# CENTRAL UNIVERSITY OF PUNJAB, BATHINDA

# &

# ALL INDIA INSTITUTE OF MEDICAL SCIENCES, BATHINDA

## SYLLABUS

## PG Diploma in AI for Digital Imaging and Healthcare Data

**Session :2025-26**

# Proposed Course Curriculum
# PG Diploma in AI for Digital Imaging and Healthcare Data

## 1. Course Description:

AI is an emerging area and is affecting research in almost all disciplines. Thus, there is a vital need to train students and researchers from various medical streams in the area of AI and deep learning. The course is designed for PG students and Ph.D. research Scholars. The course will be based on case studies from various disciplines with hands-on training. Artificial Intelligence holds the potential to revolutionize healthcare and help find solutions to the challenges faced by the healthcare industry. Focusing on automation, Big Data, and Data Analytics, AI surpasses the limitations of traditional analytics and diagnosis techniques.

The automated analysis will help reach patients remotely and assist in faster diagnosis and treatment. Clinical decision-making using supervised deep learning and different medical image modalities has shown great promise. This course aimed to apply deep learning methods to detect different diagnoses and treatment needs based on clinical photographs and radiographs. Deep learning-based techniques showed significantly superior diagnostic performance, measured by classification accuracy, compared to experienced medical practitioners for screening different diagnoses and treatment needs.

The Course provides a broad and practical overview of AI, Deep Learning, and concepts in rapidly developing areas of healthcare. Topics are relevant for the students and faculty of the computer fraternity, Medical Practitioners, and applied investigators (Medical Science and Engineering).

## 2. About the Institutions

### a. Central University of Punjab

The Central University of Punjab was established in 2009 along with other new Central Universities by an Act of Parliament (No 25, of 2009). Central University has completed a remarkable journey of 14 years. The university is accredited with an 'A+' grade in 2021 in the second accreditation cycle by NAAC. It has secured rank in the top 100 institutes in 2019, 2020, 2021and 2022 in the University category of NIRF. It is credited with the highest per capita research funding. The university has the mission to provide a wide range of instructional and research facilities across integrated and cross-disciplines, promote innovation in teaching, learning, and research, and cross-pollinate new ideas, new technologies, and new world-views. It aims to create an ignited workforce responsive to regional, national, and global needs in tune with academia, industry, and business requirements.

The university has expanded to 500 acres of land in Ghudda village. The campus is environment-friendly and energy-efficient, and its Master Plan has provisionally been certified with a five-star rating by the GRIHA Council and TERI. It has 31 departments and 11 schools in the Sciences, Technology, Education, Humanities, Social Sciences, and Law disciplines. It offers PG and Ph.D. programs in these disciplines.

The University has been a forerunner in research projects and publications among the newly established Central Universities, as evidenced by the Faculty to Projects and Faculty Publications Ratio.

### b. AIIMS Bathinda

AIIMS Bathinda is one of the apex healthcare institutes being established by the Ministry of Health & Family Welfare, Government of India, under the Pradhan Mantri Swasthya Suraksha Yojna (PMSSY).

## 3. Motivation

The PG Diploma is designed to impart knowledge on recent trends of AI in Healthcare, especially in the field of Medical Image Analysis using Deep Learning. Deep Learning is an alternative to task-specific algorithms and learns from data. Deep neural networks are a vital technology behind computer-aided systems, autonomous surgeries, and many other healthcare systems. The unstructured data in text and images carry a wealth of information, but their representation, understanding, and analysis are complex using traditional techniques. The field of deep learning has brought a revolution in healthcare using computer vision.

## 4. Outline

In the one-year program, the students will learn the basics of machine learning, programming and Python programming, neural networks, and deep neural networks, focusing on convolutional neural networks widely used for medical image analysis. The students will also be exposed to different medical image modalities, environments, and health issues, and they will finally develop a project using AI and medical data.

## 5. Objectives of the Programme:

The program provides a broad and practical overview of available techniques and concepts in AI and other Smart Technologies in the Healthcare System. The program will support the students with a working knowledge to communicate and collaborate effectively with experts trained outside his/her domain of expertise. The computer scientist will acquire a working knowledge of which techniques from machine learning are helpful and how to apply them in healthcare. The program's scope is intentionally broad since the aim is to provide the student with a comprehensive conceptual and practical overview of this interdisciplinary area. Yet the program will include practical computer exercises to ground the lectures in hands-on knowledge. The course is relevant for researchers from academia or industry. Students can advance to further studies in selected sub-areas after completing the course. Alternatively, the student develops the background and ability to collaborate and identify the relevant specialists in the appropriate sub-area.

**The primary program objectives are as follows**

1. *Understand the concept of AI and Deep learning methods specifically for healthcare technology.*
2. *Understand the concept of human anatomy and different medical imaging techniques.*
3. *Be able to build, train, and apply deep learning models to area-specific problems of medical science.*

## 6. Eligibility:

Minimum Qualification:

- Bachelors (four years or equivalent) or Masters in Science / Engineering / Medicine / Pharmacy
- Desirable: Coding experience is Desirable.

