

**END-SEMESTER EXAMINATION, JULY-2023**  
**CALCULUS - B (MTH-2101)**

**Programme: B. Tech**

**Full Marks: 60**

**Semester: 2<sup>nd</sup>**

**Time: 3 Hours**

Subject/Course Learning Outcome	*Taxonomy Level	Ques. Nos.	Marks
Determine the distances, volume, equations of spheres, lines, and planes using vector operations in space.	L3	1. a, b, c, 2. a, b, c, 3. a	2,2,2 2,2,2 2
Compute the length of a curve, curvature, tangent, and normal vectors.	L3	3. b, c, 4. a, b, c	2,2 2,2,2
Determine limit, derivatives, directional derivatives, maxima/minima, and Jacobian of a function of two or several variables.	L3	5. a, b, c.	2,2,2
Apply the computational and conceptual principles of calculus to the solution of double and triple integrals.	L3	5.a,b 6.b,c 7.c	2,2 2,2 2
Use Green's theorem to compute line integrals in terms of double integrals.	L3	5.c 6.a 7.a,b 9.c	2 2 2,2 2
Apply the most important theorems of vector calculus, such as the curl, divergence, and Stoke's theorems to simplify integration problems.	L3	8.a,b,c 9.a,b	2,2,2 2,2

\*Bloom's taxonomy levels: Remembering (L1), Understanding (L2), Applying (L3), Analysing (L4), Evaluating (L5), Creating (L6)

**Answer all questions. Each question carries equal mark.**

- 1 (a) Determine an equation of the largest sphere with [2] centre  $(5,4,9)$  that is contained in the first octant.
- (b) Determine the centre and radius of the sphere [2]  

$$2x^2 + 2y^2 + 2z^2 = 8x - 24z + 1.$$
- (c) For the scalar field  $u = \frac{x^3}{4} + \frac{y^3}{5}$ , calculate magnitude [2] of the gradient at the point  $(1,3)$ .
- 2 (a) Calculate the directional derivative of [2]  $f(x,y,z) = xy^2 + yz^2 + zx^2$  at the point  $P(2,-1,1)$  in the direction of the vector  $\langle 1,2,2 \rangle$ .
- (b) Determine the area of the triangle with vertices [2]  $K(1,2,3), L(1,3,6), M(3,8,6)$ .
- (c) Compute the distance from the point  $(-6,3,5)$  to the [2] plane  $x - 2y - 4z = 8$ .
- 3 (a) Determine the point where the curve [2]  $\vec{r}(t) = \langle t, 0, 2t - t^2 \rangle$  intersects the paraboloid  $z = x^2 + y^2$ .
- (b) Determine  $\vec{r}(t)$  if  $\vec{r}'(t) = \langle t, e^t, te^t \rangle$  and [2]  

$$\vec{r}(0) = \langle 1, 1, 1 \rangle.$$
- (c) A ball is thrown at an angle of  $45^\circ$  to the ground. If [2] the ball lands  $90m$  away, then determine the initial speed of the ball.
- 4 (a) Determine the tangential component of the [2] acceleration vector where  $\vec{r}(t) = \langle 3t - t^3, 3t^2 \rangle$ .
- (b) Compute  $\lim_{(x,y) \rightarrow (0,0)} \frac{xy}{\sqrt{x^2 + y^2}}$ , if it exists, or show that [2] the limit does not exist.
- (c) Determine  $\frac{\partial^3 z}{\partial u \partial v \partial w}$  of the function  $z = u\sqrt{v-w}$ . [2]
- 5 (a) If  $z = x^2 - xy + 3y^2$  and  $(x,y)$  changes from  $(3,-1)$  [2] to  $(2.96, -0.95)$ , then compare between  $\Delta z$  and  $dz$ .

- (b) Determine the Curl and divergent of the vector [2] function  $\langle -y, x, 0 \rangle$ .
- (c) Determine  $\nabla \cdot (\nabla \times \vec{V})$ , where  $\vec{V} = 3yz\hat{i} + 4xz\hat{j} + 2xy\hat{k}$ . [2]
- 6 (a) Determine the equation of the normal line to the [2] surface  $x + y + z = e^{xyz}$  at the point  $(0,0,1)$ .
- (b) Compute the local maximum and minimum values [2] and saddle point of the function  $f(x,y) = xy + \frac{1}{x} + \frac{1}{y}$ .
- (c) Compute the three positive numbers whose sum is 100 [2] and whose product is a maximum.
- 7 (a) Calculate the iterated integral  $\int_0^1 \int_0^1 \frac{x-y}{(x+y)^3} dx dy$ . [2]
- (b) Calculate the double integral  $\iint_R \frac{xy^2}{x^2+1} dA$ , [2] where  $R = \{(x,y) | 0 \leq x \leq 1, -3 \leq y \leq 3\}$ .
- (c) Compute the volume of the solid enclosed by the [2] surface  $z = 1 + e^x \sin y$  and the planes  $x = \pm 1, y = 0, y = \pi$ , and  $z = 0$ .
- 8 (a) Determine the double integral [2]  

$$\iint_D x dA, D = \{(x,y) | 0 \leq x \leq \pi, 0 \leq y \leq \sin x\}.$$
- (b) Sketch the region whose area is given by the integral [2]  

