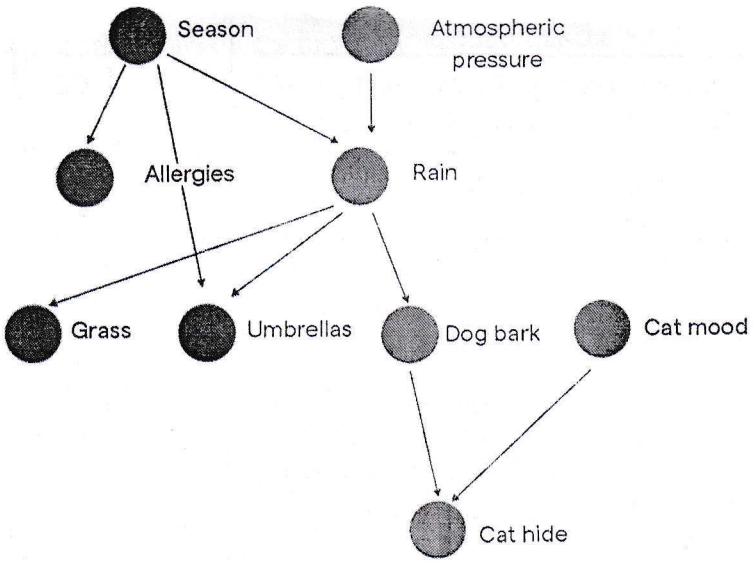
K. J. Somaiya Institute of Technology, Sion, Mumbai-22
(Autonomous College Affiliated to University of Mumbai)

Nov – Dec 2025
(B. Tech.) Program: Computer Engineering Scheme: III
Regular Examination: TY Semester: V
Course Code: CEDLC5054 and Course Name: Probabilistic Graphical Models
Date of Exam: 28/11/2025 Duration: 02.5 Hours Max. Marks: 60

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

Q. No.	Question	Max. Marks	CO	BT level
Q 1	Solve any **two** questions out of three: (05 marks each)	10		
a)	In a population, 0.5% of people have a rare disease. A medical test for the disease is 99% accurate, meaning it correctly identifies the disease 99% of the time when it is present and correctly identifies it as absent 99% of the time when it is not present. If a person tests positive for the disease, what is the probability that they actually have the disease?		CO1	Ap
b)	Write mathematical expressions for the given Bayesian network. 1. Write general mathematical expression 2. Write expression for finding probability considering conditions Season=Winter, Rain=True, Dog Bark=True, Umbrella=Leave 		CO2	Ap
c)	The random variable X has a range of {0, 1, 2} and the random variable Y has a range of {1, 2}. The joint distribution of X and Y is given by the following table:		CO3	Ap

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	i. Write down tables for the marginal distributions of X and of Y, i.e. give the values of P(X = x) for all x, and of P(Y = y) for all y. ii. Compute E(X) and E(Y). x y $P(X = x, Y = y)$ 0 1 0.2 0 2 0.1 1 1 0.0 1 2 0.2 2 1 0.3 2 2 0.2			
Q 2	**Solve any two questions out of three: (05 marks each)**	**10**		
a)	List the applications of Hidden Markov Networks (HMM). Explain importance and use of Probability concepts in HMM.		CO4	U
b)	Differentiate between Expected Value and Expected Utility with suitable examples.		CO5	U
c)	What are Probabilistic Graphical Models (PGM)? Explain with suitable examples how PGM systems will be useful in Document Classification.		CO6	U
Q.3	**Solve any two questions out of three. (10 marks each)**	**20**		
a)	i. Explain the difference between Conditional probability and Joint Probability. (5 Marks) ii. Explain how probability concepts are used in PGM systems in real time applications. (5 Marks)		CO1	U
b)	Consider the Bayesian network given below. Let, Sprinkler, Rain, Grass Wet be represented by S, R, W respectively. Identify the mistake (if any) and re-sketch the network considering all the probability distributions. i. Enumerate the basic independencies. (3 Marks) ii. Provide the mathematical expression for calculating joint probability distribution. (3 Marks) iii. Determine the following joint probabilities: (4 Marks) P(S = T, R = T, W = F) P(S = F, R = F, W = T)		CO2	Ap