7. **Duration of Program:** 1 Year (2 Semesters)

8. **No. of seats:** 15

9. Programme Fee : ₹----------/ Semester

**10. Top Digital Health Jobs to Watch Out**

- Healthcare Data Analyst
- Research Scientist, Health AI
- Senior Medical Imaging Software Engineer
- Research Scientist - Healthcare Image Analytics
- Digital Health Consultant
- Digital Health Developer And more

**Course Structure of PG Diploma in AI for Digital Imaging and Healthcare Data**
**SEMESTER-I**

| Course Code | Course Title | Course Type | Credit Hours | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | Cr |
| PGDAI.101 | Fundamentals of Computer Programming | Bridge (Elective) | 4 | 0 | 0 | 4 |
| PGDAI.102 | Basics of Cell Biology | | | | | |
| PGDAI.103 | Introduction to Smart Technologies Revolution in Healthcare | Foundation (AIIMS) | 4 | 0 | 0 | 4 |
| PGDAI.104 | Machine Learning Basics for Health Data | Core | 2 | 0 | 4 | 4 |
| PGDAI.105 | Medical Imaging: Types and Properties | Core (AIIMS) | 2 | 0 | 4 | 4 |
| **Laboratory Practices** | | | | | | |
| PGDAI.106 | Python Programming | Skill Development | 0 | 0 | 4 | 2 |
| **Total Credits** | | | **12** | **0** | **10** | **18** |

**Course Structure of PG Diploma in AI for Digital Imaging and Healthcare Data**
**SEMESTER-II**

| Course Code | Course Title | Course Type | Credit Hours | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | Cr |
| PGDAI.201 | Deep Learning and Neural Networks | Core | 3 | 0 | 4 | 5 |
| PGDAI.202 | Medical Ethics and AI | Core (AIIMS) | 2 | 0 | 0 | 2 |
| PGDAI.203 | Impact of AI on Clinical Practices | AIIMS | 3 | 0 | 0 | 3 |
| **Laboratory Practices** | | | | | | |
| PGDAI.204 | Deep Learning in Vision/Imaging | Skill Development | 0 | 0 | 4 | 4 |
| PGDAI.205 | Project-based Learning/ Dissertation | Skill Development | 0 | 0 | 10 | 10 |
| **Total Credits** | | | **7** | **0** | **18** | **22** |
| **Total Credits (I & II Semester)** | | | **40** | | | |

**SEMESTER – I**

**Course Code: PGDAI.101**
**Course Title: Fundamentals of Computer Programming** **Total Hours: 60**

**Course Objectives:** This course is designed to explore computing and to show students the art of computer programming and its fundamentals. Students will also become familiar with different types of data structures and their applications and learn various types of algorithmic techniques and strategies. To understand the concept of computer fundamentals. To learn the fundamental concept of programming and data structure.

**Course Learning Outcomes:** After completion of the course, students will be able to:
**CLO1:** Comprehend concepts related to computer hardware and software, draw flowcharts and write algorithm/pseudocode.
**CLO2**: Understand the knowledge of programming languages used
**CLO3**: Understand the concepts of arrays, strings, pointers, and functions.
**CLO4**: Understand the appropriate use of different data structures.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I** | **Computer Fundamentals:** Classification of Computers, Application of Computers, Basic Organization of Computers, Input and Output Devices, Computer Memory, Computer Software. Compiler & Interpreters, Algorithm, Flowcharts, Pseudocode, Generation of Programming Languages. | **CLO1** |
| | **Activities:** Assignment-Based Learning | |
| **II** | **Fundamental Concepts of Programming Language**: Character Set, Data Types, Identifiers, Constant, Variable, Operators, Conditional Statements IF-Else, Switch, Looping-For Loop, While Loop, Do-While Loop. | **CLO2** |
| | **Activities:** Exercise-based learning | |
| **III** | **Array & Functions:** Arrays: One-dimensional, Two-dimensional, and Multi-dimensional arrays, operations on array: traversal, insertion, deletion, merging and searching, String: Declaration, String Operations. Function: Definition, Call and return, Call by value, Call by reference, Recursive functions. | **CLO3** |
| | **Activities:** Exercise-based learning | |
| **IV** | **Data structures:** Advantage of data structure, Time complexity and Space complexity, Arrays, Linked-lists, Strings and String Processing, Stacks, Queues, Recurrence Relations, Analysis of iterative and recursive algorithms. Searching and Sorting: Linear Search, Binary Search, Bubble Sort, Selection Sort, Non-linear Data structure: Tree, Graph | **CLO4** |

| | | |
|---|---|---|
| | **Activities:** Visual Modelling of Data structures | |

