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DISCRETE STRUCTURE

GRAPH ISOMORPHISM

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AFFILIATED TO BENGALURU CITY UNIVERSITY, APPROVED BY AICTE, DELHI & RECOGNISED BY THE GOVT. OF KARNATAKA
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TEAM B- GROUP NAME

- AMAN SINGH
- ABHINAYA
- ABHISHEK SINGH
- ABRAR AHMED
- ADITI RAJ
- ABHIRUP BISHWAS

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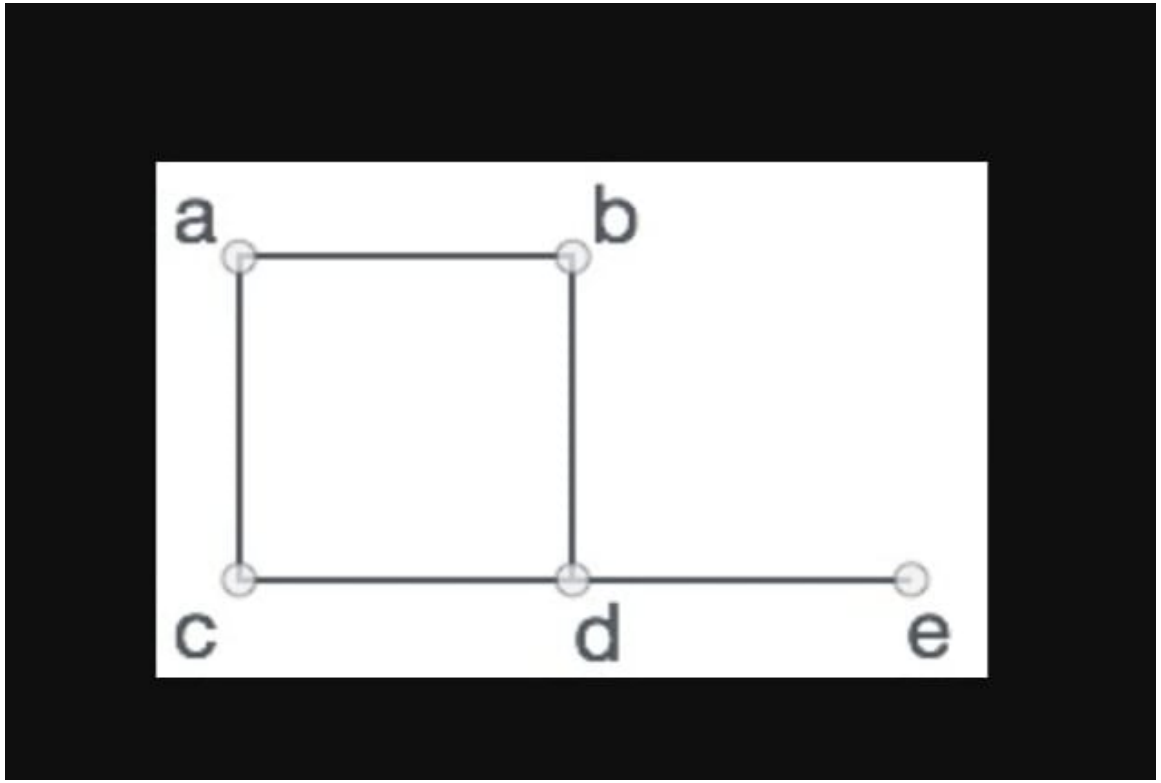
GRAPH

A graph is a pictorial representation of a set of objects where some pairs of objects are connected by links. The interconnected objects are represented by points termed as **vertices**, and the links that connect the vertices are called **edges**.

Formally, a graph is a pair of sets **(V, E)**, where **V** is the set of vertices and **E** is the set of edges, connecting the pairs of vertices. Take a look at the following graph −



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In the above graph,
V = {a, b, c, d, e}
E = {ab, ac, bd, cd, de}

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GRAPH THEORY

- Graph Theory is the study of points and lines. In Mathematics, it is a sub-field that deals with the study of graphs. It is a pictorial representation that represents the Mathematical truth. Graph theory is the study of relationship between the vertices (nodes) and edges (lines).
- Formally, a graph is denoted as a pair G(V, E).
- Where V represents the finite set vertices and E represents the finite set edges.
- Therefore, we can say a graph includes non-empty set of vertices V and set of edges E.

