Calculus II workshop

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Pre-Semester Prep
Aug 10 - 14. Trig, Calculus 1 & 2, Physics

Semester Long
Get a STEM Professional Mentor; Be a Peer-Mentor; Gain Research Experience

Weekly

Impostor Syndrome - How to see yourself as a competent, capable STEM person!

STEM Communication - both Oral and Poster presentations

Career events & STEM Mixer - network with students, staff, faculty & STEM Professionals

Mock Exams - know how you are doing in your class before it is too late

• Open House
• Graduate & Professional School Fair

Financial Fundamentals

Resume Review Sessions

Diversity & Inclusion

MATLAB - introductory hands-on workshop

Basic Excel - hands-on workshop on data entry, manipulation, and creating graphs

STEM Celebration/I am STEM Awards - network with students, staff, faculty & STEM professionals
Get a STEM Professional as a mentor
Build your network and receive guidance and support form a STEM professional working in the field.

This program is open to UNM STEM Majors. Priority is given to Freshmen and Sophomores, but all levels are encouraged to apply.

Semester deadline - Feb 5 & Sept 5
For more information, or to apply, visit: https://goto.unm.edu/ess-semester-programs

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5 - 6 PM
Zoom Webinar: https://unm.zoom.us/j/95885591380

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Calc I Revisit

**Important Concepts:**
- Domain and Range
- Properties of Inverse Functions
- Limits and Continuity
- Basic Differentiation and Integration Formulae
- Methods of Differentiation
- Differentiation of non-algebraic functions
Functions

- It is a mathematical equation that relates input(s) with output.

- A function assigns exactly one output to each input (or combination of inputs).
What makes it a function?

1. Every input must have an output.

2. All the inputs must have exactly one output. (does not matter if it is the same output!)

Note: An output can have more than one input however an input cannot have 2 outputs.
Domain and Range of Functions

**Input**

1  
2  
3  

**Output**

A  
B  
C  

**Domain**

-1  
0  
1  
2  
3  

**Range**

3  
5  
11  
21
FindingDomains and Range

- Domain represents the set of all real values that can be assigned as an input for a given function.

- Range represents the set of all real values that can be calculated as an output from a given set of domain.
More on Domain and Range

To find the domain of a given function,

1. Start with the domain as the set of all real numbers (-inf, +inf)

2. Look for any input numbers that computes to any invalid/illegal number-output
   - (terms including division by 0, negative numbers inside the square root, etc. are some invalid outputs we need to look for)

3. Finally, remove these input numbers for your starting set and the remaining numbers in the set is the domain.
More on Domain and Range

Finding range of a function can be trickier! Understanding graph of functions is a very powerful tool to evaluate both domain and range.
More on Domain and Range

Finding Range:

1. Does the function have a minimum and maximum?
2. Is the graph going to be continuous or not?
3. Are there any jumps or holes in the graph?
4. Are there any negative numbers in the output? Are there any positive numbers in the output?

Answering these will help to filter your set and understand the behavior of the given functions!
Practice Problems

Find domain and range of the following:

\[ f(x) = x^3 - x. \]
\[ f(t) = 3^t. \]
\[ f(z) = \sqrt{z - 1}. \]
\[ f(z) = \sqrt{z^2 - 1}. \]
\[ f(x) = \sqrt{6 - x - x^2}. \]
\[ g(x) = \sin(1/x). \]
\[ h(u) = 1/(u - 2). \]
Inverse Functions

Inverse Function of a function reverses the original function. This means it takes as its input, the output of the original function and relates it with its input.

If a function is $y = f(x)$, then its inverse function is $x = f^{-1}(x)$
Properties of Inverse Functions

Let $f(x)$ be a one-to-one function with domain $A$ and range $B$. The inverse function $f^{-1}(x)$ satisfies the following “cancellation” properties:

1. $f^{-1}(f(x)) = x$ for every $x \in A$
2. $f(f^{-1}(x)) = x$ for every $x \in B$

Conversely, any function $f^{-1}(x)$ satisfying the above conditions is the inverse of $f(x)$. 
Common Graphs

- Linear
- Parabola
- Square Root
- Cubic
- Cube Root
- Absolute Value
- Exponential
- Logarithmic
- Trigonometric
Parabola

$y = x^2$

domain: $(-\infty, \infty)$

range: $[0, \infty)$

even
Square Root

Domain: $[0, \infty)$

Range: $[0, \infty)$

Neither
Cubic

$y = x^3$

domain: $(-\infty, \infty)$

range: $(-\infty, \infty)$

odd
Cube Root

$y = \sqrt[3]{x}$

domain: $(-\infty, \infty)$

range: $(-\infty, \infty)$

odd
Absolute Value

$y = |x|$

domain: $(-\infty, \infty)$

range: $[0, \infty)$

even
Exponential

\[ y = e^x \]

**Domain:** \((-\infty, \infty)\)

**Range:** \((0, \infty)\)

**Neither**
Logarithm

\[ y = \ln(x) \]

- **Domain:** \((0, \infty)\)
- **Range:** \((\infty, \infty)\)
- **Neither**
The Sine and Inverse Sine Graphs
The Cosine and Inverse Cosine Graphs
The Tangent and Inverse Tangent Graphs
Break
Limits

Evaluate the following limits:

\[
\lim_{x \to 2} \frac{x^2 - 3x + 2}{x^2 - 2x}
\]

\[
\lim_{x \to \infty} \frac{(x+1)(x-2)}{3x^2 + 6x - 5}
\]

\[
\lim_{x \to 1} \frac{x^2 - 4}{x^2 - 3x + 2}
\]
Chain Rule

If $f$ and $g$ are both differentiable and $F(x)$ is the composite function defined by $F(x) = f(g(x))$ then $F$ is differentiable and $F'$ is given by the product

$$F'(x) = f'(g(x)) \cdot g'(x)$$
Product Rule

\[ F(x) = f(x) \cdot g(x) \]
\[ F'(x) = f'(x) \cdot g(x) + g'(x) \cdot f(x) \]

OR

\[ F(x) = (\text{first}) \cdot (\text{second}) \]
\[ F'(x) = (\text{first})' \cdot (\text{second}) + (\text{second})' \cdot (\text{first}) \]
Quotient Rule

\[ F(x) = \frac{f(x)}{g(x)} \]

\[ F'(x) = \frac{f'(x) \cdot g(x) - g'(x) \cdot f(x)}{[g(x)]^2} \]

OR

\[ F(x) = \frac{(top)}{(bottom)} \]

\[ F'(x) = \frac{(top)' \cdot (bottom) - (bottom)' \cdot (top)}{(bottom)^2} \]
U-sub

Idea

- Simplifying larger complex problems into simple ones by using substitution

- When integrating something of the form
  \[ \int f'(g(x)) \cdot g'(x) \, dx \]

  we let \( u = g(x) \) or the “inside function”

- Then \( \frac{du}{dx} = g'(x) \) and we get an integral that can be done in terms of \( u \)
Practice Problems

\[ W(z) = \frac{3z + 9}{2 - z} \]

\[ \int x^2 (3 - 10x^3)^4 \, dx \]
Implicit Differentiation

\[ y^5 + 2y = x^2 \]
Differentiation of Trigonometric Functions

\[ g(x) = 3 \sec(x) - 10 \cot(x) \]

\[ P(t) = \frac{\sin(t)}{3 - 2 \cos(t)} \]
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