Course Code	21CSE306J	Course Name	Quantum Computation	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*NilT*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*

Course Offering Department	*Department of Computing Technologies*	Data Book / Codes/Standards	*Nil*

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Gain knowledge about quantum computing and quantum mechanics*
CLR-2 :	*Analyze the Quantum Circuits*
CLR-3 :	*Utilize Open source Qiskit for quantum programing*
CLR-4 :	*Learn about Grover and deustch Jozsa quantum algorithms*
CLR-5 :	*Utilize the quantum concept and explore its applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*
CLO-1 :	*Identify the need of quantum computing and quantum mechanics*
CLO-2 :	*Explore the Quantum gates and Quantum Circuits*
CLO-3 :	*Develop the quantum programs for circuit optimization.*
CLO-4 :	*Incorporate the Quantum algorithms Deustch Jozsa and Grover*
CLO-5 :	*Demonstrate the different Quantum simulators and real time applications*

Program Learning Outcomes (PLO)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual &Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
1	*3*	-		-	-	-	-			-	-	-	-	-
2	*3*	*1*	-	-	-	-	-			-	-	-	-	-
2	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-
2	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-
1	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-

Unit-1

Need for Quantum Computing and fundamental concepts, Vector spaces, Probability, Complex numbers and mathematical preliminaries, Postulates of quantum mechanics, Bra-ket notations, Measurements, Composite systems, Bells state, Entanglement, Bloch sphere, Pure and Mixed states

Unit-2

Geometry of quantum states, Complexity classes, Turing machine, Turing machine concepts, Quantum gates, Quantum circuits, Quantum circuits design,

Unit-3

Quantitative measures of circuit, Analysis of quality of Circuits, Circuit optimization, Introduction to quantum parallelism, Deustch Algorithm, Deutsch Jozsa algorithm,

Unit-4

Introduction to Grover algorithm, Detailed walk through on Grovers algorithm, geometric visualization of Grovers iterations, grovers search applied to unstructured database, quantum Teleportation, shor algorithm, quantum fourier transform

Unit-5

Introduction to quantum applications, Research challenges of quantum, Introduction to QC Models, Physical Realization of Models,Varitional quantum eigen solver, quantum cryptograpgy-bb84 protocol,discussion of different use cases in quantum finance and quantum optimization.(QAOA)

LAB EXPERIMENTS:

Lab 1: *Python basics*
Lab 2: *Navigation on Circuit composer and Qiskit in Quantum Lab*
Lab 3: *Project preparation phase 1*
(Analysis of problem statement related to quantum computing)
Lab 4: *Quantum hardware and Simulators*
Lab 5: *implement single and multiple qubit gates*
Lab 6: *Project preparation phase 2*
(Design of the project based on problem statement)
Lab 7: *Quantum circuits*
Lab 8: *Visualization tools (State vector and Q-Sphere)*
Lab 9: *Project preparation phase 3*
(Implementation of quantum problem statement in cloud environment)
Lab 10 : *Quantum teleportation in Qiskit*
Lab 11: *Implementation of Grovers algorithm*
Lab 12: *Project preparation phase 4*
(Testing of the software implemented)
Lab 13: *project presentation and demo*
(use case developed)
Lab 14: *Project thesis preparation*
Lab 15: *Project report submission (Thesis of use case developed)*

Learning Resources	*1.Quantum Computation and Quantum Information. M. A. Nielsen and I. L. Chuang, Cambridge University Press* *2.Quantum Computing ,Vishal Sahni, Tata McGraw-Hill Publishing Company Limited,2007.* *3. Mikio Nakahara and Tetsuo Ohmi,"Quantum Computing", CRC Press, 2008* *4. N. David Mermin,"Quantum Computer Science", Cambridge, 2007* *5. https://qiskit.org/*	*6.An Introduction to Quantum Computing. P. Kaye, R. Laflamme, and M. Mosca, Oxford University Press, New York* *7. Quantum Computer Science. N. David Mermin:, Cambridge University Press* *8. Quantum Cryptography. D. Unruh:, Available online: https://courses.cs.ut.ee/all/MTAT.07.024/2017_fall/uploads/* *10. NIST Post Quantum Cryptography, Available online: https://csrc.nist.gov/projects/post-quantum-cryptography/round-2-submissions* *11. Quantum Algorithms for Cryptographically Significant Boolean Functions - An IBMQ Experience. SAPV Tharrmashastha, D. Bera, A. Maitra and S. Maitra, Springer 2020.*

