COLLEGE OF CREATIVE INNOVATION

Programme

Master of Software Engineering – 180 credits

Course

Quantum Computing

MSE802

(Level 8, 15 credits, Version 1)

Assessment 1

# Theory Assignment

Weighting within course:

40%

## Assessment Tasks to Learning Outcome and GPOs mapping

| Tasks | Learning Outcomes | GPOs |
|---|---|---|
| **Task 1** | LO1 | GPO1 |
| **Task 2** | LO1, LO3 | GPO1, GPO5 |
| **Task 3** | LO1, LO3, LO4 | GPO1, GPO5, GPO4 |
| **Task 4** | LO4 | GPO4 |

## Objective:

The objective of this assignment is to allow students to delve into the world of quantum algorithms, understand their theoretical underpinnings, and identify their practical applications.

## Assessment Instructions

- This assessment is an ***open-book activity***, you can use your own course and review notes as well as offline or online resources, such as textbooks or online journals.
- You can always ask your tutor if you need further explanation about forming a group or if the instructions are unclear.
- The purpose of this assessment is to assess your knowledge. In the event Yoobee suspects collusion, this will be addressed. For more information on plagiarism, please refer to the Student Handbook.
- Marks and feedback will be returned within 15 days of the submission date.

## Learning Outcomes (LOs)

**LO1:** Critically evaluate quantum information protocols in software engineering using the principles of mathematical structure of quantum mechanics to validate performance claims.

**LO3:** Critically analyse the historical development of quantum and classical computation and its application to differentiate computational capabilities in software engineering.

**LO4:** Communicate the application and critical analysis of quantum concepts to diverse software industry audiences.

## Graduate Profile Outcomes (GPOs) covered

**GPO1:** Develop advanced software engineering knowledge and skills and apply these to solve emerging or existing problems.

**GPO4:** Critically analyse, assess and solve software-related problems using project management tools and techniques, creative thinking and enterprise skills.

**GPO5:** Critically evaluate current cutting-edge research in software engineering and apply it to industry practice.

## Success Criteria:

You need to meet all the requirements of each of the learning outcomes and receive 50% or more to pass this assessment. You are allowed a maximum of three attempts. To meet all the requirements of each of the learning outcomes, you must achieve PASS results for each task item.

## Grading:

The final grade will be determined by the score achieved in this assessment based on the following table. Should a second or third attempt be required the maximum contribution toward the overall mark for the tasks that required a second or third assessment attempt is 50%. A late submission is considered a second attempt, so the contribution will be capped at 50%.

| Grade | Mark Band Range |
|---|---|
| A+ | Meet all course requirements, mark range (90-100) |
| A | Meet all course requirements, mark range (85-89) |
| A- | Meet all course requirements, mark range (80-84) |
| B+ | Meet all course requirements, mark range (75-79) |
| B | Meet all course requirements, mark range (70-74) |
| B- | Meet all course requirements, mark range (65-69) |
| C+ | Meet all course requirements, mark range (60-64) |
| C | Meet all course requirements, mark range (55-59) |
| C- | Meet all course requirements, mark range (50-54) |
| D | Did not meet all course requirements, mark range (40-49) |
| E | Did not meet all course requirements, mark range (0-39) |

## Submission requirements

- The assignment should be well-organized and divided into sections corresponding to each task and submit a well-structured document.
- Use clear headings and subheadings for each task to enhance readability
- Incorporate relevant diagrams, figures, and equations to aid in explaining concepts
- Ensure that all sources are properly cited and referenced. Citations and references should follow a consistent citation style (e.g., APA, or IEEE style).
- The final version should be a pdf document but submitting the source document such as in word or latex is desirable.

# Assessment Tasks

## Task 1: Research and Explain Quantum Principles  (LO1)

- Provide a concise explanation of the basic principles of quantum mechanics, highlighting concepts like superposition, entanglement, and quantum gates.
- Explain how qubits differ from classical bits and the significance of qubit manipulation in quantum computation.

## Task 2: Investigate Quantum Algorithms (LO1, LO3)

Choose one of the following quantum algorithms and conduct in-depth research on its functioning, mathematical basis, and potential advantages over classical algorithms:

- Grover's Algorithm
- Shor's Algorithm
- Quantum Walks
- Quantum Fourier Transform

## Task 3: Algorithm Application and technologies (LO1, LO3, LO4)

- Describe a real-world problem that the chosen quantum algorithm aims to solve.
- Highlight the specific advantages that quantum computation offers in solving this problem. This would include exploring the current state of quantum computing technologies and platforms.
- Compare and contrast various quantum computing hardware implementations (e.g., superconducting qubits, trapped ions, topological qubits).
- Also discuss the challenges and limitations faced by quantum computing technologies, such as error correction, coherence times, and scalability.

## Task 4: Future Outlook (LO4)

- Explore the future developments and advancements expected in the field of quantum computing.
- Provide insights into the potential long-term applications of quantum computing and its role in shaping various industries.

**References:**

- Make a use of variety of sources, including research papers, articles, textbooks, and online resources, to support their findings and arguments.
- You are encouraged to use reputable sources such as academic journals, conference proceedings, from IEEE Computer Society Digital Library, O' Reilly media or any other reliable online databases.

