# Computer Science GTA Project

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**Section 2 – *Project Information***

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| **Project Title** | **CARNATION** - Scalable Hybrid Quantum Classical Distributed computing |
| **Project Highlights:** | 1. | Quantum Computing |
| 2. | Machine Learning |
| 3. | Computer architectures |
| **Project Summary**  |
| Quantum Computing holds promises to address the challenges of the Post-Moore era, providing theoretical speedups for specific problems (e.g., unstructured search, polynomial factorization), improving data representation, and allowing generation of quantum data, which play a key role in simulating natural phenomena (e.g., molecular dynamics), opening doors to new computational models.However, quantum machines excel only in very specific applications. This, together with the limited number of qubits available in noisy near-term machines, hints that these machines will be used in combination with classical hardware, that will perform tasks such as encoding of classical data into quantum states, error correction and mitigation, and provide the intercommunication layer between classical and quantum hardware. Moreover, recent research effort, such as Qdislib, investigate the possibility of distributing computation between multiple quantum machines, allowing processing of more complex input on quantum machines. Therefore, research challenges such as (1) identifying efficient methods for encoding data on quantum machines, (2) finding optimal strategies to distribute computation across classical and quantum machines, (3) providing seamless integration between classical and quantum hardware and interoperation between heterogeneous quantum hardware, and (4) providing problem-specific error correction/mitigation will be of paramount importance to enable hybrid quantum-classical computation in the Post-Moore era. In CARNATION, the candidate will focus on the distribution of computation between classical and quantum machines; the candidate will then focus on distributed encoding, where methods such as Quantum Random Access Codes could be explored to distribute encoded classical input to different quantum machines; alternatively, the candidate could focus on circuit knitting and circuit cutting methods, and identify ways to distribute the computation to optimize for different performance metrics; Also, studying interoperation between quantum hardware nodes and the factors influencing quantum distributed computing will provide a significant contribution, ensuring high-quality research output for the next three-four years and further exploitation.  |