	Bloom's Level of Thinking	Formative CLA – 1 Average of unit test (45%)		Life Long Learning CLA – 2 Practice (15%)		Summative Final Examination (40% Weightage)	
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	%	15%	-
Level 2	Understand	20%	-	-	30%	20%	-
Level 3	Apply	35%	-	-	35%	35%	-
Level 4	Analyze	30%	-	-	35%	30%	-
Level 5	Evaluate	%	-	-	%	%	-
Level 6	Create	%	-	-	%	%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Prabha Narayanan Qkrishi	Dr.Jayakumar Vaithiyashankar , Presidency University,Bengaluru.	Dr.M.Gayathri, Assistant Professor,CTECH
		Dr.R.Thilagavathy,Assistant Professor,CTECH

COURSE CODE & TITLE: 21CSE303P & Product design and Innovation

REGULATION : 2021
COURSE TYPE : INDUSTRY SUPPORTED ELECTIVE
COURSE OFFERED TO : SCHOOL OF COMPUTING

OFFERING INDUSTRY NAME AND ADDRESS:
Dr.Prabakaran Veerajaagdheswar,
Co-founder, Edurobo Technologies
Address: 257 JURONG EAST STREET
24 #10-431 Singapore, 600257

STUDENTS REGISTERED:

S. No.	BATCH	ACADEMIC YEAR	SEM	No. OF STUDENTS REGISTRED FOR THE COURSE
1	2022-2026	2023-2024	EVEN	30

COMPONENT WEIGHTAGE:

INTERNAL	EXTERNAL
70%	30%

RESULTS:

S. No.	BATCH	ACADEMIC YEAR	SEM	PASS %	TARGET	ATTAINMENT LEVEL
1	2021-2025	2023-2024	EVEN			

INTERNAL TEST COMPONENTS:
TOTAL No. OF UNITS: 5
TOTAL MARKS: 100

THEORY	INTERNAL
CLAT1 -Unit 1,Unit 2	Project Proposal and Research Skills (17%) • Observation Journal Students maintain a journal documenting their observations during the campus exploration. Emphasis on using the Like/Dislike analysis and User Observation data. • Problem Scoping Report • Journey Map Analysis
CLAT2 - Unit 3	Midterm Progress Assessment (13%) • Idea Generation Portfolio Portfolio showcasing individual and team-generated ideas. Include tree diagrams, functional diagrams, and storyline drafts. • Prototyping Evaluation Assessment of the created prototypes, emphasizing functionality and alignment with user needs.
CLAT3 - Unit 4	Software Proficiency Test (10%) • Design Project Using Software: Assigning a small design project where students apply learned software skills to create a visual or functional design
CLAT4 – Unit 5	Product Presentation (30%) • Product Refinement Report Submission detailing the process of refining the design based on testing and user feedback. • Participation and engagement in additional skills sessions on presentation, pitching, and effective communication
EXTERNAL	Reflective Journal (6%) Final Project Presentation Evaluation (7%) Final Prototype Demonstration (13%) Final Prototype Q&A Session (4%)

INNOVATIVE TEACHING PEDAGOGIES ADOPTED:

1. Project-Based Learning (PBL)
2. Design Thinking Workshops
3. Flipped Classroom
4. Guest Lectures from Industry Experts

Course Code	21CSE309JJ	Course Name	GPU POWERED COMPUTING)	Course Category		PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	NIL	Co- requisite Courses	NIL	Progressive Courses	
Course Offering Department	Computing Technologies	*Data Book / Codes / Standards*			

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	To understand the power of parallelism and OpenMP framework
CLR-2 :	To understand the design and implementation strategies of various applications of complex problems using MPI
CLR-3 :	To harness the parallel computing facilities for numerical methodswith OpenMP and MPI
CLR-4 :	To understand and to apply OpenACC over the massively parallel hardware
CLR-5 :	To execute applications using parallel programming models

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO) 1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	Program Specific outcomes PSO-1	PSO-2	PSO-3
CO-1:	Exhibit knowledge on basics of Parallel programming using OpenMP	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	To illustrate strategies of various applications of MPI programs	1	3	1	-		-	-	-	-	-	-	-	-	-	-
CO-3:	Apply the numerical methods in OpenMP and MPI	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Examine the concept of OpenACC in parallelization	2	1		-	2	-	-	-	-	-	-	-	-	-	-
CO-5:	Implement real time projects	2	-		1	2	-	-	-	-	-	-	-	-	-	-

Unit-1 : OpenMP

Motivation and need for parallelization, Examples and applications in scientific computing, Parallel programming paradigms, Terminology. OpenMP Programming : Basics, scope of variables, parallel loop directives, scheduling, critical directives

Unit-2 : MPI Programming

MPI Programming : Basics, point-to-point and collective communication, MPI derived data types, performance evaluation, advanced function calls.)