**Transactional Modes:**

- Lecture
- Blended Learning
- Collaborative Learning
- Peer Learning/Teaching

**Suggested Readings:**


- Nakov, S., & Kolev, V. (2013). Fundamentals of Computer Programming with C#: The Bulgarian C# Book. Faber Publishing.
- Kanetkar, Y. P. (2022). Let Us C. 19th Edition, New Delhi: BPB Publications.
- Balagurusamy. (2019). Programming in ANSI C. 8th Edition, New Delhi: Tata Mcgraw-Hill.
- Lucas. 2004. Information Technology for Management. McGraw Hill.
- Norton P. 1998. lntroduction to Computers. 2nd Ed. Tata McGraw Hill.
- Rajaraman V. 2006. lntroduction to lnformation Technology. Prentice Hall of India

**Course Code:PGDAI.102**
**Course Title: Basics of Cell Biology**

**Total Hours: 60**

**Course Outcomes**

After completion of course, students would be able to:
CLO1: Understanding structures and functions of various cellular organelles.
CLO2: Conceptualization of basic cellular mechanisms.
CLO3: Conceptualization of molecular mechanisms involved in cellular functioning.
CLO4: Understanding the molecular processes of DNA replication

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| I<br>12 Hours | Introduction to the cell: Models of membrane structure, Membrane proteins, Membrane carbohydrates, Membrane transport of small molecules, Membrane transport of macromolecules and particles. Structural organization and function of intracellular organelles: The lysosomes, Ribosomes, The peroxisomes, The Golgi apparatus, The endoplasmic reticulum, Mitochondria. | CLO1 |
| | **Learning Activities**: Learning on the basis of Assignment and Discussion | |
| II<br>14 Hours | Cell division and cell cycle: Overview of the cell cycle and its control, molecular mechanisms for regulating mitotic and meiotic events, Amitosis, Cell cycle control, Checkpoints in cell cycle regulation. | CLO2 |
| | **Learning Activities**: Learning on the basis of Assignment and Discussion | |
| III<br>16 Hours | Nucleic acids, Genes and Genome organization: Chemical structure of DNA and base composition, Watson-Crick model, mitochondrial DNA, Chromosome Structure, Chromatin and the Nucleosome, Chromatin structure: euchromatin, heterochromatin, Constitutive and facultative heterochromatin, Regulation of chromatin structure and nucleosome assembly, typical structure of a eukaryotic genes including various regulatory elements. | CLO3 |
| | **Learning Activities**: Learning on the basis of Assignment and Discussion | |
| IV<br>14 Hours | Transcription and mRNA processing: Different forms of RNA: mRNA, tRNA, rRNA and other Types of RNA Eukaryotic transcription: Initiation, Elongation & Termination. Translation: Genetic code, eukaryotic translation, the translation machinery, mechanisms of chain initiation, elongation and termination | CLO4 |

| | | |
|---|---|---|
| | **Learning Activities:** Learning on the basis of Assignment and Discussion | |

**Transactional Modes:**

- Lecture
- Flipped Learning
- Collaborative Learning
- Peer Learning/Teaching
- Online Teaching Tools

**Suggested Readings:**

1. Alberts, B., Heald, R., Johnson, A., Morgan, D., Raff, M. Roberts, K., and Walter, P. (2022). Molecular Biology of the cell. Garland publishers, Oxford.
2. Celis, J.E. (2006). Cell biology: A laboratory handbook, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P.K. (2018). Cytology, Genetics and Evolution. Rastogi publications, Meerut, India.
4. Karp, G. (2022). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc. New Delhi, India.

**Course Code: PGDAI.103**
**Course Title: Introduction to Smart Technologies Revolution in Healthcare**
**Total Hours: 60**
**Course Objectives:** The objective of this course is to:
Smart technologies affect and change various aspects of society and its activities. Healthcare is also at the beginning of this transformation. The potential use of AI, robotics, IoT technologies in healthcare needs healthcare professionals with knowledge of these technologies to enable interactive and explanatory study and ensure the quality of smart technology systems to increase patient safety. The course introduces and provides basic knowledge about various smart technologies used in healthcare system and its application.
**Course Learning Outcomes:** After completion of course, students would be able to:
**CLO1:** Train machine learning models for classification tasks using real-world 3D medical imaging data.
**CLO2:** Integrate models into a clinician's workflow and troubleshoot deployments.
**CLO3:** Build machine learning models in a manner that is compliant with US healthcare data security and privacy standards
**CLO4:** Understand the secure and private use of healthcare information devices using computer systems

