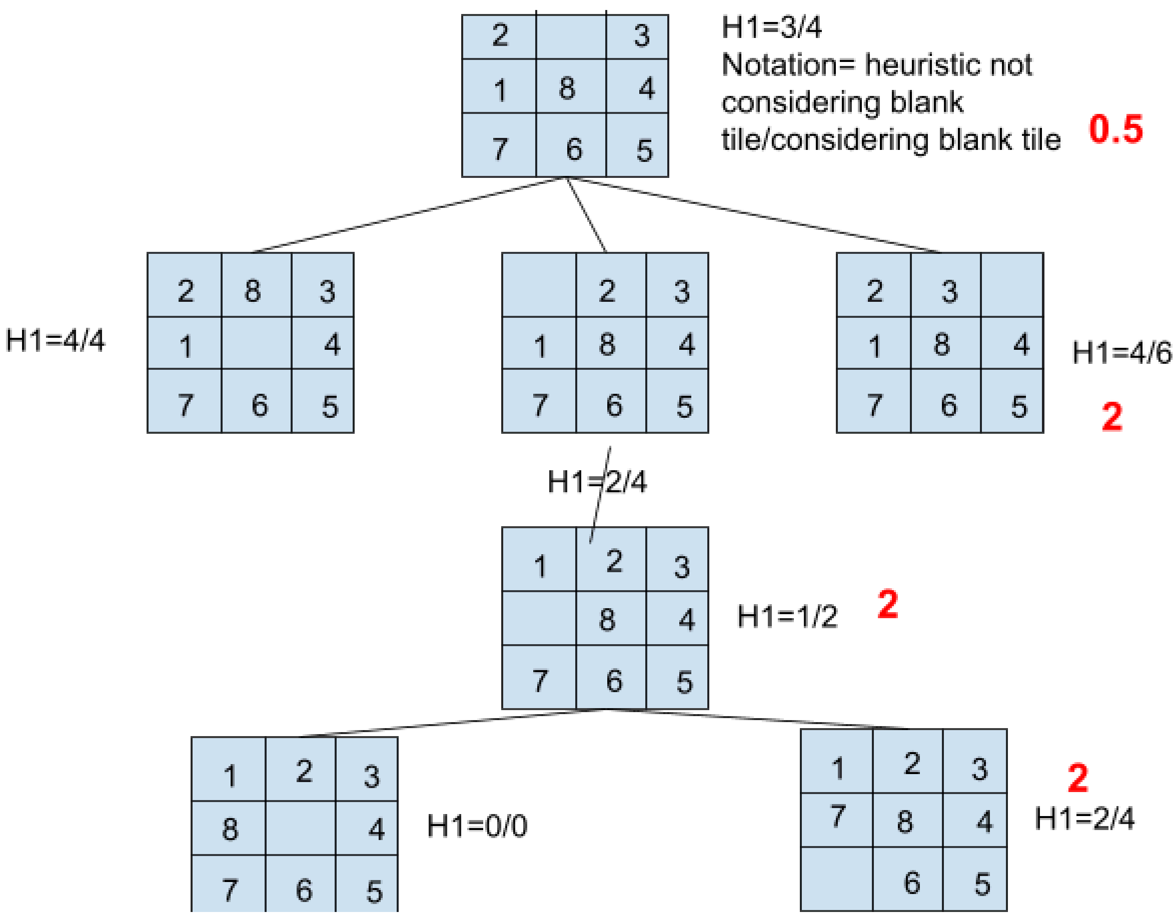