Unit-3: Numerical Methods with MPI and OpenMP

Numerical integration, explicit and implicit finite-differences, solution of system of linear equations, solution of partial differential equations

Unit-4 : OpenACC Motivation, Compute Constructs (Kernel, Parallel, Loop, Routine), Data Directives, Reductions, Atomics, Data Transfers, Asynchronous Processing, Multi-Device Programming.. Same applications as for OpenMP and MPI, with focus on optimizing for GPUs.
Unit-5:
Real-time Projects: Face Recognition, Iris Recognition, Ear biometrics, Bio traits Analysis , Lift Automation in University Building with crowd sourcing of Signals –Floor Navigator, Indigenous 32 bit RISC processor for ASIC implementation, Development of Algorithms for Large graphs; Pre-fetching for GPUs, Deploying AI Deep Learning Models with scalable classification problems, Virtual Digital Assistants

Learning Resources	1. An Introduction to PARALLEL PROGRAMMING, Peter S. Pacheco, Morgan Kaufmann, 2011 2. Parallel programming in C with MPI and OpenMP, Michael Quinn, McGraw Hill Education, 2017 3. OpenACC for Programmers: Concepts and Strategies, Sunita Chandrasekaran, Guido Juckeland, Addison Wesley, 2017 4. Parallel Scientific Computing in C++ and MPI, George Em Karniadakis, and Robert Kirby II, Cambridge Universities Press, 2003	5. Using MPI, William Gropp, Ewing Lusk, Anthony Skjellum, The MIT Press, 2014 6. Using OpenMP, Barbara Chapman, Gabriele Jost, Ruud van der Pas, The MIT Press, 2008

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 – (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	20%	-	*15%*	-
Level 2	*Understand*	*25%*	-	20%	-	*25%*	-
Level 3	*Apply*	*30%*	-	30%	-	*30%*	-
Level 4	*Analyze*	*30%*	-	30%	-	*30%*	-
Level 5	*Evaluate*	-	-		-	-	-
Level 6	*Create*	-	-		-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Blessin George Varghese,Bajaj Finserv	1. Dr.Noor Mohammad, IIITDM,Kancheepuram	1. Dr.B.Amutha,Professor,SRMIST
		2. Dr.S.Nagadevi,Assistant Professor,SRMIST

Course Code	21CSE292P	Course Name	Artificial Intelligence of Things	Course Category	E	Professional Elective	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Networking and Communications*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	Acquire the knowledge on sensors, their connectivity, protocols and power consumption
CLR-2:	Examine data sensing, data processing, data conversion and integrate all the IOT elements as a kit
CLR-3:	Apply the knowledge of RFID and GPS
CLR-4:	Implement optimization techniques such as hyper parameter tuning for an AI based IOT application
CLR-5:	To build any one of the case studies

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO) (1- Low, 2 – Medium & 3- High)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design / Development of solutions	Conduct investigation of complex problems	Modern Tool Usage	The engineer and Society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO1	PSO2	PSO3
CO-1:	Understand IOT architecture, protocols, and identify appropriate power supply design for the given applications	-	-	3	-	1	-	-	-	3	-	-	-	3	-	-
CO-2:	Choose appropriate IOT sensors and assemble them to build a hardware kit for an application	-	-	3	-	1	-	-	-	3	-	-	-	3	-	-
CO-3:	Demonstrate an application with localization techniques	-	-	3	-	3	-	-	-	3	-	-	-	3	-	-
CO-4:	Develop an application with OpenVino for optimization of a deep learning model	-	-	3	-	3	-	-	-	3	-	-	-	3	-	-
CO-5:	Implement an IOT application with artificial Intelligence	-	-	3	-	3	-	-	-	3	-	-	-	3	-	-

Unit-1: Introduction to IOT **6 Hours**

Introduction to IOT – architecture – the edge and the cloud – Data acquisition through sensing, aggregation WWW, social media etc – connectivity - Energy and Power, with special emphasis on low energy system that last several years - Application level Protocol - Applications of IOT – protocols for IOT – MQTT, COAP - IOT Infra protocols like RFID, LPWAN, Zigbee etc., - Power conditioning and management - LDOs and DC - DC converts - Low energy by "sleep" - Appropriate power supply design for a given application - Appropriate power supply design for a given application - Types of batteries - Power conditioners and Power Profilers - Sleep on exit for energy saving – Connectivity - Wifi, Bluetooth, Cellular, LORA, NBIOT, Ethernet.

