knowledge to design engineering solutions for healthcare, wearable technologies, rehabilitation, and precision medicine.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

- Interactive lectures with digital animations
- Flipped classroom learning
- Problem-Based Learning (PBL)
- Case-based learning using clinical and industrial examples
- Demonstration of biomedical instruments
- Virtual anatomy and physiology simulations
- Wearable device demonstrations
- Medical imaging interpretation sessions
- Industry expert lectures
- Hospital and medical device industry visits
- Team-based mini projects
- Student seminars and presentations

UNIT I – Organization of the Human Body	**[9 hours]**
Levels of structural organization, Homeostasis and feedback mechanisms, Anatomical terminology, Body cavities and organ systems, Cells and tissues, Epithelial tissue, Connective tissue, Muscle tissue, Nervous tissue, Cell membrane transport, Cell communication, Stem cells and tissue engineering.	

UNIT II – Musculoskeletal and Nervous Systems	**[9 hours]**
Structure and functions of the skeletal system, Bone growth and remodeling, Joints and types of joints, Structure and physiology of skeletal muscles, Muscle contraction mechanism, Central nervous system, Peripheral nervous system, Autonomic nervous system, Neurons and neuroglia, Nerve impulse transmission, Reflex action, Brain-computer interface applications.	

UNIT III – Cardiovascular and Respiratory Systems	**[9 hours]**
Structure of the heart, Cardiac cycle, Electrical conduction system of the heart, Blood vessels and circulation, Blood composition and functions, Blood pressure regulation, Electrocardiogram (ECG), Respiratory anatomy, Mechanics of breathing, Pulmonary function tests, Gas exchange, Oxygen transport, Pulse oximetry, Cardiovascular monitoring technologies.	

UNIT IV – Digestive, Endocrine and Excretory Systems	**[9 hours]**
Digestive system anatomy, Digestion and absorption, Liver and pancreas functions, Metabolism and nutrition, Endocrine glands and hormones, Hormonal regulation, Kidney anatomy, Nephron structure, Urine formation, Fluid and electrolyte balance, Acid-base balance, Renal function assessment, Artificial kidney and dialysis technologies.	

UNIT V – Reproductive System, Human Physiology and Biomedical Applications	[9 hours]
Male and female reproductive systems, Human development, Immune system and immune response, Common physiological measurements, Body temperature regulation, Blood glucose regulation, Human physiological signals, Biomedical sensors, Wearable health monitoring devices, Medical imaging overview, Human factors engineering, Biomedical engineering applications, Digital health technologies, Ethical considerations in healthcare technology.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO No.	Course Outcome	Highest Cognitive Level
CO1	Apply anatomical and physiological knowledge to identify engineering requirements for biomedical devices.	K2
CO2	Analyze physiological parameters using biomedical sensors and monitoring systems for healthcare applications.	K2
CO3	Select appropriate sensing and measurement techniques for monitoring human body functions.	K2
CO4	Evaluate engineering solutions for healthcare considering human physiology, ergonomics, and patient safety.	K2
CO5	Design technology-assisted healthcare solutions integrating anatomy, physiology, wearable devices, and digital health platforms.	K2

COs and POs Mapping:

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	2	1	1	2	---	---	---	---	---	---	1
CO2	3	2	2	2	1	1	---	---	---	---	---	1

CO3	**3**	**2**	**1**	**2**	**1**	**1**	**---**	**---**	**---**	**---**	**---**	**1**
CO4	**3**	**1**	**2**	**1**	**2**	**2**	**---**	**---**	**---**	**---**	**---**	**1**
CO5	**2**	**1**	**1**	**2**	**1**	**1**	**---**	**---**	**---**	**---**	**---**	**2**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE) - Theory	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Gerard J. Tortora and Bryan H. Derrickson, **Principles of Anatomy and Physiology**, 16th Edition, Wiley, 2021.