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I** | **AI:** Motivation of AI in healthcare, what is AI and machine learning and their workflow, Best practices of AI applications to promote fair and equitable healthcare solutions, applications of AI in healthcare: improving medical diagnosis, speeding up drug discovery, transforming patient experience, managing healthcare data, performing robotics surgery, AI for medical image analysis and imaging, healthcare system analysis | **CLO1** |
| | **Activities: Group Discussion, Case study-based learning** | |
| **II** | **IoT/ Biomedical devices:** what is IoT, Role of IoT in healthcare industry, IoT healthcare system architecture, applications of IoT: implantable glucose medical systems, activity tracker during cancer treatment, heart monitors and medical alert system, medical alert system, wearable's to fight depression, benefits and challenges of using IoT in healthcare, describe various biomedical devices such as wearable health monitoring devices, Nano technology based devices and implantable medical devices. | **CLO2** |
| | **Activities: Simulation-Based Learning** | |
| **III** | **Robotics:** Definition and history of robotics, basic concepts and terminology in robotics, overview of robotic systems and components, types of robots used in healthcare, applications of robotics in healthcare, surgical robotics, rehabilitation robotics, robotics nursing and patient care. | **CLO3** |
| | **Activities: Group Discussion, Case study-based learning** | |

| | | |
|---|---|---|
| **IV** | **Secure health information:** Introduction to healthcare information management, overview of healthcare information management, importance of security and privacy in healthcare, security in Electronic health records (EHR), IoT, artificial intelligence and machine learning security in healthcare. | **CLO4** |
| | **Activities: Group Discussion, Case study-based learning** | |

**Transactional Modes:**

- Lecture
- Blended Learning
- Collaborative Learning
- Peer Learning/Teaching

**Suggested Readings:**


- Chakraborty, C., Banerjee, A., Garg, L., & Rodrigues, J. J. (2020). Internet of medical things for smart healthcare. In Studies in big data (Vol. 80). Cham, Switzerland: Springer.
- Saranya, S., & Priya, S. (2023). Healthcare Revolution and Integration of Artificial Intelligence. In Translating Healthcare Through Intelligent Computational Methods (pp. 67-79). Cham: Springer International Publishing.
- Paul, S., & Bhatia, D. (Eds.). (2020). Smart healthcare for disease diagnosis and prevention. Academic Press.
- Yarali, A. (2023). From 5G to 6G: Technologies, Architecture, AI, and Security. John Wiley & Sons.
- Zhao, W., Luo, X., & Qiu, T. (Eds.). (2018). Recent Developments in Smart Healthcare.

**Course Code: PGDAI.104**
**Total Hours: 60**
**Course Title: Machine Learning Basics for Health Data**

**Course Objectives:** The objective of this course is to:
To help students explain the concept of how to learn patterns and concepts from data without being explicitly programmed. To analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances

**Course Learning Outcomes:** After completion of course, students would be able to:
**CLO1**: Describe machine learning approaches.
**CLO2:** Discuss features that can be used for a particular machine learning approach in healthcare applications.
**CLO3**: Compare and contrast the pros and cons of various machine learning techniques.
**CLO4:** Understand the machine learning concepts and their type to solve various problems

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**30 Hours** | Introduction to machine learning, Human Learning, Machine Learning, Types of Machine learning, Application of machine learning, Basic Types of data in machine learning, Data quality and remediation, Data Pre-processing, Basics of feature engineering: feature selection, feature extraction, Similarity measures. | **CLO1** |
| | **Activities:** Assignment-Based Learning | |
| **II**<br>**30 Hours** | Training, and Testing, Training a model: holdout method, K-fold Cross-validation. Evaluating Machine Learning Algorithms and Model Selection, Performance Measures: Confusion Matrix, Accuracy, Recall Precision, F1-Score. Introduction to Learning Techniques: Supervised Learning (Regression) Linear models: Linear Regression, Logistic Regression, Polynomial Regression, Generalized Linear Models. Improving Accuracy in the Regression Model. | **CLO2** |
| | **Activities:** Exercise-based learning | |
| **III**<br>**30 Hours** | Introduction to learning Techniques: Supervised Learning (Classification) ● Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes ● Support Vector Machines, Nonlinearity and Kernel Methods ● Beyond Binary Classification: Multiclass/Structured Outputs, Ranking. | **CLO3** |
| | **Activities:** Exercise-based learning and practical hands-on training, Brainstorming. | |
| **IV**<br>**30 Hours** | Unsupervised Learning ● Clustering: K-means/Kernel K-means ● Dimensionality Reduction: PCA and kernel PCA ● K-Medoids, Introduction Ensemble Methods (Boosting, Bagging, Random Forests), Semi-supervised Learning, Active Learning, Reinforcement Learning, | **CLO4** |

| | | |
|---|---|---|
| | **Activities:** Exercise-based learning and practical hands-on training. | |

**Transactional Modes:**

- Lecture
- Blended Learning
- Collaborative Learning
- Peer Learning/Teaching

**Suggested Readings:**


- Dutt, S., Chandramouli, S. and Das, A. (2020). Machine Learning. Pearson Press.
- Zhang, T. (2023). Mathematical analysis of machine learning algorithms. Cambridge University Press.
- Murphy, K. (2012). Machine Learning: A Probabilistic Perspective. Cambridge: MIT Press.
- Hastie, T., Tibshirani, R., and Friedman, J. (2009). The Elements of Statistical Learning. New York: Springer.
- Bishop, C. (2007). Pattern Recognition and Machine Learning, New York: Springer.
- Shalev-Shwartz, S., and Ben-David, S. (2014). Understanding Machine Learning: From Theory to Algorithms. New Delhi: Cambridge University Press.

