CBCS SCHEME

USN | | | | | | | | | | |

BCS405A

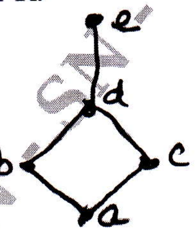
Fourth Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026
Discrete Mathematical Structures

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

			M	L	C
		Module – 1			
Q.1	a.	Define a logically equivalent. Show that $[(p \vee q) \rightarrow r] \leftrightarrow [\neg r \rightarrow \neg (p \vee q)]$ for primitive statements p, q, r is logically equivalence.	6	L1	CO1
	b.	Establish the validity of the following argument using the rules of inference: $\{(p \rightarrow q) \wedge (r \rightarrow s) \wedge (\neg q \vee \neg s)\} \rightarrow \neg (p \wedge r)$	7	L2	CO1
	c.	i) Give an indirect proof of the statement: "The product of two even integers is an even integer". ii) Provide a proof by contradiction of the following statement: "For every integer n, if n^2 is odd, then n is odd".	7	L3	CO1
		OR			
Q.2	a.	Define a tautology. Prove that, for an propositions p, q, r the compound proposition. $\{p \rightarrow (q \rightarrow r)\} \rightarrow \{(p \rightarrow q) \rightarrow (p \rightarrow r)\}$ is tautology.	6	L1	CO1
	b.	Using law of logic, prove the result. $[(p \vee q) \wedge (p \vee \neg q)] \vee q \Leftrightarrow p \vee q$	7	L2	CO1
	c.	Find whether the following argument is valid: If a triangle has two equal sides, then it is isoceles. If a triangle is isoceles, then it has two equal angles. A certain triangle PQR does not have two equal angles. $\therefore$ The triangle PQR does not have two equal sides.	7	L3	CO1
		Module – 2			
Q.3	a.	By mathematical induction, prove that $(n!) \geq 2^{n-1}$ for all integers $n \geq 1$.	6	L2	CO2
	b.	Find an in explicit form for the following: i) $a_1 = 4, a_n = a_{n-1} + n$ for $n \geq 2$ ii) $a_1 = 7, a_n = 2a_{n-1} + n$ for $n \geq 2$	7	L2	CO2
	c.	Find how many distinct four-digit integers one can make from the digits 1, 3, 3, 7, 7, 8	7	L3	CO2

VTU-19-02-2026 01:28:40pm - SN - SN - SN - SN
19-02-2026 01:32:23pm - SN - SN - SN - SN

		OR			
Q.4	**a.**	Prove that $4n < (n^2 - 7)$ for all positive integers $n \geq 6$.	6	L2	CO2
	b.	i) How many arrangements are there for all letters in the word SOCIOLOGICAL? ii) In how many of these arrangements all the vowels are adjacent?	7	L3	CO2
	c.	Determine the coefficient of i) xyz^2 in the expansion of $(2x - y - z)^4$ ii) $x^2y^2z^3$ in the expansion of $(3x - 2y - 4z)^7$	7	L2	CO2
		Module – 3			
Q.5	**a.**	Let $A = \{1, 2, 3, 4, 5, 6\}$ and $B = \{6, 7, 8, 9, 10\}$. If a function $f : A \rightarrow B$ is defined by $f = \{(1, 7), (2, 7), (3, 8), (4, 6), (5, 9), (6, 9)\}$ determine $f^{-1}(6)$ and $f^{-1}(9)$. If $B_1 = \{7, 8\}$ and $B_2 = \{8, 9, 10\}$, find $f^{-1}(B_1)$ and $f^{-1}(B_2)$.	6	L2	CO2
	b.	State Pigeon-hole principle. ABC is an equilateral triangle whose sides are of length 1cm each. If we select 5 points inside the triangle, prove that atleast two of these points are such the distance between them is less than 1/2 cm.	7	L3	CO2
	c.	Let f and g be functions from R to R defined by $f(x) = ax + b$ and $g(x) = 1 - x + x^2$ if $(gof)(x) = 9x^2 - 9x + 3$, determine a & b.	7	L2	CO2
		OR			
Q.6	**a.**	Let f, g, h be functions from z to z defined by $f(x) = x - 1$, $g(x) = 3x$, $h(x) = \begin{cases} 0, & \text{if } x \text{ is even} \\ 1, & \text{if } x \text{ is odd} \end{cases}$ Determine $(f \circ (g \circ h))(x)$ and $((f \circ g) \circ h)(x)$ and verify that $f \circ (g \circ h) = (f \circ g) \circ h$.	6	L2	CO3
	b.	For $A = \{a, b, c, d, e\}$, the Hasse diagram for the poset (A, R) is as shown in Fig.Q.6(b). i) Determine the relation matrix for R. ii) Construct the diagraph for R.  Fig.Q.6(b)	7	L3	CO3
	c.	Let $A = \{1, 2, 3, 4\}$ and let R be the relation on A defined by xRy if and only if "x divides y", i) Write down R as a set of ordered pairs ii) Draw the diagraph of R iii) Determine the in-degrees and out-degrees of the vertices in the digraph.	7	L3	CO3

Module – 4

Q.7 a. In how many ways 5 number of a's, 4 number of b's and 3 number of c's can be arranged so that all the identical letters are not in a single block. — 6 | L2 | CO4

b. Find the number of permutations of the letters a, b, c, ….. x, y, z in which none of the patterns spin, game, path or net occurs. — 7 | L3 | CO4

c. Solve the recurrence relation $a_n - 6a_{n-1} + 9a_{n-2} = 0$ for $n \geq 2$, given that $a_0 = 5$, $a_1 = 12$. — 7 | L2 | CO4

OR

Q.8 a. Find the number of derangements of 1, 2, 3, 4. Mention them. — 6 | L2 | CO4

b. By using the expansion formula, find the rook polynomial for the board c shown below (madeup of unshaded parts) : — 7 | L3 | CO4

c. Solve the recurrence relation $a_n - 3a_{n-1} = 5 \times 3^n$ for $n \geq 1$ given that $a_0 = 2$ — 7 | L2 | CO4

Module – 5

Q.9 a. Let $w_4 = \{1, -1, i, -i\}$, the set of all fourth roots of unity. Show that w_4 is an abelian group under x. — 6 | L2 | CO5

b. Define Klein-4-group. If A = {e, a, b, c} then show that this is a Klein-4 group. — 7 | L2 | CO5

c. State and prove Lagrange's theorem. — 7 | L2 | CO5

OR

Q.10 a. Show that the group (G, *) whose multiplication table is as given below is cyclic. — 6 | L | CO

*	a	b	c	d	e	f
a	a	b	c	d	e	f
b	b	c	d	e	f	a
c	c	d	e	f	a	b
d	d	e	f	a	b	c
e	e	f	a	b	c	d
f	f	a	b	c	d	e

b. Let $G = S_4$, the symmetric group of degree 4. For $\alpha = \begin{pmatrix} 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 1 \end{pmatrix}$. Find the subgroup $H = \langle\alpha\rangle$. Also, determine the number of left cosets of H in G. — 7 | L3 | CO5

c. If * is an operation on z defined by x * y = x + y + 1, prove that (z, *) is an abelian group. — 7 | L2 | CO5

* * * * *

VTU-19-02-2026 01:28:40pm - SN - SN - SN - SN
19-02-2026 01:32:23pm - SN - SN - SN - SN