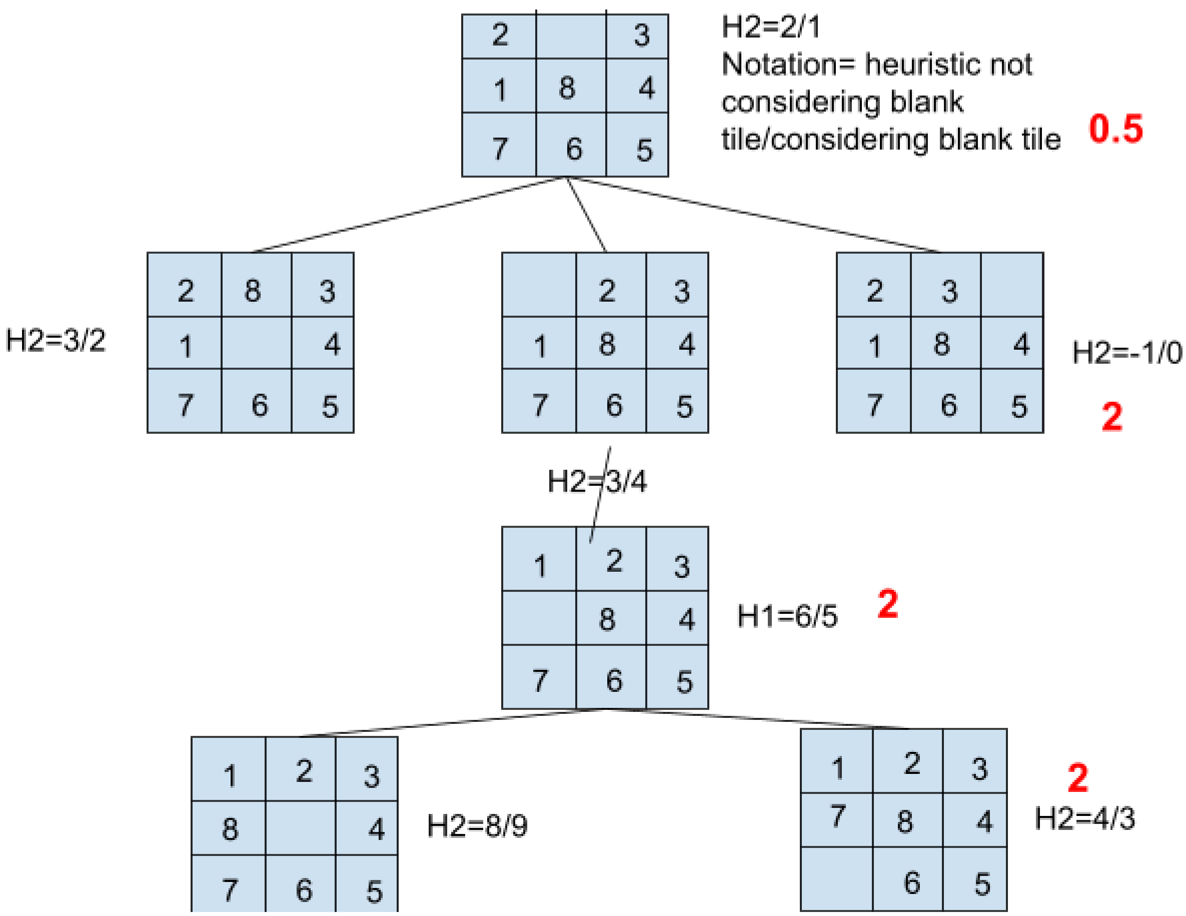
Q1