**Course Code: PGDAI.105**
**Course Title: Medical Imaging: Types and Properties** **Total Hours: 90**

**Course Objectives:**
Medical imaging encompasses various modalities that play a crucial role in diagnosis and treatment. Different types of medical imaging techniques have evolved over the years, including X-ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), Single-Photon Emission Computed Tomography (SPECT), and ultrasound imaging. These modalities generate diverse types of images, such as brain CT images, MRI images of different organs, cardiac images, and images of various regions in the human body. This course provides an in-depth exploration of various medical imaging modalities used in clinical practice. Students will learn about the principles, techniques, and applications of different imaging methods, including X-ray, computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, and nuclear medicine. Emphasis will be placed on understanding the physical principles behind each imaging modality, image acquisition, processing techniques, and clinical uses.

**Course Outcomes**
After completion of course, students would be able to:
CLO1: Demonstrate a comprehensive understanding of the fundamental principles underlying various medical imaging modalities.
CLO2: Describe the role of contrast agents in CT and MRI
CLO3: Compare and contrast the strengths, limitations, and clinical applications of different medical imaging techniques
CLO4: Critically analyze current research literature and emerging trends in medical imaging technology

| **Activities: Units/Hours** | **Contents** | **Mapping with Course Learning Outcome** |
|---|---|---|
| I<br>30 Hours | **Introduction to Medical Imaging**<br>Overview of medical imaging modalities, Historical development and evolution of medical imaging, Basic principles of image formation and interpretation<br>**X-ray:** Principles of X-ray production and interaction with matter, X-ray image formation and detection and Clinical applications and limitations of X-ray imaging.<br>**Ultrasound Imaging**:<br>Principles of ultrasound wave propagation and reflection, Transducer technology and ultrasound image formation, Doppler ultrasound and its clinical applications, Advantages and limitations of ultrasound imaging. | CLO1 |
| | **Learning Activities**: Assignment, case studies and Experiential on based learning | |

| | | |
|---|---|---|
| II<br>30 Hours | **Computerized Tomography (CT):**<br>Principles of CT scanning, Image reconstruction techniques, Contrast agents and their role in CT imaging, Clinical applications and advancements in CT technology.<br><br>Image Processing System, CT Software, Scanner Control, and Image Reconstruction, Image Display, Archiving, Recording Systems, CT Control Console Key Board Controls<br>Overview of performing a CT scan, Image acquisition protocols, Anatomy – clinical indications and contraindications.<br>Differences between convention and spiral/helical CT Scanners, High-voltage and low-voltage scanners, Slip-ring cylinders and slip-ring disk scanners, Composite and wire scanners.<br>Multislice CT detector design and terminology, Applications of volume scanning, CT Contrast media, Advanced CT imaging techniques.<br><br>**Learning Activities**: Analysis of various tools and Case Studies | CLO1,<br>CLO2 |
| III<br>30 Hours | **Magnetic Resonance Imaging (MRI)**<br>Basic principles of MRI: Magnetism, Nuclear Magnetism, Atomic Structure<br>Magnetic resonance imaging hardware, Image acquisition, Image processing/ Display/ Manipulation, The Magnetic Resonance Imaging Computer, Storage capacity, Computer speed.<br>Image weighting and contrast<br>Assessing the interaction of imaging sequence parameters- Image quality, Image contrast Factors which affect contrast, Pulse sequence repetition time (TR), echo time(TE) Effective echo time (ETE), Echo train length (ETL), Inversion time (TI) Flip angle (FA) Matrix Field of view ,Number of acquisition slice thickness , echo train spacing (ET Relaxation rates, Flow Contrast media , Spatial resolution, Inter slice gap, Matrix Field of view , Fast scan technique , Echo train length, Echo train spacing, Signal to noise ratio , Types of noise , Factors affecting SNR, Proton density.<br>Contrast agents in MRI, Clinical applications and emerging trends in MRI<br><br>**Learning Activities**: Case Studies | CLO1,<br>CLO2 |

| | | |
|---|---|---|
| IV<br>30 Hours | **Nuclear Medicine Imaging:**<br>Principles of radioactive decay and tracer kinetics, Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET), Radiopharmaceuticals and their clinical uses, Emerging technologies and applications in nuclear medicine imaging<br><br>Comparison of various medical image modalities. Overview of image-guided interventions, Role of medical imaging in minimally invasive procedures, Quantitative analysis methods in medical imaging, Clinical decision support systems and computer-aided diagnosis<br><br>Future directions and challenges in interventional imaging | CLO1, CLO3, CLO4 |
| | **Learning Activities**: Group discussion | |