Unit-2: Data sensing **6 Hours**

Data sensing - Sensing as an acquisition phenomenon - Sensors, and typical sensors as inn some commercial Sensor kit - Use of cameras for image acquisition - Machine vision techniques: Growing importance of machine vision on IOT - Use of www and social media - Data processing - Onboard Interfaces, SPI, I2C - Signal conditioning amplifiers - Data conversion Analog to Digital conversion and Digital to Analog Conversion - Design for appropriate accuracy with error budgeting - System Integration - Choosing appropriate embedded boards for IOT applications - Integrating all elements like sensors, ADC, power supply, batteries, communication modules, etc., for a given application - System software - Choice of OS (usually embedded Linux) and other drivers for a given application and their integration to system firmware - Choice of Broker services and their configuration - Writing an IOT application in the above environment

Unit-3: Introduction to "Thing identification" **6 Hours**

Introduction to "Thing identification" - Importance of identification of things in IOT - RFID for identification: Introduction of the current technology - Applications of RFID - Importance of localisation - Localisation techniques: GPS and alternatives - Use of RFID for localisation instead of the GPS - Advanced Power sources, conditioning and management - Super capacitors - Energy harvesting methods: their limits - Designing for 10 years of operation with batteries

Unit-4: Data processing **6 Hours**

Data processing - Inference engines and their applications - System Integration, integrating signal acquisition, ML and AI techniques for complete solution delivery - System software ML tools for training and verification (such as YOLO), Optimization – hyperparameter tuning - Inference engine such OpenVino - ML at edge - Writing an IOT

application in the above environment, Benchmarking.

Unit-5: Case studies **6 Hours**

Case studies - Conversational AI Chatbot for Enterprises, Structural Damage Assessment through Satellite Image Processing, Identify Drone Landing Areas, Faster Digital Twin Insights, Engineering Design Optimizations, Automate Visual Quality Control Inspections for Life Sciences, Medical Imaging Diagnostics Using Computer Vision.

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Lab Experiments: **15 Hours**

1. Implementation of Data acquisition through sensing, aggregation WWW, social media.
2. Implementation of sensors connectivity using Wifi, Bluetooth, Cellular, etc., and measuring the power consumption.
3. Configure Timestamp and MQTT out nodes.
4. Use of cameras in image acquisition.
5. Implementation of an application by Integrating all elements like sensors, ADC, power supply, batteries, communication modules, etc., for a given application
6. Implement an application using RFID and GPS.
7. Demonstration of YOLO Model.
8. Implementation of OpenVino for Optimization of a Deep Learning model
9. Implementation of any one of the case studies

Learning Resources	1. *Volker Ziemann, "A Hands-On Course in Sensors Using the Arduino and Raspberry Pi,", second edition, B/W Illustrations.* 2. *Massimo Alioto, "Enabling the Internet of Things, From Integrated Circuits to Integrated Systems", Springer.*	3. *Constandinos X. Marvomoustakis, George Mastorakis, Jordi Mongay Batalla "Internet of Things in 5G Mobile Technologies", Springer.* 4. *Simone cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri, "Internet of Things, Architecture, Protocols, and standards", Wiley*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Report & Viva voce (20% Weightage)	
		Formative CLA-1 Average of unit test (20%)		Life Long Learning CLA-2 – (60%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*15%*	-	-	*15%*	-	*15%*
Level 2	Understand	*25%*	-	-	*20%*	-	*20%*
Level 3	Apply	*30%*	-	-	*25%*	-	*25%*
Level 4	Analyze	*30%*	-	-	*25%*	-	*25%*
Level 5	Evaluate	-	-	-	*10%*	-	*10%*
Level 6	Create	-	-	-	*5%*	-	*5%*
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Girish, Intel, Bangalore	**1**. Dr. H S Jamadagni, Professor, IISc, Bangalore	1. Dr. S.Ushasukhanya, SRMIST
2. Mr. Arun, AUK Computing, Bangalore	**2.** Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	2. Dr. TYJ Naga Malleswari, SRMIST
		3. Dr. A. Suresh, SRMIST

Course Code	21CSE304P	Course Name	Cloud Computing Industry Essentials	Course Category	E	Professional Elective	L	T	P	C
							1	2	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	Computing Technologies	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale :	*The purpose of learning this course is to:*
CLR-1 :	Learn the cloud Computing Industrial Essentials
CLR-2 :	Learn the Cloud Application Architecture
CLR-3 :	Learn the Cloud Data Architecture
CLR-4 :	Learn the automation & Orchestration
CLR-5 :	Learn the basic storage and servers of cloud application.

