STEM FEST

MANARAT STEM FEST 2021

COMPUTER SCIENCE OLYMPIAD SYLLABUS

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CLASS 7-8

1. Computer Fundamentals

- Hardware vs software
- Input, output, processing and storage
- CPU and basic processor concepts
- RAM and ROM
- Primary vs secondary storage
- Common storage devices
- Operating systems and their basic functions
- Applications vs system software
- Embedded computers
- Everyday computing systems
- Basic computer architecture concepts

2. Number Systems & Data Representation

- Binary and denary numbers
- Basic hexadecimal awareness
- Binary denary conversion
- Binary addition and subtraction
- Representing letters and characters
- ASCII concept
- Bits and bytes
- File sizes
- Basic image representation
- Basic audio representation
- Even/odd parity concepts

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3. Computational Thinking

- Decomposition
- Pattern recognition
- Abstraction
- Algorithms
- Step-by-step reasoning
- Identifying patterns
- Logical deduction
- Problem decomposition
- Recognizing efficient vs inefficient approaches

4. Algorithms & Flowcharts

- What is an algorithm?
- Sequence
- Selection
- Repetition
- Flowcharts
- Simple pseudocode
- Variables
- Basic operators
- Conditions
- Counters
- Accumulators
- Tracing algorithms

5. Introductory Programming

- Variables
- Integers, strings and Boolean values
- Arithmetic operators
- Comparison operators

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- IF/ELSE
- Loops
- Nested conditions
- Basic functions
- Input/output
- Simple lists/arrays
- Debugging

6. Logic & Boolean Reasoning

- Logic gates
- NAND/NOR concept
- Truth tables
- Boolean expressions
- Logical statements
- True/false reasoning
- Basic logic circuits

7. Algorithms & Mathematical Puzzles

- Sequences and patterns
- Counting
- Simple combinatorics
- Pigeonhole principle — intuitive applications
- Parity
- Invariants — intuitive level
- Greedy reasoning
- Sorting puzzles
- Minimum/maximum problems
- Strategy problems
- Recursive patterns
- Simple optimization problems

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8. Graphs & Networks — Introduction

- Nodes/vertices
- Edges
- Paths
- Cycles
- Connected components — intuitive
- Trees — basic concept
- Simple graph representations
- Shortest-path intuition
- Network puzzles

9. Internet & Cybersecurity

- Internet vs World Wide Web
- Basic networking concepts
- LAN/WAN
- IP address concept
- Domain names
- URLs
- Web browsers
- HTTP/HTTPS concept
- Password security
- Two-factor authentication
- Malware
- Phishing
- Encryption concept
- Digital privacy
- Safe computing

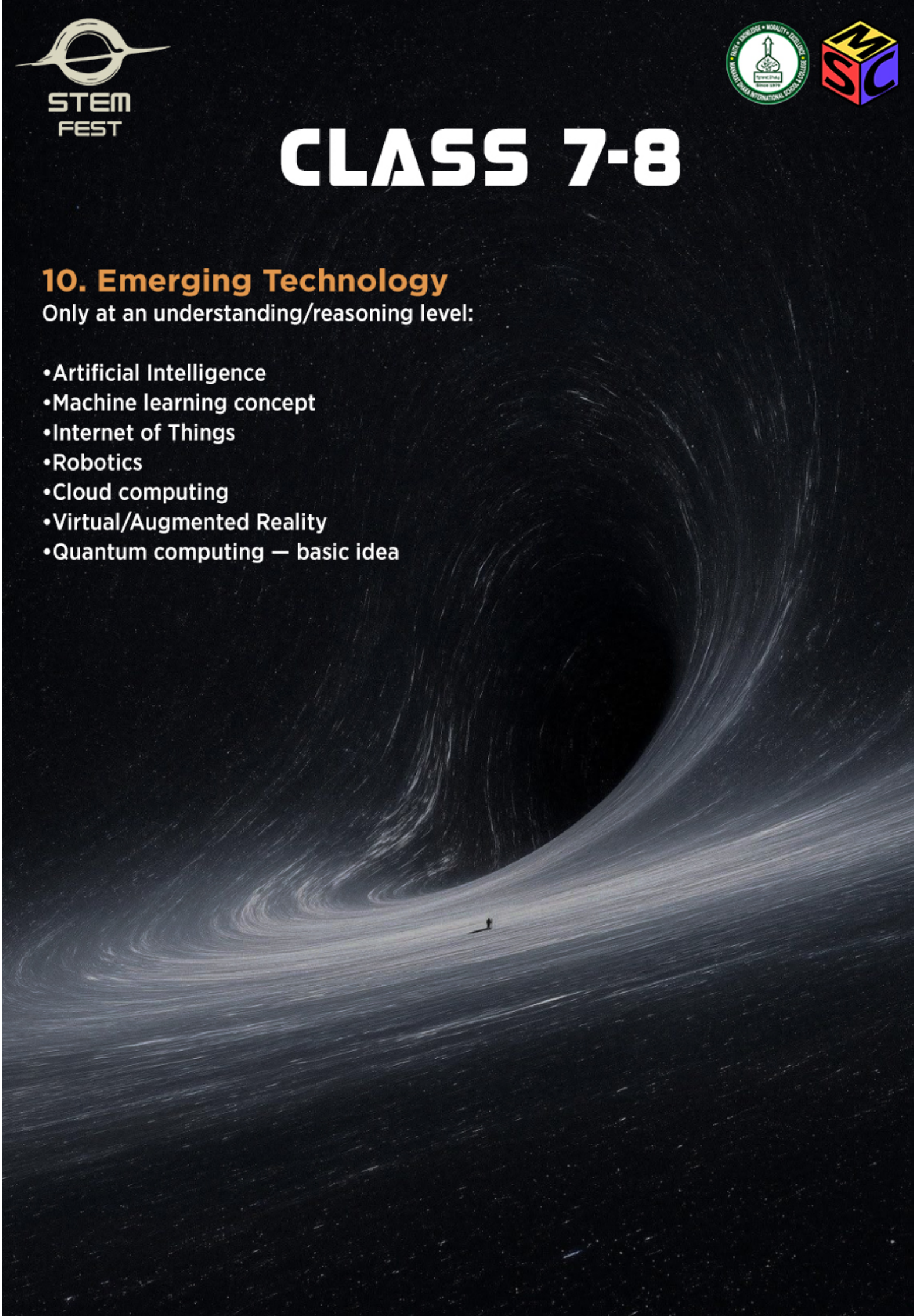
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CLASS 7-8