Example

- Suppose, a Graph G=(V,E), where
- Vertices, V={a,b,c,d}
- Edges, E={{a,b},{a,c},{b,c},{c,d}}

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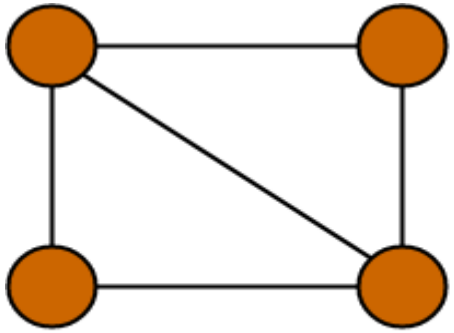
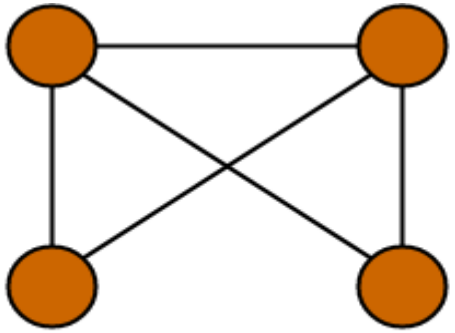
ISOMORPHISM



G1



G2

QUESTION: DO THESE TWO GRAPHS ARE SAME?

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- IF YOUR ANSWER NO THEN,YOU NEED TO RETHINK IT.
- THE GRAPHICAL ARRANGEMENT OF THE VERTICES AND EDGES MAKE THEM LOOK DIFFERENT BUT THEY ARE THE SAME GRAPH.

- THE TERM WE USE FOR THIS RELATIONSHIP BETWEEN TWO GRAPHS IS CALLED ISOMORPHIC.

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QUESTION: WHAT DOES IT MEAN TO BE TWO GRAPHS TO BE ISOMORPHIC?

- TWO GRAPHS ARE SAID TO BE ISOMORPHIC IF THERE IS ONE TO ONE CORRESPONDANCE BETWEEN THEIR VERTICES AND EDGES.
- INCIDENCE RELATIONSHIP IS PRESERVED G1(V1E1) AND G2(V2E2) ARE ISOMORPHIC IF THERE IS A BIJECTION FUNCTION TO EACH OTHER.

- F:V1(G1)→V2(G2)

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- TWO GRAPHS ARE SAID TO BE ISOMORPHIC IF THEY ARE PERHAPS THE SAME GRAPH,JUST DRAWN DIFFERENTLY WITH DIFFERENT NAMES.
- i.e THEY HAVE IDENTICAL BEHAVIOUR FOR ANY GRAPH THEORETIC PROPERTIES.

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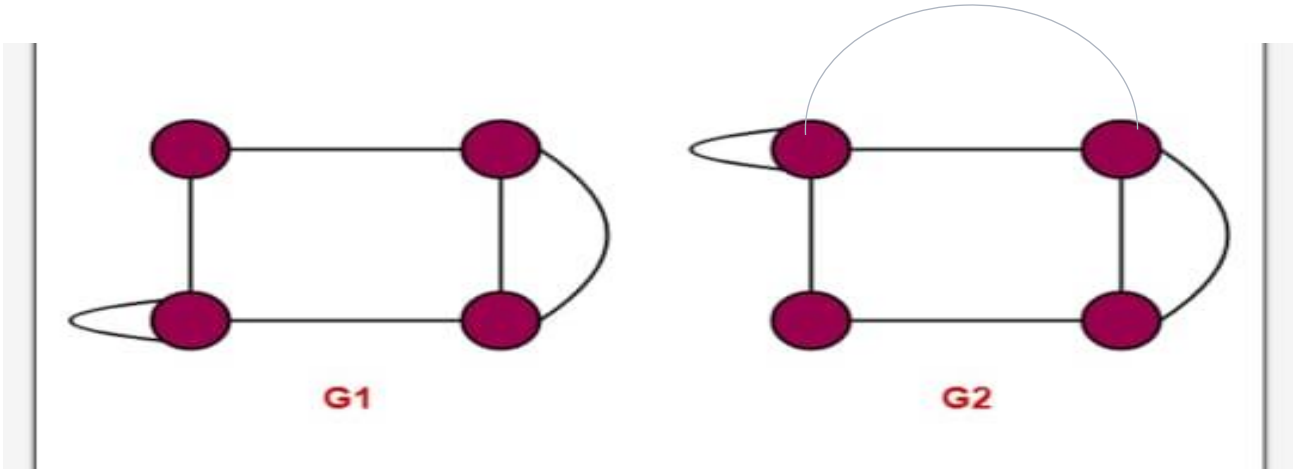
EXAMPLE 1: ARE THE FOLLOWING GRAPHS ISOMORPHIC?