Course Outcomes (CO):	*At the end of this course, learners will be able to:*
CO-1 :	How to identify the problem and generate solutions to solve it
CO-2 :	Demonstrate presentation skills, and learn team player skills
CO-3 :	Develop prototypes as a proof of concept for any innovative ideas
CO-4 :	Develop electro-mechanical systems
CO-5 :	Demonstrate product design skills

Program Outcomes (PO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual &Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
3		-	-	-	-	-	-	-	-	-	-	3	-	-
3		-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
3	-	3	-	-	-	-	-	-	-	-	-	-	3	-
2	-	2	-	-	-	-	-	-	-	-	-	-	3	-

Unit 1: Cloud Computing Basics
Private Cloud, Public Cloud, IaaS, PaaS, SaaS, AWS/ Azure/ GCP tools understanding, Understanding VM Ware/ RedHa

Unit 2: Traditional Application Architecture Basics
Mainframe, 2 Tier, 3/N Tier

Unit 3: Modern Application Architecture Basics
SOA, Microservices, and FaaS, Understanding of Netflix Architecture and AWS Lambda

Unit 4: Server basics
What is a server, Virtualization, Containerization, GPU, and CPU, Intel/AMD/ NVIDIA Analysis

Unit 5: Storage Basics
What is a storage, SDS, File/Block/Object, Compare AWS/Azure/GCP offerings

Learning Resources		
	1. *Marko Luksa (2024). Kubernetes in Action (2 ed.): Manning.* 2. *James Bond. (2015). The Enterprise Cloud: Best Practices for Transforming Legacy IT (1 ed.): O'Reilly Media, Inc..*	3. *Scott D. Lowe, David M. David, and James Green. (2016). BUILDING a MODERN DATA CENTER Principles and Strategies of Design (1 ed.): ActualTech Marketing.*

Learning Assessment

Bloom'sLevel of Thinking		Continuous Learning Assessment (CLA) - By the Course Faculty						By The CoE	
		CLA-1 Average of Unit test (20%)		CLA-2 Project Based Learning (60%)		Report and Viva Voce (20% Weightage)		Final Examination (0% weightage)	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30	-	--	20	-	10	-	-
Level 2	Understand	30	-	-	20	-	10	-	-
Level 3	Apply	20	-	-	20	-	10	-	-
Level 4	Analyze	20	-	-	20	-	10	-	-
Level 5	Evaluate	-	-	-	10	-	30	-	-
Level 6	Create	-	-	-	10	-	30	-	-
Total		100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Mr. T Mohandoss, CompassMet	Dr. Varun G Menon, SCMS Engineering College, Kerala	1. Dr.E. Poovammal, SRMIST
		2. Dr.Aswathy K Cherian, SRMIST

Course Code	21CSE307J	Course Name	Quantum Machine Learning	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Computing Technologies*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*Gain knowledge about quantum computing, quantum mechanics and analyze the quantum circuits*
CLR-2:	*Learn about the fundamentals of Machine Learning*
CLR-3:	*Utilize Qiskit for supervised learning*
CLR-4:	*Learn unsupervised learning with Qiskit*
CLR-5:	*Utilize the quantum neural networks with Pennylane*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Program Learning Outcomes (PLO)**														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual &Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1:	*Identify the need of quantum computing and quantum gates*	*1*	*3*	-		-	-	-	-			-	-	-	-	-
CLO-2:	*Compare Classical vs. Quantum Machine Learning*	*2*	*3*	*1*	-	-	-	-	-			-	-	-	-	-
CLO-3:	*Develop the Quantum Machine Learning programs*	*2*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-
CLO-4:	*Incorporate the Unsupervised learning with Qiskit*	*2*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-
CLO-5:	*Demonstrate the QNN, QCNN, QGAN using Qiskit and Pennylane*	*1*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-

Unit-1

Introduction to Quantum Computing- Introduction to Superposition- Classical superposition- Quantum superposition- What is a Qubit?- Mathematical Representation on Qubits- Bloch Sphere- Quantum Gates- Entanglement-Multi-Qubits states-CNOT gate

Unit-2

Classical vs. Quantum Machine Learning- Examples of Typical Machine Learning Problems- The Three Ingredients of a Learning Problem- Risk minimization in Supervised Learning- Training in Unsupervised Learning- Methods in Machine Learning-
Linear Models- Neural Networks- Graphical and Kernel methods

