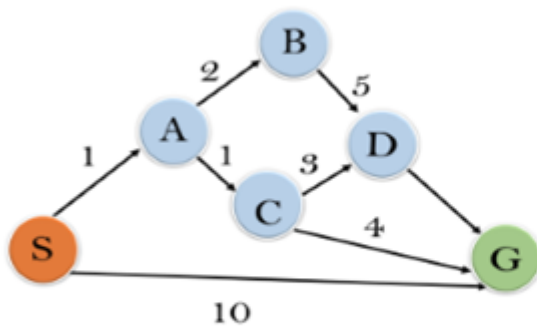


Question 01 (CLO 1): (5 marks)

Comment, with example(s), whether Kitchen is an example of Multi Agent System or not.

Question 02 (CLO 2): (3 + 2 + 2 + 2 + 3 + 3 = 10 marks)

Consider the graph and heuristic values, answer the following questions



State	$h(n)$
S	5
A	3
B	4
C	2
D	6
G	0

1. Using A* search, path with the highest cost from S to G will be?

S-A-C-D

1. Using A* search from S to D, what will be the highest cost?

11

1. Using A* search from S to G, what will be the intermediate cost for the path S-A-C?

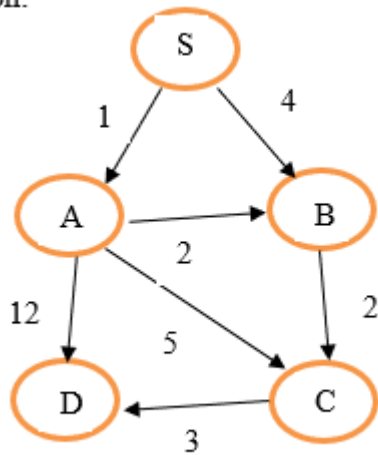
4

1. Using A* search from S to G, what will be the intermediate cost for starting the search path at S?

5

Consider the following graph

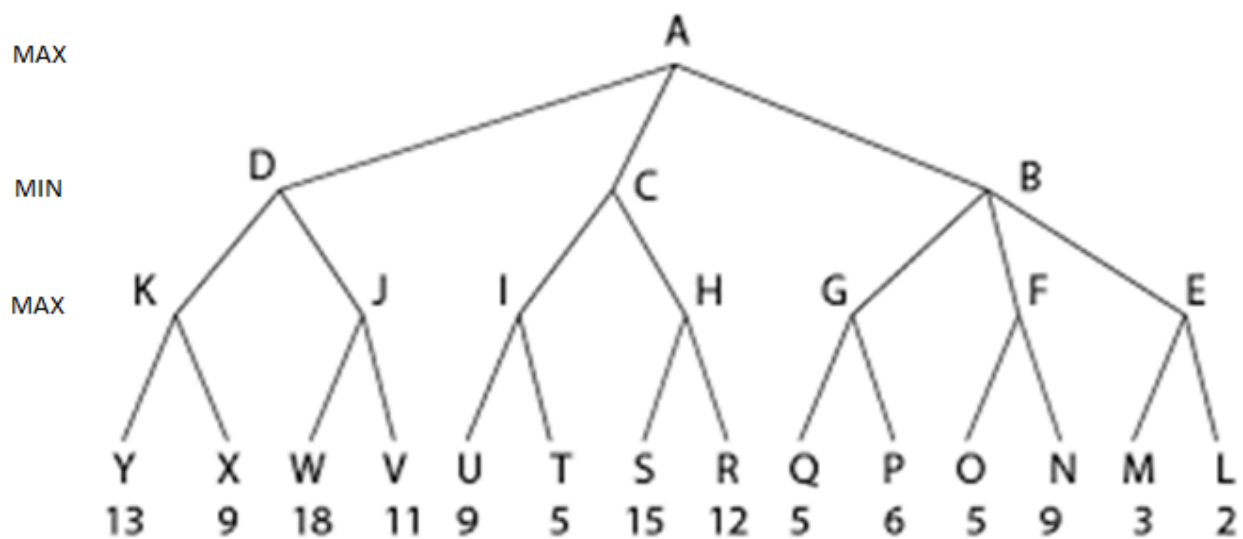
Graph:



1. Using GBFS from S to C, what will be the final path?

S-A-B-C

Consider the following graph for alpha-beta pruning and answer the following questions



1. Final Value at node B will be

6

Question 03 (CLO 3): (2 + 3 = 5 marks)

Apply CSP along with cryptarithmic to solve:

T W O

+ T W O

FOUR

1. List all constraints
2. List the values of all the digits used in the question

Solution is in the book

Question 04 (CLO 4): (5 + 5 = 10 marks)

1. Express the following sentences using first order logic (FOL). Alongside universal and/or existential quantifiers, use appropriate symbols for objects and functions.

Sentences	FOL
"Frank bought a dvd."	
"Frank bought something."	
"Susan bought everything that Frank bought."	
"If Frank bought everything, so did Susan."	
"Everyone bought something."	

