B.Sc. DEGREE EXAMINATION - MATHEMATICS PIFTH SEMESTER - APRIL 2023 UMT 5601 - GRAPH THEORY Date: 15-05-2023 Time: 01:00 PM - 04:00 PM Max. : 100 Marks Part - A (10 x 2 = 10 Marks) Q. No Answer ALL questions Max. : 100 Marks 1 Prove that the number of vertices of odd degree in a graph is always even. 0 2 Define connected graph. 0 3 Draw complete graphs on 5 and 6 vertices. 0 4 Given an example of Hamiltonian graph, but not Euler graph. 0 5 Draw all possible non-isomorphic trees on six vertices. 0 6 Define center of a graph and find the centers of a circuit with 4 vertices. 0 7 Define a fundamental cut-set. 0 8 Differentiate vertex connectivity and edge connectivity. 0 9 Define a planar graph. 0 10 What is chromatic number? PART - B (5 x 8 = 40 Marks) Answer any FIVE questions 11 Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V ₁ and V ₂ such that there exists no edge in G whose one end vertex is in V ₁ and the other end in V ₂ . 12 Prove that a connected graph G is Euler if and only if it can be decomposed	*	LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034
UMT 5601 - GRAPH THEORYDate: 15-05-2023 Time: 01:00 PM - 04:00 PMMax. : 100 Marks Time: 01:00 PM - 04:00 PMPART - A(I0 x 2 = 10 Marks)Q. No/Answer ALL questions1Prove that the number of vertices of odd degree in a graph is always even.2Define connected graph.3Draw complete graphs on 5 and 6 vertices.4Given an example of Hamiltonian graph, but not Euler graph.5Draw all possible non-isomorphic trees on six vertices.6Define center of a graph and find the centers of a circuit with 4 vertices.7Define a fundamental cut-set.8Differentiate vertex connectivity and edge connectivity.9Define a planar graph.10What is chromatic number?PART - B(5 x 8 = 40 Marks)Answer any FIVE questions11Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 .12Prove that a connected graph G is Euler if and only if it can be decomposed into circuits.13Prove that a tree with n vertices has $(n - 1)$ edges.14With respect to a given spanning tree T, prove that a chord c_1 determines a fundamental circuit T which occurs in every fundamental cut-set associated with the branches in T and in no others.15Prove that the complete graph of five vertices is nonplanar.16Prove that the complete graph of five ver	K	B.Sc. DEGREE EXAMINATION – MATHEMATICS
Date: 15-05-2023 Time: Dept. No. Max. : 100 Marks PART - A (10 x 2 = 10 Marks) Q. No/Answer ALL questions 1 Prove that the number of vertices of odd degree in a graph is always even. 2 Define connected graph. 3 3 Draw complete graphs on 5 and 6 vertices. 4 Given an example of Hamiltonian graph, but not Euler graph. 5 Draw all possible non-isomorphic trees on six vertices. 6 Define center of a graph and find the centers of a circuit with 4 vertices. 7 Define a fundamental cut-set. 8 Differentiate vertex connectivity and edge connectivity. 9 Define a planar graph. 10 What is chromatic number? PART - B (5 x 8 = 40 Marks) Answer any FIVE questions 11 Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 . I 12 Prove that a connected graph G is Euler if and only if it can be decomposed into circuits. I I Prove that a tree with n vertices has $(n - 1)$ edges. <tr< th=""><th>2</th><th>FIFTH SEMESTER – APRIL 2023</th></tr<>	2	FIFTH SEMESTER – APRIL 2023
Time: 01:00 PM - 04:00 PM PART - A (10 x 2 = 10 Marks) Q.No,Answer ALL questions 1 Prove that the number of vertices of odd degree in a graph is always even. 2 2 Define connected graph. 3 3 Draw complete graphs on 5 and 6 vertices. 4 4 Given an example of Hamiltonian graph, but not Euler graph. 5 5 Draw all possible non-isomorphic trees on six vertices. 6 6 Define center of a graph and find the centers of a circuit with 4 vertices. 7 7 Define a fundamental cut-set. 8 8 Differentiate vertex connectivity and edge connectivity. 9 9 Define a planar graph. 10 10 What is chromatic number? 7 PART - B (5 x 8 = 40 Marks) Answer any FIVE questions 11 Prove that a graph <i>G</i> is disconnected if and only if its vertex set <i>V</i> can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in <i>G</i> whose one end vertex is in V_1 and the other end in V_2 . Prove that a connected graph <i>G</i> is Euler if and only if it can be decomposed into circuits. 13	Luci	UMT 5601 – GRAPH THEORY
