

COURSE CODE (CREDITS): 19B1WCI832 (3)

MAX. MARKS: 15

COURSE NAME: Probabilistic Graphical Models

COURSE INSTRUCTORS: Dr. Nancy Singla

MAX. TIME: 1 Hour

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

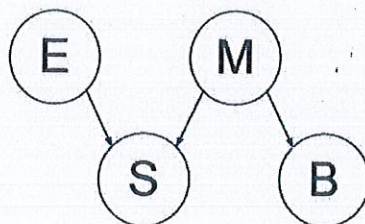
(b) Marks are indicated against each question in square brackets.

(c) The candidate is allowed to make suitable numeric assumptions wherever required for solving problems

- Q1. (a) In the context of social networks, consider, vertices represent users, and edges represent connections between users. How do you define a clique and a maximal clique? [2+3] (CO1)
- (b) What is the relationship between variance and expectation?
- Q2. A manufacturer has a machine that, when operational at the beginning of a day, has a probability of 0.1 of breaking down sometime during the day. When this happens, the repair is done the next day and completed at the end of the day. [2+3] (CO2)
- (a) Formulate the evolution of states of the machine as 3-state Markov Chain.
- (b) Construct the state-transition diagram and transition probability matrix?
- Q3. A smell of sulphur (S) can be caused either by rotten eggs (E) or as a sign of the doom brought by the Mayan Apocalypse (M). The Mayan Apocalypse also causes the oceans to boil (B). The Bayesian network and corresponding conditional probability tables for this situation are shown below. For each part, you should give either a numerical answer (e.g. 0.81) or an arithmetic expression in terms of numbers from the tables below (e.g.  $0.9 \cdot 0.9$ ). [1\*5] (CO4)

$P(E)$	
+e	0.4
-e	0.6

$P(S E, M)$			
+e	+m	+s	1.0
+e	+m	-s	0.0
+e	-m	+s	0.8
+e	-m	-s	0.2
-e	+m	+s	0.3
-e	+m	-s	0.7
-e	-m	+s	0.1
-e	-m	-s	0.9



$P(M)$	
+m	0.1
-m	0.9

$P(B M)$		
+m	+b	1.0
+m	-b	0.0
-m	+b	0.1
-m	-b	0.9

- (a) Compute  $P(-e, -s, -m, -b)$  from the joint distribution.
- (b) What is the probability that the oceans boil?
- (c) What is the probability that the Mayan Apocalypse is occurring, given that the oceans are boiling?
- (d) What is the probability that the Mayan Apocalypse is occurring, given that there is a smell of sulphur, the oceans are boiling, and there are rotten eggs?
- (e) What is the probability that rotten eggs are present, given that the Mayan Apocalypse is occurring?