$$\int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \int_0^3 r dr d\theta$$
 and determine the integral.
- (c) Compute  $\iint_D e^{-x^2-y^2} dA$ , where  $D$  is the region [2] bounded by the semicircle  $x = \sqrt{4-y^2}$  and the  $y$ -axis.
- 9 (a) Use triple integral to determine the volume of the [2] solid enclosed by the paraboloids  $y = x^2 + z^2$  and

$$y = 8 - x^2 - z^2.$$

- (b) Compute the line integral [2]  
 $\int_C y^3 ds, \quad C: x = t^3, y = t, \quad 0 \leq t \leq 3.$
- (c) Determine the line integral  $\int_C \langle xy, 3y^2 \rangle \cdot d\vec{r}$ , where. [2]  
 $C: \vec{r}(t) = 10t^4 i + 3t^3 j, \quad 0 \leq t \leq 1.$
- 10 (a) Determine a function  $f$  such that  $\vec{F} = \vec{\nabla}f = \langle x^2, y^2 \rangle$  [2]  
and use it to compute  $\int_C (x^2 \hat{i} + y^2 \hat{j}) \cdot d\vec{r}$ , where  $C$  is  
the parabola  $y = 2x^2$  from  $(1, 2)$  to  $(2, 8)$ .
- (b) Use Green's Theorem to determine the line integral [2]  
 $\oint_C xy^2 dx + x^2 y dy$  where  $C$  is the closed curve defined  
by the circle  $x^2 + y^2 = 1$  oriented anti-clockwise.
- (c) Use Stoke's theorem to determine [2]  
 $\iint_S \text{curl}(\langle 2y \cos z \hat{i} + e^x \sin z \hat{j} + xe^y \hat{k} \rangle) \cdot d\vec{s}$ , where  $S$   
is the hemisphere  $x^2 + y^2 + z^2 = 9, \quad z \geq 0$  oriented  
upward.

\* \* \*

**END SEMESTER EXAMINATION, JULY-2023**  
**DATA STRUCTURE AND ALGORITHMS (CSE 2001)**

**Programme: B.Tech.**  
**Full marks: 60**

**Semester: 2<sup>nd</sup>**  
**Time: 3 hours**

Subject Learning Outcome	*Taxonomy Level	Question Number	Marks
Ability to state and explain the basic programming syntax, semantics, building blocks.	L1, L2	2(a,b,c) 3a, 4c, 6a	12
Ability to develop java programs using programming constructs like conditional statements, looping, array, methods and class.	L1, L2, L3	3(b,c), 4(a,b) 5(a,b,c)	14
Ability to analyze, debug and test the programs and correctly predict their outputs.	L2, L3	1(a,b,c)	6
Ability to differentiate the behaviors of different data structures and their memory representations.	L3, L4	6(b,c), 7(a,b), 8a, 9(b,c)	14
Ability to choose appropriate data structures that efficiently model the problem of interest.	L3, L4	7c, 8(b,c), 9a	8
Ability to apply advanced programming techniques for developing solutions of different problems.	L3, L4	10(a,b,c)	6

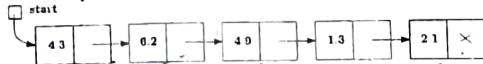
\* Bloom's taxonomy levels: Knowledge (L1), Comprehension (L2), Application (L3), Analysis (L4), Evaluation (L5), Creation (L6)

**Answer all questions. All questions carry equal marks. All bits of each question carry equal marks.**

1. (a) Find the output of the given code snippet for the method call *abc(10)*. [2]

```
public static void abc(int n) {
    if (n==0)
        return;
    abc(n-=2);
    System.out.print(n+" ");
}
```

- (b) Find output of the given code snippet referring to the given figure.



```
double s=0.0;
for(node p=start;p.next!=null;p=p.next){
    System.out.println(p.info);s=s+p.info;}
System.out.println(s); [2]
```

- (c) Find Big-Oh( $O$ ) notation for the given code snippet.

```
sum=0;
for(i=0;i<n;i++)
    for(j=0;j<=i;j++)
        sum++; [2]
```

2. (a) Why main method is static? Explain. [2]

- (b) Can you have private constructors (yes/no)? If yes then how it can be accessed? If no then discuss why? [2]

- (c) Consider the statements P and Q below and explain which one is correct or incorrect with proper reason.

P: Abstract class can be initiated by new operator.