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CONDITION-1:

- NUMBER OF VERTICES IN GRAPH G1 = 4
- NUMBER OF VERTICES IN GRAPH G2 = 4
- HERE, BOTH THE GRAPH G1 AND G2 HAVE SAME NUMBER OF VERTICES.
- SO,CONDITION-1 SATISFIES.

CONDITION-2:

- NUMBER OF EDGES IN GRAPH G1 = 5
- NUMBER OF EDGES IN GRAPH G2 = 6
- HERE,BOTH THE GRAPH G1 AND G2 HAVE DIFFERENT NUMBER OF EDGES.
- SO, CONDITION-2 VIOLATES
- SINCE,CONDITION-2 VIOLATES,SO GIVEN GRAPHS CAN NOT BE ISOMORPHIC.
- THEREFORE,G1 AND G2 ARE NOT ISOMORPHIC GRAPHS.

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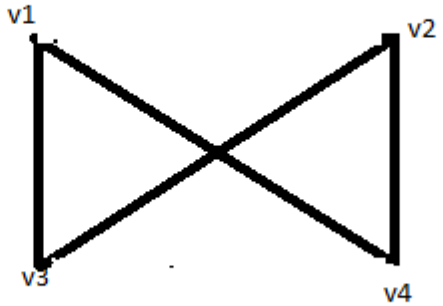
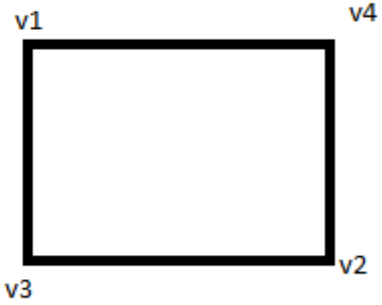
EXAMPLE 2: SHOW THAT G AND H ARE ISOMORPHIC

G



H



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- NUMBER OF VERTICES IN GRAPH G = 4
- NUMBER OF VERTICES IN GRAPH H = 4
- HERE,BOTH THE GRAPH G AND H ARE HAVING SAME NUMBER OF VERTICES.
- CONDITION 2
- NUMBER OF EDGES IN GRAPH G = 4
- NUMBER OF EDGES IN GRAPH H = 4
- BOTH THE GRAPH G AND H HAVE SAME NUMBER OF EDGES.

CONDITION 3

DEGREE SEQUENCE OF GRAPH G = 2,2,2,2.

DEGREE .SEQUENCE OF GRAPH H = 2,2,2,2

HENCE CONDITION 3 SATISFIED

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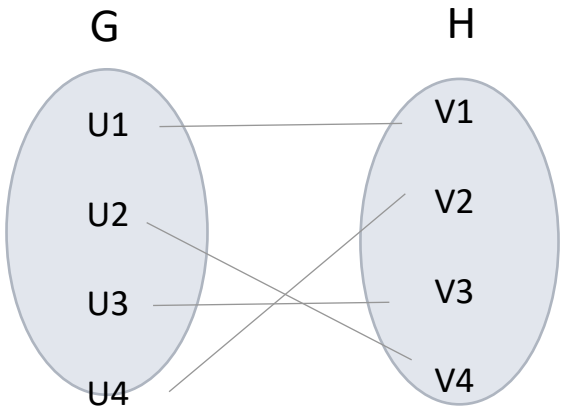
F(U1)=V1 F(U3)=V3 ONE TO ONE