Average branching factor= No of nodes expanded/length of optimal path= 3/3 =1 1 mark



Average branching factor= No of nodes expanded/length of optimal path= 3/3 =1 1 mark

Both heuristic values have same branching factor so any of them can be used. 1 mark

Q 2(a) **2 marks - Any four types (0.5 Each)**

What are the different types of task environments where the Agent may act?

1. Fully observable vs. Partially observable
2. Deterministic vs.Stochastic
3. Episodic vs.Sequential
4. Static vs.Dynamic

5. Discrete vs.Continuous
6. Single agent vs. multiagent

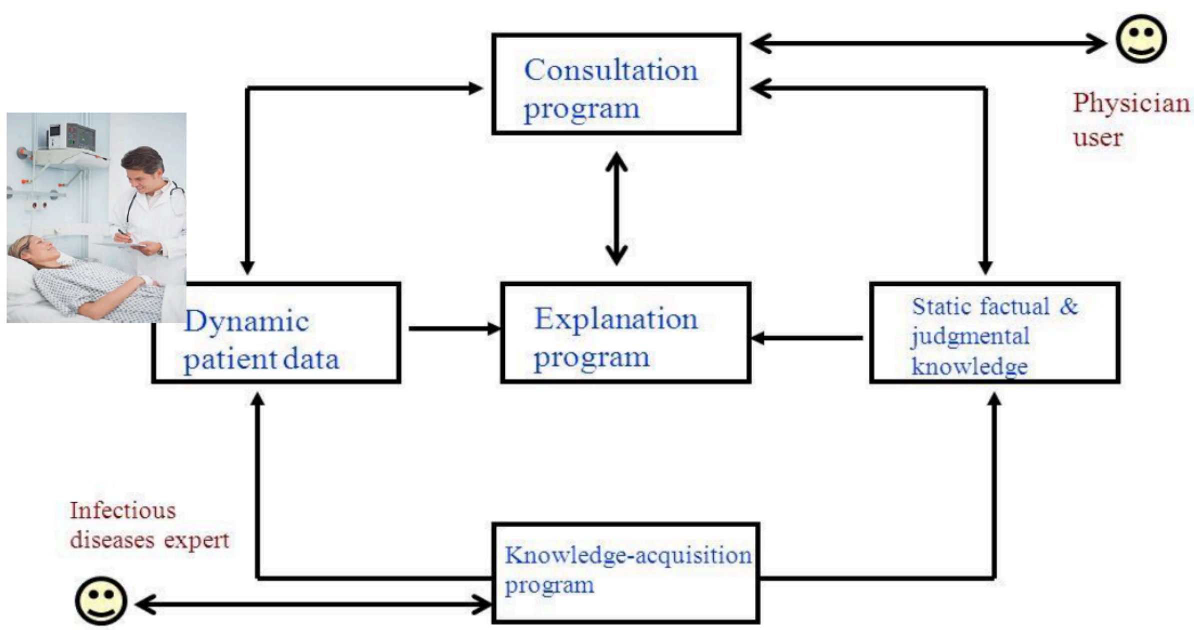
Q2(b) **4 marks**

What are the components of Expert Systems, also, explain the MYCIN architecture with a diagram?

Components of expert system - 2marks (0.25 each)

1. Knowledge Base
2. Explanation Facility
3. Inference Engine
4. Knowledge base acquisition facility
5. Experts
6. Dynamic Data
7. User Interface
8. User

MYCIN Architecture - **2marks (Deduct 0.5 for every mistake)**



Q2 (c) **5 marks**

Write the following in Prolog syntax.

1. Define the predicate max (X, Y, Z) that takes numbers X and Y and unifies Z with the maximum of the two.

2. Make use of built-in predicate 'cut' to complete the code.

```
max(X, Y, Z) :-          → (1)
  (X >= Y, Z is X, !);   → (3) (1 each)
  Z is Y.                → (1)
```

Q2 d **5 marks**

Write a recursive LISP program to calculate the Fibonacci series with the function name 'Fibonacci' and take 'N' as input. Also, use the 'Zerop' Boolean function in the code wherever required. Following is the condition that represents the Fibonacci series:

Fib(n) = 1 for *n = 0* or *n = 1*

Fib(n) = Fib(n-1) + Fib(n-2) for *n > 1*

```
(defun fibonacci (N)                     → (1)
(if (or (Zerop N) (= N 1))               → (2)
    1
   (+ (fibonacci (- N 1)) (fibonacci (- N 2)))))) → (2)
```

Q3 (a)

i) Write the sentence "You can access the internet from campus only if you are a computer science major or you are not a freshman" in prepositional logic. **(1 mark)**

