Register Number															

SRM Institute of Science and Technology
College of Engineering and Technology
School of Computing
Department of Data Science & Business Systems
SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamil Nadu
Academic Year: 2023-24 (EVEN)

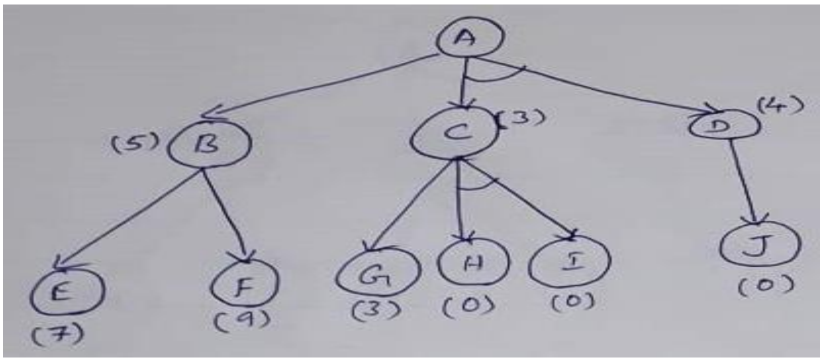
Set - B

Test: CLA-T2 **Date: 02.04.2024**
Course Code & Title: 18CSC305J – Artificial Intelligence (Answer Key) **Duration:** 9.45 – 11.30 AM
Year & Sem: III Year / VI Sem **Max. Marks:** 50

Course Articulation Matrix:

S. No	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	CO1	3	2	3	-	-	-	-	-	-	-	-	-
2	CO2	3	2	3	-	-	-	-	-	-	-	-	-
3	CO3	2	3	3	-	-	-	-	-	-	-	-	-
4	CO4	2	3	2	-	-	-	-	-	-	-	-	-
5	CO5	2	3	3	2	-	-	-	-	-	-	-	-

Answer any **Five** Questions
(5 x 10 = 50 Marks)

Q. No	Question	Marks	BL	CO	PO	PI Code
1.	Consider the given graph. The numbers in brackets are the heuristic value. Each edge is considered to have a value of 1 by default.  (a) Identify the searching algorithm that we can apply for the above graph. (b) Find the actual cost of traversal from the initial state to the goal state. (c) Apply the identified algorithm and find the solution. Whether optimal solution possible for this graph? Justify your answer.	10	3	2	2	2.2.1

Solution:

(i) (a)Identify the searching algorithm that we can apply for the above graph. (1 mark)

AO* algorithm

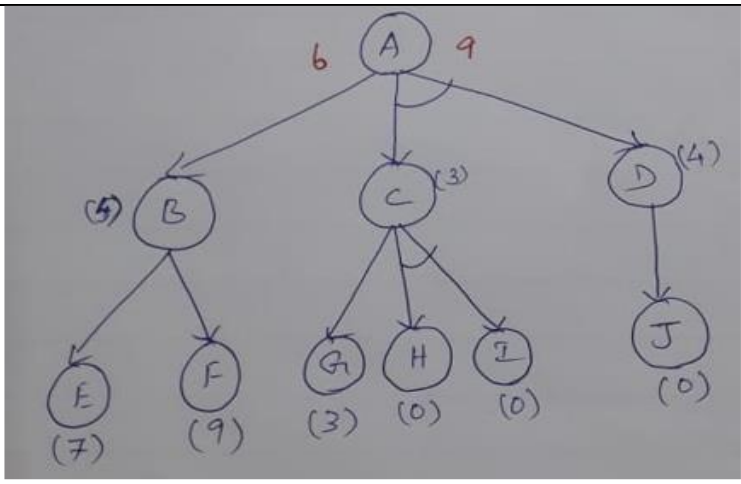
(a) Find the actual cost of traversal from the initial state to the goal state. (2 marks)

f(n) = g(n) + h(n)