Time: 01:00 PM - 04:00 PM PART - A (10 x 2 = 10 Marks) Q.No,Answer ALL questions 1 Prove that the number of vertices of odd degree in a graph is always even. 2 2 Define connected graph. 3 3 Draw complete graphs on 5 and 6 vertices. 4 4 Given an example of Hamiltonian graph, but not Euler graph. 5 5 Draw all possible non-isomorphic trees on six vertices. 6 6 Define center of a graph and find the centers of a circuit with 4 vertices. 7 7 Define a fundamental cut-set. 8 8 Differentiate vertex connectivity and edge connectivity. 9 9 Define a planar graph. 10 10 What is chromatic number? 7 PART - B (5 x 8 = 40 Marks) Answer any FIVE questions 11 Prove that a graph <i>G</i> is disconnected if and only if its vertex set <i>V</i> can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in <i>G</i> whose one end vertex is in V_1 and the other end in V_2 . Prove that a connected graph <i>G</i> is Euler if and only if it can be decomposed into circuits. 13		
PART – A(10 x 2 = 10 Marks)Q. No Answer ALL questions1Prove that the number of vertices of odd degree in a graph is always even.2Define connected graph.3Draw complete graphs on 5 and 6 vertices.4Given an example of Hamiltonian graph, but not Euler graph.5Draw all possible non-isomorphic trees on six vertices.6Define center of a graph and find the centers of a circuit with 4 vertices.7Define a fundamental cut-set.8Differentiate vertex connectivity and edge connectivity.9Define a planar graph.10What is chromatic number?PART – B(5 x 8 = 40 Marks)Answer any FIVE questions11Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 .12Prove that a connected graph G is Euler if and only if it can be decomposed into circuits.13Prove that a tree with n vertices has $(n - 1)$ edges.14With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit T which occurs in every fundamental cut-set associated with the branches in T and in no others.15Prove that the complete graph of five vertices is nonplanar.16Prove that every circuit has an even number of edges in common with any cut-set.17Explain the following graph operations with examples: intersection, union and ring sum.		
Q. No Answer ALL questions 1 Prove that the number of vertices of odd degree in a graph is always even. 2 Define connected graph. 3 Draw complete graphs on 5 and 6 vertices. 4 Given an example of Hamiltonian graph, but not Euler graph. 5 Draw all possible non-isomorphic trees on six vertices. 6 Define center of a graph and find the centers of a circuit with 4 vertices. 7 Define a fundamental cut-set. 8 Differentiate vertex connectivity and edge connectivity. 9 Define a planar graph. 10 What is chromatic number? PART – B (5 x 8 = 40 Marks) Answer any FIVE questions 11 Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 . 12 Prove that a connected graph G is Euler if and only if it can be decomposed into circuits. 13 Prove that a tree with n vertices has $(n - 1)$ edges. 14 With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit T which occurs in every fundamental cut-set associated with the branches in T and in no others.	111	
1 Prove that the number of vertices of odd degree in a graph is always even. 2 Define connected graph. 3 Draw complete graphs on 5 and 6 vertices. 4 Given an example of Hamiltonian graph, but not Euler graph. 5 Draw all possible non-isomorphic trees on six vertices. 6 Define center of a graph and find the centers of a circuit with 4 vertices. 7 Define a fundamental cut-set. 8 Differentiate vertex connectivity and edge connectivity. 9 Define a planar graph. 10 What is chromatic number? PART – B (5 x 8 = 40 Marks) Answer any FIVE questions 11 Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 . 12 Prove that a connected graph G is Euler if and only if it can be decomposed into circuits. 13 13 Prove that a tree with n vertices has $(n - 1)$ edges. 14 With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit T which occurs in every fundamental cut-set associated with the branches in T and in no others. 15 Prove that every circuit has an even		PART – A (10 x 2 = 10 Marks)
2 Define connected graph. 3 Draw complete graphs on 5 and 6 vertices. 4 Given an example of Hamiltonian graph, but not Euler graph. 5 Draw all possible non-isomorphic trees on six vertices. 6 Define center of a graph and find the centers of a circuit with 4 vertices. 7 Define a fundamental cut-set. 8 Differentiate vertex connectivity and edge connectivity. 9 Define a planar graph. 10 What is chromatic number? PART – B (5 x 8 = 40 Marks) Answer any FIVE questions 11 Prove that a graph <i>G</i> is disconnected if and only if its vertex set <i>V</i> can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in <i>G</i> whose one end vertex is in V_1 and the other end in V_2 . 12 Prove that a connected graph <i>G</i> is Euler if and only if it can be decomposed into circuits. 13 Prove that a tree with <i>n</i> vertices has $(n - 1)$ edges. 14 With respect to a given spanning tree <i>T</i> , prove that a chord c_i determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in <i>T</i> and in no others. 15 Prove that every circuit has an even number of edges in common with any cut-set. <	Q. No.	Answer ALL questions
