MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu

Mathematics

MKC

2021-22

Must Know Concepts (MKC)

Course Code & Course Name : **21CAA01 / Mathematical Foundations of Computer Science**

Year/Sem/Sec : **I / I / -**

S.No	Term	Notation (Symbol)	Concept / Definition / Meaning / Units / Equation / Expression	Units
		Unit – I Logic And Proofs		
1	Proposition		It is a declarative sentence which is either true or false but not both.	I
2	Statement Formula		It is an expression which is a string consisting of variables (Captial letters with or with out subscripts), parenthesis and connectives symbols.	I
3	Logical Connectives	~, ∨, ∧, →, ↔	Negation, Conjunction, Disjunction, Conditional, Bi Conditional.	I
4	Truth Table Negation Conjunction (And)		A truth table is a table consists of the truth values (True or False)	I
		~	The negation of a statement is generally formed by introducing the word “not” at a proper place in the given statement.	I
		^	If both P and Q have the truth values T, then P∧Q has the truth value T.Otherwise P^Q has the truth value F.	I
5	Disjunction (OR)	∨	P ∨ Q has the truth value T if any one of P or Q has the truth value T	I
6	Biconditional	↔	The Statement P ↔ Q has the truth value T whenever both P and Q have same truth values.	I
7	Tautology		A Statement formula which is always true is called a Tautology.	I
8	Contradiction		A Statement formula which is always true is called a Contradiction.	I
9	Contingency		A Statement formula which is neither tautology nor contradiction is called Contingency.	I

10	Converse, Inverse and Contrapositive		$P \rightarrow Q$ is a conditional statement Converse of $P \rightarrow Q$ is $Q \rightarrow P$ Contra positive of $P \rightarrow Q$ is $\sim Q \rightarrow \sim P$ Inverse of $P \rightarrow Q$ is $\sim P \rightarrow \sim Q$.	I
11	Idempotent Laws		1. $P \wedge P \leftrightarrow P$ 2. $P \vee P \leftrightarrow P$	I
12	Identity Laws		1. $P \wedge T \leftrightarrow P$ 2. $P \vee F \leftrightarrow P$	I
13	De Morgans Laws		1. $\sim(p \wedge q) \leftrightarrow (\sim p \vee \sim q)$ 2. $\sim(p \vee q) \leftrightarrow (\sim p \wedge \sim q)$	I
14	Double Negation Law		$\sim(\sim p) \leftrightarrow p$	I
15	Proposition		It's a declarative sentence which is either true or false but not both.	I
16	Statement Formula		It is an expression which is a string consisting of variables (Capital letters with or without subscripts), parenthesis and connectives symbols.	I
17	Quantifiers		It is one which is used to quantify the nature of variables.	I
18	Types of Quantifiers		1. Universal Quantifier 2. Existential Quantifier	I
19	Universal Quantifier	(x) or $\forall x$	The quantifier "for all x" is called the Universal Quantifier.	I
20	Existential Quantifier	$(\exists x)$	The quantifier "some x" is called the Existential Quantifier.	I
21	Disjunctive Normal Form	DNF	A Statement formula which is equivalent to a given formula and which consists of a sum of elementary products is called a Disjunctive Normal Form.	I
22	Conjunctive Normal Form	CNF	A Statement formula which is equivalent to a given formula and which consists of a product of elementary Sum is called a Conjunctive Normal Form.	I
23	Principal Disjunctive Normal Form	PDNF	For a given Statement formula, an equivalent formula consisting of disjunction of min terms only is known as Principal Disjunctive Normal Form.	I
24	Principal Conjunctive Normal Form	PCNF	For a given Statement formula, an equivalent formula consisting of conjunction of max terms only is known as Principal Disjunctive Normal Form	I