**Transactional Modes:**

- Lecture
- Case Studies
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Melville, S., and Goddard, W. (1996). Research methodology: An introduction for science & engineering students. South Africa: Juta Academic.
2. Goddard, W., and Melville, S. (2001). Research Methodology: An Introduction. South Africa: Juta Academic.
3. Kumar, R. (2019). Research Methodology: A Step by Step Guide for beginners. New Delhi: SAGE Publications Ltd.
4. Halbert, (2006). Resisting Intellectual Property. New Delhi: Taylor & Francis Ltd.
5. Mayall, (2011). Industrial Design. New Delhi: McGraw Hill.
6. Niebel, (1974). Product Design. New Delhi: McGraw Hill.
7. Asimov, M. (1976). Introduction to Design. United States: Prentice Hall.
8. Merges, R. P., Menell, P. S., & Lemley, M. A. (2003). Intellectual Property in New Technological Age. United States: Aspen Law & Business.
9. Flick, U. (2011). Introducing research methodology: A beginner's guide to doing a research project. New Delhi: Sage Publications India.
10. Research Articles from SCI & Scopus indexed Journals.

**Course Code: PGDAI.106**
**Course Title: Python Programming** **Total Hours: 30**

**Course Objectives:** The objective of this course is to:

- Introduces the concepts of Python Programming.
- Gives the students the opportunity to learn Python Modules.
- Practically develop Python code to perform various activities

**Course Learning Outcomes:** After completion of course, students would be able:

- CLO1: Use basics python programming constructs and various Python modules required for Machine Learning.
- CLO2: Write scripts in Python language for Healthcare Data related activities.
- CLO3: Prepare python scripts to perform activities related to Image Classification.

1. Variables and Variables type, Data types, Data Types Conversion, Operators
2. Python Decision making (if, el if, else, nested if),
3. Python loops (while, for, nested loops), Break and continue statements.
4. Sequence introduction, Number operations, String Operations
5. Implementation of List and operations.
6. Implementation of Tuples and its operation
7. User defined functions, Functions with parameters, Keywords and optional parameters
8. Modules, Standard Modules (Sys, Math, Time)
9. Python File handling: Read Write and Update operations
10. Implementation of Various Supervised Machine Learning Algorithms
11. Implementation of Various Unsupervised Machine Learning Algorithms
12. Implementation of Supervised ANN
13. Implementation of Un-Supervised ANN
14. Analysis of real-world data from Kaggle.com/dataworld.org website Implementation of various Healthcare related tasks.

**Transactional Modes:**

- Lecture
- Blended Learning
- Collaborative Learning
- Peer Learning/Teaching

**Suggested Readings:**


- Lutz, M., and Ascher, D. (2003). Learning Python. California: O'REILLY Media.
- Berry, P. (2016). Head First Python, California: O'REILLY Media.
- Jose, J., and Lal, P. S. (2016) Introduction to Computing & Problem Solving with Python. New Delhi: Khanna Books.
- Lutz, Mark. (2012). Learning Python. New Delhi: Shroff publishers & distributors pvt. ltd.
- Miller, Bradley N., Ranum, David L. (2014). Programming in context. Burlington: Jones & Bartlett learning.

# SEMESTER – II

**Course Code: PGDAI.201**
**Course Title: Deep Learning and Neural Networks** **Total Hours: 60**

**Course Objectives:** Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems.

**Course Learning Outcomes:** After completion of course, students would be able to:

**CLO1:** Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.

**CLO2:** Implement deep learning algorithms and solve real-world problems.

**CLO3:** The main objective of this course is to make students comfortable with tools and techniques required in handling large amounts of datasets. They will also uncover various deep learning methods in NLP, Neural Networks etc.

**CLO4:** Several libraries and datasets publicly available will be used to illustrate the application of these algorithms. This will help students in developing skills required to gain experience of doing independent research and study.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I** | Introduction to CNNs: Overview of artificial neural networks and their applications. Introduction to CNNs and their significance in computer vision tasks. Basic concepts of convolution and pooling operations.<br><br>Convolutional Layer: Understanding the convolution operation and its role in CNNs, Convolutional filters and their properties, Padding and stride in convolutional layers, Feature maps and activation functions. Pooling Layer: Different types of pooling operations (e.g., max pooling, average pooling), Importance of pooling in downsampling and dimensionality reduction, Spatial invariance and pooling , Activation Functions<br><br>**Activities:** Assignment Based Learning, Brainstorming | **CLO1** |
| **II** | Commonly used activation functions in CNNs (e.g., ReLU, sigmoid, tanh).<br><br>Role of activation functions in introducing non-linearity.<br><br>Activation functions for different layers in a CNN. | **CLO2** |

| | | |
|---|---|---|
| | Fully Connected Layer: Understanding the fully connected layer and its role in CNN architectures, Connection between convolutional and fully connected layers.<br><br>Weight sharing and parameter reduction in CNNs. | |
| | **Activities:** Assignment Based Learning, Brainstorming. | |
| **III** | CNN Architectures: Introduction to popular CNN architectures (e.g., LeNet-5, AlexNet, VGGNet, ResNet).<br><br>Analysis of the architectural design choices and their impact on performance.<br><br>Transfer learning and fine-tuning pre-trained CNN models.<br><br>Training CNNs: Loss functions for CNNs (e.g., softmax, cross-entropy), Backpropagation and gradient descent optimization, Regularization techniques (e.g., dropout, L1/L2 regularization), Batch normalization and its effect on training CNNs. | **CLO3** |
| | **Activities:** Exercise-based learning and practical hands-on training. | |
| **IV** | Data Augmentation: Importance of data augmentation in CNN training, Common data augmentation techniques for image data.<br><br>Image preprocessing and normalization.<br><br>CNN Applications: CNNs for image classification and object detection, CNNs for semantic segmentation and instance segmentation. | **CLO4** |
| | **Activities:** Exercise-based learning and practical hands-on training. | |