1. With the help of the following table, prove that the logical equivalency mentioned below always holds.

$$\neg(\alpha \Rightarrow (\beta \wedge \gamma)) \equiv (\alpha \wedge \neg\beta) \vee (\alpha \wedge \neg\gamma)$$

$$(\alpha \wedge \beta) \equiv (\beta \wedge \alpha) \quad \text{commutativity of } \wedge$$

$$(\alpha \vee \beta) \equiv (\beta \vee \alpha) \quad \text{commutativity of } \vee$$

$$((\alpha \wedge \beta) \wedge \gamma) \equiv (\alpha \wedge (\beta \wedge \gamma)) \quad \text{associativity of } \wedge$$

$$((\alpha \vee \beta) \vee \gamma) \equiv (\alpha \vee (\beta \vee \gamma)) \quad \text{associativity of } \vee$$

$$\neg(\neg\alpha) \equiv \alpha \quad \text{double-negation elimination}$$

$$(\alpha \Rightarrow \beta) \equiv (\neg\beta \Rightarrow \neg\alpha) \quad \text{contraposition}$$

$$(\alpha \Rightarrow \beta) \equiv (\neg\alpha \vee \beta) \quad \text{implication elimination}$$

$$(\alpha \Leftrightarrow \beta) \equiv ((\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha)) \quad \text{biconditional elimination}$$

$$\neg(\alpha \wedge \beta) \equiv (\neg\alpha \vee \neg\beta) \quad \text{De Morgan}$$

$$\neg(\alpha \vee \beta) \equiv (\neg\alpha \wedge \neg\beta) \quad \text{De Morgan}$$

$$(\alpha \wedge (\beta \vee \gamma)) \equiv ((\alpha \wedge \beta) \vee (\alpha \wedge \gamma)) \quad \text{distributivity of } \wedge \text{ over } \vee$$

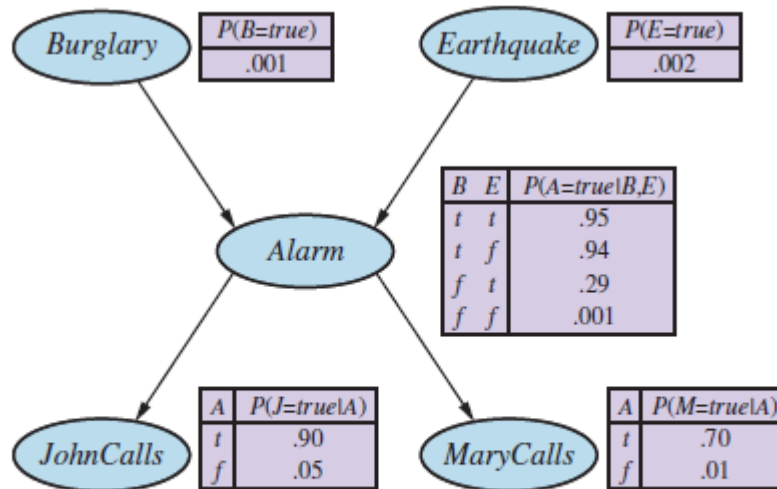
$$(\alpha \vee (\beta \wedge \gamma)) \equiv ((\alpha \vee \beta) \wedge (\alpha \vee \gamma)) \quad \text{distributivity of } \vee \text{ over } \wedge$$

1. $bought(Frank, dvd)$
2. $\exists x.bought(Frank, x)$
3. $\forall x.(bought(Frank, x) \rightarrow bought(Susan, x))$
4. $\forall x.bought(Frank, x) \rightarrow \forall x.bought(Susan, x)$
5. $\forall x \exists y.bought(x, y)$

$$\begin{aligned}
 & \neg(S \rightarrow P \wedge R) \\
 & \neg(\neg S \vee \neg(P \wedge R)) \\
 & \neg((\neg S \vee P) \wedge (\neg S \vee R)) \\
 & \neg[\neg S \vee P] \wedge \neg[\neg S \vee R] \\
 & (S \wedge \neg P) \wedge (S \wedge \neg R)
 \end{aligned}$$

Question 05 (CLO 5):

1. Consider the following data set. Apply Naive Bayes approach to determine the probability of Alarm has sounded and neither the burglary nor the earthquake occurred, but John and Mary both did not call? (5 marks)
2. Consider the following data set. Apply Naive Bayes approach to determine the probability of Alarm has not sounded and both the burglary and the earthquake occurred, but John and Mary both called? (5 marks)



A typical Bayesian network, showing both the topology and the conditional probability tables (CPTs). In the CPTs, the letters B , E , A , J , and M stand for *Burglary*, *Earthquake*, *Alarm*, *JohnCalls*, and *MaryCalls*, respectively.

$$P(H|X)$$

$$= P(X|H) P(H) / P(X)$$

1. Consider the problem of changing a flat tire (Figure 11.2). The goal is to have a good spare tire properly mounted onto the car's axle, where the initial state has a flat tire on the axle and a good spare tire in the trunk. To keep it simple, our version of the problem is an abstract one, with no sticky lug nuts or other complications. There are just four actions: removing the spare from the trunk, removing the flat tire from the axle, putting the spare on the axle, and leaving the car unattended overnight. We assume that the car is parked in a particularly bad neighborhood, so that the effect of leaving it overnight is that the tires disappear. (5 marks)

[Remove(Flat;Axle);Remove(Spare;Trunk);PutOn(Spare;Axle)] is a solution to the problem.