Q: Abstract class can't have constructor and static methods. [2]

3. (a) How parameterized constructors are accessed in inheritance? Explain with suitable example. [2]

- (b) Write a Java program to design a package that contains two classes Student & Test. The Student class has data members as name, roll and instance methods input() & output(). Similarly the Test class has data members as mark1, mark2 and instance methods input(), output(). Student is extended by Test. Another package carry interface Sports with 2 attributes score1, score2. Find grand total mark & score in another class. [2]

- (c) Create a class Student having instance variables name, mark and instance methods input() and display(). Write a Java program to input the details of a student and display it. If mark is less than zero or more than hundred then your program should throw an exception MarksOutOfBoundsException and print a customized message "Invalid Marks". [2]

4. (a) Write a Java program that outputs all possible strings formed by using the character 'S', 'P', 'Y' exactly once. [2]

- (b) Write a Java method using recursion to find binary equivalent of a +ve integer. [2]

- (c) For the Question no. 4(b) draw the recursive trace.. [2]

5. (a) Write a Java program using recursion that takes all the lines input to standard input and writes them to standard output in reverse order. That is, each line is output in the correct order, but the ordering of the lines is reversed. [2]

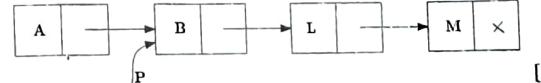
- (b) Write a java method using Generics to count the occurrence of an element in an array of any type. The signature of count method is given below. `public static int count(T[] array, T item)` [2]

- (c) Create an interface Shape with an abstract method area() and the implementer classes Square, Triangle and Circle. Write a Java program to display area of different shapes. Add the required instance variables, appropriate constructors and a display() method in the above three classes. [2]

6. (a) What is a linked list? What are its advantages over array? [2]

- (b) For a single linked list identified by the reference start, write the condition for linked list is empty and write the condition for linked list containing exactly one node. [2]

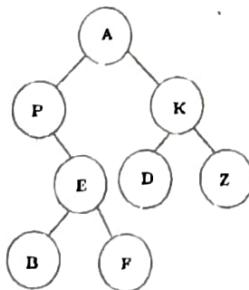
- (c) For the given single linked list, write Java statements to insert a new node after the node referenced by P.



7. (a) Write a Java method to count number of odd element present in the linked list. [2]

- (b) Given single linked list; write a Java method to delete the first node. [2]

- (c) What is the value of top and stack[top] after the following operations performed in array representation of a stack. Consider stack size is 5. push (1), push (2), push(3),pop(),push(4),push(5), pop(), push(6),push(7),push(8),push(9),pop(),pop(),pop(). [2].
8. (a) Write the Java methods to perform pop operations in a stack using Linked List. [2]  
 (b) Convert the following infix expression to post-fix using stack.  $A+B-(C*D^E/F)+G$  [2]  
 (c) If the index of the parent node is 13, what will be the index of its left child and right child in an array based memory representation of a Binary tree. [2]
9. (a) Evaluate the following postfix expression.  $10,5,2,7, -, *, 3, 8, 3, /, +, +, -$  [2]  
 (b) Write a Java method to perform insertion operation in a linear queue using linked list. [2].  
 (c) Write a Java method to perform deletion operation in a linear queue using array. [2].
10. (a) For the given Binary tree find height and depth of node 'P'. Mention whether it is a almost complete binary tree or not if not convert it to a almost complete binary tree with same number of nodes with minimum modification. [2]



- (b) Draw a binary search tree by inserting the following elements in the sequence given below. (Initially tree is empty.)  
~~55,33,88,44,66,77,11,22,99,63,39,12.~~ [2]
- (c) Find the in-order and post-order traversal of the binary tree that you have constructed in Question no. 10(b). [2]

# END SEMESTER EXAMINATION, JULY - 2023

## Principles of Microeconomics (HSS1021)

**Programme: B.Tech**  
**Full Marks: 60**

**Semester: 2nd**  
**Time: 3 Hours**

Subject/Course Learning Outcome	*Taxonomy Level	Ques. Nos.	Marks
CO-1: Be able to apply various economic concepts, principles, and models, to take rational economic decisions.	L3 & L4	1 & 2	12
CO-2: Be able to analyze how demand and supply determine the price and quantity, both in product and factor markets.	L3 & L4	3 & 4	12
CO-3: Be able to analyze the responsiveness of quantity demanded and quantity supplied of a commodity to change in various factor(s) influencing it, through demand and supply elasticity.	L3	5	6
CO-4: Be able to analyze the impact of various government policies such as price ceiling, price floor, and tax on the market outcome and its role in the provision of public good and correcting externalities.	L3	6 & 8(b) (c)	10
CO-5: Be able to apply the concept of consumer surplus and producer surplus to analyze how the allocation of resources through market mechanisms affects economic well-being.	L3 & L4	7,8(a) & 9	14
CO-6: Be able to analyze how profit maximizing price and output are determined under different market structures, considering revenue and cost conditions.	L3	10	6

**\*Bloom's taxonomy levels: Remembering (L1), Understanding (L2), Applying (L3), Analysing (L4), Evaluating (L5), Creating (L6)**

**Answer all questions. Each question carries equal mark.**

1.	(a)	Rajnandan has Rs. 500 left over this week and he wants to contribute to a charitable cause. With Rs. 50, Rajnandan can feed one homeless person one meal. With Rs. 100, he can provide shelter for one homeless person one night. What is the opportunity cost of Rajnandan using all his money to shelter homeless people?	2														
	(b)	You like the movie "Adipurish" and want to visit the movie as many times as possible. The total satisfaction derived from watching movie is given in the following table.  <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>No of times watch the Movie</td> <td>1<sup>st</sup></td> <td>2<sup>nd</sup></td> <td>3<sup>rd</sup></td> <td>4<sup>th</sup></td> <td>5<sup>th</sup></td> <td>6<sup>th</sup></td> </tr> <tr> <td>Total Satisfaction</td> <td>400</td> <td>700</td> <td>950</td> <td>1170</td> <td>1270</td> <td>1300</td> </tr> </table> If the cost of watching movie each time is Rs. 220/-, then How many times you will watch the Movie?	No of times watch the Movie	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	Total Satisfaction	400	700	950	1170	1270	1300	2
No of times watch the Movie	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>											
Total Satisfaction	400	700	950	1170	1270	1300											
	(c)	Suppose the government increases tax on cigarettes. As a result the teenage smoking rate has reduced. Analyse the situation by stating the relevant basic principles of economics.	2														