F(U2)=V4 F(U4)=V2 FUNCTION MAPPING



(U1,U2) ≅(V1,V4) (U3,U4) ≅(V3,V2)

(U1,V3) ≅(U1,V3) (U4,U2) ≅(V2,V4)

THEREFORE,G AND H ARE ISOMORPHIC. G ≅ H

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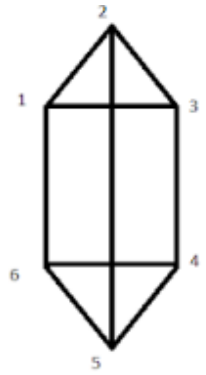
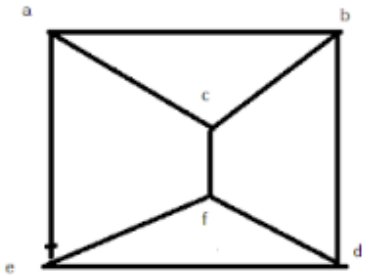
EXAMPLE 3: CHECK G AND H FOR ISOMORPHISM.





G H

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CONDITION 1

- NUMBER OF VERTICES IN G = 6
- NUMBER OF VERTICES IN H = 6
- HERE,BOTH HAVE SAME NUMBER OF VERTICES.

- CONDITION 2
- NUMBER OF EDGES IN G = 9
- NUMBER OF EDGES IN H = 9
- BOTH HAVE SAME NUMBER OF EDGES.

CONDITION 3

DEGREE SEQUENCE OF GRAPH G= 3,3,3,3,3,3

DEGREE SEQUENCE OF GRAPH H= 3,3,3,3,3,3

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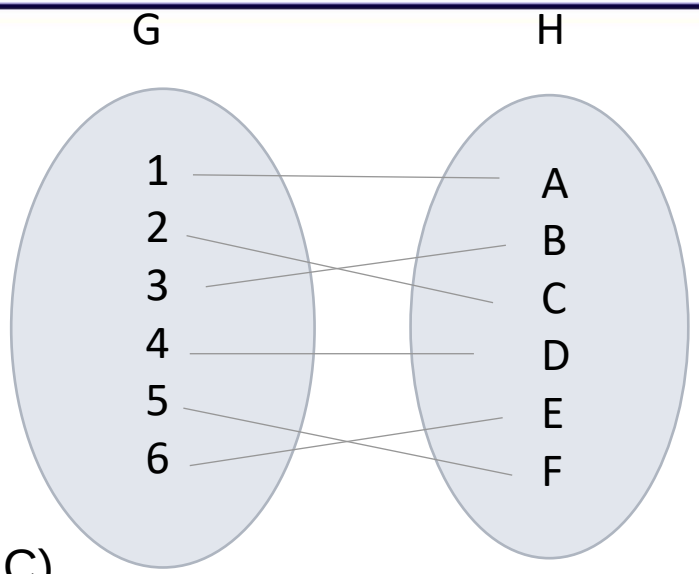
CONDITION 4



(1,2) ≅(A,C)
(1,3) ≅(A,B)
(1,6) ≅(A,E)
.
.
.

THEREFORE, G AND H ARE ISOMORPHIC.