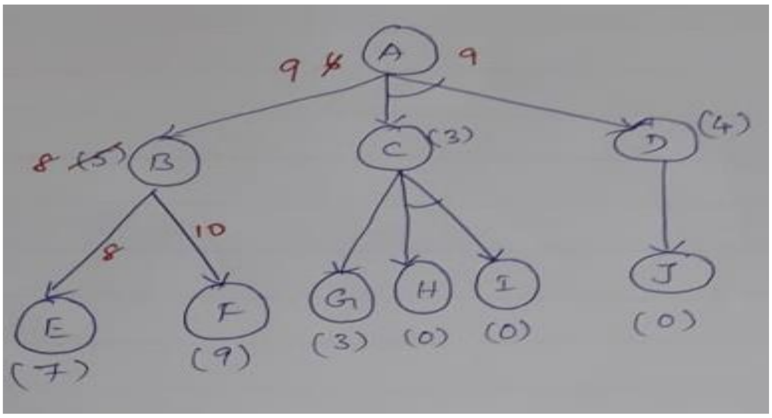
- g(n): The actual cost of traversal from initial state to the current state.
- h(n): The estimated cost of traversal from the current state to the goal state.
- f(n): The actual cost of traversal from the initial state to the goal state.

(c) Apply the identified algorithm and find the solution. Whether optimal solution is possible for this graph? Justify your answer. (15+2 marks)

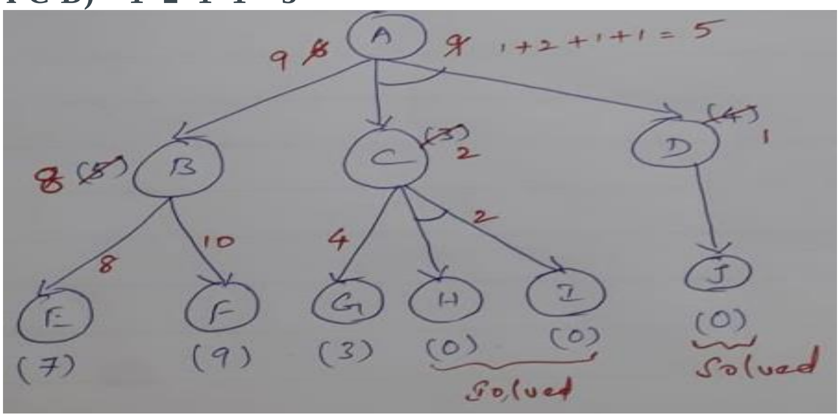
Step 1: Starting from node A, we first calculate the best path.
f(A-B) = g(B) + h(B) = 1+5= 6, where 1 is the default cost value of travelling from A to B and 5 is the estimated cost from B to Goal state. f(A-C-D) = g(C) + h(C) + g(D) + h(D) = 1+3+1+4 = 9
The minimum cost path is chosen i.e A-B.