**Transactional Modes:**

- Lecture
- Blended Learning
- Collaborative Learning
- Peer Learning/Teaching

**Suggested Readings:**


- HandS-On Unsupervised learning with Python by Giuseppe Bonaccorso – Packt publication
- Python Deep Learning by Daniel Slater, Gianmario Spacagna and Peter Roelants – Packt Publication
- Machine Learning with Tensorflow by Nishant Shukla
- Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016..
- Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.
- Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
- Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
- Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

**Course Code: PGDAI.203**
**Course Title:Medical Ethics and AI** **Total Hours: 30**

**Course Objectives:**
Course Description:
This course explores the intersection of medical ethics and artificial intelligence (AI), examining the ethical implications of integrating AI technologies into healthcare systems. Students will explore various ethical frameworks and principles as they apply to AI in medicine, critically analyze case studies, and engage in discussions on topics such as patient privacy, algorithmic bias, autonomous decision-making, and the role of healthcare professionals in an AI-driven healthcare landscape.

Critically analyze case studies to identify ethical dilemmas and propose ethical solutions in AI-driven healthcare scenarios.
Develop ethical reasoning and decision-making skills through class discussions, debates, and written assignments.

**Course Outcomes**
After completion of course, students would be able to:
**CLO1:** Understand the fundamental principles of medical ethics and their application in the context of AI in healthcare and Evaluate the ethical implications of AI technologies in medical diagnosis, treatment, and research.
**CLO2:** Explore the impact of AI on healthcare disparities, patient autonomy, and privacy.
**CLO3:** Discuss regulatory frameworks and guidelines for the ethical development and deployment of AI in medicine.
**CLO4:** Develop strategies for ethical decision-making and responsible deployment of AI technologies in healthcare settings.
**CLO5:** Develop ethical reasoning and decision-making skills through class discussions, debates, and written assignments.

| **Activities: Units/Hours** | **Contents** | **Mapping with Course Learning Outcome** |
|---|---|---|
| I<br>8 Hours | **Introduction to Medical Ethics and AI:** Overview of medical ethics principles, Introduction to artificial intelligence in healthcare Ethical considerations in the use of AI technologies.<br>Overview of ethical principles in healthcare: Historical perspectives on healthcare ethics, The importance of ethical reasoning in healthcare practice and policy<br>**Patient Autonomy and Informed Consent:** Importance of patient autonomy in healthcare decision-making, Challenges in obtaining informed consent for AI-driven interventions, Case studies on informed consent issues in AI-enabled diagnosis and treatment | CLO1 |
| | **Learning Activities**: Assignment, and Case studies | |

| | | |
|---|---|---|
| II<br>8 Hours | **Privacy and Confidentiality:** Patient data protection and privacy concerns, Ethical issues in data collection, storage, and sharing in AI-enabled healthcare systems, Regulatory frameworks and guidelines<br>**AI in Medical Diagnosis:** Ethical implications of AI in diagnostic decision-making, Bias and fairness in AI algorithms, Case study analysis: Diagnostic AI systems<br>**AI in Treatment and Patient Care:** Ethical considerations in AI-assisted treatment planning, Patient-provider relationships in the era of AI, Case study analysis: AI-driven treatment decisions | CLO1, CLO2 |
| | **Learning Activities**: Assignment, and Case studies | |
| III<br>8 Hours | **AI in Medical Research:** Ethical challenges in using AI for medical research, Informed consent and data privacy in AI-driven research, Case study analysis: Ethical issues in AI-enabled research studies<br>**Healthcare Disparities and AI:** Impact of AI on healthcare disparities, Addressing bias and equity in AI algorithms, Case study analysis: AI interventions and healthcare equity.<br>**Patient Autonomy and AI:** Patient autonomy in the context of AI-assisted decision-making, Shared decision-making with AI systems Case study analysis: Patient perspectives on AI in healthcare | CLO3, CLO4 |
| | **Learning Activities**: Assignment, case studies and Group discussion | |
| IV<br>6 Hours | **Ethical Decision-Making in AI:** Ethical reasoning and decision-making frameworks, Role-play exercises: Ethical dilemmas in AI-driven healthcare, Group discussions and debates on controversial AI applications.<br>**Future Directions and Conclusion:** Emerging trends in AI and healthcare ethics, Reflections on the ethical implications of AI in medicine | CLO5 |
| | **Learning Activities**: Assignment, case studies and Group discussion | |

**Transactional Modes:**

- Lecture
- Case Studies
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Stanley Joel Reiser et al., Ethics in Medicine: Historical Perspectives and Contemporary Concerns.
2. John McMillan et al., Artificial Intelligence in Healthcare: Ethical Considerations and Guidelines.