10. Emerging Technology

Only at an understanding/reasoning level:

- Artificial Intelligence
- Machine learning concept
- Internet of Things
- Robotics
- Cloud computing
- Virtual/Augmented Reality
- Quantum computing — basic idea



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CLASS 9-10

1. Computer Systems & Architecture

- CPU
- ALU
- Control Unit
- Registers
- Buses
- RAM/ROM
- Cache
- Storage technologies
- Von Neumann architecture
- Fetch-decode-execute cycle
- Operating systems
- System vs application software
- Embedded systems
- Performance factors
- CPU/GPU concepts

2. Data Representation

- Binary
- Denary
- Hexadecimal
- Binary arithmetic
- Two's complement
- Signed/unsigned representation
- Overflow
- Character encoding
- ASCII
- Unicode
- Bitmap images
- Colour depth
- Resolution
- Sampling
- Bit rate
- File Size Calculations
- Compression

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CLASS 9-10

3. Boolean Algebra & Digital Logic

- Logic gates
- Truth tables
- Boolean expressions
- Boolean identities
- Logic circuits
- NAND/NOR as universal gates
- XOR applications
- Simplification
- Combining multiple gates

4. Programming & Computational Problem Solving

- Variables
- Data types
- Operators
- Selection
- Iteration
- Nested loops
- Functions
- Parameters
- Arrays/lists
- Strings
- Searching
- Sorting
- Recursion — introductory
- File handling concepts
- Debugging
- Algorithm tracing

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5. Algorithms

- Linear search
- Binary search
- Bubble sort
- Insertion sort
- Selection sort
- Merge sort concept
- Recursive algorithms
- Divide and conquer
- Greedy algorithms
- Algorithm correctness
- Efficiency
- Big-O notation — introductory
- Time/space trade-offs

6. Problem Solving

- Number theory basics
- Divisibility
- Prime numbers
- Greatest common divisor
- Least common multiple
- Modular arithmetic
- Parity
- Counting
- Permutations and combinations
- Pigeonhole principle
- Recurrence patterns
- Invariants
- Graph-based puzzles
- Optimization
- Greedy reasoning
- Logic puzzles

7. Data Structures

- Arrays
- Stacks
- Queues
- Linked lists — conceptual
- Trees
- Binary trees
- Binary search trees
- Hash tables — conceptual
- Graphs
- Adjacency matrix/list

8. Networking & Communications

- LAN/WAN
- Network topologies
- IP/MAC addressing
- Packets
- Routers/switches
- TCP/IP
- UDP
- HTTP/HTTPS
- DNS
- Client-server model
- Transmission methods
- Error detection
- Parity
- Checksum
- ARQ
- Basic OSI model awareness

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9. Cybersecurity & Cryptography

- Malware
- Phishing
- Social engineering
- Authentication
- Access control
- Password security
- Encryption/decryption
- Symmetric vs asymmetric encryption
- Hashing
- Digital signatures — conceptual

Basic cryptographic puzzles

- SQL injection/XSS — conceptual awareness

10. Databases & SQL

- Databases
- Tables
- Records
- Fields
- Primary keys
- Foreign keys
- Relationships
- Basic SQL
- Simple aggregation
- Sorting/filtering
- Database design
- Redundancy
- Normalization — introductory