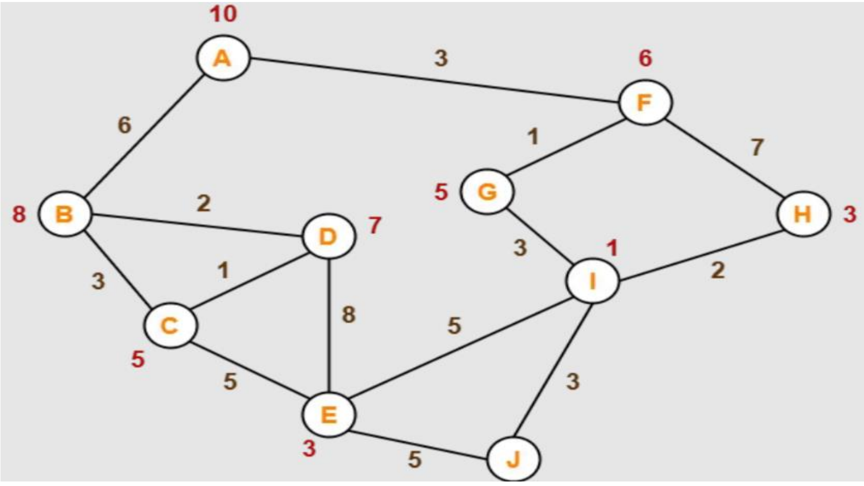
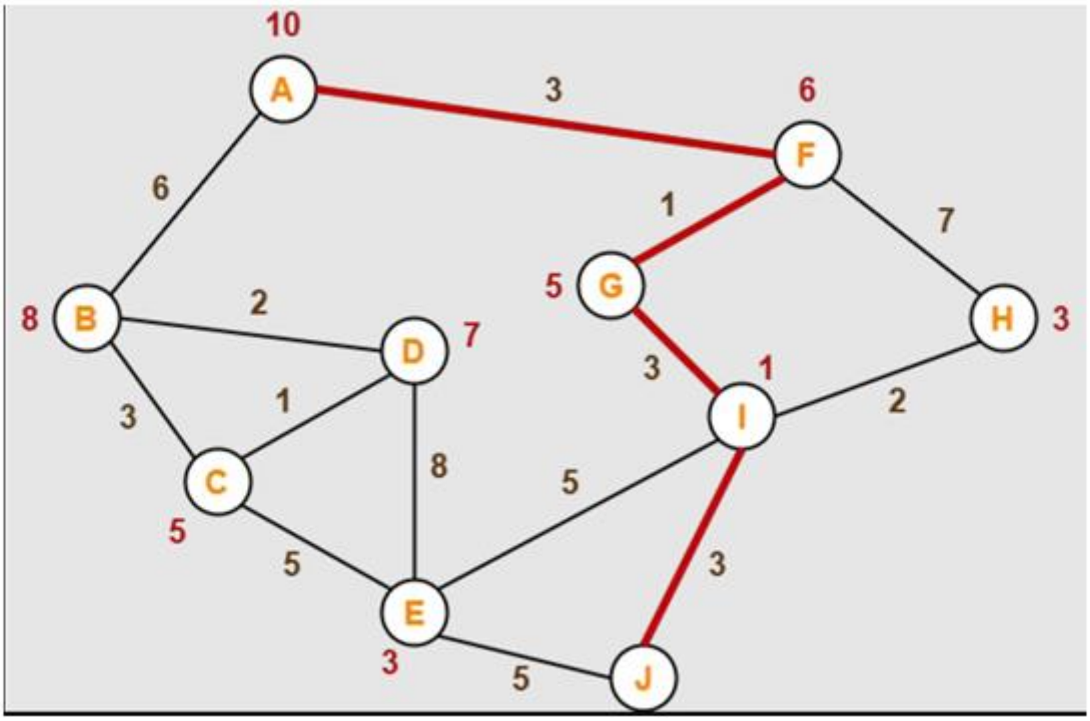
Step 2:
f(B-E) = 1 + 7 = 8 -□ lesser cost f(B-F) = 1 + 9 = 10 Now the heuristics (lesser value) must be updated since there is a difference between actual and heuristic value of B. Because of change in heuristic of B there is also change in heuristic of A which is to be calculated again.
f(A-B) = g(B) + updated((h(B)) = 1+8=9



Step 3:
Comparing path of f(A-B) and f(A-C-D), both are having same cost. Hence f(A-C-D) needs to be explored. Now the current node becomes C node and the cost of the path is calculated, f(C-G) = 1+3 = 4 f(C-H-I) = 1+0+1+0 = 2 -□ lesser cost
Now the heuristics (lesser value) must be updated since there is a difference between actual and heuristic value of C. Hence heuristic of C to be updated to 2. Because of change in heuristic of C there is also change in heuristic of A which is to be calculated again. Heuristic of path of H and I are 0 and hence they are solved. but Path A-D also needs to be calculated. since it has an AND-arc. f(D-J) = 1+0 = 1, hence heuristic of D needs to be updated to 1.
Finally the f(A-C-D) needs to be updated. f(A-C-D) = g(C) + h(C) + g(D) + updated((h(D)) = 1+2+1+1 =5.
The solved path is f(A-C-D) = 1+2+1+1 = 5



The solution is not optimal, because the first solution f(A-B) = 9 is considered in AO*and the other paths are not explored.