2.	India wants to produce 2 commodities, shoes & sandals. Utilizing 1000 labour hours available with it. Various alternatives of production of shoes & sandals are given in the following table.							
	Production Alternatives	A	B	C	D	E		
	Shoes (No)	0	150	250	375	500		
	Sandals (No)	100	70	50	25	0		
	(a) Using the information given in the above table draw a production possibilities frontier (PPF)?	2						
	(b) Compute the opportunity cost per unit of production of shoes at each possibility given is the above table.	2						
	(c) Assuming that the labour increases from 1000 labour hours to 2000 labour hours. Analyse the situation with the help of the PPF.	2						
3.	The quantity demanded and supplied for Tropicana Juice per day in Angul city is given in following table.							
	Price (Rs)	0	20	40	60	80	100	120
	Demand (No's)	240	200	160	120	80	40	0
	Supply (No's)	0	40	80	120	160	200	240
	(a) Draw the demand and supply graph and show the market equilibrium price and quantity.	2						
	(b) Graphically analyze the market situation if the actual price of Tropicana Juice is Rs.100/- . What will be the quantity demanded and supplied?	2						
	(c) Graphically analyze what will happen to the price and quantity demanded and supplied of Tropicana Juice, if the price of Real Juice decreases (the competitor of Tropicana Juice) and at the same time price of sugar increases.	2						
4.	The supply and demand function for labour in the Cuttack city is given below: $Q_d^L = 160 - 2W$ and $Q_s^L = (-)20 + 4W$ , Where $Q_d^L$ = Quantity demanded of labour, $Q_s^L$ = Quantity supplied of labour, and $W$ = Wage rate.							
	(a) Graphically represent the demand and supply functions of labour and Compute the Quantity demanded of labour, Quantity supplied, and Wage rate of labour in the Cuttack city.	2						
	(b) Graphically analyse the labour market situation if the actual wage rate of labour is Rs.20/. Determine its impact on the wage rate?	2						
	(c) A competitive firm sells its output for Rs.20 per unit. The marginal product of the 5 <sup>th</sup> worker is 10 units of output per day and the marginal product of the 6 <sup>th</sup> worker is 7 units of output per day. The firm pays its worker a wage of Rs. 150 per day. Find out how many workers the firm will employ?	2						
5.	(a) The demand for apple in a small town was 200kg, when the price was Rs. 20 per kg. It expanded to 250 kg when the price was reduced to Rs. 18 per kg. Using mid-point method calculate the price elasticity of demand for apples in the town?	2						
	(b) The cross price elasticity between frozen yogurt and ice-cream is estimated at 0.80. What does it imply about the relationship between frozen yogurt and ice-cream? If the price of frozen Yogurt increases by 10%, what will be its effect on the quantity demanded of Ice-cream.	2						