G ≅ H

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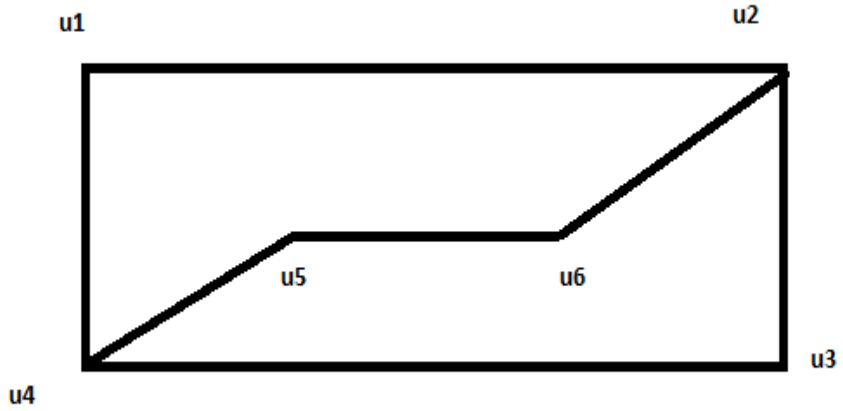
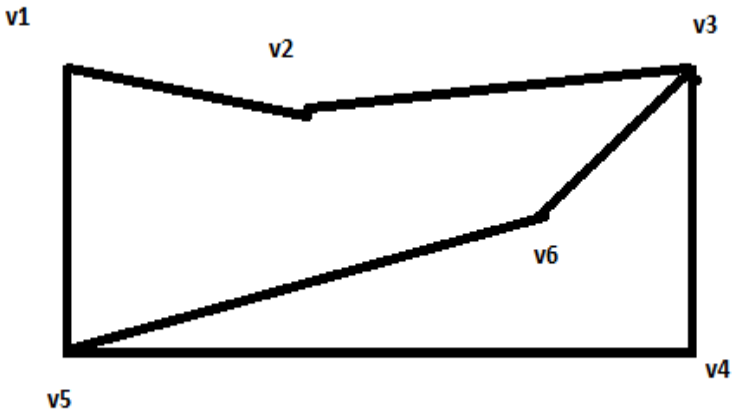
QUESTIONS FROM PREVIOUS YEARS QUESTION PAPERS

Q1. DEFINE ISOMORPHISM OF TWO GRAPHS. DETERMINE WHETHER THE FOLLOWING GRAPHS ARE ISOMORPHIC OR NOT?





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(i) number of vertices in both the graph =6
(ii) number of edges in both the graph=7
(iii) degree

G1		G2
d(v1)--->2	=	d(v1)--->2
d(v2)--->3	=	d(v3)--->3
d(v3)--->2	=	d(v2)--->2
d(v4)--->3	=	d(v5)--->3
d(v5)--->2	=	d(v4)--->2
d(v6)--->2	=	d(v6)--->2

(iv)maping

d(v1)=v4	d(v3)=v6	d(v5)=v1
d(v2)=v3	d(v4)=v5	d(v6)=v2

HENCE PROVED the given graph is isomorphism

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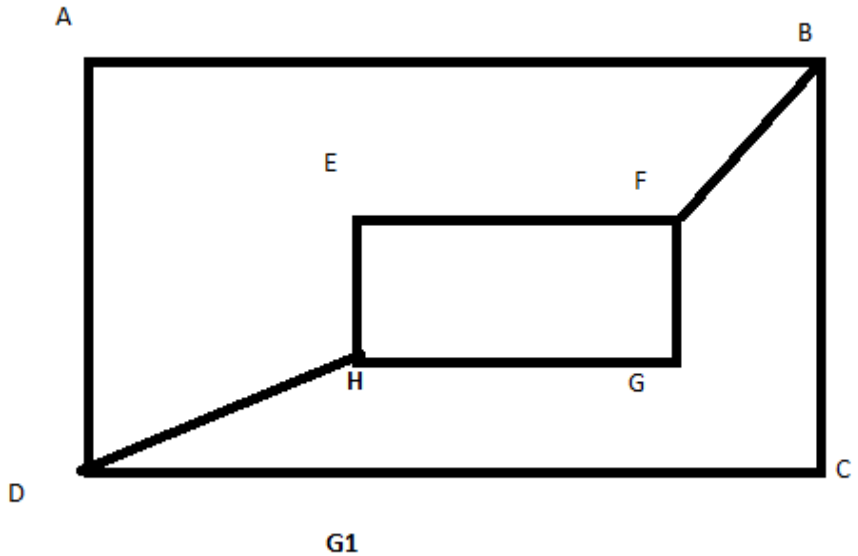
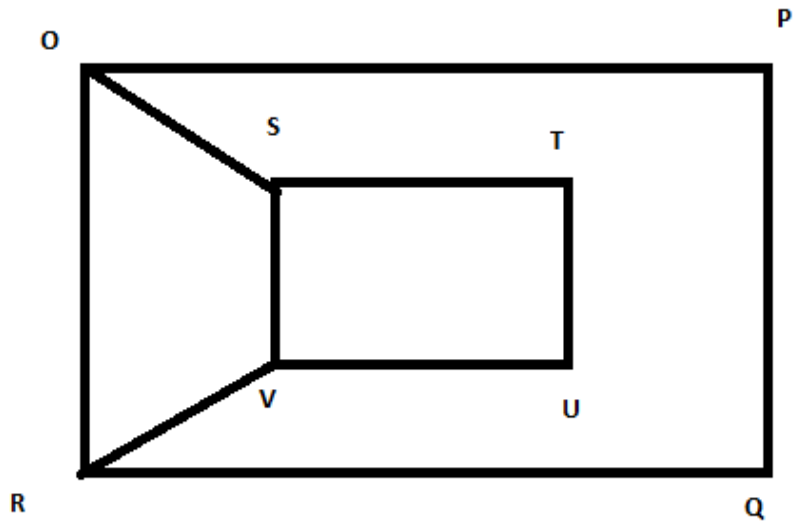
QUESTION 2- EXAMINE WHETHER THE FOLLOWING PAIR OF GRAPHS ARE ISOMORPHIC OR NOT. JUSTIFY YOUR ANSWER.



