| **2 marks questions** | |
| --- | --- |
| 1 | State the difference between positive numbers and natural numbers. |
| 2 | What do you understand by imaginary number? |
| 3 | What is the value of i3 ? |
| 4 | What is complex number? |
| 5 | What do you understand by field? |
| 6 | When a field can be called algebraically complete? |
| 7 | How you can change sign of a complex number? |
| 8 | What is conjugation? |
| 9 | What do you understand by complex conjugate? |
| 10 | Write a C^4 zero vectors. |
| 11 | What can be called as an inverse of a vector? |
| 12 | What is abelian group? |
| 13 | What is Hermitian matrix? |
| 14 | What is unitary matrix? |
| 15 | What is bit? |
| 16 | What is qubit? |
| 17 | What is qubyte? |
| 18 | What are the basic logic gates? |
| 19 | What are the universal logic gates? |
| 20 | What is quantum gate? |
| 21 | What is encryption? |
| 22 | What is decryption? |
| 23 | What is ciphertext? |
| 24 | What is eavesdropping? |
| 25 | What does the term superposition refer to? |
| 26 | How is a qubit in quantum computing different from a regular bit in  classical computing? |
| 27 | In quantum computing, what is the basic unit of information? |
| 28 | Which part of the drug discovery life cycle can quantum computing impact the most? |
| 29 | What does it mean when we say that we are currently in the noisy,  intermediate scale quantum computing stage? |
| 30 | What is the purpose of “post-quantum” cryptography? |
| 31 | Why might businesses be interested in using quantum computers? |
| 32 | What is a current concern regarding the advancement of quantum  computing? |
| 33 | Which technology will quantum computing impact most significantly? |
| 34 | How could quantum computing benefit the Financial Service Industry? |
| 35 | Which problem is more classical effectively solved using quantum  computing rather than classical computer? |
| 36 | How you can define complex number as an ordered pair? |
| 37 | Let c = 1 + i. What is its polar representation? |
| 38 | What is complex vector space? |
| 39 | What can be depicted by C^4? |
| 40 | What can be called as an inverse of a vector? |
| 41 | When a set of vectors can be called linearly independent? |
| 42 | How a qubit pair can be written? |
| 43 | How a two bit qubit can be expressed? |
| 44 | What do you understand by probabilistic system? |
| 45 | A mathematician is trying to break down a large number into smaller prime numbers that, when multiplied, would arrive at that larger number. what is this process called? |
| 46 | What is the term for breaking a larger number apart into smaller numbers that can be multiplied together to get a specific result? |
| 47 | Which phenomena of quantum mechanics used in Quantum computing? |
| 48 | What can be states of a qubit? |
| 49 | In a Quantum circuit, If memory consists of n bits of information, then what will be the possible no. of states? |
| 50 | When the information is between 0 and 1 in a quantum computer, what do we call this? |
| 51 | What does 'entanglement' mean? |
| 52 | Quantum encryption keys can be hacked and broken into. True or False? |
| 53 | Why are we not able to use quantum computers in our homes? |
| 54 | What is supercomputer? |
| 55 | How quantum computer differs from super computer? |
| 56 | Convert 23D916 to binary, decimal and octal. |
| 57 | Solve for the decimal equivalent of (101101.10101)2 |
| 58 | Write De-Morgan’s law and verify it with the truth table. |
| 59 | Which possible Attacks in Quantum Cryptography can take place? |
| 60 | Which two principles of quantum mechanics on which quantum  cryptography are dependent? |
| 61 | What is the greatest threat to public cryptography or asymmetric  algorithms? |
| 62 | What is active attack? |
| 63 | What is passive attack? |
| 64 | What is the difference between symmetric and asymmetric cryptography? |
| 65 | What is information gain? |
| 66 | What is the modulus of c = (1-i)? |
| 67 | Calculate the modulus of c = (4-3i) |
| 68 | Consider the complex numbers c = 3 + 4i. Find the length of the vector. |
| 69 | What is the meaning of AND |11>? |
| 70 | Why AND gate is not reversible? |
| 71 | Let (x+3) + i(y-2) = (5+2i), find x and y. |
| 72 | Calculate the value of |
| 73 | Calculate the value of |
| 74 | What is the probability of getting a sum as 3 if a dice is thrown? |
| 75 | In a box, there are 8 orange, 7 white, and 6 blue balls. If a ball is picked up randomly, what is the probability that it is neither orange nor blue? |
| 76 | If a number is selected at random from the first 50 natural numbers, what will be the probability that the selected number is a multiple of 3 and 4? |
| 77 | What are the limitations of present quantum computers? |
| 78 | What is the role of error correction when working with quantum  computers? |
| 79 | What is the relationship between quantum computing and machine  learning? |
| 80 | Is a qubit still considered digital? |
|  |  |
| **5 marks Question** | |
| 1 | Let, c1 = (3 - i) and c2 = (1+4i) and Compute c1 + c2 and c1 × c2. |
| 2 | Let, c1 = (-3 + i) and c2 = (2 - 4i) and Compute c1 + c2 and c1 × c2. |
| 3 | Verify that the complex number (-1+i) is a solution for the polynomial equation |
| 4 | Write a program (any language) that accepts two complex numbers and outputs their sum and their product. |