6.	(c) Draw the demand curve for the perfectly inelastic demand. If the price of the product increases by 50%, find out how much change in quantity demanded takes place?	2																								
	Suppose the market demand and supply function for Coffee per day in Hyderabad city is given as $Q^d = 150 - 5P$ and $Q^s = (-) 70 + 5P$ , Where $Q^d$ , $Q^s$ and $P$ refers to quantity demanded, quantity supplied and price (Rs.) respectively.																									
	(a) Compute the market equilibrium price, quantity of Coffee demanded and supplied when no tax is imposed.	2																								
	(b) Suppose the Government imposes a goods and services tax (GST) of Rs.4 on per cup of Coffee, find out the price paid by the buyer ( $P_b$ ), price received by the seller ( $P_s$ ) and the quantity of Coffee demanded and supplied after imposition of tax.	2																								
	(c) Compute the tax revenue collected by the Government and the dead weight loss (DWL).	2																								
7.	Suppose the market for almonds in a small closed economy is depicted by the following domestic demand and supply function, $Q^d = 420 - 2P$ , $Q^s = (-) 30 + 3P$ ; where $Q$ is the quantity and $P$ is the price.																									
	(a) Using a well labeled demand and supply diagram compute the consumer's surplus, producer's surplus and total surplus at equilibrium.	2																								
	(b) Barsha bought a mobile phone for Rs. 15,000 and received a consumer surplus of Rs. 2800. What was her willingness to pay? If she would have purchased the mobile phone at Rs. 12,500 during the annual clearance sale of the store what would have been her consumer surplus?	2																								
	(c) The demand function for Orio Biscuits in Bhubaneswar market is given as $Q^d = 150 - 5P$ . If market price for Orio Biscuit is Rs. 20 calculate the consumer surplus. When the price of Orio Biscuit falls to Rs. 10 per packet find out the consumer's surplus at the new market price.	2																								
8.	(a) Assume a country can adopt any one tax system out of three as given in the following table. If the country decided to adopt progressive tax system from equity point of view, compute the amount of tax paid by the tax payers under different income levels.	2																								
	<table border="1"> <thead> <tr> <th rowspan="2">Tax rate (%)</th> <th colspan="4">Income Level (Rs.)</th> </tr> <tr> <th>7,50,000</th> <th>12,00,000</th> <th>15,00,000</th> <th>20,00,000</th> </tr> </thead> <tbody> <tr> <td>Tax System A</td> <td>10</td> <td>15</td> <td>20</td> <td>25</td> </tr> <tr> <td>Tax System B</td> <td>15</td> <td>15</td> <td>15</td> <td>15</td> </tr> <tr> <td>Tax System C</td> <td>15</td> <td>12</td> <td>10</td> <td>8</td> </tr> </tbody> </table>	Tax rate (%)	Income Level (Rs.)				7,50,000	12,00,000	15,00,000	20,00,000	Tax System A	10	15	20	25	Tax System B	15	15	15	15	Tax System C	15	12	10	8	
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Tax System A	10	15	20	25																						
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	(b) The market demand and supply functions for electronic toy in Nuapada market are given as $Q^d = 60 - 5P$ and $Q^s = (-)20 + 5P$ , where $Q^d$ & $Q^s$ refer to number of electronic toys demanded and supplied respectively and $P$ refers to price (Rs.) per electronic toy. In order to augment revenue, Government decided to impose sales tax of Rs. 2/- per toy on seller. Compute the dead weight loss arising out of this tax on seller.	2																								

	(a)	Government thinks of increasing the tax revenue by increasing the sales tax from Rs. 2 per toy to Rs. 6 per toy. Will government be able to achieve its objective of increasing tax revenue by increasing the tax on toys? For this, use the demand and supply functions of toys given in (b) above, i.e., $Q^D = 60 - 5P$ and $Q^S = (-)20 + 5P$ , where $Q^D$ & $Q^S$ refer to number of electronic toys demanded and supplied and P refers to price (Rs.) per electronic toy.	2																					
9.		The domestic demand and supply of herbal tea in India are given as $Q^d = 16000 - 20P$ and $Q^s = 20P$ where $Q^d$ , $Q^s$ and P are the quantity demanded quantity supplied and price (Per kg) respectively.																						
	(a)	Find out the domestic price of herbal tea (Per kg) and Calculate the quantity demanded, quantity supplied at this price.	2																					
	(b)	If the world price of herbal tea is Rs. 200 per kg. Find out the quantity of herbal tea imported by the country.	2																					
	(c)	Graphically analyze the welfare effects of free trade using the concepts of consumer surplus (CS), producer surplus (PS) and total surplus (TS).	2																					
10	(a)	The following details given relating to total number of labourers employed by Amool dairy cooperative and different amount of milk powder produced in a day. Compute Average Productivity of Labour (APL) at each day of production.	2																					
		<table border="1"> <thead> <tr> <th>Day</th><th>Mon</th><th>Tue</th><th>Wed</th><th>Thu</th><th>Fri</th><th>Sat</th></tr> </thead> <tbody> <tr> <td>Total number of laborers employed</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr> <tr> <td>Total kg of milk powder produced</td><td>200</td><td>350</td><td>450</td><td>500</td><td>530</td><td>540</td></tr> </tbody> </table>	Day	Mon	Tue	Wed	Thu	Fri	Sat	Total number of laborers employed	1	2	3	4	5	6	Total kg of milk powder produced	200	350	450	500	530	540	
Day	Mon	Tue	Wed	Thu	Fri	Sat																		
Total number of laborers employed	1	2	3	4	5	6																		
Total kg of milk powder produced	200	350	450	500	530	540																		
	(b)	The following cost information is given relating to different levels of ball-pen produced by Reynolds. Compute Total Fixed Cost at each level of ball-pen produced by Reynolds.	2																					
		<table border="1"> <tbody> <tr> <td>Total number of ball-pen produced</td><td>1000</td><td>2000</td><td>3000</td><td>4000</td><td>5000</td></tr> <tr> <td>Total Cost (Rs)</td><td>2000</td><td>3000</td><td>4000</td><td>5000</td><td>6000</td></tr> <tr> <td>Total Variable Cost (Rs)</td><td>1500</td><td>2500</td><td>3500</td><td>4500</td><td>5500</td></tr> </tbody> </table>	Total number of ball-pen produced	1000	2000	3000	4000	5000	Total Cost (Rs)	2000	3000	4000	5000	6000	Total Variable Cost (Rs)	1500	2500	3500	4500	5500				
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Total Cost (Rs)	2000	3000	4000	5000	6000																			
Total Variable Cost (Rs)	1500	2500	3500	4500	5500																			
	(c)	Celesty, an ice-cream producing company is able to produce 2000 cups of ice-cream by engaging 10 labourers in a day. If the wage rate per labour is Rs 1000/- in a day and the company has total fixed cost of Rs 5000 per day, then estimate the total cost of producing 2000 cup of ice-cream by Celesty.	2																					
		<b>*End of Questions*</b>																						