## Marking Rubric

| Criteria & Weighting | | E (0-39) % | D (40-49) % | C (50-64) % | B (65-79) % | A (80-100) % |
|---|---|---|---|---|---|---|
| Basic Concepts Knowledge (LO1) | 25% | Lacks understanding of fundamental quantum principles and concepts, demonstrating a significant gap in knowledge of the subject matter.<br>Provides inaccurate or insufficient explanations of quantum mechanics, indicating a lack of comprehension or research.<br>Offers inadequate or unclear differentiation between qubits and classical bits, showing a lack of understanding of key concepts in quantum computing. | Lacks understanding of fundamental quantum principles and concepts.<br>Inaccurate or insufficient explanations of quantum mechanics.<br>Inadequate or unclear differentiation between qubits and classical bits. | Demonstrates a basic understanding of quantum principles and concepts.<br>Provides an explanation of quantum mechanics with some inaccuracies or omissions.<br>Identifies the differentiation between qubits and classical bits, but with some gaps. | Demonstrates a solid understanding of quantum principles and concepts.<br>Provides a clear and accurate explanation of quantum mechanics.<br>Effectively differentiates between qubits and classical bits. | Demonstrates an exceptional understanding of quantum principles and concepts.<br>Provides a clear, accurate, and concise explanation of quantum mechanics.<br>Offers profound differentiation between qubits and classical bits. |
| Research Depth (LO1,3) | 35% | Demonstrates superficial research on the chosen quantum algorithm, indicating a lack of depth in understanding or analysis.<br>Provides insufficient information on the mathematical basis and advantages of the quantum algorithm over classical algorithms, showing a lack of critical evaluation and synthesis of information.<br>Shows limited use of reputable sources and references, suggesting a lack of thorough research and reliance on credible information. | Superficial research on the chosen quantum algorithm.<br>Insufficient information on mathematical basis and advantages over classical algorithms.<br>Limited use of reputable sources and references. | Conducts moderate research on the chosen quantum algorithm.<br>Presents information on mathematical basis and some advantages over classical algorithms.<br>Uses a mix of reputable and non-reputable sources and references. | Conducts in-depth research on the chosen quantum algorithm.<br>Presents a comprehensive understanding of mathematical basis and advantages over classical algorithms.<br>Utilizes a wide range of reputable sources and references. | Conducts extensive research on the chosen quantum algorithm.<br>Presents a profound understanding of mathematical basis and advantages over classical algorithms.<br>Utilizes a wide range of reputable sources and references and synthesizes the information effectively. |

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|---|---|---|---|---|---|---|
| Application Analysis (LO1,3,4) | 25% | Fails to describe a real-world problem or its solution using the chosen quantum algorithm, indicating a lack of practical application or relevance of the algorithm.<br><br>Lacks an understanding of the advantages and limitations of quantum computing technologies, demonstrating a limited grasp of the potential and challenges of quantum computing. | Fails to describe a real-world problem or its solution using the chosen quantum algorithm.<br><br>Lacks an understanding of the advantages and limitations of quantum computing technologies. | Describes a real-world problem and its potential solution using the chosen quantum algorithm.<br><br>Identifies some advantages and limitations of quantum computing technologies.<br><br>Shows some organization with a limited use of diagrams and equations. | Describes a real-world problem and its solution using the chosen quantum algorithm with clarity.<br><br>Identifies and thoroughly explains the advantages and limitations of quantum computing technologies.<br><br>Well-organized presentation with the effective use of diagrams and equations. | Describes a real-world problem and its solution using the chosen quantum algorithm with exceptional clarity.<br><br>Identifies, critically analyzes, and provides innovative insights into the advantages and limitations of quantum computing technologies.<br><br>Exceptionally well-organized presentation with the creative use of diagrams and equations. |
| Future Outlook (LO4) | 15% | Does not explore future developments in quantum computing, indicating a lack of foresight or understanding of the evolving nature of the field.<br><br>Fails to provide insights into the long-term applications of quantum computing, showing a lack of depth in understanding the potential impact of quantum computing on various industries.<br><br>Demonstrates a lack of well-structured and properly cited references, suggesting a lack of rigor and academic integrity in the research. | Does not explore future developments in quantum computing.<br><br>Fails to provide insights into the long-term applications of quantum computing.<br><br>Lack of well-structured and properly cited references. | Explores future developments in quantum computing to a basic extent.<br><br>Provides some insights into the long-term applications of quantum computing.<br><br>Includes references but lacks consistency in citation style. | Thoroughly explores future developments in quantum computing.<br><br>Provides insightful predictions regarding the long-term applications of quantum computing.<br><br>Consistently follows a citation style with well-structured references. | Provides a comprehensive and visionary exploration of future developments in quantum computing.<br><br>Offers groundbreaking insights into the long-term applications of quantum computing.<br><br>Adheres to a consistent citation style with a meticulously structured reference list. |

**Note:** *The ranges for each grade level encompass the full 11-point grading system as outlined in the accompanying table. Please refer to the table for detailed percentage ranges associated with each letter grade*