| 5 | Let c1 =(3, -2) and c2 = (1,2). Multiply them. |
| 6 | Let c1 =(-3, -1) and c2 = (1,-2). Calculate the product. |
| 7 | Let, c1 = (-2+i) and c2 = (1+2i). Compute c1/c2. |
| 8 | Let, c1 = (3i) and c2 = (-1 - i). Compute c1/c2. |
| 9 | Show that conjugation respects addition, i.e., c1 + c2 = c2 + c1. |
| 10 | Show that conjugation respects multiplication, i.e., c1 × c2 = c1 × c2 |
| 11 | Describe complex plane with proper diagram. |
| 12 | Verify that multiplication by (-1,0) changes the sign of the real and imaginary components of a complex number. |
| 13 | Discuss parallelogram rule for addition of vectors. |
| 14 | Discuss parallelogram rule for subtraction of vectors. |
| 15 | Write a program (any language) that converts a complex number from its Cartesian representation to its polar representation and vice versa. |
| 16 | Draw the complex numbers c1 = (2-i) and c2 = (2+i) in the complex plane, and subtract them using the parallelogram rule. Verify that you would get the same result as subtracting them algebraically. |
| 17 | Take any C^5 vector and take another C^5 vector and prove that second one is an inverse of a first one. |
| 18 | Add the given vectors |
| 19 | What can be possible eigen values for the given matrix? |
| 20 | Find eigen vector for the given matrix with a eigen  value of 7. |
| 21 | Find eigen vector for the given matrix with a eigen  value of 6. |
| 22 | When following set of vectors can be called as linearly independent? |
| 23 | When following set of vectors can be called as linearly independent? |
| 24 | Show that the following set of vectors are not linearly independent. |
| 25 | Show that given matrix is Hermitian matrix. |
| 26 | Express inputs and output of NAND gate as matrix. |
| 27 | Show that NAND is a combination of NOT and AND. |
| 28 | Express inputs and output of NOR gate as matrix. |
| 29 | Explain controlled-NOT gate. |
| 30 | Discuss pauli matrices. |
| 31 | Explain square root of NOT gate. |
| 32 | Explain Deutsch gate. |
| 33 | Find the probability of the qubit belonging to state |0> and |1>. |
| 34 | Calculate (i) 244,443 Mod 247 (ii) 18,154 Mod 247 (iii) 226,006 Mod 247. |
| 35 | Show that (i) 1,977 1 Mod 247 (ii) 16,183 15,442 Mod 247 (iii) 2,439,593 238,082 Mod 247 |
| 36 | If state of a classical deterministic system is expressed as X = [6, 2, 1, 5, 3, 10]^T, what we understand from this? |
| 37 | If state of a classical deterministic system is expressed as X = [5, 5, 0, 2, 0, 15]^T, what we understand from this? |
| 38 | In a probabilistic system a state is expressed by X = [1/ 5 , 3/10 , 1/2 ]^T, explain X. |
| 39 | Normalize the vector [2 3i, 1 + 2i]^ T. |
| 40 | Find the unitary adjacency matrix for the given graph. |

|  | **10 marks Question** |
| --- | --- |
| 1 | Verify that the multiplication of complex numbers is associative. |
| 2 | Derive the general equation for subtraction and division of complex numbers. |
| 3 | Illustrate the following expression: AB + CD, Using only NAND gate.  Transform the following expression: (A + B) (C + D), Using only NOR gate. |
| 4 | Find eigen values for the given matrix. |
| 5 | Find eigen values for the given matrix. |
| 6 | Find eigen values for the given matrix. |
| 7 | Find eigen values and eigen vector for the given matrix. |
| 8 | Show that given matrix is unitary. |
| 9 | Express input and output of basic gates as matrix. |
| 10 | Discuss different quantum gates. |
| 11 | Consider the function from {0, 1}^2 to {0, 1} that always outputs a 1.  Give the corresponding 8-by-8 unitary matrix. |
| 12 | Explain Deutsch algorithm.  . |
| 13 | Explain Deutsch-Jozsa algorithm.  . |
| 14 | Explain Simon's Periodicity Algorithm. |
| 15 | Explain Shor's factoring algorithm. |
| 16 | Consider the following balanced function from {0, 1}^2 to {0, 1} and  represent it as a matrix. |
| 17 | Let N = 15 and a = 2, 4, 13. Apply Shor’s algorithm to find f(a,N). |
| 18 | Calculate the first few values of f(a,N) for N = 247 and (i) a = 2 (ii) a = 17(iii) a = 23. |
| 19 | Consider a circuit that is represented by OR \*(NOT  AND). Find its corresponding matrix operations. |
| 20 | Consider the given graph for a dynamic system and describe it as  matrix. |
| 21 | Multiply M\*N and show the result is doubly stochastic matrix. |
| 22 | Consider the given graph and a specific state : probability is 1/ 6 that the marble is on vertex 0, the probability is 1/ 6 that the marble is on vertex 1, and the probability is 2/3 that the marble is on vertex 2. Calculate how a state changes. |
| 23 | Explain the quantum billiard ball with proper graph and matrix. |
| 24 | Prove that Shannon entropy is always positive or zero. |
| 25 | Justify von Neumann entropy. |
| 26 | Explain data compression techniques. |
| 27 | Explain Huffman coding and its application in data compression process. |
| 28 | Explain error-correcting codes. |
| 29 | A file contains the following characters with the frequencies as shown. If Huffman Coding is used for data compression, determine-  a.Huffman Code for each character Average code length  b. Length of Huffman encoded message (in bits)   |  |  | | --- | --- | | Characters | Frequencies | | a | 10 | | e | 15 | | i | 12 | | o | 3 | | u | 4 | | s | 13 | | t | 1 | |
| 30 | Reframe error-correcting codes. |