**END SEMESTER EXAMINATION, JULY-2023**  
**University Physics: Electricity & Magnetism (PHY 2001)**

**Programme: B.Tech**  
**Full Marks: 60**

**Semester: 2nd**  
**Time: 3 Hours**

Subject/Course Learning Outcome	*Taxonomy Level	Ques. Nos.	Marks
<b>CO-1:</b> Able to comprehend Laws of electricity and magnetism Electromagnetic waves, active components of dc and ac circuits.	L <sub>1</sub> , L <sub>2</sub>	1(a),2(a),3(a), 4(a),5(a),6(a), 7 (a), 8 (a)	16
<b>CO-2:</b> Able to apply theoretical concepts and laws of electricity & magnetism to solve problems related to circuits analysis, electromagnetic theory and relevant engineering applications.	L <sub>2</sub> , L <sub>3</sub>	1(b), 2(b), 3(b), 4(b),5(b),6 (c), 7(b)	14
<b>CO-3:</b> Able to apply the fundamental laws of electromagnetism to give appropriate solutions to complex problems, design experiments and circuits, design small electrical equipments related to day to day life.	L <sub>2</sub> , L <sub>3</sub>	1(c), 2(c), 3(c), 4(c),5(c), 6 (b),7 (c),	14
<b>CO-4:</b> Able to apply the concepts of electromagnetism to conduct the experiments, acquire data in order to explore physical principles, effectively communicate the results and critically analyze & interpret the observed data related to scientific/engineering studies.	L <sub>2</sub> , L <sub>3</sub> , L <sub>4</sub>	9 (a),10 (a)	4
<b>CO-5:</b> Able to apply the concepts of electromagnetic force, electromagnetic wave to select and apply appropriate technique to design small engineering tools.	L <sub>2</sub> , L <sub>3</sub> , L <sub>4</sub>	8 (b), 8 (c),9 (b), 9(c)	8
<b>CO-6:</b> Able to apply the concepts of use of circuit elements in dc and ac electrical circuits analyze their effects and response to various electromagnetic fields and can assess the safety measures.	L <sub>2</sub> , L <sub>3</sub> , L <sub>4</sub>	10 (b), 10 (c)	4

\*Bloom's taxonomy levels: Remembering (L1), Understanding (L2), Applying (L3), Analysing (L4), Evaluating (L5), Creating (L6)