**Course Code: PGDAI.203**
**Course Title: Impact of AI on Clinical Practices** **Total Hours: 45**

**Course Objectives:**
Course Description:

Studying the impact of AI on clinical practices involves exploring various facets of how artificial intelligence technologies are transforming healthcare delivery.

**Course Outcomes**
After completion of course, students would be able to:
**CLO1:** Understand the fundamental concepts of AI in healthcare and its various applications in clinical settings, including machine learning, natural language processing, and computer vision.
**CLO2:**Analyze the ethical implications of AI deployment in healthcare, considering issues such as patient privacy, data security, and compliance with regulatory frameworks governing AI applications in clinical settings.
**CLO3:**Apply AI algorithms for diagnosis and prognosis, including medical imaging interpretation, planning of ESWL in Kidney stones, and disease diagnosis, to enhance clinical decision-making and patient outcomes.
**CLO4:**Evaluate the role of AI in clinical decision support systems, including its benefits, challenges, and impact on treatment recommendations, to improve healthcare delivery and patient care.

| **Activities: Units/Hours** | **Contents** | **Mapping with Course Learning Outcome** |
|---|---|---|
| I<br>13 Hours | **Introduction to AI in Healthcare:** Definition of AI and its applications in clinical settings, Overview of machine learning, natural language processing, and computer vision in healthcare.<br>**Ethical and Regulatory Considerations:** Ethical implications of AI in healthcare, including privacy and data security, Regulatory frameworks governing AI applications in clinical settings.<br>**AI Tools for Diagnosis and Prognosis:** Use of AI algorithms for medical imaging interpretation (e.g., radiology, pathology), Use of AI in the planning of ESWL (Extracorporeal Shock Wave Lithotripsy) in Kidney stones, AI applications in diagnosing diseases and predicting outcomes. | CLO1, CLO3 |
| | **Learning Activities**: Assignment and Case studies | |

| | | |
|---|---|---|
| II<br>10 Hours | **Clinical Decision Support Systems:** The role of AI in assisting healthcare providers with treatment recommendations and the challenges and benefits of integrating AI into clinical decision-making.<br>**Precision Medicine and Personalized Treatment:** AI-driven approaches for personalized treatment plans based on genomic data, Case studies demonstrating the impact of AI on precision medicine.<br>**Learning Activities**: Assignment and Case studies | CLO2 |
| III<br>10 Hours | Patient Management and Monitoring: AI technologies for remote patient monitoring and chronic disease management, Virtual health assistants and chatbots in patient care.<br>Natural Language Processing in Healthcare: Applications of NLP for extracting insights from clinical notes and medical literature, Use of AI in automating medical documentation and coding.<br>**Learning Activities**: Assignment, case studies and Group discussion | CLO1,<br>CLO4 |
| IV<br>12 Hours | **Healthcare Operations and Resource Optimization:** AI tools for optimizing hospital workflows, resource allocation, and scheduling, Predictive analytics in healthcare operations management.<br>**AI in Drug Discovery and Development:** Role of AI in accelerating drug discovery and repurposing existing drugs, Challenges and opportunities in AI-driven pharmaceutical research.<br>**Future Directions and Challenges:** Emerging trends in AI for clinical practice (e.g., federated learning, explainable AI), Addressing biases and limitations of AI models in healthcare.<br>**Learning Activities**: Assignment, case studies, and Group discussion | CLO4 |

**Transactional Modes:**

- Lecture
- Case Studies
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Artificial Intelligence in Healthcare: A Leader's Guide to Winning in the New Age of Intelligent Health Systems" by Prashant Natarajan and Anil K. Jain
2. Clinical Decision Support Systems: Theory and Practice by Eta S. Berner
3. Precision Medicine: A Guide to Genomics in Clinical Practice by Jeanette J. McCarthy and Bryce A. Mendelsohn
4. Healthcare Analytics for Quality and Performance Improvement by Trevor L. Strome
5. AI in Drug Discovery: A Practical Guide" by Angus King

**Course Code: PGDAI.205**
**Course Title: Project-based Learning/ Dissertation**

**Course Objectives:**
In the Dissertation, the student shall have to carry out the activities/experiments to be completed during the Dissertation (as mentioned in the synopsis).

**Course Learning Outcomes**

The students would present their work to the evaluation Committee (constituted as per the university rules).
The Evaluation criteria shall be as detailed below:

| Evaluation Parameter | Maximum Marks | Evaluated By |
|---|---|---|
| Project Report and Implementation | 50 | **Supervisor** |
| Presentation and defense of research work | 50 | |
| **Total** | 100 | |