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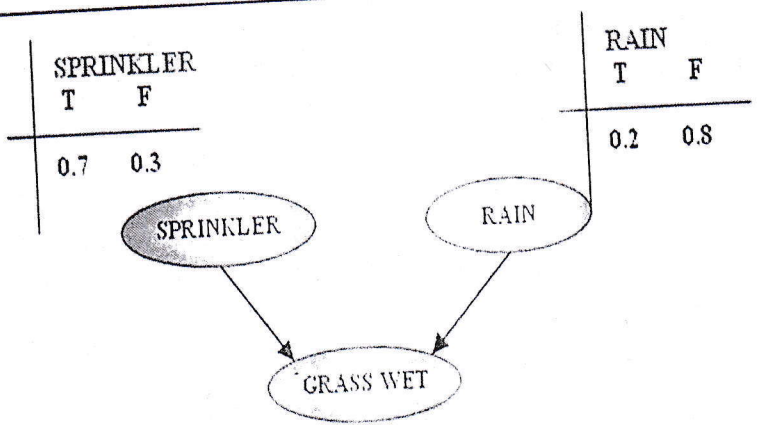

SPRINKLER	RAIN	GRASS WET T	GRASS WET F
F	F	0.0	1.0
F	T	0.8	0.2
T	F	0.9	0.1
T	T	0.99	0.01

c)	Consider the Markov chain with transition matrix $P = \begin{pmatrix} 1/2 & 1/3 & 1/6 \\ 3/4 & 0 & 1/4 \\ 0 & 1 & 0 \end{pmatrix}$ i. Draw Transition diagram (3 Marks) ii. Show that this is irreducible (3 Marks) iii. Assume that the process is started in state 1. Find the probability that it is in state 3 after two steps. (4 Marks)		CO3	Ap
Q.4	**Solve any two questions out of three. (10 marks each)**	**20**		
a)	From the HMM given below, find the likelihood of the sequence {Happy, Grumpy}.		CO4	Ap

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	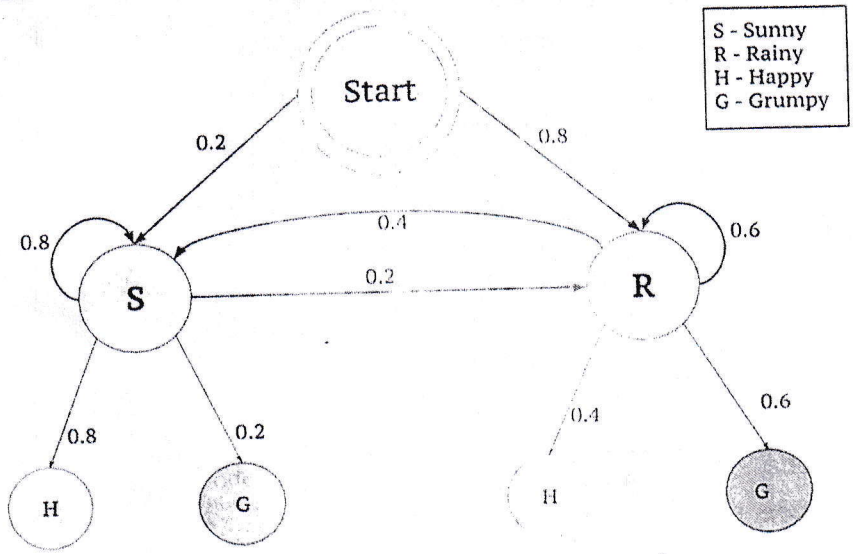			
b)	Archana owns a car worth 50,000 which can get stolen with probability 1%. She can purchase coverage of the amount q ∈ [0; 50, 000] at premium $\pi = 0.05$ dollars for each dollar covered. Her utility function is U = ln(w). Assume she has no other assets. i. Set up her maximization problem. (4 Marks) ii. How much insurance will she choose to buy? (3 Marks) iii. How much profit does the insurance company earn on insuring Archana? (3 Marks)		CO5	Ap
c)	i. Explain the working of Page Ranking Algorithms with an example. (5 Marks) ii. Explain Viterbi Algorithm and its applications. (5 Marks)		CO6	U

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