**Answer all questions. Each question carries equal mark.**

1. (a) Evaluate the potential energy of an electric dipole in a uniform external electric field. 2
- (b) An electric dipole is in a uniform electric field of magnitude  $5 \times 10^5 \text{ N/C}$ . The charges are  $\pm 1.6 \times 10^{-19} \text{ C}$  each and are separated by  $0.125 \text{ nm}$ . Find the magnitude of the potential energy of the dipole if it makes an angle  $145^\circ$  with the direction of electric field. 2
- (c) An electric dipole is placed in a region of uniform electric field  $E$ , with the electric dipole moment  $p$ , pointing in the direction opposite to  $E$ . Is the dipole (i) in stable equilibrium (ii) in unstable equilibrium (iii) neither? Justify. 2
2. (a) A charged non-conducting sphere of radius  $R$  has a total positive charge  $q$ . Find the electric field at any point inside the sphere. 2
- (b) A solid non-conducting sphere with radius  $0.45 \text{ m}$  carries a net charge of  $0.25 \text{ nC}$ . Find the magnitude of the electric field at a point  $0.1 \text{ m}$  inside and outside the surface of the sphere. 2
- (c) An amount of charge 'Q' is placed on an irregularly shaped conductor. Can it be possible to calculate the electric field at an arbitrary position outside the conductor applying the Gauss law if the shape and size of the conductor is known? Justify your answer. 2
3. (a) Derive an expression for electric field in terms of potential gradient. 2
- (b) A small particle has charge  $-5 \mu\text{C}$  and mass  $2 \times 10^{-4} \text{ kg}$ . It moves from point 'A' where the electric potential is  $V_A = +200\text{V}$ , to point 'B' where the electric potential is  $V_B = +800\text{V}$ . The electric force is the only force acting on the particle. The particle has speed  $5\text{m/s}$  at point 'A'. What is its speed at point 'B'? Is it moving faster or slower at 'B' than at 'A'? Explain. 2
- (c) If the electric potential at a certain point is zero, does the electric field at that point have to be zero? 2
4. (a) Derive an expression for energy density of a capacitor having Capacitance 'C', Cross sectional Area of each plate 'A' and Separation between each plate 'd'. 2
- (b) Consider a parallel plate capacitor, in which each plate has an area of  $0.2 \text{ m}^2$  and are  $0.01\text{m}$  apart. We connect the capacitor to a power supply, charge it to a potential difference  $V_0 = 3 \text{ kV}$  and disconnect the power supply. We then insert a sheet of insulating plastic material between the plates, completely filling the space between them. We find that the potential difference decreases to  $1.00 \text{ kV}$  while the charge on each capacitor plate remains constant. Find the energy density, both before and after the dielectric sheet is inserted. 2
5. (a) A capacitor has vacuum in the space between the conductors. If you double the amount of charge on each conductor, what happens to the capacitance? Justify your answer. 2
- (b) Derive the expression for current in a conducting wire in terms of drift velocity. 2
- (c) A copper wire of diameter  $1\text{mm}$  carries a current of  $1.75 \text{ A}$  to a  $200\text{-W}$  lamp. The free electron density in the wire is  $8.5 \times 10^{28} \text{ per cubic meter}$ . Find (i) the current density; and (ii) the drift velocity. 2
- (c) Suppose you replace the copper wire as in Q.5 (b) to another copper wire having twice diameter. If the current remains same, what will be the magnitude of drift velocity? 2
6. (a) A charged capacitor of capacitance  $C$  is discharged through a resistor of resistance  $R$ . Obtain the expression for instantaneous charge on the capacitor during discharging. 2
- (b) A  $1.50\text{-}\mu\text{F}$  capacitor is charging through a  $12.0\text{-}\Omega$  resistor using a  $10.0\text{-V}$  battery. What will be the current when the capacitor has acquired  $\frac{1}{4}$  of its maximum charge? Will it be  $\frac{1}{4}$  of the maximum current? 2
- (c) Show graphically the variation of charge  $q$  and current  $i$  with time when the charged capacitor is being discharged in  $RC$  circuit. 2
7. (a) Evaluate the force on a current carrying conductor in a magnetic field. 2
- (b) A straight horizontal copper rod carries a current of  $50\text{A}$  from west to east in a region between the poles of a large electromagnet. In this region there is horizontal magnetic field toward the northeast (that is,  $45^\circ$  north of east) with magnitude  $1.20 \text{ T}$ . Find the magnitude and direction of the force on a  $1.00\text{-m}$  section of rod. 2
- (c) If you double the speed of the charged particle in a magnetic field while keeping the magnetic field, charge and mass constant, how does this affect the radius of the trajectory and time required to complete one circular orbit. 2
8. (a) State Ampere's circuital law and express its modified form with help of displacement current. 2
- (b) A cylindrical conductor with radius  $R$  carries a current  $I$ . The current is uniformly distributed over the cross-sectional area of the conductor. Find the magnetic field as a function of the distance  $r$  from the conductor axis for points both inside ( $r < R$ ) and outside ( $r > R$ ) the conductor. 2
- (c) A closed curve encircles several conductors. The close line integral of magnetic field around this curve is  $3.83 \times 10^{-4} \text{ Tm}$ . (a) What is the current in the conductors? (b) If you were to integrate around the curve in the opposite direction, what would be the value of the line integral? 2

9. (a) Express the instantaneous current in an R-L circuit when there is growth of current. Explain it graphically. 2
- (b) A 35.0-V battery with negligible internal resistance, a resistor of resistance  $50.0\Omega$  and a  $1.25\text{-mH}$  inductor with negligible resistance are connected in series with an open switch. The switch is suddenly closed. How long after closing the switch will the current through the inductor reach one-half of its maximum value? 2
- (c) Explain the charge oscillation in LC Circuit. 2
- 10 (a) Write the key features of electromagnetic wave. 2
- (b) For an electromagnetic wave propagating through free space, calculate the frequency of a wave, with a wavelength of (a)  $30 \text{ \AA}$ ; (b)  $300 \text{ \AA}$ ; (c)  $3000 \text{ \AA}$  and (d)  $30 \text{ m}$ . 2
- (c) Express the Maxwell's electromagnetic equations which are not changed in the presence of charges and currents. 2

\*End of Questions\*

**END SEMESTER EXAMINATION, JULY-2023  
INTRODUCTORY GRAPH THEORY (CSE 1004)**

**Programme: B.Tech  
Full Marks: 60**

**Semester: 2nd  
Time: 3 Hours**

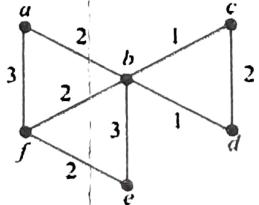
<b>Subject/Course Learning Outcome</b>	<b>*Taxonomy Level</b>	<b>Ques. Nos.</b>	<b>Marks</b>
Able to understand the fundamental concepts of graphs and apply them to study graph isomorphisms, Eulerian graphs, graphic sequences and digraphs.	L3, L3, L3, L3, L3, L3	1(a),1(b), 1(c),2(a), 2(b),2(c)	2,2, 2,2, 2,2
Able to understand the concepts of trees, spanning trees and study its various concepts and apply the Kruskal's algorithm to find the minimum spanning tree and Dijkstra's algorithm to find the shortest path of connected weighted graphs.	L3, L3, L3, L3, L3, L3	3(a),3(b), 3(c),4(a), 4(b), 4(c)	2,2, 2,2, 2,2
Able to understand matchings and factorization of graphs and its various applications.	L3, L3, L3	5(a),5(b), 5(c)	2,2, 2
Able to understand and analyze coloring of graphs, it's enumerative aspects and its applications.	L3, L3, L3, L3, L3, L3	6(a),6(b), 6(c),7(a), 7(b),7(c)	2,2, 2,2, 2,2
Able to understand and analyze planar graphs and its various applications.	L3, L3, L3, L3, L3, L3	8(a),8(b), 8(c),9(a), 9(b),9(c)	2,2, 2,2, 2,2
Able to understand the concepts of line graphs, edge-coloring and the various aspects of Hamiltonian cycles.	L3, L3, L3	10(a),10(b), 10(c)	2,2, 2