<table>
<tr><td>2.</td><td>The numbers written on edges represent the distance between the nodes. The numbers written on nodes represent the heuristic value. Find the most cost-effective path to reach from start state A to final state J using A* Algorithm.

</td><td>10</td><td>3</td><td>2</td><td>2</td><td>2.2.3</td></tr>
<tr><td colspan="7">Solution:


Justification – 4 Marks</td></tr>
<tr><td>3.</td><td>Suppose a genetic algorithm uses chromosomes of the form “x = abcdefgh” with a fixed length of eight genes. Each gene can be any digit between 0 and 9. Let the fitness of individual x be calculated as:
f(x) = (a+b)−(c+d)+(e+f)−(g+h)
and let the initial population consist of four individuals with the following chromosomes:
x1 = 65413532
x2 = 87126601
x3 = 23921285
x4 = 41852094
a) Evaluate the fitness of each individual, showing all your workings, and arrange them in order with the fittest first and the least fit last.
b) Cross the fittest two individuals using one–point crossover at the middle point.
c) Cross the second and third fittest individuals using a two–point crossover (points b and f).
d) Suppose the new population consists of the six offspring individuals received by the cross over operations in the above question. Evaluate the fitness of the new population, showing all your workings. Has the overall fitness improved?</td><td>10</td><td>3</td><td>2</td><td>2</td><td>2.2.3</td></tr>
<tr><td colspan="7">Solution:</td></tr>
</table>

a) Evaluate the fitness of each individual, showing all your workings, and arrange them in order with the fittest first and the least fit last.

Answer:

$$\begin{aligned}
f(x_1) &= (6+5)-(4+1)+(3+5)-(3+2) = 9 \\
f(x_2) &= (8+7)-(1+2)+(6+6)-(0+1) = 23 \\
f(x_3) &= (2+3)-(9+2)+(1+2)-(8+5) = -16 \\
f(x_4) &= (4+1)-(8+5)+(2+0)-(9+4) = -19
\end{aligned}$$

The order is x_2, x_1, x_3 and x_4.

b) Perform the following crossover operations:

i) Cross the fittest two individuals using one–point crossover at the middle point.

Answer: *One–point crossover on x_2 and x_1:*

$$\begin{array}{rl|l} x_2 = & \mathbf{8\,7\,1\,2} & \mathbf{6\,6\,0\,1} \\ x_1 = & 6\,5\,4\,1 & 3\,5\,3\,2 \end{array} \Rightarrow \begin{array}{rl} O_1 = & \mathbf{8\,7\,1\,2}\,3\,5\,3\,2 \\ O_2 = & 6\,5\,4\,1\,\mathbf{6\,6\,0\,1} \end{array}$$

ii) Cross the second and third fittest individuals using a two–point crossover (points b and f).

Answer: *Two–point crossover on x_1 and x_3*

$$\begin{array}{rl|l|l} x_1 = & \mathbf{6\,5} & \mathbf{4\,1\,3\,5} & \mathbf{3\,2} \\ x_3 = & 2\,3 & 9\,2\,1\,2 & 8\,5 \end{array} \Rightarrow \begin{array}{rl} O_3 = & \mathbf{6\,5}\,9\,2\,1\,2\,\mathbf{3\,2} \\ O_4 = & 2\,3\,\mathbf{4\,1\,3\,5}\,8\,5 \end{array}$$

