

## Quantum Computing Assignment #1 Total Marks = 60

Reference videos

- Quantum Computing: Eigenvalues of a Unitary Matrix Lie on the Unit Circle
- Properties of Eigenvalues and Eigenvectors
- Speedy Eigenvalues and Eigenvectors calculation using properties
- Example of Eigenvector and Eigenvalue
- Breaking Cryptography Using Shor's Factoring Algorithm
- How to solve a cubic equation using the factor theorem

1. Compute eigenvectors and eigenvalues of the following matrix: [10 Marks]

$$\begin{pmatrix} 3 & 1 & -1 \\ 1 & 2 & 1 \\ -1 & 0 & 1 \end{pmatrix}$$

2. Find all eigenvalues and eigenvector using properties of Eigenvectors and eigenvalues (whenever possible). Specify which property you have used: [5+5+5 Marks]

$$a) \begin{pmatrix} 7 & 0 \\ 0 & -1 \end{pmatrix}$$

$$b) \begin{pmatrix} 1 & 0 & 2 \\ 0 & 2 & 3 \\ 0 & 0 & 5 \end{pmatrix}$$

$$c) \begin{pmatrix} 1 & 3 \\ 0 & 4 \end{pmatrix}$$

3. Find factors of  $N=437$  using Shor's algorithm. [10 Marks]
4. Prove that eigenvalues of a unitary matrix lie on the unit circle. Thus, can always be represented at  $e^{2\pi i\theta}$  where  $\theta \in [0, 1)$  [10 Marks]
5. Given two primes  $p=13$ , and  $q=7$ 
  - a) Create public key and private keys for RSA (at a receiver).
  - b) Make encrypt  $x=3$  at the sender.
  - c) Show description of encrypted message at the receiver. [5+5+5 Marks]