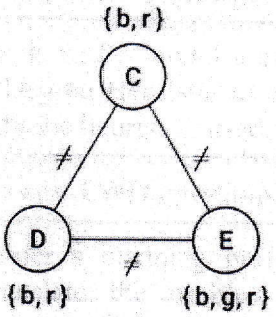
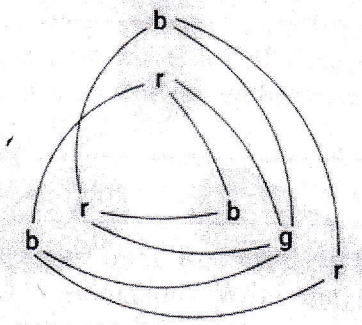
K. J. Somaiya Institute of Technology, Sion, Mumbai-22
(Autonomous College Affiliated to University of Mumbai)

May – June 2025

PhD Program: Academic Year 2024-25
Course Work Examination
Course Code: **PhD102** and Course Name: **AI: Constraint Satisfaction**
Date: 21-05-2025 Duration: 2.00 PM to 4.30 PM Max. Marks: 70

Instructions:
(1) All questions are compulsory.
(2) Draw neat diagrams wherever applicable.
(3) Assume suitable data, if necessary.

	Question	Max. Marks	CO	BT Level
Qu-1	Solve any **Six** questions out of **Eight.**	**30**		
i)	What is a Constraint Satisfaction Problem (CSP)? Derive Components of Constraint Satisfaction Problems for Map Colouring.	5	CO1	2
ii)	Figure shows the constraint graph and the matching diagram of a map colouring problem.Express the problem as a CSP.After the CSP is made arc-consistent what values will remain in the domain of C?  	5	CO3	3
iii)	Explain Gaschnig's Backjumping with an example.	5	CO4	2
iv)	Create a model-based diagnosis for a car that won't start. Identify components, correct behavior, observed behavior, and conflicts. Derive the faulty part.	5	CO5	3
v)	Prepare a model for the n-queen problem. List what variables are needed for the problem, Give their domains.	5	CO1	3
vi)	Use a constraint satisfaction formulation to solve a planning problem: Making a sandwich (Get bread, apply butter, add filling, etc.). What are the variables and constraints?	5	CO6	3

vii)	Take a graph-coloring problem with 6 nodes and simulate Least Constraining Value (LCV) ordering for domain values. Explain your choice at each step	5	CO5	3
viii)	The following is a cryptarithmetic puzzle, an addition problem, where each alphabet/variable denotes a unique digit (0 to 9), so no two variables are assigned the same digit, and a sequence of alphabets denotes a number whose highest significant digit is non-zero. M A Y + J U N E --------- J U L Y --------- A solution to the puzzle is a set of value assignments to variables that satisfy the addition problem. Model this problem as a CSP.	5	CO3	3
Qu-2	Solve any **TWO** questions out of **THREE.**	**20**		
i)	Describe what is Constraint Graph or Constraint Network. Design Constraint Network for crossword puzzle .	10	CO2	2
ii)	Explain Arc Consistency. Give the pseudo-code of AC-3 algorithm. Briefly explain the idea behind it .	10	CO3	3
iii)	What is CSP? Model a class scheduling problem as a CSP. Use MRV and Degree Heuristic to assign classrooms to lectures without clashes. Justify the heuristics used.	10	CO4	3
Qu-3	Solve any **TWO** questions out of **THREE.**	**20**		
i)	Consider a planning problem (robot moves from Room A → B → C)Translate the problem into a SAT formulation. Write the CNF encoding and solve it using a basic SAT solver or logic tool.	10	CO4	3
ii)	Consider the following constraint network R = <{x1, x2, x3}, {D1, D2, D3}, {C}> where D1 = D2 = D3 = {a,b, c} and C = <{x1, x2, x3}, {<a, a, b>, <a, b, b>, <b, a, c>, <b, b, b>}. How many solutions exist? Give all solutions..	10	CO2	2
iii)	Combine Forward Checking (lookahead) with Conflict-Directed Backjumping (lookback) in a sample problem. What's the performance gain?	10	CO6	3

****