25	Predicate Calculus		Predicate Calculus deals with the study of predicates.	I
		Unit-II Combinatorics		
26	Permutation	nP_r	The process of arranging things is called Permutation.	II
27	Combination	nC_r	The process of selecting things is called Combination.	II
28	Generating function.	G(x)= $\sum_{n=0}^{\infty} a_n x^n$	The generating function of a sequence $a_0,a_1,a_2,\ldots\ldots,a_n$, is the expression G(x)= $\sum_{n=0}^{\infty} a_n x^n$	II
29	Principle of Inclusion and Exclusion for two variables		$\lvert A_1 \cup A_2\rvert = \lvert A_1\rvert + \lvert A_2\rvert - \lvert A_1 \cap A_2\rvert$	II
30	The principle of Inclusion – Exclusion for three variables		$\lvert A_1 \cup A_2 \cup A_3\rvert = \lvert A_1\rvert + \lvert A_2\rvert + \lvert A_3\rvert - \lvert A_1 \cap A_2\rvert - \lvert A_1 \cap A_3\rvert - \lvert A_2 \cap A_3\rvert + \lvert A_1 \cap A_2 \cap A_3\rvert$	II
31	Recurrence relation		An equation that expresses a_n the general term of the sequence (a_n)in terms of one or more of the previous terms of the sequence namely $a_0,a_1,a_2,\ldots\ldots,a_{n-1}$ for all integers n with $n \geq n_0$ where n_0 is a non-negative integer is called Recurrence relation.	II
32	Linear recurrence relation		A recurrence relation of the form $c_0a_n + c_1a_{n-1} + c_2a_{n-2} + \cdots + c_ka_{n-k} = f(n)$ is called a linear recurrence relation of degree k with constant coefficients,where $c_0, c_1, \ldots c_k$ are real numbers and $c_k \neq 0$.	II
33	Homogeneous recurrence relation	$f(n) = 0$	If $f(n) = 0$, then the given recurrence relation is called homogeneous recurrence relation.	II
34	Non-Homogeneous recurrence relation	$f(n) \neq 0$	If $f(n) \neq 0$, then the given recurrence relation is called homogeneous recurrence relation.	II
35	Characteristic equation of order 2		$c_0r^2 + c_1r + c_2 = 0$,$r \neq 0$ is called the characteristic equation.	II
36	Recurrence relation for the Fibonacci sequence	$f_n=f_{n-1}+f_{n-2}$	Fibonacci sequence recurrence relation $f_n=f_{n-1}+f_{n-2}$	II
37	Complementary function of the		$a_n = k_1r^n + k_2r^n$	II

	recurrence relation, if the roots are real and unequal			
38	Complementary function of the recurrence relation, if the roots are real and equal		$a_n = (k_1 + k_2\, n)\, r^n$	II
39	Complementary function of the recurrence relation, if the roots are Imaginary		$a_n = r^n(k_1 cosn\theta + k_2\, sinn\theta)$	II
40	Generating function of the sequence 1,1,1,1…. is		G(x)= $\sum_{n=0}^{\infty} x^n$	II
41	Generating function of the sequence 1,2,3,4…. is		G(x)= $\sum_{n=0}^{\infty}(n+1)x^n$	II
42	Generating function of the sequence $1, a, a^2, a^3$ .... is		$G(x) = \frac{1}{1-ax}$ $, for\ \lvert ax \rvert < 1$	II
43	Generalisation of the Pigeonhole principle		If n pigeons are accommodated in m pigeonholes and $n > m$,then one of the pigeonholes must contain atleast $\left\lfloor \frac{n-1}{m} \right\rfloor$ pigeons	II
44	Circular permutations		If the objects are arranges in a circle (or any closed curve),we get circular permutation and the number of circular permutations will be different from the number of linear permutations.	II
45	Number of different circular permutations of n objects		$(n-1)!$	II
46	Number of different circular arrangements of n objects		$\frac{(n-1)!}{2}$	II
47	The principle of Mathematical induction		Let P(n) be a statement or proposition involving the nature number 'n' (i) If P(1) is true (ii) Under the assumption that when P(k) is true, P(k+1) is true, then we conclude that a statement P(n) is true for all natural	II

			numbers ‘n’	
48	Well-ordering Property		Every non empty set of non negative integers has a least element.	II
49	Pigeonhole principle		If (n+1) pigeon occupies ‘n’ holes then atleast one hole has more than 1 pigeon.	II
50	Principle of strong induction		P(j) is true for j =1,2…..k and shows that P(k+1) must also be true based on this assumption. This is called strong induction.	II