2. Elaine N. Marieb and Katja Hoehn, **Human Anatomy & Physiology**, 12th Edition, Pearson, 2023.

3. John E. Hall, **Guyton and Hall Textbook of Medical Physiology**, 15th Edition, Elsevier, 2024.

4. John D. Enderle and Joseph D. Bronzino, **Introduction to Biomedical Engineering**, 4th Edition, Academic Press, 2021.
5. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, **Biomedical Instrumentation and Measurements**, 2nd Edition, Pearson.

Reference Books:

1. Frederic H. Martini, Judi L. Nath and Edwin F. Bartholomew, **Fundamentals of Anatomy & Physiology**, Pearson.
2. Arthur C. Guyton and John E. Hall, **Guyton and Hall Physiology Review**, Elsevier.
3. Richard S. Snell, **Clinical Anatomy by Regions**, Wolters Kluwer.
4. Joseph D. Bronzino (Ed.), **Biomedical Engineering Handbook**, CRC Press.
5. John G. Webster (Ed.), **Medical Instrumentation: Application and Design**, Wiley.
6. Mark Braunstein, **Health Informatics on FHIR**, Springer.
7. Eric Topol, **Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again**, Basic Books.

Skill Development Activities

Students shall complete **any five** of the following.

1. Recording and interpretation of physiological signals (ECG/PPG)
2. Blood pressure measurement and analysis
3. Pulse oximeter performance evaluation
4. Wearable health device analysis
5. Medical imaging case interpretation
6. Ergonomic assessment of workplace design
7. Human gait analysis
8. Healthcare mobile application evaluation
9. Biomedical sensor interfacing

Course Code:	**24PH602**	**Course Title:**	**Biomedical Signal Processing & Health Data Analytics**
Credits:	**3**	**L – T – P**	**3-0-0**

Course objectives:

To impart knowledge on the

- Understand the operating principles and characteristics of medical sensors used in healthcare systems.
- Explain the architecture and functioning of wearable medical devices for continuous physiological monitoring.
- Apply engineering principles to acquire, process, and transmit physiological signals using modern sensing technologies.
- Analyze the performance, reliability, and safety requirements of medical sensors and wearable healthcare systems.
- Design smart wearable healthcare solutions integrating sensors, IoMT, AI, and wireless communication technologies.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

- Interactive lectures with multimedia demonstrations
- Problem-Based Learning (PBL)
- Case-based learning using real healthcare applications
- Flipped classroom
- Demonstration of commercial wearable devices
- Hands-on sensor interfacing activities
- IoMT and embedded system demonstrations
- Simulation using Arduino, ESP32, Raspberry Pi and wearable development kits
- Industry expert lectures
- Hospital and MedTech industry case studies
- Student seminars
- Design Thinking workshops

UNIT I – FUNDAMENTALS OF Medical Sensors	**[9 hours]**
Introduction to medical sensors, Sensor characteristics and performance parameters, Classification of medical sensors, Physiological signal measurement, Biosensors, Electrochemical sensors, Optical sensors, Temperature sensors, Pressure sensors, Motion sensors, Flexible and printed sensors, Sensor calibration, Sensor selection for healthcare applications.	

UNIT II – Physiological Signal Acquisition and Biomedical Instrumentation	**[9 hours]**
Biomedical signal acquisition, ECG sensors, EEG sensors, EMG sensors, Photoplethysmography (PPG), Pulse oximetry, Blood pressure monitoring, Respiratory sensors, Glucose monitoring sensors, Body temperature monitoring, Biomedical instrumentation systems, Signal conditioning, Noise reduction techniques, Data acquisition systems	

UNIT III – Wearable Devices and Internet of Medical Things (IoMT)	**[9 hours]**
Wearable healthcare devices, Smart watches and fitness bands, Smart textiles, Implantable medical devices, Internet of Medical Things (IoMT), Wireless Body Area Networks (WBAN), Bluetooth Low Energy (BLE), Wi-Fi, NFC, ZigBee, Edge computing, Cloud-enabled healthcare systems, Remote patient monitoring, Mobile health (mHealth).	