Unit-3

Introduction to Quantum Machine Learning- Four approaches to QML-Parameterized quantum circuits (PQC)- Quantum Information Encoding- Training parameterized quantum circuits- Supervised learning- Quantum variational classification- Quantum kernel estimation- Quantum feature map and kernels- Quantum Support Vector classification (QSVM)

Unit-4

Introduction to Unsupervised learning- Principal Component Analysis- Clustering- Classifiers used in QML- Problem solving session- QML programming concepts in Qiskit- Analysis of Qiskit- Analysis of exercises created by Qiskit- Discussion about IBM Qiskit Summer School Challenge exercises 2022 and 2023

Unit-5

Introduction to Quantum Neural Networks- Quantum Convolutional Neural Networks (QCNN)- Hybrid QNN- Problem solving session on a real dataset- Classical Generative Adversarial Networks (GAN)- Quantum Generative Adversarial Networks (QGAN)-
QGAN in Qiskit- Problem Solving session- Pennylane and AWS Quantum Braket introduction- Use cases in QML

LAB EXPERIMENTS:

1. *Introduction to Qiskit with some execises*
2. *Develop circuit composer in Qiskit lab*
3. *Demonstrate Quantum gates using Qiskit*
4. *Python basics and Project preparation phase 1 (Analysis of problem statement related to quantum computing)*
5. *Implement single and multiple qubit gates using python*
6. *Project preparation phase 2 (Design of the project based on problem statement using Qiskit or Pennylane)*
7. *Implementation of QML algorithms*
8. *Implementation of Quantum classifiers*
9. *Implementation of QSVM and Project preparation phase 3(Implementation of quantum problem statement in Qiskit or Pennylane)*
10. *Implementation of Quantum K Nearest Neighbour*
11. *Implementation of different QML models*
12. *Project presentation phase 4 demo (use case developed) and thesis preparation*
13. *Implementation of Quantum Neural Networks*
14. *Implementation of QCNN in healthcare applications*
15. *Project report submission (Thesis of use case developed)*

Learning Resources	1. *Quantum Computation and Quantum Information. M. A. Nielsen and I. L. Chuang, Cambridge University Press* 2. *Ciaran Hughes, Joshua Isaacson, Anastatsia Perry, Ranbel F. Sun, Jessica Turner, "Quantum Computing for the Quantum Curious", Springer, 2021*	*11.An Introduction to Quantum Computing. P. Kaye, R. Laflamme, and M. Mosca, Oxford University Press, New York* *12. Quantum Computer Science. N. David Mermin:, Cambridge University Press* *13. Quantum Algorithm Zoo. https://quantumalgorithmzoo.org/*

	3. *Maria Schuld and Francesco Petruccione, "Machine Learning with Quantum Computers", Second Edition, Springer, 2021* 4. *Maria Schuld and Francesco Petruccione, "Supervised Learning with Quantum Computers", Springer, 2018* 5. *Peter Wittek, "Quantum Machine Learning – What Quantum Computing Means to Data Mining", Elsevier* *6. Michael A. Nielsen and Issac L. Chuang," Quantum Computation and Information, Cambridge, 2002* *7. Mikio Nakahara and Tetsuo Ohmi,"Quantum Computing", CRC Press, 2008* *8. N. David Mermin, "Quantum Computer Science", Cambridge, 2007* 9.*https://qiskit.org/* *10. https://qiskit.org/documentation/machine-learning/*	*14. Quantum Algorithm Zoo. https://quantumalgorithmzoo.org/* *15. https://qiskit.org/textbook/ch-algorithms/index.html* *16. Course | 8.370.1x | MIT Open Learning Library* *17. https://github.ibm.com/dmadan07/Grover-ex* *18. https://qiskit.org/documentation/finance/* *19. https://qiskit.org/textbook/ch-algorithms/index.html* *20. https://cds.cern.ch/record/1522001/files/978-1-4614-6336-8_BookBackMatter.pdf* *21. The Story of Shor's Algorithm, Straight From the Source | Peter Shor - YouTube* *22. Janani A (Resource Website) (google.com)* *23. https://www.youtube.com/watch?v=3-c4xJa7Flk (IBM Qiskit Summer School – 2023 tutorials)*