P: access the internet from campus; Q: computer science major; R: freshman

$$P \rightarrow (Q \vee \sim R)$$

ii) Construct truth table for the compound proposition $(p \wedge q) \vee (\neg q \wedge r)$. **(2 marks = 0.25 mar * 8 ent)**

p	q	r	$p \wedge q$	$\neg q$	$\neg q \wedge r$	$(p \wedge q) \vee (\neg q \wedge r)$
0	0	0	0	1	0	0
0	0	1	0	1	1	1
0	1	0	0	0	0	0
0	1	1	0	0	0	0
1	0	0	0	1	0	0
1	0	1	0	1	1	1
1	1	0	1	0	0	1
1	1	1	1	0	0	1

iii) Write the sentence "Every student who takes French passes it" in first order logic form. **(1 mark)**

$$\forall\ x, s\quad \textit{Student}\ (x) \wedge \textit{Takes}\ (x, F, s) \Rightarrow \textit{Passes}\ (x, F, s)$$

iv) Write the sentence "Every person who buys a policy is smart" in first order logic form. **(1 mark)**

$$\forall\ x\quad \textit{Person}\ (x) \wedge (\exists\ y, z\ \ \textit{Policy}\ (y) \wedge \textit{Buys}\ (x, y, z)) \Rightarrow \textit{Smart}\ (x)$$

Q3 (b) Write down conceptual dependency structure for the following sentences.

1) My grandmother told me a story. **(2 marks = 1 (nodes) + 1 (relations))**

2) Prakhar eats ice-cream. **(2 marks = 1 (nodes) + 1 (relations))**

3) Jatin bagged Meeta for a pencil. **(2 marks = 1 (nodes) + 1 (relations))**

(iii) My grandmother told me a story.

$$\text{Grandmother} \overset{p}{\Leftrightarrow} \text{MTRANS} \xleftarrow{\text{o}} \text{story}$$

(iv) Prakhar eats ice cream.

$$\text{Prakhar} \overset{p}{\Leftrightarrow} \text{INGEST} \xleftarrow{\text{o}} \text{ice cream}$$

(v) Jatin bagged Meeta for a pencil.

$$\text{Jatin} \Leftrightarrow \text{SPEAK} \xleftarrow{\text{o}} \text{pencil} \longleftarrow \left[\begin{array}{l} \rightarrow \text{Meeta} \\ \rightarrow \text{Jatin} \end{array}\right.$$

Q3 (c) Write down script for going to the bank to withdraw money.

(5 marks = 1 (description) + 4 (1 mark for each scene))

SCRIPT: Withdraw money
TRACK: Bank
PROPS: Money, Counter, Form, Token
Roles: P= Customer, E= Employee, C= Cashier
Entry conditions: P has no or less money. The bank is open.
Results: P has more money.

Scene 1: Entering P PTRANS P into the Bank P ATTEND eyes to E P MOVE P to E	**Scene 3:** Withdrawing money P ATTEND eyes to counter P PTRANS P to queue at the counter P PTRANS token to C C ATRANS money to P
Scene 2: Filling form P MTRANS signal to E E ATRANS form to P P PROPEL form for writing P ATRANS form to P E ATRANS form to P	**Scene 4:** Exiting the bank P PTRANS P to out of bank

Q4 (a) **06 Marks =**

02 mark for correct precision score
02 mark for correct recall score
02 marks for correct F1 score

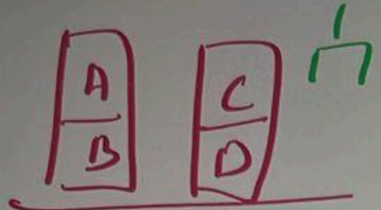
Class	TP	FP	FN	Precision	Recall	F1-Score
A	200	400	200	0.33	0.50	0.4
B	300	100	100	0.75	0.75	0.75
C	300	100	300	0.75	0.50	0.60

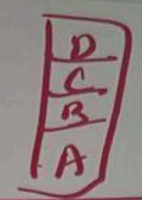
Q4 (b) **10 Marks = 1 mark for each state considering pushing and popping elements (A-1 to A-10)**