Unit-III Graphs

51	Graph	$G = G\langle V, E\rangle$	A graph $G = G\langle V, E\rangle$ consists of a non-empty set V,called the set of vertices (nodes, points) and a set E of ordered or unordered pairs of elements of V called the set of edges, such that there is a mapping from the set E to the set of ordered or unordered pairs of elements of V.	III
52	Directed graph		If in a graph $G = G\langle V, E\rangle$,each edge $e \in E$ is associated with an ordered pair of vertices, then G is called a directed graph or Digraph.	III
53	Undirected Graph		If each edge is associated with an unordered pair of vertices, then G is called an undirected graph.	III
54	Simple graph		A graph in which there is only one edge between a pair of vertices is called a simple graph.	III
55	Multi Graph		A graph which contains some parallel edges is called a multigraph.	III
56	Pseudo Graph		A graph in which loops and parallel edges are allowed is called a pseudo graph.	III
57	Regular graph		Every vertex of a simple graph has the same degree.	III
58	Complete graph		There exists an edge between every pair of vertices.	III
59	Degree of a Vertex	deg(v)	The degree of a vertex in an undirected graph is the number of edges incident with it, with the exception that a loop at a vertex contributes twice to the degree of that vertex.	III
60	Pendant Vertex		If the degree of a vertex is one then it is called pendant vertex.	III
61	Bipartite graph		If the vertex set of a simple graph $G = G\langle V, E\rangle$ can be partitioned into two subsets V_1 and V_2 such that every edge of G connects a vertex in V_1 and and a vertex V_2 , then G is called a bipartite graph.	III
62	Completely Bipartite graph		If each vertex of V_1 is connected with every vertex of V_2 by an edge,then G is called Completely Bipartite graph	III

63	Adjacency Matrix	$A = [a_{ij}]$	$= \begin{cases} 1 & , if\ there\ exist\ an\ edge\ between\ v_i\ and\ v_j \\ 0, & otherwise \end{cases}$	III
64	Incidence Matrices	$B = [b_{ij}]$	$= \begin{cases} 1 & , when\ edge\ e_j\ incident\ on\ v_i \\ 0, & otherwise \end{cases}$	III
	Path Matrix	$P = [p_{ij}]$	$= \begin{cases} 1 & , if\ there\ exist\ a\ path\ from\ v_i\ to\ v_j \\ 0, & otherwise \end{cases}$	III
65	Graph Isomorphism		If G_1& G_2 are isomorphic then G_1& G_2 have (i)the same number of vertices (ii)the same number of edges (iii) an equal number of vertices with a given degree	III
66	Path		Starting with the vertex v_1, one can travel along edges (v_1, v_2),(v_2, v_3),….. and reach the vertex v_k.	III
67	Length of the path		the number of edges appearing in the sequence of a path.	III
68	Cycle or Circuit		A path which originate and ends in the same node	III
69	Eulerian Path		A path of a graph G is called an Eulerian path, if it includes each of edges of G exactly once.	III
70	Eulerian Circuit		(i)Starting and ending points (vertices) are same. (ii)Cycle should contain all the edges of the graph but exactly once.	III
71	Eulerian Graph		A graph containing an Eulerian circuit is called an Eulerian graph.	III
72	Hamiltonian Path		A path of graph G is called a Hamiltonian path,if it includes each vertex of g exactly once.	III
73	Hamiltonian Circuit		Cycle should contain all the vertices of graph but exactly once, except the starting and ending vertices.	III
74	Hamiltonian Graph		A graph containing an Hamiltonian circuit is called an Hamiltonian graph.	III
75	Connected Graph		An undirected graph is said to be connected if a path between every pair of distinct vertices of the graph.	III
Unit-IV Algebraic Systems				
76	Semi Group		Closure property: $a * b\ \varepsilon\ G, for\ all\ a, b\ \varepsilon\ G$ Associative property: $(a * b) * c = a * (b *), for\ all\ a, b, c\ \varepsilon\ G$	IV
77	Monoid		Closure property: $a * b\ \varepsilon\ G, for\ all\ a, b \varepsilon G$ Associative property: $(a * b) * c = a * (b * c), for\ all\ a, b, c\ \varepsilon\ G$ Identity element: : $a * e\ =\ e * a\ =\ a\ for\ all\ a\ \varepsilon\ G$	IV

