Course Code: 23CS0519 **R23**

SIDDHARTH INSTITUTE OF ENGINEERING &TECHNOLOGY:: PUTTUR
(AUTONOMOUS)
Siddharth Nagar, Narayanavanam Road – 517583
QUESTION BANK (DESCRIPTIVE)

Subject with Code: INTRODUCTION TO QUANTUM TECHNOLOGIES AND APPLICATIONS**(23CS0519)**
Course & Branch: **B.Tech – COMMON TO ALL**

Regulation: **R23** Year &Sem: **III-B.Tech & I-Sem**

UNIT –I
INTRODUCTION TO QUANTUM THEORY AND TECHNOLOGIES AND APPLICATIONS

1	a)	Define superposition principle in quantum mechanics.	**[L1][CO1]**	**[2M]**
	b)	What is meant by wave–particle duality?	**[L1][CO1]**	**[2M]**
	c)	State Heisenberg's Uncertainty Principle.	**[L1][CO1]**	**[2M]**
	d)	What is meant by quantization of energy levels**?**	**[L1][CO1]**	**[2M]**
	e)	List any two examples of a quantum system from nature.	**[L2][CO1]**	**[2M]**
2	a)	Explain the transition from classical physics to quantum physics with suitable examples.	**[L2][CO1]**	**[5M]**
	b)	Illustrate the concept of wave–particle duality with an example.	**[L3][CO1]**	**[5M]**
3		Discuss in detail the fundamental principles of quantum mechanics: superposition, entanglement, uncertainty principle.	**[L2][CO1]**	**[10M]**
4	a)	Describe the concept of quantum states and explain ho**w** measurement affects the state**.**	**[L2][CO1]**	**[5M]**
	b)	Compare classical mechanics and quantum mechanics	**[L4][CO1]**	**[5M]**
5	a)	Discover the concept of quantization in atoms and discuss its importance using the hydrogen atom model**.**	**[L4][CO1]**	**[5M]**
	b)	Illustrate the strategic importance of quantum technologies in modern science and defense.	**[L3][CO1]**	**[5M]**
6	a)	Explain about quantum communication and its applications	**[L2][CO1]**	**[5M]**
	b)	Describe about quantum sensing and its applications	**[L2][CO1]**	**[5M]**
7		Generalize the scientific, strategic and technological significance of quantum mechanics	**[L6][CO1]**	**[10M]**
8		Compare classical mechanics vs. quantum mechanics in terms of determinism, observables, measurement, and mathematical framework.	**[L4][CO1]**	**[10M]**
9		Express the global efforts in quantum research**:** compare initiatives of India, USA, EU, and China**.**	**[L6][CO1]**	**[10M]**
10		Describe the working principle of Quantum Computers and how they differ from classical computers.	**[L2][CO1]**	**[10M]**
11		Discuss the role of photons,atoms and electrons as quantum systems with examples	**[L2][CO1]**	**[10M]**

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UNIT –II
Theoretical Structure of Quantum Information Systems

