

# **INTERNSHIP PROGRAMME FOR UG DEGREE (SEMESTER-V)**

*(For the students admitted under New Curriculum and Credit Framework from the academic session 2023-24)*



<b>Course Title:</b> <b>An Introduction to Artificial Intelligence</b>	
<b>Internship Providing Organization (IPO):</b>	<b>Department of Physics, Bankura Sammilani College</b>
<b>Category of Course:</b>	<b>For UG DEGREE (SEM-V)</b>
<b>Duration:</b>	<b>60 Hours</b>
<b>Course Coordinator and Contact Details:</b>	<b>Dr. Priyam Das Mob: 9205660991</b>
<b>Mentors:</b>	<b>Mr. Chakradhar Rajowar Mr. Uttam Mandal Dr. Pradipta Chakraborty Mr. Narendranath Pal Mr. Surajit Bosu</b>
<b>Intake Capacity:</b>	<b>25 Students</b>
<b>Course Fees:</b>	<b>Rs. 100/- (Students from Host Institution) Rs. 400/- (Students from Other Institution)</b>

# SYLLABUS

## **Course Title: An Introduction to Artificial Intelligence [50 Marks/2 Credits/60 Hours]**

### **Learning Outcomes (LO)**

- Understand the conceptual foundations of quantum computation – including qubits, superposition, quantum gates, entanglement, and measurement.
- Differentiate between classical and quantum information, and recognize the key principles that distinguish quantum computing from conventional computing.
- Grasp the fundamental ideas in Artificial Intelligence and Machine Learning, including types of AI, learning paradigms, and basic neural network models.
- Appreciate the motivation behind Quantum Machine Learning, including its potential advantages over classical approaches and conceptual frameworks.
- Familiarize themselves with practical tools and software platforms (such as Qiskit, PennyLane, and TensorFlow Quantum) used in QML research and development.
- Explore emerging applications and interdisciplinary opportunities where QML is being actively researched and deployed, such as in chemistry, finance, and optimization.
- Engage in hands-on problem-solving and assignments that reinforce conceptual understanding and introduce them to real-world QML tools and techniques.
- Critically evaluate the ethical and societal impacts of AI and quantum technologies, fostering responsible and thoughtful application of such systems.

### **Unit 1: Introduction to Quantum Computation**

**[20 hrs.]**

**Qubits and Superposition:** Bits vs Qubits, Motivation for quantum computation - Advantages and limitations; Dirac notation, Superposition:  $|0\rangle$ ,  $|1\rangle$ , and  $\alpha |0\rangle + \beta |1\rangle$ , Measurement and probability amplitudes, multi-qubit states and tensor product, Visualization using the Bloch sphere (intuitive picture);

**Quantum Gates and Circuits:** Single-qubit gates: Pauli-X, Y, Z; Hadamard (H), Phase (S), T gates, multi-qubit gates: CNOT, Toffoli, SWAP, Unitary operations, Circuit diagrams and gate composition;

Geometric representation of qubit states, Visualization of superposition and gates, Quantum circuit basics;

**Entanglement and Measurement:** Definition and examples of entangled states, EPR pairs and Bell states, Measurement outcomes and nonlocal correlations, Role in quantum information;

**Quantum Information:** Pure vs mixed states, Density matrices (basic idea, no heavy math), No-Cloning Theorem - intuitive explanation and implications; Classical copying vs Quantum information preservation, Distinction from classical copying;

### **Hands-on -training/Assignment/Problem solving skill:**

**[10 hrs.]**

## **Unit 2: Basics of Artificial Intelligence**

**[15 hrs.]**

### **Introduction to Artificial Intelligence (AI) (4 hours)**

Definition and goals of AI, Brief history and evolution of AI; Components of AI: reasoning, learning, perception, language understanding; Symbolic AI vs. Statistical AI; Types of AI: (i) Based on Capabilities - Narrow AI, General AI, Super/Strong AI; (ii) Based on Functionality - Reactive machines, Limited memory, Theory of mind, Self-awareness; Domains of AI - Neural networks, Robotics, Expert system, Fuzzy logic system, Natural language processing (NLP); AI Ethics and Social impact - AI bias, fairness, job displacement, transparency, and decision accountability; Subsets of Artificial Intelligence – Machine Learning & Deep Learning;

### **Hands-on -training/Assignments/Problem solving skills:**

**[15 hrs.]**

### **Suggested Books and References:**

- Quantum Computation and Quantum Information, Michael A. Nielsen, Isaac L. Chuang, Cambridge University Press.
- Quantum Computing for Everyone, Chris Bernhardt, MIT Press.
- Dancing with Qubits: How Quantum Computing Works and How It Can Change the World, Robert S. Sutor, Packt Publishing.
- **Artificial Intelligence: A Guide for Thinking Humans**, *Melanie Mitchell*, Farrar, Straus and Giroux, McMillan Publishers.