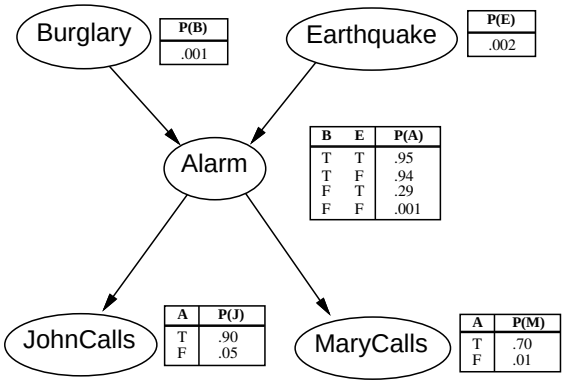
22C:145 ARTIFICIAL INTELLIGENCE I
(total points = 32)

1. (8 points) **(Belief Network)** Consider the following belief network.



Please compute the probability for the following events (you may leave a numeric expression as the final answer):

(a) $P(\neg A \wedge \neg B \wedge E \wedge \neg J \wedge M)$

(b) $P(A)$

(c) $P(A \mid B)$

(d) $P(E \mid A)$

2. (8 points) **(Fuzzy Logic)** Consider two fuzzy logic assertions X and Y, with their fuzzy values $t(X) = \alpha$ and $t(Y) = \beta$. Let's define $t(X \rightarrow Y) = max(1 - t(X), t(Y))$.

(a) Please compute the fuzzy value of the following expressions:
$t((X \rightarrow Y) \rightarrow X) \ =$
$t((X \vee Y) \wedge (X \vee \neg Y)) \ =$

(b) If $t((X \rightarrow Y) \rightarrow X) = t(X)$ should α and β satisfy what conditions?

(c) If $t((X \vee Y) \wedge (X \vee \neg Y)) = t(X)$ should α and β satisfy what conditions?

3. (8 points) **(Decision Tree)** We will build a decision tree to recognize objects from their silhouettes. The following attributes are provided:

   Size : small, large

   Shape : long, compact

   Hole : none, one, more

   We also have the following data on three types of objects: pen, pin, and key.

Case	Size	Shape	Hole	Type
1	small	long	none	pen
2	small	long	one	pen
3	large	long	one	pin
4	large	long	more	pin
5	small	compact	none	key
6	small	compact	one	key
7	large	compact	one	key
8	large	compact	more	key

   Please (a) compute the remainder of every available attribute using the remainder formula and (b) draw the final decision tree, using the algorithm we have studied.

4. (8 points) **(Perceptrons)** The left portion of the following table specifies a 3-bit boolean function $f(x, y, z)$. Assuming the activation function is $\text{step}_{0.9}$ and the learning rate is 0.5, we will use the perceptron learning procedure to compute the weights of a 3-input perceptron for f.

   Please update the weights in the right portion of the table, after each line of the input is fed to the perceptron. (The initial weights are given before the first line of the input.)

line	x	y	z	f		w_1	w_2	w_3
						0	0	0
1	0	0	0	0				
2	0	0	1	0				
3	0	1	0	0				
4	0	1	1	1				
5	1	0	0	0				
6	1	0	1	1				
7	1	1	0	1				
8	1	1	1	1				