G1



G2

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(i)number of vertices=8
(ii) number of edges=10
(iii) degree

G2		G2
d(a)--->2	=	d(p)--->2
d(b)--->3	=	d(o)--->3
d(c)--->2	=	d(q)--->2
d(d)--->3	=	d(r)--->3
d(e)--->2	=	d(t)--->2
d(f)--->3	=	d(s)--->3
d(g)--->2	=	d(u)--->2
d(h)--->3	=	d(v)--->3

(iv) here maping is not able to do because g1 (A) has 2degree which is connected with 3 and 3 degree so we should see that same thing to be satisficed by g2 in g2(t) has 2degree which is connected with 3 and 2 degree so that 4th condition is not satisfied

HENCE the given graph is not an isomorphism.

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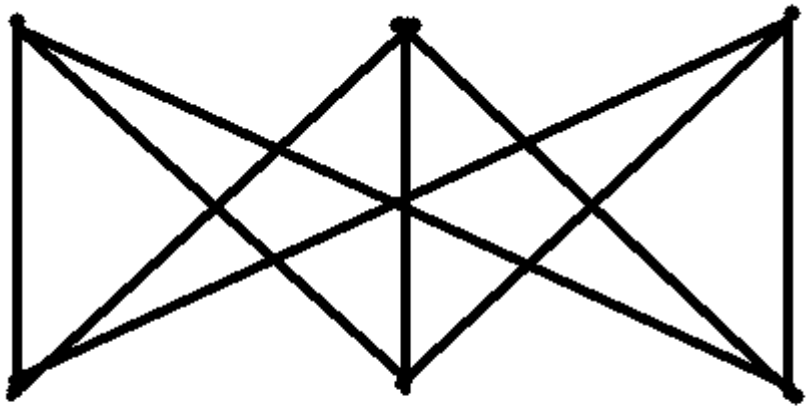
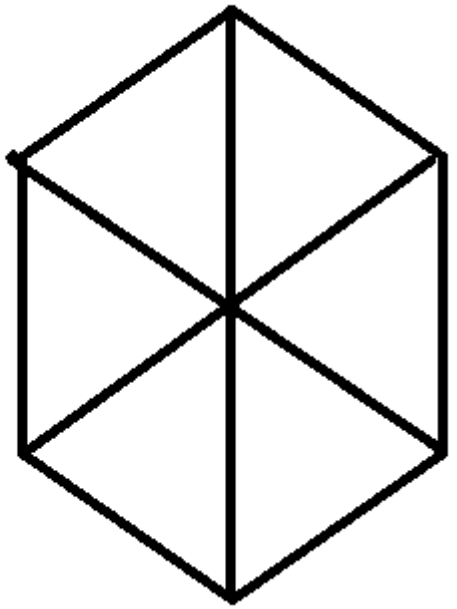
- QUESTION-4- DEFINE ISOMORPHISM OF GRAPHS.VERIFY THAT THE 2 GRAPHS SHOWN BELOW ARE ISOMORPHIC.