78	Semi group Homomorphism		Let $(S,*)$ and (T,Δ) be any two semi group. A mapping $g:S\rightarrow T$ such that for any two elements $a,b\in S$. $g(a*b)=g(a)\Delta g(b)$ is called a semi group homomorphism.	IV
79	Group		Closure property: $a*b\ \varepsilon\ G, for\ all\ a,b \varepsilon G$ Associative property: $(a*b)*c = a*(b*c), for\ all\ a,b,c\ \varepsilon\ G$ Identity element: : $a*e = e*a = a\ for\ all\ a\ \varepsilon\ G$ Inverse element: $a*a^{-1} = a^{-1}*a = e\ for\ all\ a,a^{-1}\ \varepsilon\ G$	IV
80	Abelian Group		Closure property: $a*b\ \varepsilon\ G, for\ all\ a,b \varepsilon G$ Associative property: $(a*b)*c = a*(b*c), for\ all\ a,b,c\ \varepsilon\ G$ Identity element: : $a*e = e*a = a\ for\ all\ a\ \varepsilon\ G$ Inverse element: $a*a^{-1} = a^{-1}*a = e\ for\ all\ a,a^{-1}\ \varepsilon\ G$ Commutative Property: $a*b = b*a\ for\ all\ a,b\ \varepsilon\ G.$	IV
81	Order of group	$O(G)$	The number of elements in a group G.	IV
82	Finite group		$O(G)$ is finite.	IV
83	Infinite group		$O(G)$ is infinite.	IV
84	Subgroup		Let $(G,*)$ be a group.Then $(H,*)$ is said to be subgroup of $(G,*)$ if $H \subseteq G$ and $(H,*)$ itself is a group under the operation *.	IV
85	Lagrange's theorem		If G is a finite group and H is a sub group of G then the order of H is a divisor of order of G. The converse of Lagrange's theorem is false.	IV
86	Ring		(i) (a+b)+c=a+(b+c) a,b,c ϵR (ii) There exists an element 0 ϵ R called zero element such that a+0 = 0+a =a for all a ϵ R (iii) For all a ϵ R, a+(-a) =(-a)+a = 0, -a is the negative of a. (iv) a+b =b+a for all a,b ϵR (v) (a.b).c =a.(b.c) for all a,b,c ϵR The operation * is distributive over + i.e.,for any a,b,c ϵ R, a.(b+c) = a.b +a.c (b+c).a = b.a +c.a In otherwords if R is an abelian group under addition with the properties (v) and (vi) then R is a ring.	IV

87	Field		A commutative ring (R,+,●) with identity is called a field if every non-zero element has a Multiplicative inverse. Thus (R,+,●) is a field if (i) (R,+) is abelian group and (ii) (R-{0},●) is also abelian group.	IV
88	Cyclic Group		A group {G,*} is said to be cyclic,if there exists an element $a \varepsilon G$ such that every element x of G can be expressed as $x=a^n$ for some integer n.	IV
89	Kernal of a Homomorphism	ker(f)	If $f: G \to G'$ is a group homomorphism ,then the set of elements of G, which are mapped into e', the identity element of G' is called the kernel of the homomorphism f .	IV
90	Left Co sets		If {H,*} is subgroup of a group {G,*}, then the set aH , where $a \varepsilon G$,defined by aH={a*h / h εH} is called the left cosetof H in G.	IV
91	Right Co sets		If {H,*} is subgroup of a group {G,*}, then the set Ha , where $a \varepsilon G$,defined by Ha={h*a / h εH} is called the right co set of H in G.	IV
92	Algebraic systems		A system consisting of non-empty set and one or more n-ary operations on the set is called an algebraic system.	IV
93	Homomorphism		If $\{X, \circ\}$ *and* $\{Y, *\}$ are two algebraic systems, where $\circ$ & $*$ are binary (n-ary) operations, then a mapping $g: X \to Y$ is called homomorphism or simply morphism from $\{X, \circ\}$ to $\{Y, *\}$,if for any $x_1, x_2 \in X$, $g(x_1 \circ x_2) = g(x_1) * g(x_2)$,If a function g satisfying the above condition exists, then $\{Y, *\}$ is called the homomorphic image of $\{X, \circ\}$	IV
94	Epimorphism		If the homomorphism $g: X \to Y$ is onto ,then g is called Epimorphism	IV
95	Monomorphism		If the homomorphism $g: X \to Y$ is one-to-one ,then g is called Epimorphism	IV
96	Isomorphism		If $g: \{X, \circ\} \to \{Y, *\}$ is one0to-one and onto, then g is called isomorphism	IV
97	Endomorphism		A homomorphism $g: \{X, \circ\} \to \{Y, *\}$ is called an endomorphism ,if $Y \subseteq X$	IV
98	Automorphism		A homomorphism $g: \{X, \circ\} \to \{Y, *\}$ is called an endomorphism ,if $Y = X$	IV
99	Sub Semi groups		If $\{S, *\}$ is a semi group and $T \subseteq S$ is closed under the operation $*$,then $\{T, *\}$ is called a subsemigroup of $\{S, *\}$	IV