UNIT IV -Smart Healthcare Analytics and Device Design	**[9 hours]**
Embedded systems for wearable devices, Low-power electronics, Microcontrollers for healthcare devices, Artificial Intelligence in wearable healthcare, Machine learning for physiological data analysis, Sensor fusion, Energy harvesting techniques, Battery management, Human factors engineering, Ergonomic wearable design, User-centered healthcare device development.	

UNIT V –Safety, Standards and Emerging Wearable Technologies	**[9 hours]**
Medical device safety, Biocompatibility, Healthcare cybersecurity, Medical data privacy, Wireless security for wearable devices, Interoperability, Medical device regulations, FDA medical device classification, ISO 13485, IEC 60601, ISO 14971, HL7, FHIR, Digital biomarkers, Electronic skin (E-Skin), Smart patches, Digital therapeutics, Future trends in wearable healthcare technologies	

Course outcomes:

On completion of the course, the student will have the ability to:

CO No.	Course Outcome	Highest Cognitive Level
CO1	Select suitable medical sensors for monitoring physiological parameters in clinical and home healthcare applications.	K2
CO2	Apply biomedical signal acquisition techniques for developing wearable health monitoring systems.	K3
CO3	Analyze sensor data using embedded systems and IoMT technologies for real-time healthcare applications.	K3
CO4	Evaluate wearable healthcare devices based on performance, usability, safety, interoperability, and regulatory standards.	K3
CO5	Design an IoMT-enabled wearable device for personalized healthcare using appropriate sensing, communication, and data analytics techniques.	K4

COs and POs Mapping:

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	2	1	1	2	---	---	---	---	---	---	1
CO2	3	2	2	2	1	1	---	---	---	---	---	1
CO3	3	2	1	2	1	1	---	---	---	---	---	1
CO4	3	1	2	1	2	2	---	---	---	---	---	1
CO5	2	1	1	2	1	1	---	---	---	---	---	2

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE) - Theory	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. John G. Webster and Amit Nimunkar, **Medical Instrumentation: Application and Design**, 5th Edition, Wiley, 2020.
2. Joseph D. Bronzino and Donald R. Peterson, **Biomedical Engineering Fundamentals**, 5th Edition, CRC Press, 2022.
3. N. H. Lovell (Ed.), **Wearable Monitoring Systems**, Springer.
4. Shyam Varma, **Wearable Electronics and Smart Textiles**, CRC Press.
5. Octavian Postolache and Subhas Mukhopadhyay (Eds.), **Sensors for Healthcare**, Elsevier.

Reference Books:

1. Richard Aston, **Principles of Biomedical Instrumentation and Measurement**, Merritt Publishing.

2. John D. Enderle and Susan Blanchard, **Introduction to Biomedical Engineering**, Academic Press.
3. Joseph Wang, **Electrochemical Sensors: From Basic Principles to Advanced Applications**, Wiley.
4. Mark Braunstein, **Health Informatics on FHIR**, Springer.
5. Eric Topol, **Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again**, Basic Books.
6. John G. Webster (Ed.), **The Measurement, Instrumentation and Sensors Handbook**, CRC Press.
7. Sergio Saponara and Alessandro De Gloria (Eds.), **Wearable Technologies for Healthcare**, IET.

SKILL DEVELOPMENT ACTIVITIES

Students shall complete **any five** of the following:

- ECG signal acquisition using wearable sensors
- Pulse oximeter performance analysis
- PPG signal acquisition and interpretation
- Wearable device teardown and functional analysis
- Smartwatch healthcare feature evaluation
- IoMT communication setup using ESP32
- Bluetooth-based patient monitoring
- Physiological signal visualization using Python/MATLAB
- Sensor calibration and performance evaluation
- Literature review on next-generation wearable technologies

Course Code:	**24PH701**	**Course Title:**	**Biomedical Signal Processing & Health Data Analytics**
Credits:	**3**	**L – T – P**	**3-0-0**

Course objectives:

To impart knowledge on the

- Understand the characteristics of biomedical signals and the principles of digital signal processing used in healthcare.
- Apply signal processing techniques to acquire, analyze, and interpret physiological signals for clinical applications.
- Explain the role of health data analytics, artificial intelligence, and machine learning in precision healthcare.
- Analyze biomedical datasets using statistical and computational methods to support healthcare decision-making.
- Design intelligent healthcare solutions integrating biomedical signal processing, health informatics, and predictive analytics.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Interactive lectures with multimedia demonstrations
2. Problem-Based Learning (PBL)
3. Flipped classroom
4. Case-based learning using real clinical datasets
5. MATLAB/Python laboratory demonstrations
6. Hands-on biomedical signal processing exercises
7. AI and machine learning tutorials
8. Healthcare data visualization workshops
9. Open-source dataset analysis (PhysioNet, MIMIC)
10. Industry expert lectures
11. Team-based mini projects
12. Journal paper discussions
13. Design Thinking for digital health solutions

UNIT I – Fundamentals of Biomedical Signals	[9 hours]
Introduction to biomedical signals, Characteristics of physiological signals, Analog and digital signals, Signal acquisition systems, Biomedical transducers, ECG, EEG, EMG, PPG, PCG, Respiratory signals, Sampling and quantization, Noise and artifacts, Signal conditioning, Biomedical data acquisition systems	

UNIT II – Biomedical Signal Processing Techniques	[9 hours]
Digital signal processing fundamentals, Time-domain analysis, Frequency-domain analysis, Fourier Transform, Fast Fourier Transform (FFT), Digital filters, Wavelet Transform, Signal denoising, Feature extraction, Pattern recognition, Biomedical image preprocessing, Real-time signal processing techniques.	

UNIT III – Health Data Analytics and Machine Learning	[9 hours]
Introduction to healthcare data analytics, Healthcare data sources, Electronic Health Records (EHR), Clinical databases, Data preprocessing, Data cleaning, Data integration, Exploratory data analysis, Statistical analysis, Machine learning fundamentals, Supervised learning, Unsupervised learning, Predictive analytics, Clinical decision support systems.	

UNIT IV - Artificial Intelligence and Precision Healthcare	[9 hours]
Deep learning for healthcare, Medical image analytics, Disease prediction models, Personalized healthcare analytics, Natural Language Processing (NLP) in healthcare, Explainable Artificial Intelligence (XAI), Digital twins, Remote patient monitoring analytics, Population health analytics, Precision medicine, AI ethics in healthcare.	

UNIT V –Big Data, Security and Future Healthcare Analytics	[9 hours]
Healthcare big data, Cloud computing for healthcare, Edge AI, Internet of Medical Things (IoMT), Healthcare interoperability, HL7, FHIR, DICOM, Healthcare cybersecurity, Medical data privacy, HIPAA and GDPR overview, Data governance, Healthcare dashboards, Digital biomarkers, Smart hospitals, Future trends in biomedical signal processing and health analytics.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO No.	Course Outcome	Highest Cognitive Level
CO1	Apply digital signal processing techniques to preprocess and analyze biomedical signals such as ECG, EEG, EMG, and PPG.	K3
CO2	Analyze healthcare datasets using statistical methods, machine learning algorithms, and visualization tools to identify clinically relevant patterns.	K3
CO3	Evaluate biomedical signal quality and develop appropriate feature extraction techniques for healthcare applications	K3
CO4	Develop predictive healthcare models using biomedical data while considering privacy, interoperability, and ethical requirements.	K4
CO5	Design an AI-enabled biomedical data analytics solution for disease prediction, remote patient monitoring, or personalized healthcare.	K4

COs and POs Mapping:

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	2	1	1	2	---	---	---	---	---	---	1
CO2	3	2	2	2	1	1	---	---	---	---	---	1
CO3	3	2	1	2	1	1	---	---	---	---	---	1
CO4	3	1	2	1	2	2	---	---	---	---	---	1
CO5	2	1	1	2	1	1	---	---	---	---	---	2

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE) - Theory	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. Willis J. Tompkins, **Biomedical Digital Signal Processing**, Prentice Hall.
2. Rangaraj M. Rangayyan, **Biomedical Signal Analysis: A Case Study Approach**, 2nd Edition, Wiley-IEEE Press.
3. Metin Akay, **Biomedical Signal Processing**, Academic Press.
4. Sergio Cerutti and Carlo Marchesi, **Advanced Methods of Biomedical Signal Processing**, Wiley-IEEE Press.
5. Mohammed J. Zaki and Wagner Meira Jr., **Data Mining and Machine Learning: Fundamental Concepts and Algorithms**, Cambridge University Press.