**\*Bloom's taxonomy levels: Remembering (L1), Understanding (L2), Applying (L3), Analyzing (L4), Evaluating (L5), Creating (L6)**

**Answer all questions. Each question carries equal mark.**

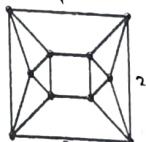
1. (a) Prove that every  $u, v$ -walk contains a  $u, v$ -path. 2
- (b) Draw four simple nonisomorphic graphs of order 4. 2
- (c) Prove or disprove: If  $u$  and  $v$  are the only vertices of odd degree in a graph  $G$ , then  $G$  contains a  $u, v$ -path. 2
2. (a) Prove that if every vertex of a graph  $G$  has degree atleast 2, then  $G$  contains a cycle. 2

- (b) Prove or disprove: If  $D$  is an orientation of a simple graph with 10 vertices, then the vertices of  $D$  cannot have distinct outdegrees. 2
- (c) Determine, whether the following is a graphic sequence. 2  
If yes, construct the graph.  
 $d : 5, 5, 4, 4, 2, 2, 1, 1$
3. (a) Prove that every tree with at least two vertices has at least two leaves. 2
- (b) Determine the diameter and radius of the cycle graph  $C_5$ , by calculating the eccentricity of each vertex of the graph. 2
- (c) Prove that  $G$  is a tree if and only if adding any edge with endpoints in  $V(G)$  creates exactly one cycle. 2
4. (a) Let  $T$  be an  $n$ -vertex tree having one vertex of each degree  $i$  with  $2 \leq i \leq k$ ; the rest  $n-k+1$  vertices are leaves. Determine  $n$  in terms of  $k$ . 2
- (b) Let  $G$  be a complete undirected graph with 4 vertices and 6 edges having weights 1, 2, 3, 4, 5 and 6. Determine the maximum possible weight that a minimum weight spanning tree of  $G$  can have. 2
- (c) Find the minimum spanning tree of the given graph by using Kruskal's algorithm. 2

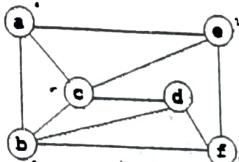


5. (a) How many perfect matchings does the graph  $K_{2,2}$  have? 2  
Draw all the perfect matchings of  $K_{2,2}$ .
- (b) Let  $T$  be a tree with  $n$  vertices, and let  $k$  be the maximum size of an independent set in  $T$ . Determine  $\alpha'(T)$  in terms of  $n$  and  $k$ . 2

- (c) In the graph given below exhibit a  $k$ -factor for  $k=1$  and  $k=2$ . 2



6. (a) Determine the chromatic number of the given graph. 2



- (b) Prove that the chromatic number of a graph equals the maximum of the chromatic numbers of its components. 2

- (c) Prove or disprove: If  $G = F \cup H$ , then  $\chi(G) \leq \chi(F) + \chi(H)$ . 2

7. (a) Draw  $P_3 \vee K_3$  and compute  $\chi(P_3 \vee K_3)$ . 2

- (b) Compute the chromatic polynomial of the given graph. 2



- (c) Determine  $\chi(C_n \vee K_1; k)$  and hence find  $\chi(C_3 \vee K_1; 4)$ . 2

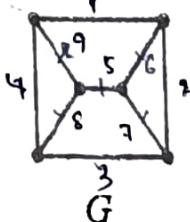
8. (a) Show that  $K_5$  is nonplanar. 2

- (b) Prove or disprove: Every subgraph of a planar graph is planar. 2

- (c) Draw the dual graph of  $K_4$ . 2

9. (a) If  $G$  is a triangle-free simple planar graph with atleast 3 vertices then prove that  $e(G) \leq 2n(G) - 4$ . 2

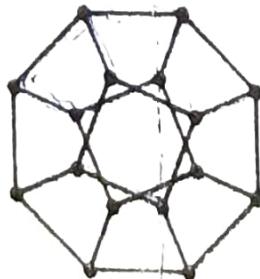
- |
- (b) If in an undirected connected planar graph  $G$ , there are 2 eight vertices and five faces, then determine the number of edges in  $G$ .
- (c) Let  $G$  be a simple undirected planar graph with 10 vertices and 15 edges. If  $G$  is connected, then determine the number of bounded faces in any embedding of  $G$  on the plane.
- 10 (a) For the given graph  $G$ , compute the edge-chromatic 2 number  $\chi'(G)$  and draw the line graph  $L(G)$ .



- (b) Determine the maximum edge multiplicity  $\mu(G)$  of the 2 graph  $G$  given below.



- (c) Determine whether the given graph is Hamiltonian or 2 not. If yes, show the Hamiltonian cycle by suitably naming the vertices.



\*End of Questions\*