3 Draw complete graphs on 5 and 6 vertices. 4 Given an example of Hamiltonian graph, but not Euler graph. 5 Draw all possible non-isomorphic trees on six vertices. 6 Define center of a graph and find the centers of a circuit with 4 vertices. 7 Define a fundamental cut-set. 8 Differentiate vertex connectivity and edge connectivity. 9 Define a planar graph. 10 What is chromatic number? PART – B (5 x 8 = 40 Marks) Answer any FIVE questions 11 Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 . 12 Prove that a connected graph G is Euler if and only if it can be decomposed into circuits. 13 Prove that a tree with n vertices has $(n-1)$ edges. 13 Prove that a tree with n vertices has $(n-1)$ edges. 14 With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit I which occurs in every fundamental cut-set associated with the branches in T and in no others. 15 Prove that the complete graph of five vertices is nonplanar. 16	1	Prove that the number of vertices of odd degree in a graph is always even.
4Given an example of Hamiltonian graph, but not Euler graph.5Draw all possible non-isomorphic trees on six vertices.6Define center of a graph and find the centers of a circuit with 4 vertices.7Define a fundamental cut-set.8Differentiate vertex connectivity and edge connectivity.9Define a planar graph.10What is chromatic number?PART – B (5 x 8 = 40 Marks)Answer any FIVE questions11Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 .12Prove that a connected graph G is Euler if and only if it can be decomposed into circuits.13Prove that a tree with n vertices has $(n - 1)$ edges.14With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit I which occurs in every fundamental cut-set associated with the branches in T and in no others.15Prove that the complete graph of five vertices is nonplanar.16Prove that every circuit has an even number of edges in common with any cut-set.17Explain the following graph operations with examples: intersection, union and ring sum.	2	Define connected graph.
5 Draw all possible non-isomorphic trees on six vertices. 6 Define center of a graph and find the centers of a circuit with 4 vertices. 7 Define a fundamental cut-set. 8 Differentiate vertex connectivity and edge connectivity. 9 Define a planar graph. 10 What is chromatic number? PART – B (5 x 8 = 40 Marks) Answer any FIVE questions 11 Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 . 12 Prove that a connected graph G is Euler if and only if it can be decomposed into circuits. 13 Prove that a tree with n vertices has $(n - 1)$ edges. 14 With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit T which occurs in every fundamental cut-set associated with the branches in T and in no others. 15 Prove that the complete graph of five vertices is nonplanar. 16 Prove that every circuit has an even number of edges in common with any cut-set. 17 Explain the following graph operations with examples: intersection, union and ring sum.	3	Draw complete graphs on 5 and 6 vertices.
6Define center of a graph and find the centers of a circuit with 4 vertices.7Define a fundamental cut-set.8Differentiate vertex connectivity and edge connectivity.9Define a planar graph.10What is chromatic number?PART - B (5 x 8 = 40 Marks)Answer any FIVE questions11Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 .12Prove that a connected graph G is Euler if and only if it can be decomposed into circuits.13Prove that a tree with n vertices has $(n-1)$ edges.14With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in T and in no others.15Prove that the complete graph of five vertices is nonplanar.16Prove that every circuit has an even number of edges in common with any cut-set.17Explain the following graph operations with examples: intersection, union and ring sum.	4	Given an example of Hamiltonian graph, but not Euler graph.
7 Define a fundamental cut-set. 8 Differentiate vertex connectivity and edge connectivity. 9 Define a planar graph. 10 What is chromatic number? PART – B (5 x 8 = 40 Marks) Answer any FIVE questions 11 Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 . 12 Prove that a connected graph G is Euler if and only if it can be decomposed into circuits. 13 Prove that a tree with n vertices has $(n - 1)$ edges. 14 With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in T and in no others. 15 Prove that the complete graph of five vertices is nonplanar. 16 Prove that every circuit has an even number of edges in common with any cut-set. 17 Explain the following graph operations with examples: intersection, union and ring sum.	5	Draw all possible non-isomorphic trees on six vertices.