Reference Books:

1. John G. Webster and Amit Nimunkar, **Medical Instrumentation: Application and Design**, 5th Edition, Wiley.
2. Kevin P. Murphy, **Probabilistic Machine Learning: An Introduction**, MIT Press.

3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, **The Elements of Statistical Learning**, Springer.
4. Mark Braunstein, **Health Informatics on FHIR**, Springer.
5. Eric Topol, **Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again**, Basic Books.
6. Thomas H. Davenport and Ravi Kalakota, **The Potential for Artificial Intelligence in Healthcare**, Future Healthcare Journal.
7. Joseph D. Bronzino (Ed.), **Biomedical Engineering Handbook**, CRC Press.

SKILL DEVELOPMENT ACTIVITIES

Students shall complete **any five** of the following:

1. ECG signal preprocessing using MATLAB/Python
2. EEG signal visualization and analysis
3. EMG signal feature extraction
4. PPG signal-based heart rate estimation
5. Biomedical signal denoising using digital filters
6. Healthcare dashboard development using Power BI/Tableau
7. Clinical dataset visualization
8. Disease prediction using machine learning
9. Health data preprocessing using Python
10. PhysioNet database analysis

Course Code:	24PH701	Course Title:	Artificial Intelligence and Machine Learning in Healthcare
Credits:	3	L – T – P	3-0-0

Course objectives:

To impart knowledge on the

- Understand the fundamental concepts of Artificial Intelligence (AI), Machine Learning (ML), and their applications in healthcare.
- Explain various AI techniques used for medical diagnosis, prediction, healthcare automation, and personalized medicine.
- Apply machine learning and deep learning algorithms to analyze biomedical signals, medical images, and healthcare datasets.
- Evaluate AI-based healthcare solutions considering accuracy, interpretability, ethics, security, and regulatory requirements.
- Develop AI-enabled healthcare applications addressing real-world clinical and industrial challenges.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

- Interactive lectures with healthcare case studies
- Problem-Based Learning (PBL)
- Project-Based Learning
- Flipped classroom approach
- Hands-on AI model development
- Python programming demonstrations
- Medical dataset analysis workshops
- Deep learning framework demonstrations
- Medical image and signal processing exercises
- Industry case studies
- Guest lectures from healthcare AI professionals

- Research paper discussions
- Hackathons and innovation challenges
- Capstone project development

UNIT I – Fundamentals of Artificial Intelligence in Healthcare	**[9 hours]**
Introduction to Artificial Intelligence, History and evolution of AI, AI applications in healthcare, Healthcare challenges and AI solutions, Machine learning concepts, Types of machine learning, Supervised learning, Unsupervised learning, Reinforcement learning, Healthcare datasets, Data preprocessing, Feature selection, Healthcare data quality issues.	

UNIT II – Machine Learning Techniques for Healthcare Applications	**[9 hours]**
Regression techniques, Classification algorithms, Decision trees, Random forests, Support Vector Machines, K-Nearest Neighbors, Naive Bayes classifiers, Clustering techniques, Dimensionality reduction, Feature extraction, Model training and validation, Performance evaluation metrics, Healthcare prediction models, Clinical decision support systems.	

UNIT III – Deep Learning and Medical Data Analysis	**[9 hours]**
Introduction to deep learning, Artificial neural networks, Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Transformers in healthcare, Deep learning for medical image analysis, Computer-aided diagnosis, Biomedical signal analysis using AI, Natural Language Processing (NLP) in healthcare, Electronic Health Record (EHR) analytics.	