14:32 Tue, 14 May

Title

71%





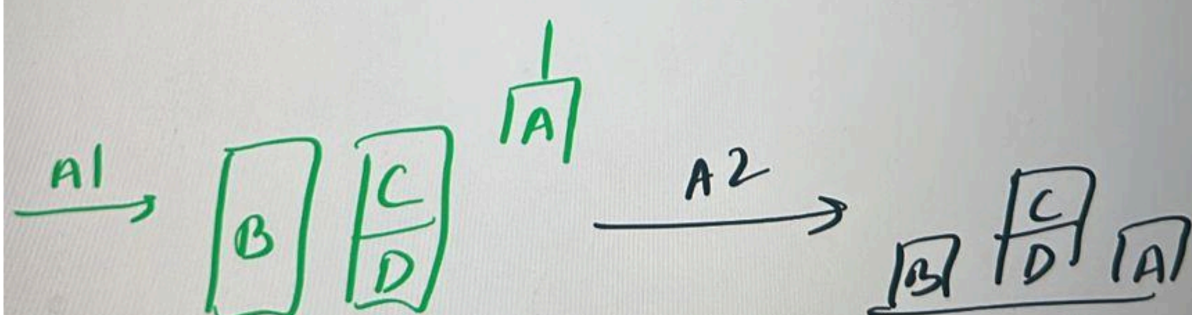
Pre –
2 – Top
A – bottom

Tie –
A – Top
2 – Bottom

~~on(A,B)~~ ✗
~~Clear(A)~~ ✗
~~Arm Empty~~ ✗
~~A: Unstack(A,B)~~ A1
~~Table(A)~~ ✗
on(B,A)
on(C,B)
on(D,C)

→

~~Holding(A)~~ ✗
A2 ~~A: Putdown(A)~~
~~onTable(B)~~
~~Clear(B)~~ ✗
~~Arm Empty~~ ✗
A Pickup(B)
~~Holding(B)~~ ✗
Clear(A)
A Stack(B,A)
~~on(B,A)~~ ✗
on(C,B)
on(D,C)



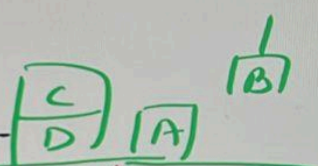
~~A: Pickup(B)~~ A3
~~Clear A~~ ✗
~~A: Stack(B,A)~~ ✗ A4
on(C,B)
on(D,C)

→

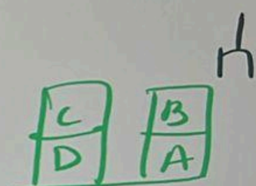
2-Top
A-Bottom

~~on Table(C)~~ ✗
Clear(C)
Arm Empty
A: Pickup(C)
~~Holding(C)~~ ✗
Clear(B)
stack(C,B)
~~On(C,B)~~ ✗
on(D,C)

A3 →

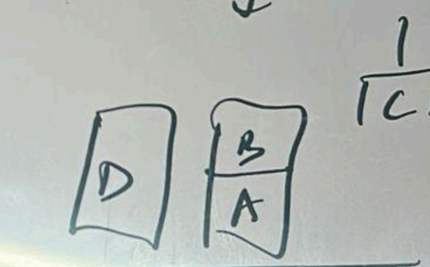


A4 →

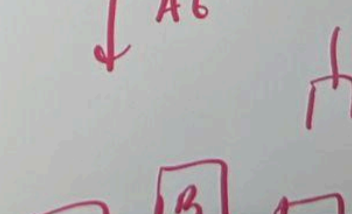


✗ ~~clear(C)~~
✗ ~~on(C,D)~~
✗ ~~Arm Empty~~
A5 ~~A: Unstack(C,D)~~
Clear(C)
Arm Embty
A: Pickub(C)
Clear(B)
A Stack(C,B)
on(D,C)