8Differentiate vertex connectivity and edge connectivity.9Define a planar graph.10What is chromatic number?PART – B (5 x 8 = 40 Marks)Answer any FIVE questions11Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 .12Prove that a connected graph G is Euler if and only if it can be decomposed into circuits.13Prove that a tree with n vertices has $(n - 1)$ edges.14With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit I which occurs in every fundamental cut-set associated with the branches in T and in no others.15Prove that the complete graph of five vertices is nonplanar.16Prove that every circuit has an even number of edges in common with any cut-set.17Explain the following graph operations with examples: intersection, union and ring sum.	6	Define center of a graph and find the centers of a circuit with 4 vertices.
9Define a planar graph.10What is chromatic number?PART - B (5 x 8 = 40 Marks)Answer any FIVE questions11Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 .12Prove that a connected graph G is Euler if and only if it can be decomposed into circuits.13Prove that a tree with n vertices has $(n - 1)$ edges.14With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in T and in no others.15Prove that the complete graph of five vertices is nonplanar.16Prove that every circuit has an even number of edges in common with any cut-set.17Explain the following graph operations with examples: intersection, union and ring sum.	7	Define a fundamental cut-set.
10 What is chromatic number? PART – B (5 x 8 = 40 Marks) Answer any FIVE questions 11 Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 . 12 Prove that a connected graph G is Euler if and only if it can be decomposed into circuits. 13 Prove that a tree with n vertices has $(n - 1)$ edges. 14 With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in T and in no others. 15 Prove that the complete graph of five vertices is nonplanar. 16 Prove that every circuit has an even number of edges in common with any cut-set. 17 Explain the following graph operations with examples: intersection, union and ring sum.	8	Differentiate vertex connectivity and edge connectivity.
PART - B(5 x 8 = 40 Marks)Answer any FIVE questions11Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 .12Prove that a connected graph G is Euler if and only if it can be decomposed into circuits.13Prove that a tree with n vertices has $(n - 1)$ edges.14With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in T and in no others.15Prove that the complete graph of five vertices is nonplanar.16Prove that every circuit has an even number of edges in common with any cut-set.17Explain the following graph operations with examples: intersection, union and ring sum.	9	Define a planar graph.
Answer any FIVE questions11Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in V_1 and the other end in V_2 .12Prove that a connected graph G is Euler if and only if it can be decomposed into circuits.13Prove that a tree with n vertices has $(n-1)$ edges.14With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in T and in no others.15Prove that the complete graph of five vertices is nonplanar.16Prove that every circuit has an even number of edges in common with any cut-set.17Explain the following graph operations with examples: intersection, union and ring sum.	10	What is chromatic number?
 Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two nonempty disjoint subsets V₁ and V₂ such that there exists no edge in G whose one end vertex is in V₁ and the other end in V₂. Prove that a connected graph G is Euler if and only if it can be decomposed into circuits. Prove that a tree with n vertices has (n - 1) edges. With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in T and in no others. Prove that the complete graph of five vertices is nonplanar. Prove that every circuit has an even number of edges in common with any cut-set. Explain the following graph operations with examples: intersection, union and ring sum. 		PART – B (5 x 8 = 40 Marks)
Image: Prove that a connected graph G is Euler if and only if it can be decomposed into circuits.12Prove that a connected graph G is Euler if and only if it can be decomposed into circuits.13Prove that a tree with n vertices has $(n - 1)$ edges.14With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in T and in no others.15Prove that every circuit has an even number of edges in common with any cut-set.17Explain the following graph operations with examples: intersection, union and ring sum.	Answ	er any FIVE questions
V1 and the other end in V2. 12 Prove that a connected graph G is Euler if and only if it can be decomposed into circuits. 13 Prove that a tree with n vertices has (n – 1) edges. 14 With respect to a given spanning tree T, prove that a chord ci determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in T and in no others. 15 Prove that the complete graph of five vertices is nonplanar. 16 Prove that every circuit has an even number of edges in common with any cut-set. 17 Explain the following graph operations with examples: intersection, union and ring sum.	11	Prove that a graph G is disconnected if and only if its vertex set V can be partitioned into two
 Prove that a connected graph <i>G</i> is Euler if and only if it can be decomposed into circuits. Prove that a tree with <i>n</i> vertices has (<i>n</i> – 1) edges. With respect to a given spanning tree <i>T</i>, prove that a chord <i>c_i</i> determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in <i>T</i> and in no others. Prove that the complete graph of five vertices is nonplanar. Prove that every circuit has an even number of edges in common with any cut-set. Explain the following graph operations with examples: intersection, union and ring sum. 		nonempty disjoint subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in
 13 Prove that a tree with <i>n</i> vertices has (<i>n</i> – 1) edges. 14 With respect to a given spanning tree <i>T</i>, prove that a chord <i>c_i</i> determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in <i>T</i> and in no others. 15 Prove that the complete graph of five vertices is nonplanar. 16 Prove that every circuit has an even number of edges in common with any cut-set. 17 Explain the following graph operations with examples: intersection, union and ring sum. 		V_1 and the other end in V_2 .
