NCERT Solutions Class 12 Maths
Chapter 5: Continuity and Differentiability
Exercise 5.2

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 5 Exercise 5.2, students learn advanced differentiation techniques for composite functions and trigonometric functions. This exercise covers chain rule applications, derivatives of inverse trigonometric functions, and composite function differentiation which are essential for CBSE Board exams and JEE preparation.

Key Takeaways:

- Chain Rule for composite functions: (d)/(dx)[f(g(x))] = f'(g(x)) · g'(x)
- Differentiation of trigonometric composites like \sin(x^2), \cos(\sin x), and \sec(\tan(√x))
- Step-by-step application of differentiation rules for complex nested functions
- Foundation concepts for Mean Value Theorem and Rolle's Theorem applications in higher mathematics

Complete Solutions

Question 1

QUESTION

Differentiate with respect to x: \sin(x^2+5).

SOLUTION

We are asked to find the derivative of the function with respect to . This requires applying the chain rule.

Step 1: Identify the outer and inner functions

The outer function is , and the inner function is . So, we have .

Step 2: Differentiate the outer function

The derivative of with respect to is:

Step 3: Differentiate the inner function

The derivative of with respect to is:

Step 4: Apply the chain rule

The chain rule states that:

In our case, this means:

Step 5: Simplify the expression

Rearranging the terms, we get:

Final Answer: The derivative of with respect to is .

ANSWER

2x\cos(x^2+5)

Question 2

QUESTION

Differentiate with respect to x: \cos(\sin x).

SOLUTION

We are asked to find the derivative of with respect to .

Step 1: Identify the composite function

The given function is a composite function, where the outer function is cosine and the inner function is sine. That is, we have where and .

Step 2: Apply the chain rule

The chain rule states that if we have a composite function , then its derivative with respect to is given by:

In our case, . So, we need to find the derivative of the outer function (cosine) with respect to its argument (sine), and then multiply it by the derivative of the inner function (sine) with respect to .

Step 3: Differentiate the outer function

The derivative of with respect to is . Therefore, the derivative of with respect to is .

Step 4: Differentiate the inner function

The derivative of with respect to is .

Step 5: Combine the derivatives using the chain rule

We multiply the derivative of the outer function by the derivative of the inner function.

Final Answer:

The derivative of with respect to is .

ANSWER

-\cos x\,\sin(\sin x)

Question 3

QUESTION

Differentiate with respect to x: \sin(ax+b).

SOLUTION

We need to find the derivative of with respect to .

This problem involves the chain rule of differentiation.

Step 1: Identify the outer and inner functions

The outer function is , and the inner function is .

Step 2: Differentiate the outer function with respect to the inner function

The derivative of with respect to is . So,

Step 3: Differentiate the inner function with respect to

The derivative of with respect to is . So,

Step 4: Apply the chain rule

The chain rule states that . In our case,

Substituting the derivatives we found:

Step 5: Substitute back the inner function

Replace with :

Final Answer: The derivative of with respect to is .

ANSWER

a\cos(ax+b)

Question 4

QUESTION

Differentiate with respect to x: \sec(\tan(√x)).

SOLUTION

We need to find the derivative of with respect to . This requires applying the chain rule multiple times.

Step 1: Identify the outer function and its derivative

The outermost function is the secant function. Recall that the derivative of with respect to is .

Step 2: Apply the chain rule to the outer function

Let . Then we have . Applying the chain rule:

Step 3: Differentiate the next inner function

Now we need to differentiate . Recall that the derivative of with respect to is .

Let . Then we have . Applying the chain rule:

Step 4: Differentiate the innermost function

Now we need to differentiate , which is . Using the power rule:

Step 5: Combine all the derivatives

Putting it all together, we have:

Step 6: Simplify the expression

We can rewrite this as:

Final Answer:

The derivative of with respect to is .

ANSWER

\sec(\tan√x)\,\tan(\tan√x)\,\sec^2√x2√x

Question 5

QUESTION

Differentiate with respect to x: (\sin(ax+b))/(\cos(cx+d)).

SOLUTION

We need to differentiate the given function with respect to : .

Step 1: Identify the applicable rule

We will use the quotient rule for differentiation, which states that if , then . In our case, and .

Step 2: Differentiate with respect to

Step 3: Differentiate with respect to

Step 4: Apply the quotient rule

Step 5: Simplify the expression

We can rewrite the expression by dividing each term in the numerator by :

Final Answer:

ANSWER

a\cos(ax+b)\sec(cx+d)+c\sin(ax+b)\tan(cx+d)\sec(cx+d)

Question 6

QUESTION

Differentiate with respect to x: \cos(x^3)· \sin^2(x^5).

SOLUTION

We need to differentiate the function with respect to . This requires the use of the product rule and the chain rule.

Step 1: Apply the Product Rule

The product rule states that if we have two functions and , then the derivative of their product is given by: In our case, let and . We'll find the derivatives of and separately.

Step 2: Differentiate

Using the chain rule, we have:

Step 3: Differentiate

Again, using the chain rule:

Step 4: Apply the Product Rule with the calculated derivatives

Now we substitute and back into the product rule formula:

Step 5: Simplify the expression

Rearranging the terms, we get:

Final Answer: The derivative of with respect to is .

ANSWER

10x^4\sin(x^5)\cos(x^5)\cos(x^3)-3x^2\sin(x^3)\sin^2(x^5)

Question 7

QUESTION

Differentiate with respect to x: 2√\cot(x^2).

SOLUTION

We are asked to differentiate the function with respect to .

Step 1: Rewrite the function

Let . We can rewrite this as .