UNIT IV - AI Applications in Precision Healthcare	**[9 hours]**
AI-assisted medical diagnosis, AI in radiology and pathology, Disease prediction and risk assessment, Personalized medicine, Drug discovery using AI, Genomic data analysis, Digital biomarkers, Remote patient monitoring analytics, AI-powered wearable devices, Healthcare chatbots, Virtual health assistants, Robotic healthcare systems, Digital twins in medicine.	

UNIT V –Responsible AI, Deployment and Future Healthcare Technologies	[9 hours]
Explainable Artificial Intelligence (XAI), AI ethics in healthcare, Bias and fairness in healthcare AI, Medical data privacy, Healthcare cybersecurity, HIPAA and GDPR overview, AI model deployment, Cloud AI and Edge AI, Healthcare interoperability, HL7 and FHIR standards, Medical device regulations, AI validation and certification, Future trends in healthcare AI.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO No.	Course Outcome	Highest Cognitive Level
CO1	Apply machine learning algorithms for analysis and prediction of healthcare-related problems using clinical datasets.	K3
CO2	Develop AI models for biomedical signal analysis, medical image interpretation, and disease prediction.	K3
CO3	Evaluate the performance of healthcare AI systems using appropriate validation and evaluation metrics	K3
CO4	Design explainable and ethical AI-based healthcare solutions considering patient safety, privacy, and regulatory standards.	K4
CO5	Implement AI-driven healthcare applications for precision medicine, remote monitoring, and clinical decision support.	K4

COs and POs Mapping:

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	2	1	1	2	---	---	---	---	---	---	1
CO2	3	2	2	2	1	1	---	---	---	---	---	1
CO3	3	2	1	2	1	1	---	---	---	---	---	1

CO4	**3**	**1**	**2**	**1**	**2**	**2**	**---**	**---**	**---**	**---**	**---**	**1**
CO5	**2**	**1**	**1**	**2**	**1**	**1**	**---**	**---**	**---**	**---**	**---**	**2**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	**Type of assessment**	**Max Marks**	**Reduced Marks**	**Total**	**Final marks**
Continuous Internal Examination (CIE) - Theory	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books:

1. **Artificial Intelligence in Healthcare** – Adam Bohr and Kaveh Memarzadeh, Academic Press, 2020.
2. **Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow** – Aurélien Géron, O'Reilly Media.
3. **Deep Learning** – Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press.
4. **Machine Learning for Healthcare Analytics Projects** – David Foster, Packt Publishing.

5. **Biomedical Informatics: Computer Applications in Health Care and Biomedicine** – Edward H. Shortliffe and James J. Cimino, Springer.

Reference Books:

1. John G. Webster and Amit Nimunkar, **Medical Instrumentation: Application and Design**, 5th Edition, Wiley.
2. Kevin P. Murphy, **Probabilistic Machine Learning: An Introduction**, MIT Press.
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, **The Elements of Statistical Learning**, Springer.
4. Mark Braunstein, **Health Informatics on FHIR**, Springer.
5. Eric Topol, **Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again**, Basic Books.
6. Thomas H. Davenport and Ravi Kalakota, **The Potential for Artificial Intelligence in Healthcare**, Future Healthcare Journal.
7. Joseph D. Bronzino (Ed.), **Biomedical Engineering Handbook**, CRC Press.

SKILL DEVELOPMENT ACTIVITIES

Students shall complete **any five** of the following:

1. Healthcare dataset preprocessing using Python
2. Disease prediction model development
3. Medical image classification using CNN
4. ECG signal classification using machine learning
5. Healthcare chatbot prototype development
6. Clinical data visualization dashboard
7. AI model performance evaluation
8. Explainable AI analysis using SHAP/LIME
9. Literature survey on healthcare AI applications
10. AI healthcare product evaluation

Course Code:	**24PH702**	**Course Title:**	**Precision Health Project**
Credits:	**3**	**L – T – P**	**0-0-6**

Course objectives:

To impart knowledge on the

- Identify current healthcare challenges and formulate engineering-based solutions using precision health technologies.
- Apply knowledge of biomedical systems, sensors, artificial intelligence, data analytics, and digital health platforms for healthcare applications.
- Design, develop, and validate prototypes or software solutions addressing real-world healthcare needs.
- Analyze healthcare data and evaluate the performance of precision health solutions using appropriate technical methodologies.
- Demonstrate innovation, project management, ethical responsibility, and professional communication in healthcare technology development.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Design Thinking methodology
2. Problem-Based Learning (PBL)
3. Industry problem identification
4. Faculty mentoring
5. Clinical problem analysis
6. Literature survey and patent review
7. Prototype development
8. Simulation and modelling
9. Data-driven solution development
10. Industry expert review
11. Research paper analysis
12. Demonstration and technical presentation
13. Continuous project monitoring
14. Hackathons and innovation challenges

15. Capstone project development

Phase -I Problem Identification and Planning	[15 hours]
• Identification of healthcare challenges • Literature survey • Study of existing solutions • Problem definition • Requirement analysis • Project proposal preparation • Selection of technology platform	

Phase II: Design and Development	[15 hours]
• System architecture design • Hardware/software selection • Data collection strategy • Algorithm development • Prototype development • Simulation and testing • Integration of sensors, AI, IoT, or analytics platforms	

Phase III: Testing, Validation and Documentation	[15 hours]
• Performance evaluation • Accuracy analysis • User interface evaluation	

- Safety and ethical assessment
- Comparison with existing solutions
- Project report preparation
- Technical presentation and demonstration

Course outcomes:

On completion of the course, the student will have the ability to:

CO No.	Course Outcome	Highest Cognitive Level
CO1	Identify and analyze healthcare problems using user requirements, clinical needs, and engineering approaches.	K3
CO2	Design and implement precision health solutions integrating sensors, AI, IoT, biomedical data, or digital health technologies.	K4
CO3	Develop prototypes, computational models, or analytical frameworks for healthcare applications.	K4
CO4	Evaluate the performance, usability, safety, and effectiveness of healthcare technology solutions.	K5
CO5	Present and document a healthcare innovation project following engineering standards, ethical guidelines, and industry practices.	K6

Suggested Project Domains

1. Wearable Healthcare Technologies

- Smart wearable ECG monitoring system
- Continuous glucose monitoring platform

- Smart posture correction device
- Wearable stress monitoring system
- Elderly activity monitoring system

2. Artificial Intelligence in Healthcare

- AI-based disease prediction
- Medical image classification
- AI-assisted diagnosis system
- Healthcare chatbot using NLP
- Clinical decision support system

3. Biomedical Signal Processing

- ECG abnormality detection
- EEG-based neurological disorder analysis
- PPG-based health monitoring
- Biomedical signal visualization platform
- Sleep quality analysis system

4. IoT and Smart Healthcare

- Remote patient monitoring system
- Smart hospital monitoring platform
- IoMT healthcare gateway
- Home healthcare monitoring system
- Emergency health alert system

5. Precision Medicine and Health Analytics

- Personalized health recommendation system
- Disease risk prediction model
- Healthcare data analytics dashboard

- Digital biomarker identification
- Population health analytics

Suggested Reference Materials

1. Eric Topol, **Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again**, Basic Books.
2. John G. Webster, **Medical Instrumentation: Application and Design**, Wiley.
3. Rangaraj M. Rangayyan, **Biomedical Signal Analysis: A Case Study Approach**, Wiley-IEEE Press.
4. Aurélien Géron, **Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow**, O'Reilly Media.
5. Mark Braunstein, **Health Informatics on FHIR**, Springer.

Industry-Oriented Problem Statements

Students may select problems related to:

1. Remote healthcare delivery
2. Preventive healthcare
3. Aging population care
4. Chronic disease monitoring
5. Smart hospitals
6. Healthcare accessibility in rural areas
7. Medical device innovation
8. AI-assisted diagnosis
9. Healthcare data security