 Prove that a tree with <i>n</i> vertices has (<i>n</i> – 1) edges. With respect to a given spanning tree <i>T</i>, prove that a chord <i>c_i</i> determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in <i>T</i> and in no others. Prove that the complete graph of five vertices is nonplanar. Prove that every circuit has an even number of edges in common with any cut-set. Explain the following graph operations with examples: intersection, union and ring sum. 		
 14 With respect to a given spanning tree <i>T</i>, prove that a chord <i>c_i</i> determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in <i>T</i> and in no others. 15 Prove that the complete graph of five vertices is nonplanar. 16 Prove that every circuit has an even number of edges in common with any cut-set. 17 Explain the following graph operations with examples: intersection, union and ring sum. 	12	Prove that a connected graph <i>G</i> is Euler if and only if it can be decomposed into circuits.
 14 With respect to a given spanning tree <i>T</i>, prove that a chord <i>c_i</i> determines a fundamental circuit Γ which occurs in every fundamental cut-set associated with the branches in <i>T</i> and in no others. 15 Prove that the complete graph of five vertices is nonplanar. 16 Prove that every circuit has an even number of edges in common with any cut-set. 17 Explain the following graph operations with examples: intersection, union and ring sum. 		
which occurs in every fundamental cut-set associated with the branches in T and in no others.15Prove that the complete graph of five vertices is nonplanar.16Prove that every circuit has an even number of edges in common with any cut-set.17Explain the following graph operations with examples: intersection, union and ring sum.	13	Prove that a tree with <i>n</i> vertices has $(n - 1)$ edges.
15 Prove that the complete graph of five vertices is nonplanar. 16 Prove that every circuit has an even number of edges in common with any cut-set. 17 Explain the following graph operations with examples: intersection, union and ring sum.	14	With respect to a given spanning tree T, prove that a chord c_i determines a fundamental circuit Γ
 16 Prove that every circuit has an even number of edges in common with any cut-set. 17 Explain the following graph operations with examples: intersection, union and ring sum. 		which occurs in every fundamental cut-set associated with the branches in T and in no others.
17 Explain the following graph operations with examples: intersection, union and ring sum.	15	Prove that the complete graph of five vertices is nonplanar.
	16	Prove that every circuit has an even number of edges in common with any cut-set.
18 Show that every tree with two or more vertices is 2-chromatic.	17	Explain the following graph operations with examples: intersection, union and ring sum.
	18	Show that every tree with two or more vertices is 2-chromatic.

PART – C Answer any TWO questions. (2 X 20 = 40 Marks)				
19				
17	<i>(a)</i>		(10)	
	(1-)	degree.	(10)	
	(b)	Show that a simple graph with <i>n</i> vertices and <i>k</i> components can have at most $\binom{n-k}{n-k+1}$	(10)	
		$\frac{(n-k)(n-k+1)}{2}$ edges.		
20	(a)	Prove that every tree has either one or two centers.	(10	
	(b)	If <i>n</i> is an odd number and $n \ge 3$, prove that in a complete graph with <i>n</i> vertices there	(10	
		are $(n-1)/2$ edge-disjoint Hamiltonian circuits.		
21	(a)	Prove that the ring sum of any two cut-sets in a graph is either a third cut-set or an	(10	
		edge disjoint union of cut-sets.		
	(b)	Prove that a connected planar graph with <i>n</i> vertices and <i>e</i> edges has $e - n + 2$ regions.	(10	
22	(a)	Explain the digraph and write down the advantages and disadvantages over an	(10	
		undirected graph.	•	
	(b)	Show that a graph with at least one edge is 2-chromatic if and only if it has no circuits	(10	
		of odd length.		
		#######################################		