Step 2: Apply the chain rule

We will use the chain rule: . Let , so . Then .

Now let , so . Then .

Finally, .

Step 3: Combine the derivatives

Using the chain rule, we have:

So, .

Step 4: Simplify the expression

Recall that and . Therefore,

Multiply by :

Final Answer:

ANSWER

-2√2\,x\sin(x^2)√\sin(2x^2)

Question 8

QUESTION

Differentiate with respect to x: \cos(√x).

SOLUTION

We are asked to find the derivative of the function with respect to .

This problem requires us to use the chain rule.

Step 1: Recall the chain rule

The chain rule states that if we have a composite function , then its derivative is given by:

In our case, and .

Step 2: Find the derivative of the outer function

The derivative of with respect to is:

So, .

Step 3: Find the derivative of the inner function

The derivative of with respect to is:

Step 4: Apply the chain rule

Now, we multiply the derivative of the outer function by the derivative of the inner function:

Step 5: Simplify the expression

Final Answer:

ANSWER

-\sin√x2√x

Question 9

QUESTION

Prove that the function f given by f(x)=|x-1|, x\in\mathbbR, is not differentiable at x=1.

SOLUTION

We need to prove that the function is not differentiable at . To do this, we will examine the left-hand derivative (LHD) and the right-hand derivative (RHD) at . If LHD and RHD are not equal, the function is not differentiable at that point.

Step 1: Define the function

The function is defined as . We can rewrite this as a piecewise function:

Step 2: Calculate the Left-Hand Derivative (LHD) at

The LHD is defined as:

Since we are approaching from the left (), we use the part of the piecewise function where , so .

Therefore, the LHD at is -1.

Step 3: Calculate the Right-Hand Derivative (RHD) at

The RHD is defined as:

Since we are approaching from the right (), we use the part of the piecewise function where , so .

Therefore, the RHD at is 1.

Step 4: Compare LHD and RHD

We found that LHD = -1 and RHD = 1. Since LHD RHD, the function is not differentiable at .

Conclusion:

Since the left-hand derivative and the right-hand derivative at are not equal, the function is not differentiable at .

ANSWER

Question 10

QUESTION

Prove that the greatest integer function defined by f(x)=[x], 0<x<3, is not differentiable at x=1 and x=2.

SOLUTION

We need to prove that the greatest integer function is not differentiable at and within the interval .

Step 1: Understand the Greatest Integer Function

The greatest integer function, denoted by , returns the largest integer less than or equal to . For example, , , and . This function is a step function, and it's discontinuous at integer values.

Step 2: Check differentiability at x=1

To check differentiability at , we need to examine the left-hand derivative (LHD) and the right-hand derivative (RHD) at .

Step 3: Calculate the Left-Hand Derivative (LHD) at x=1

As approaches 0 from the left (i.e., is a small negative number), will be slightly less than 1. Therefore, .

Step 4: Calculate the Right-Hand Derivative (RHD) at x=1

As approaches 0 from the right (i.e., is a small positive number), will be slightly greater than 1 but still less than 2. Therefore, .

Step 5: Compare LHD and RHD at x=1

Since LHD is not equal to RHD at , the function is not differentiable at .

Step 6: Check differentiability at x=2

Similarly, we check differentiability at .

Step 7: Calculate the Left-Hand Derivative (LHD) at x=2

As approaches 0 from the left, will be slightly less than 2. Therefore, .

Step 8: Calculate the Right-Hand Derivative (RHD) at x=2

As approaches 0 from the right, will be slightly greater than 2 but still less than 3. Therefore, .

Step 9: Compare LHD and RHD at x=2

Since LHD is not equal to RHD at , the function is not differentiable at .

Conclusion: The greatest integer function is not differentiable at and .

ANSWER

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📐 Key Formulas

Important Formulas for Exercise 5.2

Formula / Concept	Description
Differentiability at a Point	A function f is said to be differentiable at a point c if the left-hand derivative (LHD) and right-hand derivative (RHD) at c are finite and equal. The derivative of f at c is then given by f'(c) = \lim_h \to 0 (f(c+h) - f(c))/(h).
Chain Rule	Used to find the derivative of a composite function. If y = f(g(x)), then the chain rule states that (dy)/(dx) = f'(g(x)) · g'(x). Another form is if y = f(u) and u = g(x), then (dy)/(dx) = (dy)/(du) × (du)/(dx).
Product Rule	Used to find the derivative of a product of two functions. If y = u(x) · v(x), then the product rule is given by (dy)/(dx) = u(x) (dv)/(dx) + v(x) (du)/(dx).
Quotient Rule	Used to find the derivative of a quotient of two functions. If y = (u(x))/(v(x)), then the quotient rule is (dy)/(dx) = (v(x) du)/(dx) - u(x) (dv)/(dx)[v(x)]^2.
Derivatives of Trigonometric Functions	(d)/(dx)(\sin x) = \cos x (d)/(dx)(\cos x) = -\sin x (d)/(dx)(\tan x) = \sec^2 x (d)/(dx)(\cot x) = -\csc^2 x (d)/(dx)(\sec x) = \sec x \tan x (d)/(dx)(\csc x) = -\csc x \cot x
Rolle's Theorem	If a function f is continuous on the closed interval [a, b], differentiable on the open interval (a, b), and f(a) = f(b), then there exists at least one number c in (a, b) such that f'(c) = 0.
Mean Value Theorem (Lagrange's)	If a function f is continuous on the closed interval [a, b] and differentiable on the open interval (a, b), then there exists at least one number c in (a, b) such that f'(c) = (f(b) - f(a))/(b - a).

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Miscellaneous Exercise on Chapter 5 →

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