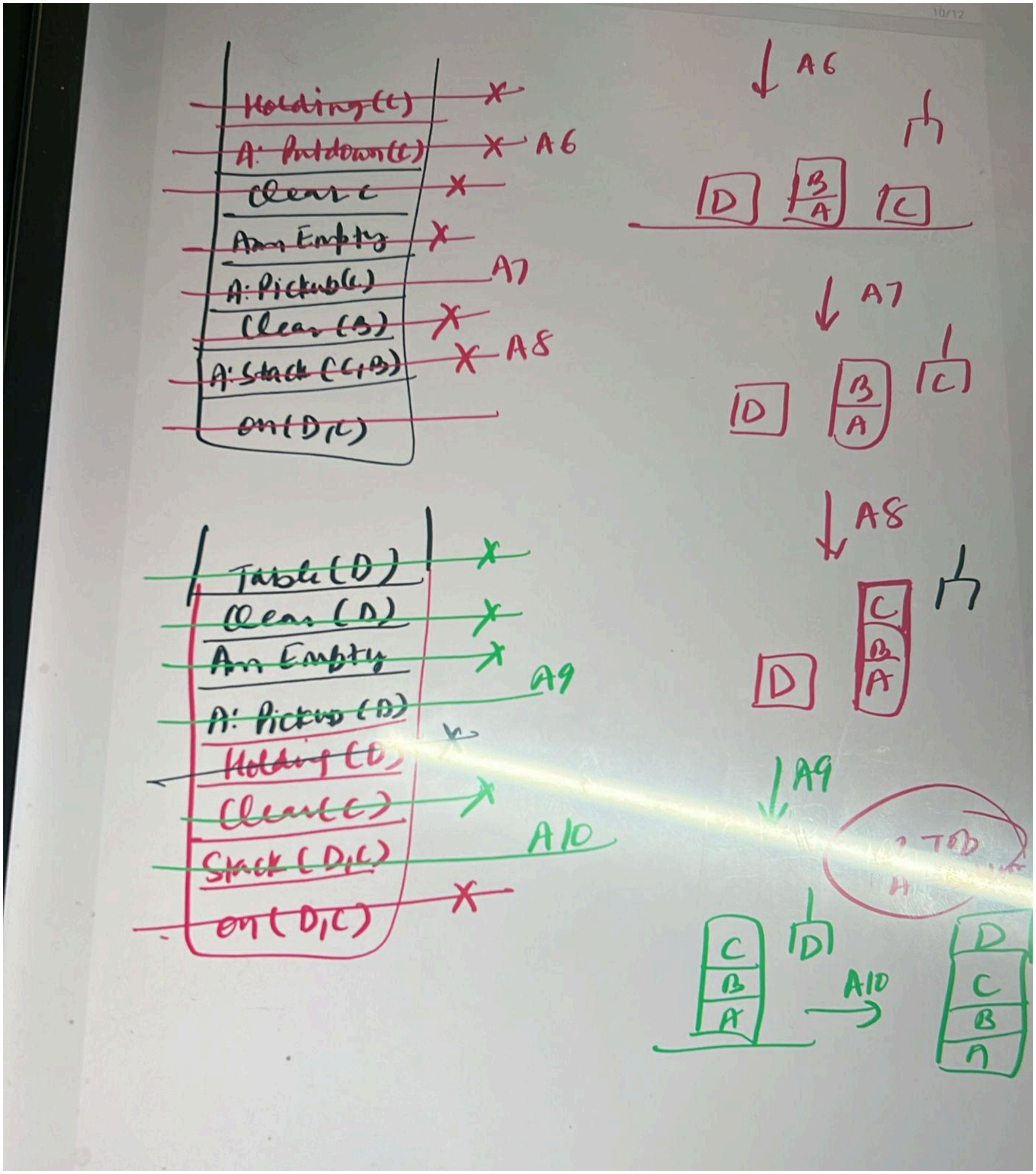
↓ A5



↓ A6



~~Holding(C)~~ ✗
~~Holding(C)~~ ✗ A6



Q5. (a) 6 Marks = (1 + 1 + 1+ 1 +1+ 1)

Let A be the event of receiving an A, G be the event of being a girl, and B the event of being a boy.

We are given P(A | G) = 0.30, P(A | B) = 0.25, P(G) = 0.60 and we want P(G | A).

From the definition $P(G \mid A) = P(G \cap A) / P(A)$.

$P(G \cap A) = P(A \mid G)P(G) = (0.30)(0.60) = 0.18$.

To find P(A), we write $P(A) = P(G \cap A) + P(B \cap A)$.

Since the class is 40% men, $P(B \cap A) = P(A \mid B)P(B) = (0.25)(0.40) = 0.10$.

So $P(A) = P(G \cap A) + P(B \cap A) = 0.18 + 0.10 = 0.28$.