	Bloom's Level of Thinking	Formative CLA – 1 Average of unit test (45%)		Life Long Learning CLA – 2 Practice (15%)		Summative Final Examination (40% Weightage)	
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	%	15%	-
Level 2	Understand	20%	-	-	30%	20%	-
Level 3	Apply	35%	-	-	35%	35%	-
Level 4	Analyze	30%	-	-	35%	30%	-
Level 5	Evaluate	%	-	-	%	%	-
Level 6	Create	%	-	-	%	%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Karthick Ganesh and Janani Ananthanarayanan, BOSONQ PSi	Dr. Jayakumar Vaithiyashankar , Presidency University, Bengaluru. *IBM Quantum Educator, IBM Qiskit Advocate*	Dr. M. Gayathri, Assistant Professor, CTECH
		Dr. S. Nalini Assistant Professor, CTECH

Course Code	21CSE325P	Course Name	Quantum Communication & Cryptography	Course Category	P	Professional elective	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil

Course Offering Department	Computing Technologies	Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Outcomes (PO)														
CLR-1	Gain knowledge about basics of cryptographic techniques	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2	Learn about the Symmetric and Asymmetric Cryptographic algorithms																		
CLR-3	Utilize quantum tools for error correction, encryption and decryption																		
CLR-4	Learn the protocols for secure key transmission																		
CLR-5	Utilize The Post Quantum Cryptographic Techniques																		

Course Outcomes (CO): (CO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual &Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO – 2	PSO – 3
CO-1	Identify basic cryptographic techniques	2	75	70	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	Compare symmetric and asymmetric cryptographic algorithms	4	75	70	2	2	-	1	-	-	-	-	-	-	-	-	-	-	-
CO-3	Develop a tool for cryptographic algorithm and error correction mechanisms	6	75	70	2	3	1	3	1	-	-	-	-	-	-	-	-	-	-
CO-4	Incorporate the secure key transmission protocols	4	75	70	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	Demonstrate the Post cryptographic techniques	6	75	70	1	3	-	1	-	-	-	-	-	-	-	-	-	-	-

Unit 1 – Basics of Cryptography

Introduction to Cryptography, Classical Cryptography Vs Quantum Cryptography, Need for Quantum Cryptography, Security Threats, Active and Passive attacks, Brute Force Attacks, Symmetric Cipher Model, Cryptanalysis, Substitution Techniques, Transposition Techniques, Steganography.

Unit 2 – Symmetric and Asymmetric Key Cryptography Feistel Cipher Structure, Simplified DES, DES, AES, Public-Key Cryptography: Principles Of Public-Key Cryptography, RSA Algorithm, Diffie- Hellman Key Exchange, Cbits VS Qbits, Quantum bits, Quantum entanglement, Quantum Teleportation.
Unit 3 – Quantum Communication Single Qubits, Multiple Qubits, Quantum Circuits, Combining Qubits using Tensor Product, Quantum Tools and a first protocol, quantum money, Basic quantum error correction tools.
Unit 4 – Secure Key Distribution Key distribution in a special classical channel, Quantum key distribution protocols - The BB84 quantum key distribution protocol, BBM92 protocol, Ekert91 protocol, Six state protocols.
Unit 5 – Post Quantum Cryptography Lattice Based Cryptography, Code-Based Cryptography, Hash-Based Cryptography, Multivariate Polynomial Cryptography, Use Cases in Quantum Cryptography.

Learning Resources	1. William Stallings, Cryptography and Network Security Principles and Practice Fourth Edition, Pearson Education, 2019. 2. Thomas Vidick and Stephanie Wehner, "Introduction to Quantum Cryptography", Cambridge University Press, 2023.	3. Daniel J. Bernstein, Johannes Buchmann and Erik Dahmen, "Post-Quantum Cryptography", 2007. 4. N. David Mermin, "*Quantum Computer Science*" by Cambridge University Press, 2007.

Learning Assessment									
Bloom's Level of Thinking		Continuous Learning Assessment (CLA) - By the Course Faculty						By The CoE	
		CLA-1 Average of Unit test (20%)		CLA-2 Project Based Learning (60%)		Report and Viva Voce (20% Weightage)		Final Examination (0% weightage)	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30	-	--	20	-	10	-	-
Level 2	Understand	30	-	-	20	-	10	-	-

Level 3	Apply	20	-	-	20	-	10	-	-
Level 4	Analyze	20	-	-	20	-	10	-	-
Level 5	Evaluate	-	-	-	10	-	30	-	-
Level 6	Create	-	-	-	10	-	30	-	-
Total		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Jithesh Lalwani Founder and CEO Artificial Brain, Pune	Nishant K Pathak Senior Research Fellow, (Experimental Quantum optics) IIT Delhi	Dr. G. K. Sandhia, Associate Professor, Computing Technologies, SRM Institute of Science and Technology, KTR Campus, Chennai. Dr. M. Gayathri, Assistant Professor, Computing Technologies, SRM Institute of Science and Technology, KTR Campus, Chennai.