1	a)	Define a qubit. How does it differ from a classical bit?	**[L1&L4][CO2]**	**[2M]**
	b)	What is the role of spin in representing a qubit?	**[L2][CO2]**	**[2M]**
	c)	State one difference between quantum coherence and decoherence.	**[L1][CO2]**	**[2M]**
	d)	What is a Hilbert space in the context of quantum mechanics?	**[L1][CO2]**	**[2M]**
	e)	Mention one example of a physical system used to implement qubits.	**[L1][CO2]**	**[2M]**
2	a)	Explain how spin is used to represent qubits.	**[L2][CO2]**	**[5M]**
	b)	Compare spin-based qubits with polarization-based qubits.	**[L4][CO2]**	**[5M]**
3		Compare classical bits and quantum bits with suitable examples.	**[L4][CO2]**	**[10M]**
4		Explain the implementation of qubits using trapped ions, superconducting circuits, and photons .	**[L3][CO2]**	**[5M]**
5	a)	What is quantum coherence? Give an intuitive explanation.	**[L2][CO2]**	**[5M]**
	b)	Explain quantum decoherence with an example.	**[L2][CO2]**	**[5M]**
6	a)	Differentiate between quantum information and classical information.	**[L4][CO2]**	**[5M]**
	b)	Discuss the role of the observer in quantum measurement.	**[L4][CO2]**	**[5M]**
7		Explain quantum coherence and decoherence as two sides of quantum system evolution. How do they affect the reliability of quantum information processing?	**[L2&L4][CO2]**	**[10M]**
8		Discuss the abstract concepts of Hilbert spaces, quantum states, and operators in the quantum framework.	**[L2][CO2]**	**[10M]**
9		Explain entanglement and non-locality, and their significance in quantum information systems.	**[L2&L4][CO2]**	**[10M]**
10		How does randomness arise in quantum mechanics? Compare this with determinism in classical systems.	**[L4][CO2]**	**[10M]**
11		Discuss the philosophical implications of quantum mechanics in terms of the observer's role in measurement.	**[L5][CO2]**	**[10M]**

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UNIT –III
BUILDING A QUANTUM COMPUTER-THEORETICAL CHALLENGES AND REQUIREMENTS

1	a)	What is the basic requirement to build a quantum computer?	**[L1][CO3]**	**[2M]**
	b)	Define decoherence in the context of quantum systems	**[L1][CO1]**	**[2M]**
	c)	State one condition necessary for a functional quantum computer?	**[L1][CO3]**	**[2M]**
	d)	Why is maintaining entanglement difficult in practice?	**[L2][CO1]**	**[2M]**
	e)	Discuss one role of quantum software in managing hardware limitations?	**[L2][CO3]**	**[2M]**
2		Explain the essential requirements to build a quantum computer.	**[L2][CO3]**	**[10M]**
3	a)	Why are quantum systems fragile? Briefly explain the role of decoherence?	**[L2][CO1]**	**[5M]**
	b)	Explain the effect of noise and control challenges in quantum systems.	**[L2][CO3]**	**[5M]**
4		List and explain the conditions required for a functional quantum computer?	**[L2][CO3]**	**[10M]**
5		Why is maintaining quantum entanglement theoretically difficult?	**[L2][CO1]**	**[10M]**
6	a)	Why is quantum error correction important?	**[L2][CO3]**	**[5M]**
	b)	Give an example of an error type in quantum computing and how it can be corrected?	**[L3][CO3]**	**[5M]**
7	a)	Write short notes on super conducting circuits and trapped ions as quantum hardware platforms.	**[L2][CO3]**	**[5M]**
	b)	Explain the role of photonics in quantum computing.	**[L2][CO4]**	**[5M]**
8		Discuss the gap between vision and reality in current quantum computers.	**[L4][CO3]**	**[10M]**
9		How does quantum software help manage theoretical and hardware complexities?	**[L3][CO3]**	**[10M]**
10		Explain how spin and polarization are used to represent qubits with neat diagrams.	**[L3][CO1]**	**[10M]**
11		Evaluate scalability issues in building large-scale quantum computers.	**[L5][CO3]**	**[10M]**

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UNIT –IV
QUANTUM COMMUNICATION AND COMPUTING,THEORETICAL PERSPECTIVE