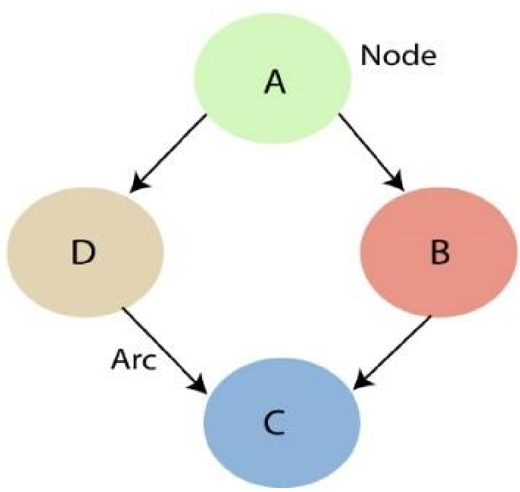
Finally, $P(G \mid A) = P(G \cap A) / P(A) = 0.18 / 0.28$.

Q5(b) 2marks = 1 mark for definition + 1 mark for explanation with diagram (no marks will be awarded if random diagram is drawn without explanation)

A Bayesian network is a probabilistic graphical model which represents a set of variables and their conditional dependencies using a directed acyclic graph." Bayesian Network can be used for building models from data and experts opinions, and it consists of two parts:

- **Directed Acyclic Graph**
- **Table of conditional probabilities.**

A Bayesian network graph is made up of nodes and Arcs (directed links), where:



Q5(c)

a) **4 marks (2+1+1)**

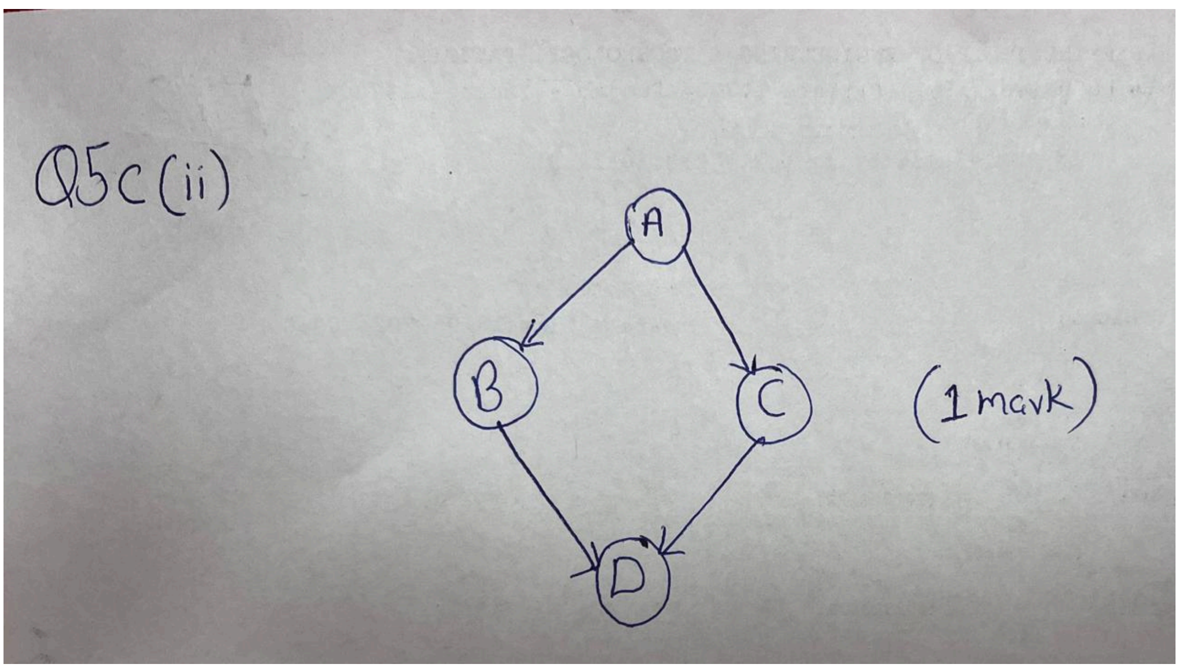
b) 1 mark (diagram after adding variable D) (No marks if undirected graph is made)
c) 3 marks (0.5 (No) + 1 (reasoning)+0.5 (Yes)+ 1(reasoning))

a) P(A | B', Ĉ) = P(B', Ĉ | A) P(A) / P(B', Ĉ)
= P(B', C | A) P(A) / (P(B', C | A) P(A) + P(B', C | A') P(A')) ------------- (1)