Course Code	21CSE294P	Course Name	Introduction to Metaverse	Course Category	E	Professional Elective	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Computing Technologies*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	Understand the fundamental concepts and principles of the metaverse
CLR-2 :	Explore cutting-edge technologies like virtual reality (VR), augmented reality (AR), blockchain, and IoT
CLR-3 :	Develop the ability to design and conceptualize metaverse solutions tailored to specific industrial applications
CLR-4 :	Learn to integrate real-time data streams, sensor data, and IoT devices into metaverse environments
CLR-5 :	Gain practical skills in developing metaverse projects by utilizing relevant tools, platforms, and programming languages

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Program Learning Outcomes (PLO)**														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual &Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Showcase a comprehensive understanding of metaverse concepts	3-	-3	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Effectively employ emerging technologies, such as VR, AR, blockchain, and IoT, in the design and development of metaverse projects for industrial applications.	-	-	-3	3-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Design and create immersive metaverse solutions that prioritize user experience, interaction design, and accessibility while addressing real-world industrial needs.	-	-2	-3	-	-3	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Demonstrate proficiency in developing functional metaverse projects, incorporating interactivity, realism, and usability into the applications.	-	-	-3	-2	-3	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Integrate real-time data streams, sensor information, and IoT devices into metaverse environments to enhance decision-making and optimize industrial processes.	1-	-	3-	-	-3	-	-	-	-	-	-	-	-	-	-

Unit-1
: Introduction to Metaverse and Digital Twin
Introduction to Industrial Metaverse, Digital Twin, Technologies used in Digital Twin, Essential Building Blocks of Metaverse, Working of Industrial Metaverse, Industrial Metaverse Use cases.

Unit-2 .
Building Physical layer & Transport Layer using Cloud Services for Industrial Metaverse
Building Physical Layer - Introduction to Phygital environment, Microcontrollers and Sensors, Analog and Digital Data, Programming of microcontrollers, Interface sensors with microcontrollers. Building Transport Layer - Introduction to IoT and Cloud, Features of cloud and its initialization, Reading and Writing data to cloud, Integration of microcontroller and sensors from simulator with cloud

Unit-3
Creating digital assets required for XR interaction by using a 3D modelling tool
Introduction to Blender, 3d modelling Structure, 3D assets and Textures, Creating models -3D Models Building, 3D Models Animation, Setup state machines, Bake and prepare environment for sensor data

Unit-4
Integrating Digital and Physical assets
Introduction to Unity and packages, Optimization of 3d model, Introduction to REST API, Interfacing cloud data with unity, Testing Hardware and cloud with unity

Unit-5
Building Industrial Metaverse
Introduction to Oculus quest2, Integration of Oculus Quest2 with unity, Deploying project to Oculus Quest2, Building Final Metaverse Digital twin, Demonstrate metaverse twin with VR, Creation of portfolio of all products using metaverse

Learning Resources		
	1. Terry Winters, 2021, "The Metaverse", ISBN: 979-8450959283.	3. QuHarrison T., Keeney, S., 2022, "The Metaverse Handbook: Innovating for the Internet's Next Tectonic Shift", Wiley, ISBN: 978-1119892526 The Metaverse Handbook: Innovating for the Internet's Next Tectonic Shift.
	2. Ball, M., 2022, "The Metaverse and How It Will Revolutionize Everything", Liveright, ISBN: 978- 1324092032	4. Nidagundi, P., 2022, "Metaverse Development: Handbook For Software Developer, Analyst, Consultant, Startups and Business Owners" ISBN: 979-8418729293

	Bloom's Level of Thinking	Formative CLA – 1 Average of unit test (45%)		Life Long Learning CLA – 2 Practice (15%)		Summative Final Examination (40% Weightage)	
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*15%*	-		*15%*		*15%*
Level 2	Understand	*25%*	-		*20%*		*20%*
Level 3	Apply	*30%*	-		*25%*		*25%*
Level 4	Analyze	*30%*	-		*25%*		*25%*
Level 5	Evaluate	%	-		*15%*		*10%*
Level 6	Create	%	-		-		*5%*
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
AshokkumarManisekaranFounder,PRAYA LABS		Dr R I Minu,Professor,CTECH
Mr Srivastava, ,Ingage Group of Companies		Dr M Sindhuja,Asst Professor,CTECH, Dr.V.S. Bakkialakshmi, Asst Professor,CTECH