11. AI & Modern Computing

- Artificial intelligence
- Machine learning
- Training data
- Classification
- Neural networks — conceptual
- Algorithms behind recommendation systems
- Bias in datasets
- Big data
- Cloud computing
- Parallel processing
- Quantum computing — conceptual

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1. Advanced Programming

- Advanced pseudocode
- Python/C++-style reasoning
- Functions
- Recursion
- Nested data structures
- Strings
- Arrays
- Dictionaries/maps
- Sets
- File processing
- Object-oriented programming
- Classes and objects
- Encapsulation
- Inheritance
- Polymorphism
- Abstraction
- Exception/error handling
- Debugging
- Algorithm implementation reasoning

2. Data Structures

- Arrays
- Linked lists
- Stacks
- Queues
- Deques
- Hash tables
- Hash functions
- Trees
- Binary trees
- Binary search trees
- Heaps
- Priority queues
- Balanced trees — conceptual
- Graphs
- Adjacency matrices/lists

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CLASS 11-12

3. Algorithms & Complexity

- Algorithm analysis
- Big-O
- Big-Theta concept
- Time complexity
- Space complexity
- Best/worst/average cases
- Binary search
- Sorting algorithms
- Merge sort
- Quick sort
- Heap sort
- Divide and conquer
- Greedy algorithms
- Dynamic programming
- Backtracking
- Recursion
- Memoization
- Algorithm optimization

4. Graph Algorithms

- Graph terminology
- Directed/undirected graphs
- Weighted graphs
- BFS
- DFS
- Connected components
- Cycle detection
- Shortest paths
- Dijkstra's algorithm
- Minimum spanning trees
- Prim's algorithm
- Kruskal's algorithm
- Topological sorting
- Bipartite graphs
- Graph traversal problems

5. Competitive Programming Concepts

- Prefix sums
- Two pointers
- Sliding window
- Binary search on answer
- Greedy strategies
- Recursion
- Backtracking
- Dynamic programming
- State representation
- Invariants
- Coordinate/compression
- Bit manipulation
- Bitmasking

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6. Discrete Mathematics related to CS

- Logic
- Sets
- Relations
- Functions
- Proof techniques
- Proof by contradiction
- Mathematical induction
- Combinatorics
- Permutations and combinations
- Pigeonhole principle
- Recurrences
- Graph theory
- Trees
- Modular arithmetic
- Number theory
- Probability for algorithms

7. Computer Architecture

- CPU architecture
- Registers
- Buses
- Cache
- Memory hierarchy
- Instruction cycle
- Machine instructions
- Assembly concepts
- RISC vs CISC
- Pipelining
- Parallel processing
- Multicore processors
- CPU vs GPU
- Von Neumann vs Harvard
- Performance and bottlenecks

8. Operating Systems

- Processes
- Threads
- Scheduling
- FCFS
- SJF
- Round Robin
- Priority scheduling
- Context switching
- Interrupts
- Memory management
- Virtual memory
- Paging
- Page replacement
- FIFO
- LRU
- Deadlocks
- Process synchronization
- File systems

9. Databases

- Relational databases
- Keys
- Relationships
- Entity/relationship concepts
- SQL
- Joins
- Aggregation
- Subqueries — basic
- Functional dependencies
- Normalization
- 1NF, 2NF, 3NF
- Transactions
- ACID properties
- Concurrency
- Indexing concepts
- Database optimization
- Redundancy

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10. Networking & Distributed Systems

- TCP/IP
- UDP
- HTTP/HTTPS
- DNS
- IP addressing
- Routing
- Packets
- Network layers
- OSI model
- Error detection
- Flow/congestion concepts
- Client-server architecture
- Distributed systems
- Parallel computing
- Cloud computing
- CAP theorem — introductory
- Fault tolerance

11. Cybersecurity & Cryptography

- Symmetric encryption
- Asymmetric encryption
- Hash functions
- Digital signatures
- Authentication
- Security protocols
- Public/private keys
- RSA
- Modular arithmetic in cryptography
- Cryptographic reasoning
- SQL injection
- XSS
- Buffer overflow
- Access control
- Secure communication

12. AI & Machine Learning

- AI fundamentals
- Search algorithms
- Classification
- Regression
- Training/testing data
- Overfitting
- Features
- Neural networks
- Deep learning concepts
- Decision trees
- Clustering concepts
- Recommendation systems
- Bias and data quality
- Large-scale data processing

13. Theory of Computation

- Formal languages
- Regular expressions
- Finite automata
- Deterministic/non-deterministic finite automata — conceptual
- Grammars
- Parsing
- Computational models
- Decidability — introductory
- Halting problem
- P vs NP — conceptual
- NP-complete problems

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14. Emerging & Specialized Computing

- Quantum computing
- Quantum bits
- Quantum gates — introductory
- Parallel computing
- GPU computing
- Distributed systems
- Blockchain concepts
- Big data
- Cloud architectures
- Computer hardware industry and processor evolution