100	Sub Monoids		If $\{M, *, e\}$ is a monoid and $T \subseteq M$ is closed under the operation $*$ and $e \in T$, then $\{T, *, e\}$ is called a sub Monoid of $\{M, *, e\}$.	IV
		Unit V : Lattices And Boolean Algebra		
101	Reflexive		A relation R on a set A is said to be reflexive, if a R a for every $a \in A$.	V
102	Symmetric		A relation R on a set A is said to be symmetric, if whenever a R b then b R a.	V
103	Anti symmetric		A relation R on a set A is said to be anti symmetric, if whenever (a,b) and (b,a) $\in R$ then a = b.	V
104	Transitive		A relation R on a set A is said to be transitive, if whenever a R b and b R C then a R c.	V
105	Partial ordering		A relation R on a set A is called a partial ordering if R is reflexive, anti symmetric and transitive.	V
106	Poset		A set A together with a partial order relation R is called partially ordered set or poset.	V
107	Hasse diagram		The pictorial representation of a poset is called Hasse diagram	V
108	Upper bound		When A is a subset of a poset $\{P, \leq\}$ and if u is an element of P such that a $\leq$ u for all elements $a \in A$, then u is called an upper bound of A.	V
109	Lower bound		When A is a subset of a poset $\{P, \leq\}$ and if l is an element of P such that $l \leq$ a for all elements $a \in A$, then l is called a lower bound of A.	V
110	LUB		The element x is called the least upper bound of the subset A of a poset $\{P, \leq\}$, if x is an upper bound that is less than every other upper bound of A.	V
111	GLB		The element y is called the greatest lower bound of the subset A of a poset $\{P, \leq\}$, if y is an lower bound that is greater than every other lower bound of A.	V
112	Lattice		A partially ordered set $\{L, \leq\}$ in which every pair of elements has a least upper bound and a greatest lower bound is called a lattice.	V
113	Sub lattice		A non empty subset M of a lattice $\{L, \vee, \wedge\}$ is called a sub lattice of L, iff M is closed under both the operations $\wedge$ *and* $\vee$	V
114	Idempotent		If $\{L, \leq\}$ is a lattice, then for any a,b,c $\in L$, a $\vee$ a=a and a $\wedge$ a=a	V