Answer: *In the simplest case uniform crossover means just a random exchange of genes between two parents. For example, we may swap genes at positions a, d and f of parents x_2 and x_3:*

$$\begin{array}{rl} x_2 = & \mathbf{\underline{8}\,7\,1\,\underline{2}\,6\,\underline{6}\,0\,1} \\ x_3 = & \underline{2}\,3\,9\,\underline{2}\,1\,\underline{2}\,8\,5 \end{array} \Rightarrow \begin{array}{rl} O_5 = & 2\,\mathbf{7\,1\,2\,6}\,2\,\mathbf{0\,1} \\ O_6 = & \mathbf{8}\,3\,9\,\mathbf{2}\,1\,\mathbf{6}\,8\,5 \end{array}$$

Answer: *The new population is:*

$$
\begin{aligned}
O_1 &= 8\,7\,1\,2\,3\,5\,3\,2\\
O_2 &= 6\,5\,4\,1\,6\,6\,0\,1\\
O_3 &= 6\,5\,9\,2\,1\,2\,3\,2\\
O_4 &= 2\,3\,4\,1\,3\,5\,8\,5\\
O_5 &= 2\,7\,1\,2\,6\,2\,0\,1\\
O_6 &= 8\,3\,9\,2\,1\,6\,8\,5
\end{aligned}
$$

Now apply the fitness function $f(x) = (a+b)-(c+d)+(e+f)-(g+h)$:

$$
\begin{aligned}
f(O_1) &= (8+7)-(1+2)+(3+5)-(3+2) = 15\\
f(O_2) &= (6+5)-(4+1)+(6+6)-(0+1) = 17\\
f(O_3) &= (6+5)-(9+2)+(1+2)-(3+2) = -2\\
f(O_4) &= (2+3)-(4+1)+(3+5)-(8+5) = -5\\
f(O_5) &= (2+7)-(1+2)+(6+2)-(0+1) = 13\\
f(O_6) &= (8+3)-(9+2)+(1+6)-(8+5) = -6
\end{aligned}
$$

The overall fitness has improved.

4.	Consider the following Bayesian network, where F=having the flu and C = Coughing P(F) = 0.1  P(C/F) = 0.8, (C/¬F) = 0.3 Write down the joint probability table Specified by the Bayesian Network.	10	3	3	2	2.2.1

Solution:

Answer:

F	C	
t	t	$0.1 \times 0.8 = 0.08$
t	f	$0.1 \times 0.2 = 0.02$
f	t	$0.9 \times 0.3 = 0.27$
f	f	$0.9 \times 0.7 = 0.63$

5.	Explain the unification algorithm used for reasoning under predicate logic with an example. Consider the following facts. a) Team Delhi b) Team Mumbai c) Final match between Delhi and Mumbai d) Delhi scored 350 runs, Mumbai scored 350 runs, Delhi lost 5 wickets, Mumbai lost 7 wickets. e) The team which scored the maximum runs wins f) If the scores are same the team which lost minimum wickets wins the match. Represent the facts in predicate, convert to clause form and prove by resolution "Delhi wins the match".	10	3	3	2	2.2.3

Solution:

Convert into predicate Logic

(a) team(Delhi)

(b) team(Mumbai)

(c) team(Delhi) ^ team(Mumbai) → final_match(Delhi,Mumbai)
(d) score(Delhi,275) ^ score(Mumbai,275) ^ wicket(Delhi,4) ^ wicket(Mumbai,6)
(e) □x team(x) ^ wins(x) → score(x,mat_runs)
(f) □xy score(x,equal(y)) ^ wicket(x,min) ^ final_match(x,y) → win(x)

Convert to clausal form
(i) Eliminate the → sign
(a) team(Delhi)
(b) team(Mumbai)
(c) □(team(Delhi) ^ team(Mumbai) v final_match(Delhi,Mumbai)
(d) score(Delhi,275) ^ score(Mumbai,275) ^ wicket(Delhi,4) ^ wicket(Mumbai,6)
(e) □x□ (team(x) ^ wins(x)) vscore(x,max_runs))
(f) □xy□ (score(x,equal(y)) ^ wicket(x,min) ^final_match(x,y)) vwin(x)