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• Let's name the graph G1:u1,u2, u3,u4,u5,u6

G2:v1,v2,v3,v4,v5,v6

1) No of vertices in both the graphs =6

2) No of edges in both the graphs=9

3) Degree

G1	G2
u1=3	v1=3
u2=3	v2=3
u3=3	v3=3
u4=3	v4=3
u5=3	v5=3
u6=3	v6=3

4) Mapping

(u1)→(v1)

(u2)→(v2)

(u3)→(v3)

(u4)→(v4)

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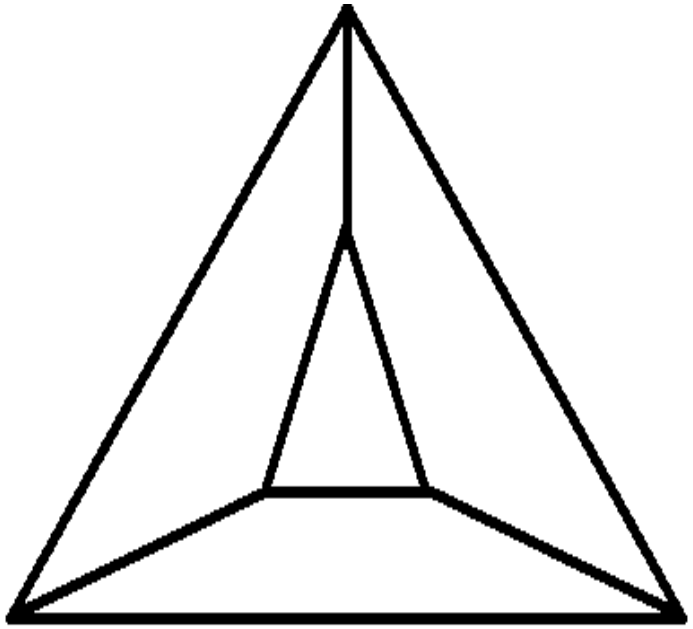
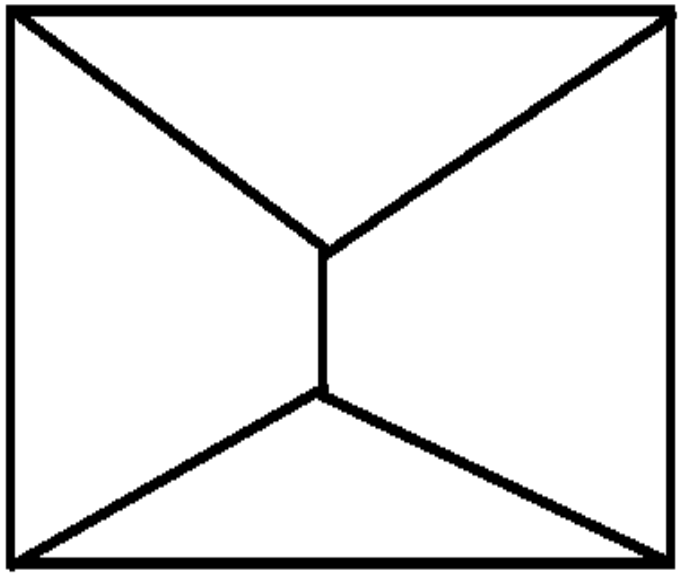
QUESTION-5-DEFINE ISOMORPHIC GRAPHS.VERIFY WHETHER THE FOLLOWING GRAPHS ARE ISOMORPHIC ARE NOT.





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- Let's name the graph G1: a,b,c,d,e,f &
- G2 :p,q,r,s,t,u
- 1)No of vertices in both the graphs are =6
- 2)No of edges in both the graphs are=9
- 3) Degree
- G1 G2
- a=3 p=3
- b=3 q=3
- c=3 r=3
- d=3 s=3
- e=3 t=3
- f=3 u=3
- 4) Mapping
- (a)→(p)
- (b)→(q)
- (c)→(r)
- (d)→(s)
- (e)→(t)

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