115	Commutative		If $\{L,\leq\}$ is a lattice ,then for any a,b,c $\in L$, $a\vee b=b\vee a$ and $a\wedge b=b\wedge a$	V
116	Associative		If $\{L,\leq\}$ is a lattice ,then for any a,b,c $\in L$, $a\vee(b\vee c)=(a\vee b)\vee c$ and $a\wedge(b\wedge c)=(a\wedge b)\wedge c$	V
117	Absorption		If $\{L,\leq\}$ is a lattice ,then for any a,b,c $\in L$, $a\vee(a\wedge b)=a$ and $a\wedge(a\vee b)=a$	V
118	Lattice Homomorphism		If $\{L_1,\vee,\wedge\}$ and $\{L_2,+,*\}$ are two lattices, is called a lattice homomorphism from L_1 to L_2, if for any a,b $\in L_1$, $f(a\vee b)=f(a)+f(b)$ and $f(a\wedge b)=f(a)*f(b)$	V
119	Distributive lattice		A lattice $\{L,\vee,\wedge\}$ is called distributive lattice,if for any elements a,b,c $\in L$, $a\wedge(b\vee c)=(a\wedge b)\vee(a\wedge c)$ $a\vee(b\wedge c)=(a\vee b)\wedge(a\vee c)$.	V
120	Complement		If $\{L,\vee,\wedge,0,1\}$ is a bound lattice and $a\in L$,then an element $b\in L$ is called a complement of a, $a\vee b=1$ and $a\wedge b=0$	V
121	Boolean Algebra		A lattice which is complemented and distributive is called Boolean algebra.	V
122	Dominance Law		i) a+1=1 and ii) a.0 =0	V
123	Demorgan's law		$(a+b)'=a'.b'$ and $(a.b)'=a'+b'$	V
124	Double complement law		$(a')'=a$	V
125	Zero and one law		$0'=1$ and $1'=0$	V
Placement Questions				
126	Prime Number		A prime number is a natural number greater than 1 that has no positive divisors other than 1 and itself.	
127	Composite number		A composite number is a positive number that can be formed by multiplying two smallest positive integers. Equivalently, it is a positive integer that has at least one divisor other than 1 and itself.	
128	Average		$\frac{Sum\ of\ quantities}{\text{Number of quantities}}$	
129	Ratio		A ratio is the comparison of two homogeneous quantities, or a ratio is the division of two quantities a and b having the same units. It is denoted by a:b	

130	Arithmetic Progression	AP	Arithmetic progression(AP) or arithmetic sequence is a sequence of numbers in which each term after the first is obtained by adding a constant.	
131	Geometric Progression	GP	Geometric Progression of non-zero numbers in which the ratio of any term and its preceding term is always constant.	
132	Probability		Probability is nothing but a chance that a given event will occur. The probability of getting success is 0.5 and failure is 0.5 .Total probability is 1.	
133	L.C.M		L.C.M. is the least non-zero number in common multiples of two or more numbers.	
134	Methods of L.C.M		i) Factorization Method. ii) Division Method.	
135	H.C.F		The highest common factor of two or more numbers is the greatest number which divides each of them exactly without any remainder.	
136	Reciprocal or Inverse Ratio		If the antecedent and consequent of a ratio interchange their places. The new ratio is called the inverse ratio of the first ratio.	
137	Selling Price	SP	The price at which goods are sold is called the selling price.	
138	Cost Price	CP	The price at which goods are bought is called the cost price	
139	Market Value		The stock of different companies are sold and bought in the open market through brokers at stock-exchanges.	
140	Profit	Profit = SP - CP	When the selling price is more than the cost price, then the trader makes a profit.	
141	Loss	Loss = CP - SP	When the selling price is less than the cost price, then the trader makes a loss.	
142	Stock Capital		The total amount of money needed to run the company is called the stock capital	
143	Shares or Stock		The whole capital is divided into small units, called shares or stock.	
144	Simple Interest	$SI = \frac{PNR}{100}$	P – Initial principal balance N – Number of years R - Interest rate	
145	Compound Interest		Compound interest is calculated on the principal amount and also on the accumulated interest of previous periods, and can thus be regarded as “interest on interest”.	
146	Mean Price		The cost of a unit quantity of the mixture is called the mean price.	
147	Odd one out		A person or thing that is different from or kept apart from others that form a group or set is called as odd one out	

148	Speed		$\text{Speed} = \frac{\text{Distance}}{Time}$	
149	Time		$\text{Time} = \frac{\text{Distance}}{Speed}$	
150	Face Value		The value of a share or stock printed on the share-certificate is called its Face Value or Nominal Value or Par Value	
Faculty Prepared		**Name of the Staff**	**Signature**	
		Ms.S.Ranjitha		

HoD