(ii) Reduce the scope of negation
(a) team(Delhi)
(b) team(Mumbai)
(c) □team(Delhi) v □team(Mumbai) v final_match(Delhi, Mumbai)
(d) score(Delhi,275) ^ score(Mumbai,275) ^ wicket(Delhi,4) ^

wicket(Mumbai,6)
(e) □x□ team(x) v □wins(x) vscore(x,max_runs))
(f) □xy□ (score(x,equal(y)) v □ wicket(x,min_wicket) v□final_match(x,y)) vwin(x)

(iii) Standardize variables apart

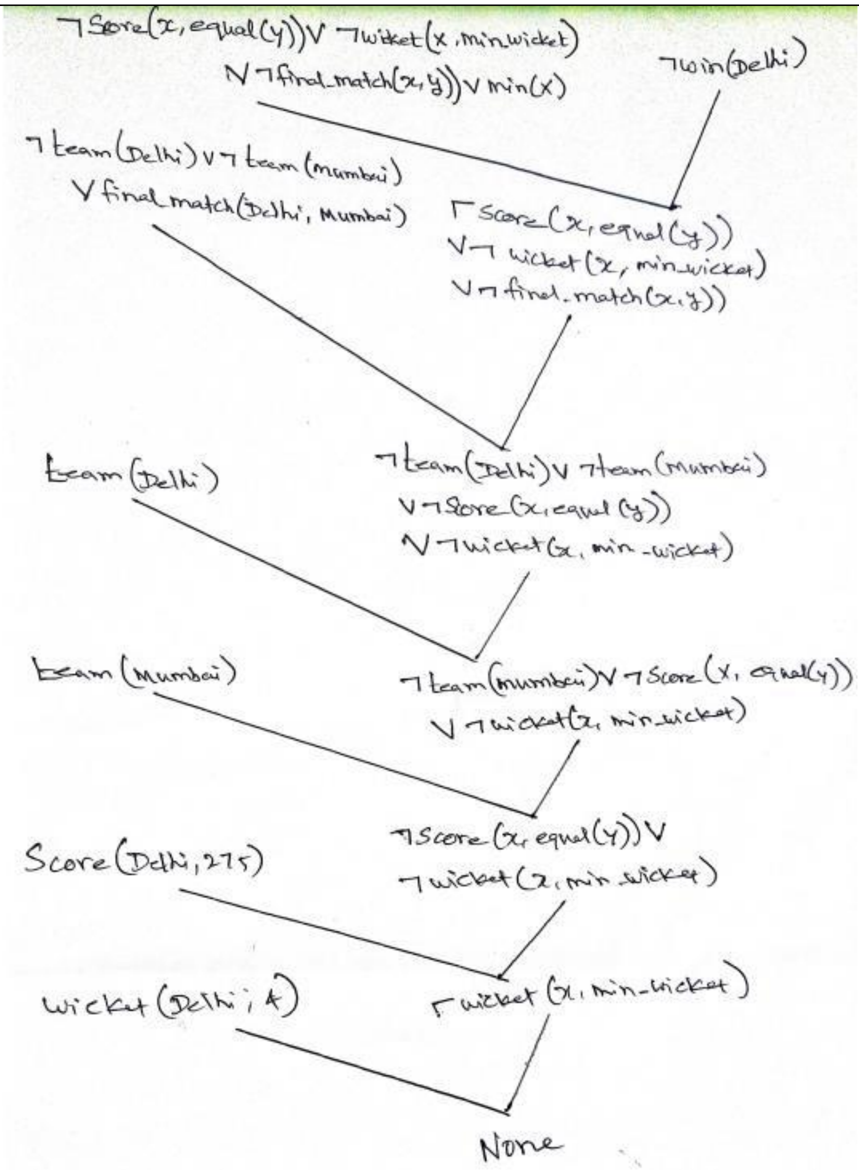
(iv) Move all quantifiers to the left

(v) Eliminate □□
(a) team(Delhi)
(b) team(Mumbai)
(c) □team(Delhi) v □team(Mumbai) v final_match (Delhi,Mumbai)
(d) score(Delhi,275) ^ score(Mumbai,275) ^ wicket(Delhi,4) ^ wicket(Mumbai,6)
(e) □team(x) v □wins(x) vscore(x, max_runs))
(f) □score(x,equal(y)) v□wicket(x,min_wicket) v-final_match(x,y)) vwin(x)
(vi) Eliminate□□
(vii) Convert to conjunct of disjuncts form.

(viii) Make each conjunct a separate clause.
(a) team(Delhi)
(b) team(Mumbai)
(c) □team(Delhi) v □team(Mumbai) v final_match (Delhi,Mumbai)
(d) score(Delhi,275)

Score(Mumbai,275) Wicket(Delhi,4) Wicket(Mumbai,6)
(e) □team(x) v □wins(x) vscore(x,max_runs))
(f) □score(x,equal(y)) v□wicket(x,min_wicket) v□final_match(x,y)) vwin(x)

(ix) Standardize variables apart again
(x) To prove: win(Delhi)
(xi) Disprove:□win(Delhi)
(xii) Resolution Graph



6.	Consider a scenario in artificial intelligence (AI) where an AI system is tasked with solving a murder mystery using Dempster–Shafer Theory. The setting is a room with four individuals: A, B, C, and D. Suddenly, the lights go out, and upon their return, B is discovered dead, having been stabbed in the back with a knife. No one entered or exited the room, and it is known that B did not commit suicide. The objective is to identify the murderer.	10	3	3	2	2.2.3

Solution:

To solve these there are the **following possibilities**:

- Either {A} or {C} or {D} has killed him.
- Either {A, C} or {C, D} or {A, D} have killed him.
- Or the three of them have killed him i.e.; {A, C, D}
- None of them have killed him {o} (let's say).

