Submit your work in a single file. Show your work step by step, do NOT submit the final answer only. The Midterm consists of six questions. Cheat sheets are allowed (2 letter/A4 double-sided papers).

Question 1.

Here is a joint distribution of variables A and B.

A	B	P(A,B)
L	T	0.1
L	F	0.1
M	T	0.2
M	F	0.1
H	T	0.2
H	F	0.3

Find P(B=T)

Question 2.

You are given five random variables A, B, C, D, and E. The sizes of the domains are the following.
A: 4, B: 5, C: 6, D: 7, E: 8

How many independent parameters are needed to represent P(A, B, C|D, E)?

Question 3.

We have two binary variables X1 and X2. The Markov network over these two variables is: X1 - X2.
We have a log-linear model for this network with the following features and weights:
f 1 (X1) = 1 if X1= T; 0 otherwise.
f 2 (X2) = 1 if X2= F , 0 otherwise.
f 3 (X1, X2) = 1 if X1 ≠ X2, 0 otherwise.
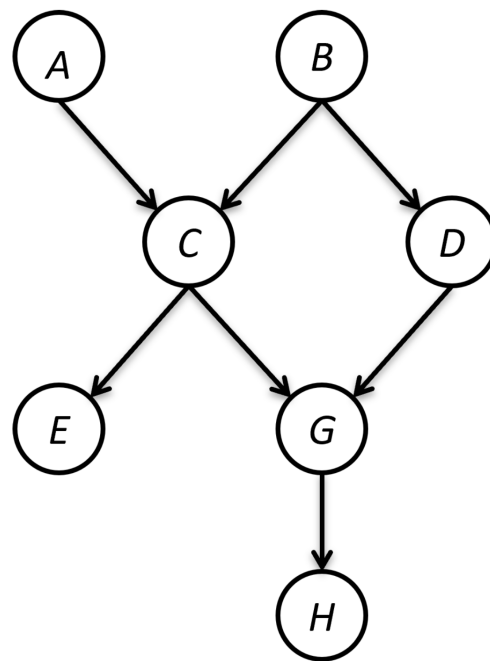f 4 (X1, X2) = 1 if X1= X2, 0 otherwise.
w1 = -ln(2)
w2 = -ln(3)
w3 = -ln(4)
w4 = -ln(9)
What is P(X1 = T, X2 = T)? Your final answer must be within 0.001 of the correct answer.
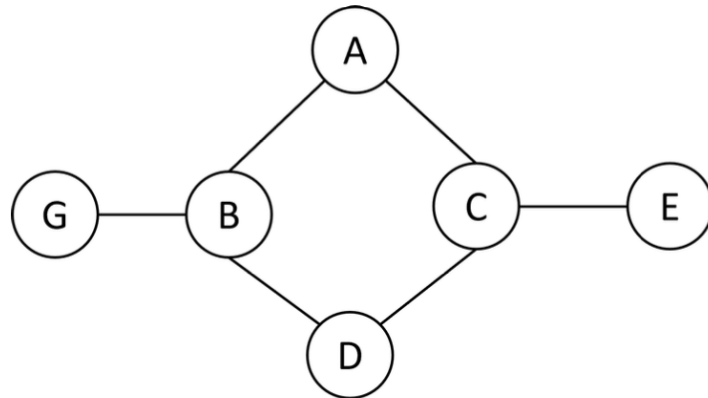
Question 4.

Here is a Bayesian Network structure.

Which statements are true?

a) $A \perp B$
b) $A \perp B \mid D$
c) $A \perp B \mid E$
d) $E \perp D$
e) $A \perp B \mid H$

Question 5.

Here is a Markov Network.

Convert this structure to Bayesian Network using the variable order B, G, C, E, A, D.
Submit a picture of your solution.

Question 6.

Create minimal I-Maps for Bayesian Network, using the following variable order:

E, G, D, J, A, B, C, H