Now, P (B', Ĉ | A) = P (B' | A) P (Ĉ | A) = (0.15)(0.75) = 0.1125

So, From (1) we have, P(A | B', Ĉ)
= (0.1125 * 0.10664) / ((0.1125 * 0.10664) + (0.096* 0.89336))
= 0.1227

b) i. No (An undirected path between A and D exists through C)
ii. Yes (All paths either pass through A which is an evidence node, or D which is not an evidence node, but has all edges as incoming edges)



Q6. a) 1. Supervised Learning
In supervised learning, the algorithm is trained on a labeled dataset, which means that each training example is paired with an output label. The model learns to map inputs to the desired output. Example: Email spam detection where the model is trained with emails labeled as "spam" or "not spam". [1 mark]

2. Unsupervised Learning
In unsupervised learning, the algorithm is given data without explicit instructions on what to do with it. The system tries to learn patterns and the structure from the data. Example: Customer segmentation where customers are grouped based on purchasing behavior without predefined categories. Example: Reducing the number of features in a dataset to visualize it in 2D or 3D plots. [1 mark]

3. Reinforcement Learning
Reinforcement learning involves training an agent to make a sequence of decisions by rewarding it for positive actions and penalizing it for negative ones. The agent learns to maximize cumulative rewards. Example: Training a robot to navigate a maze where it receives rewards for reaching the destination and penalties for hitting walls. [1 mark]

4. Semi-Supervised Learning
This type of learning falls between supervised and unsupervised learning. It uses a small amount of labeled data and a large amount of unlabeled data. Example: Improving image recognition models by using a few labeled images along with a large set of unlabeled images.
[1 mark]

Q6. b)
i) Regression and inference **(1+1 marks)**

ii) Classification and prediction **(1+1 marks)**

iii) Regression and prediction **(1+1 marks)**

Q6 c) **i) 0.33 marks for each nearest neighbor euclidean distance**

ii) 1 mark for correct output, 1 mark for Probability

iii) 1 mark for correct output, 1 mark for Probability

Obs.	X_1	X_2	X_3	Y	Distance
1	0	3	0	Red	3
2	2	0	0	Red	2
3	0	1	3	Red	3.16
4	0	1	2	Green	2.23
5	-1	0	1	Green	1.41
6	1	0	2	Red	2.23

If $K = 1$ *then* $x_5 \in \mathcal{N}_0$ *and we have*

$$P(Y = \text{Red}|X = x_0) = \frac{1}{1}\sum_{i \in \mathcal{N}_0} I(y_i = \text{Red}) = I(y_5 = \text{Red}) = 0$$

and

$$P(Y = \text{Green}|X = x_0) = \frac{1}{1}\sum_{i \in \mathcal{N}_0} I(y_i = \text{Green}) = I(y_5 = \text{Green}) = 1.$$

Our prediction is then Green.

c. What is our prediction with $K = 3$? Why ?

If $k = 3$ then nearesest neighbours will be

$ED(5) = 1.414 \longrightarrow$ Green
$ED(2) = 2 \longrightarrow$ Red

and either of $ED(4)$ or $ED(6)$ as both equal 2.2

$$\underset{\text{Green}}{\underset{\downarrow}{ED(4)}} \qquad \underset{\text{Red}}{\underset{\downarrow}{ED(6)}}$$

So, the prediction can be either Green or Red according to neighbour chosen.

Bayes theorem for $ED(2,4,5,6)$

X1	Y	X2	Y	X3	Y
2	Red	0	Red	0	Red
0	Green	1	Green	2	Green
-1	Green	0	Green	1	Green
1	Red	0	Red	2	Red

$\Rightarrow P(X_1, X_2, X_3) \rightarrow \text{Red} = 0.5$
$P(X_1, X_2, X_3) \rightarrow \text{Green} = 0.5$