There will be possible evidence by which we can find the murderer by the measure of plausibility.
Using the above example we can say:
Set of possible conclusion (P): {p1, p2….pn}
where P is a set of possible conclusions and cannot be exhaustive, i.e. at least one (p) I must be true.
(p)I must be mutually exclusive.
Power Set will contain 2n elements where n is the number of elements in the possible set.
For e.g.:-
If P = { a, b, c}, then Power set is given as
{o, {a}, {b}, {c}, {a, d}, {d ,c}, {a, c}, {a, c ,d }}= 23 elements.
Mass function m(K): It is an interpretation of m({K or B}) i.e; it means there is evidence for {K or B} which cannot be divided among more specific beliefs for K and B.

Belief in K: The belief in element K of Power Set is the sum of masses of the element which are subsets of K. This can be explained through an example

Lets say K = {a, d, c}

Bel(K) = m(a) + m(d) + m(c) + m(a, d) + m(a, c) + m(d, c) + m(a, d, c)

Plausibility in K: It is the sum of masses of the set that intersects with K.

i.e.; Pl(K) = m(a) + m(d) + m(c) + m(a, d) + m(d, c) + m(a, c) + m(a, d, c)

7.	For each of the following arguments, explain which rules of inference can be applied for each step. The universe is a set of people. [2.5 * 4 = 10] ▪ "Every student in this class owns a personal computer. Everyone who owns a personal computer can use the Internet. Therefore, John, a student in this class, can use the Internet." ▪ "Everyone in this class owns a personal computer. Someone in this class has never used the Internet. Therefore, someone who owns a personal computer has never used the Internet." ▪ "John, a student in this class, is 16 years old. Everyone who is 16 years old can get a driver's license. Therefore, someone in this class can get a driver's license." ▪ "Somebody in this class enjoys hiking. Every person who enjoys hiking also likes biking. Therefore, there is a person in this class who likes biking."	10	3	3	2	2.3.1

