Self Assessment Ethics Form

Section 1: Student Details		
Student Name:	Christopher Lawrence	Group 1
What course stream are you enrolled on?:	MSc Computer science with Artificial intelligence	
Section 2: Project title		
Proposal number	1	
Project title:	Transfer Learning in ML Quantum Error Mitigation (provisional)	
Provide a clear statement of your research question(s) or your experimental hypothesis(es).	* Which transfer learning strategies most effectively minimise the amount of empirical data required to achieve a target level of error mitigation while minimising quantum computational overheads? * How do simulated noise profiles affect the quality and scope of the learned representations, and how sensitive is the final model to mismatch between simulated and real-world noise? * What empirical data acquisition strategy yields the greatest performance improvement when used in conjunction with pretraining on simulated data?	
Section 3: Project description		
Briefly explain what you are going to do in your study. Give sufficient detail that a non-expert in the subject can understand what you are proposing to do.:		
In this study, I will investigate how machine learning models can be trained to reduce errors in quantum computations without directly changing the quantum hardware or quantum circuits themselves. These models work by learning the patterns of noise unwanted variations caused by imperfections in quantum hardware and then using that knowledge to adjust the output of quantum computers so that the results more closely match what would be expected from an ideal, noise-free machine.		

To make the learning process efficient and practical, I will explore how to combine two different sources of data: computer-generated simulations of quantum noise and real measurements taken from actual quantum hardware. Simulations are cheaper and easier to produce, but they cannot fully capture the kinds of noise that occur in real devices. Real measurements, while more accurate, are costly and time-consuming to collect. The aim is to use simulated data to initially train the model and then use a small amount of real data to fine-tune it, making the model more accurate for real-world quantum computers.

Specifically, I will focus on applying transfer learning, a machine learning technique where a model trained in one setting is reused and adapted in another. I will study how well this approach works in reducing the amount of real data needed, what kinds of simulated data provide the most useful starting point for training, and which strategies for collecting real data produce the best results when used alongside the pre-trained models.

Through this, I aim to create a method for training error mitigation models that balances cost, efficiency, and accuracy, making it easier to use current quantum computers more effectively despite their noisy outputs.

Section 4: Data Sources

Please provide details of your data source, such as name, location and this should include any links to the data sets.

The data for this study will be sourced from IBM Quantum services, specifically leveraging both their quantum simulators and cloud-accessible quantum hardware, which are part of the IBM Quantum platform available at https://quantum.ibm.com.

Terms: https://quantum.ibm.com/terms

Simulated data will be generated using IBM's high-performance quantum circuit simulators, notably the qasm_simulator provided through Qiskit, IBM's open-source quantum computing SDK. These simulators allow the construction and execution of quantum circuits with user-defined noise models, including depolarising noise, amplitude damping, and custom non-Markovian models. Simulated noise can be systematically varied by adjusting noise parameters programmatically, and the simulator allows for high-throughput execution without access restrictions. These simulations are executed locally or on IBM's cloud-based backends through the IBM Quantum runtime service, enabling efficient generation of large-scale training datasets.

Empirical data will be collected from IBM's publicly available quantum processors hosted on the IBM Quantum cloud, which include devices such as ibmq_jakarta, ibmq_belem, and ibmq_mumbai, all of which are accessible through the same platform. These devices operate physical superconducting qubits and are subject to realistic noise processes including crosstalk, gate infidelities, readout errors and decoherence. Access to these devices is provided through IBM's managed queue system and governed by their service-level policies. The backends are selected based on their calibration characteristics, which are also made available through the platform, and historical noise data is recorded for characterisation and reproducibility.

All data interactions are mediated through Qiskit and the IBM Quantum API, which supports job submission, result retrieval, backend monitoring, and calibration data acquisition. Full documentation of the data access methods, device specifications and simulator capabilities is available at https://docs.quantum.ibm.com.

Have you checked the terms and conditions of the data source in order to use the data? Do you have permission to use it?	Yes

Section 5: Potential Ethical Issues

Does your project involve any of the following? Please mark Yes or No for all issues.

1. Human participants (adults or children)	No

2. Human material (e.g. tissue or fluid samples)	No
3. Human data (e.g. surveys and questionnaires on issues such as lifestyle, housing and working environments, attitudes and preferences)	No
4. Vertebrates, especially mammals and birds	No
5. Any other biological organisms (animals, plants etc.) not previously mentioned	No
6. Military or defence context – is this project sponsored/supported by military organisations or contractors? Is a military application one of the goals or sources of information?	No
7. Funding sources or collaboration with potential to adversely affect existing relationships or bring the University or Department into disrepute (e.g. projects related to gambling, dark markets, dark web, etc.)	No
1. Restrictions on publication - does anyone outside the University have the right to approve or veto publication, edit or request changes to the contents of publication or restrict publication of this work in any other way?	No
8. Overseas countries under regimes with poor human rights records or identified as dangerous by the UK Government's Foreign, Commonwealth Development Office.	No
9. Applications that could potentially involve unethical practice, including potential dual-use applications which could be unethical (e.g. projects involving tools or data that can be used to attack systems or people)	No

If you answered No to all the above bar Q8, you do not need an ethical approval.

If you answered Yes to any of the above bar Q8, you must complete the Fast-Track Ethical Approval Form, and submit it to your project advisor (or module leader), for approval by the Departmental Ethics Officer(s).

The Fast-Track form is designed to verify specific conditions. If certain conditions are not satisfied, the form will guide you to complete a full Ethical Approval Application, to be approved by the Physical Science Ethics Committee. This process can take several weeks to complete.

Section 4: Student Declaration

I have considered the ethical implications of this project and have identified no significant ethical implications requiring an ethics application submission to the Physical Sciences Ethics Committee.

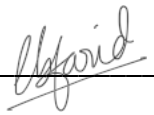
Student Name: Chris Lawrence 

Date: 30/6/2025

Instructions for Project Supervisor. Satisfy yourself a Fast Track form is not required, then approve this form yourself. Do not forward it to the ethics committee.

Supervisor declaration:

I have checked this form and I understand that completion of this form indicates that from the ethical point of view I am willing to share responsibility for the work being conducted.

Supervisor Name: 

Date: 08/07/2025