(23)

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2025

B.Tech-VIII Semester (CSE/IT)

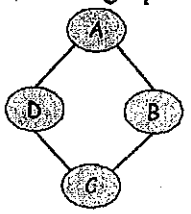
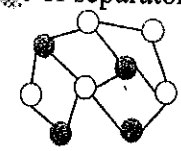
COURSE CODE (CREDITS): 19B1WCI832 (3) MAX. MARKS: 35

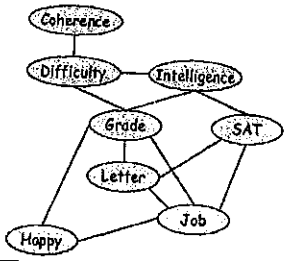
COURSE NAME: PROBABILISTIC GRAPHICAL MODELS

COURSE INSTRUCTORS: Prof. Vivek Kumar Sehgal MAX. TIME: 2 Hours

Note: *(a) All questions are compulsory.*

(b)) Use of calculator is allowed

Q.No	Question	CO	Marks
Q1	(a) Explain how undirected graphical models simplify the representation of probabilistic dependencies. What is the role of scope of the factor in these graphs? (b) Calculate the partition function and joint probability for following undirected graph.  $\phi_1[A,B]$: $a^0\ b^0\ 30$; $a^0\ b^1\ 5$; $a^1\ b^0\ 1$; $a^1\ b^1\ 10$ $\phi_2[B,C]$: $b^0\ c^0\ 100$; $b^0\ c^1\ 1$; $b^1\ c^0\ 1$; $b^1\ c^1\ 100$ $\phi_3[C,D]$: $c^0\ d^0\ 1$; $c^0\ d^1\ 100$; $c^1\ d^0\ 100$; $c^1\ d^1\ 1$ $\phi_4[D,A]$: $d^0\ a^0\ 100$; $d^0\ a^1\ 1$; $d^1\ a^0\ 1$; $d^1\ a^1\ 100$	CO-2,3	5
Q2	(a) In the following Markov Network, how does the concept of an "active path" help determine conditional independence between two sets of variables? Explain the role of separator set Z in this context.  (b) State and explain the significance of the Hammersley–Clifford Theorem in Markov Networks. Why is the positivity condition important for a distribution to factorize as a Gibbs distribution?	CO-3	5
Q3	(a)Explain the following Independence assumptions in Markov Networks: i. Global assumption ii. Pairwise Markov assumption iii. Markov blanket assumption	CO-3	5
Q4	(a)Explain the role of features and weights in a log-linear model for a Markov Network. Why is the log-linear representation considered more compact for variables with large domains? (b) Compare an Ising Model and a Boltzmann Machine in terms of node representation, energy function, and neural activation behavior. How does a Restricted Boltzmann Machine (RBM) differ from a standard Boltzmann Machine?	CO-3,4	5

Q5	(a)Let $M[G]$ be the moral graph of a Bayesian Network G over X. Explain why, for any distribution P_B such that B is a parameterization of G, the graph $M[G]$ is an Imap for P_B. Also explain how the addition of moralizing edges causes the loss of independence information, for example in the structure $$X \rightarrow Z \leftarrow Y$$ where the independence $X \perp Y$ is lost. (b) Let X, Y, Z be three disjoint sets of nodes in a Bayesian Network G. Given $$U = X \cup Y \cup Z$$ and $H = M[G']$, where G' is the induced Bayesian Network over $$U \cup \text{Ancestor}(U),$$ i. Explain the meaning of the relation $$d - \text{sep}_G(X; Y \mid Z) \leftrightarrows \text{sep}_H(X; Y \mid Z)$$ ii. Discuss its significance in determining conditional independence in Bayesian Networks.	CO 3,4	5
Q6	(a) Consider the following undirected chordal graph H with 6 vertices {A, B, C, D, E, F} and edges: Edges: A-B, A-C, B-C, B-D, C-D, C-E, D-E, D-F, E-F i. Identify the Maximal Cliques ii. Construct the Clique Tree iii. Calculate Sepsets (b)What is a Conditional Random Field (CRF)? Explain: i. What variables does a CRF contain (X and Y)? ii. What distribution does a CRF encode: P(X,Y) or P(Y|X)? iii. Why is it useful that a CRF does not encode P(X)?	CO-4	5
Q7	(a)For chordal graphs, how can we can construct an optimal ordering via de clique tree? Write a max-cardinality algorithm for constructing an elimination ordering (b) Write a conditioning algorithm using Sum-Product-Conditioning and (c) Give the Elimination ordering in {C, D, I, H, S, L, G) conditioning on G with: variable involved and new factors  	CO-4	5