Solution:

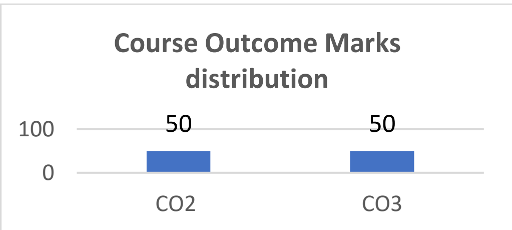
a) Let *C(x)* be "*x* is a student in this class, " *S(x)* be "*x* is 16 years old, " and *D(x)* be "*x* can get a driver's liscence." The premises are *C*(John), *S*(John) and *x* (*S*(*x*) *D*(*x*)). Using universal instantiation and the last premise, *S* (John) *D* (John) follows. Applying modus ponens to this conclusion and the second premise, *D*(John) follows. Using conjunction and the first premise, *C* (John) *D* (John) follows. Finally, using existential generalization, the desired conclusion, *x* (*C*(*x*) *D*(*x*)) follows.

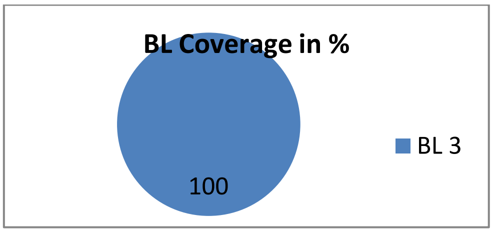
b) Let *C(x)* be "*x* is in this class, " *H(x)* be "*x* enjoys hiking, " and *B(x)* be "*x* likes biking." The premises are *x* (*C*(*x*) *H*(*x*)) and *x* (*H*(*x*) *B*(*x*)). Using existential instantiation and the first premise *C*(*d*) *H*(*d*) for some person *d*. From this by simplification *H*(*d*) is obtained. For that person *d*, by universal instantiation and the second premise, *H*(*d*) *B*(*d*). Hence by modus ponens *B*(*d*) follows. Also by simplification from *C*(*d*) *H*(*d*) , *C*(*d*) is obtained. Using the conjunction on the last two conclusions, *C*(*d*) *B*(*d*) is obtained. Then applying existential generalization to this *x* (*C*(*x*) *B*(*x*)) follows.

c) Let *C(x)* be "*x* is a student in this class, " *P(x)* be "*x* owns a personal computer, " and *I(x)* be "*x* can use the Internet." The premises are *x* (*C*(*x*) *P*(*x*)), *x* (*P*(*x*) *I*(*x*)) and *C*(John). Using universal instantiation and the first premise, *C*(John) *P*(John) follows. Applying modus ponens to this conclusion and the last premise, *P*(John) follows. Using universal instantiation and the second premise, *P*(John) *I*(John) follows. From the last two conclusions by modus ponens *I*(John) follows. Hence from this conclusion and the last premise by conjunction *C*(John) *I*(John) follows.

d) Let *C(x)* be "*x* is a student in this class, " *P(x)* be "*x* owns a personal computer, " and *I(x)* be "*x* has used the Internet." The premises are *x* (*C*(*x*) *P*(*x*)) and *x* (*C*(*x*) *I*(*x*)). Using existential instantiation and the second premise *C*(*d*) *I*(*d*) for some person *d*. Hence by simplification *C*(*d*). For that person *d*, by universal instantiation and the first premise *C*(*d*) *P*(*d*). >From this and the previous conclusion, by modus ponens *P*(*d*). Also from *C*(*d*) *I*(*d*) by simplification *I*(*d*). Hence by conjunction *P*(*d*) *I*(*d*). Hence by existential generalization *x* (*C*(*x*) *I*(*x*)).

***Performance Indicators are available separately for Computer Science and Engineering in AICTE examination reforms policy.**





Approved by the Audit Professor/Course Coordinator