1	a)	Define quantum information and differentiate it from classical information.	**[L1][CO4]**	**[2M]**
	b)	What is Quantum Key Distribution (QKD)?	**[L1][CO4]**	**[2M]**
	c)	State the role of entanglement in quantum communication.	**[L1][CO4]**	**[2M]**
	d)	What is meant by quantum parallelism?	**[L1][CO4]**	**[2M]**
	e)	List any two differences between classical and quantum gates.	**[L2][CO4]**	**[2M]**
2	a)	Explain the basics of quantum communication and its advantages over classical methods.	**[L2][CO4]**	**[5M]**
	b)	Describe the working principle of Quantum Key Distribution (QKD).	**[L3][CO4]**	**[5M]**
3		Discuss the role of entanglement in quantum communication and its implications for secure networking.	**[L2][CO4]**	**[10M]**
4	a)	Illustrate the idea of the Quantum Internet and its potential for global secure networking.	**[L3][CO4]**	**[5M]**
	b)	Compare quantum information with classical information in terms of storage and transmission.	**[L4][CO4]**	**[5M]**
5	a)	Introduce the concept of quantum computing and explain quantum parallelism.	**[L2][CO4]**	**[5M]**
	b)	Differentiate between classical gates and quantum gates with examples.	**[L3][CO4]**	**[5M]**
6	a)	Explain the challenges of decoherence and error correction in quantum computing.	**[L2][CO4]**	**[5M]**
	b)	Describe the real-world importance of quantum technologies in communication and computing.	**[L2][CO4]**	**[5M]**
7		Elaborate on the theoretical perspective of quantum vs. classical information, including basics of quantum communication.	**[L3][CO4]**	**[10M]**
8		Compare classical and quantum gates, highlighting quantum parallelism and its advantages.	**[L4][CO4]**	**[10M]**
9		Discuss the future potential of quantum computing and communication, including the role of QKD and the Quantum Internet.	**[L6][CO4]**	**[10M]**
10		Analyze the challenges in quantum communication and computing, such as decoherence, and propose theoretical solutions.	**[L5][CO4]**	**[10M]**
11		Explain how entanglement enables secure global networking in the Quantum Internet framework.	**[L3][CO4]**	**[10M]**

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UNIT –V
Applications, Use Cases, and the Quantum Future

1	a)	Name two key real-world application domains for quantum computing.	**[L1][CO6]**	**[2M]**
	b)	How can quantum computing benefit the logistics and optimization sector?	**[L1][CO6]**	**[2M]**
	c)	What is the primary focus of Psi Quantum in the quantum industry?	**[L1][CO6]**	**[2M]**
	d)	What is a key policy consideration that governments must address regarding quantum technology?	**[L1][CO6]**	**[2M]**
	e)	Why is standardization a challenge for quantum technology adoption?	**[L2][CO6]**	**[2M]**
2	a)	Explain how quantum computing is applicable in healthcare and medical	**[L2][CO6]**	**[5M]**
	b)	Explain how quantum computing is applicable in material science and logistics	**[L2][CO6]**	**[5M]**
3	a)	Discuss the future impact of quantum internet and its potential applications.	**[L3][CO6]**	**[5M]**
	b)	Explain how Psi Quantum is using photonic qubits to advance quantum technologies.	**[L2][CO6]**	**[5M]**
4		Explain about the ethical, societal, and policy challenges of quantum technologies.	**[L2][CO6]**	**[10M]**
5		List emerging careers in the quantum domain and describe required skill sets with preparation pathways.	**[L3][CO6]**	**[10M]**
6	a)	Explain the current educational and research initiatives driving quantum technology growth worldwide.	**[L2][CO6]**	**[5M]**
	b)	Discuss one application of quantum computing in the field of financial modelling.	**[L3][CO6]**	**[5M]**
7		Discuss the use of quantum computing in material science for designing novel materials.	**[L3][CO6]**	**[10M]**
8	a)	Explain the role of quantum sensing and precision timing in industrial and defense applications.	**[L2][CO6]**	**[5M]**
	b)	Give a real world use case of quantum machine learning and explain its significance.	**[L1][CO6]**	**[5M]**
9		Discuss the major skills gap in the quantum workforce and suggest strategies to overcome it.	**[L4][CO6]**	**[10M]**
10		Describe, with examples, how leading tech companies such as IBM, Google, and Microsoft are advancing quantum technologies. What are the distinguishing features of their approaches?	**[L2][CO6]**	**[10M]**
11		Discuss India's educational and research landscape in quantum technology and its global positioning in the quantum race.	**[L4][CO6]**	**[10M]**