Math 135 Final Exam, Fall 2019

Name: ________________________________

Signature: ____________________________ RUID: ____________

Lecturer: ____________________________ Section: ____________________________

Do this now:

- On the separate bubble sheet, in the field labeled “Version”, mark the bubble that corresponds to the letter of the version of this exam, which can be found in the upper-right corner of this page.

- Verify that your name and RUID have been correctly filled in on the separate bubble sheet.

- Fill out the top of this page and put your Rutgers photo ID card on your desk next to you for checking, but do not open the exam until you are instructed to start the exam.

Instructions:

- Do not detach any pages from this exam.

- No calculators, cell phones or any other electronic devices, or any books, notes or scratch paper may be used during the exam.

- You may use the back of any page for scratch work.

<table>
<thead>
<tr>
<th>Prob No.</th>
<th>Max Pts</th>
<th>Points</th>
<th>Prob No.</th>
<th>Max Pts</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
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<td>6</td>
<td></td>
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<td>7</td>
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<td>22</td>
<td>6</td>
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<td>6</td>
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<td>24</td>
<td>6</td>
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<tr>
<td>Subtotal</td>
<td>28</td>
<td></td>
<td>Subtotal</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{Multiple Choice} \quad (\#1 - \#16) \quad \times 3 \text{ points} = \quad \text{total points (max 48)}
\]
Multiple-choice:
Each of these problems is worth 3 points. For each problem, choose the best answer and mark your response on the bubble sheet. Your scratch work for these problems will not be graded.

1. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
   (a) text for 1st choice
   (b) text for 2nd choice
   (c) text for 3rd choice
   (d) text for 4th choice
   (e) text for 5th choice
   (f) none of the above

2. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
   (a) text for 1st choice
   (b) text for 2nd choice
   (c) text for 3rd choice
   (d) text for 4th choice
   (e) text for 5th choice
   (f) none of the above

3. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
   (a) text for 1st choice
   (b) text for 2nd choice
   (c) text for 3rd choice
   (d) text for 4th choice
   (e) text for 5th choice
   (f) none of the above

4. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
   (a) text for 1st choice
   (b) text for 2nd choice
   (c) text for 3rd choice
   (d) text for 4th choice
   (e) text for 5th choice
   (f) none of the above
Multiple-choice:
Each of these problems is worth 3 points. For each problem, choose the best answer and mark your response on the bubble sheet. Your scratch work for these problems will not be graded.

5. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
(a) text for 1st choice
(b) text for 2nd choice
(c) text for 3rd choice
(d) text for 4th choice
(e) text for 5th choice
(f) none of the above

6. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
(a) text for 1st choice
(b) text for 2nd choice
(c) text for 3rd choice
(d) text for 4th choice
(e) text for 5th choice
(f) none of the above

7. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
(a) text for 1st choice
(b) text for 2nd choice
(c) text for 3rd choice
(d) text for 4th choice
(e) text for 5th choice
(f) none of the above

8. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
(a) text for 1st choice
(b) text for 2nd choice
(c) text for 3rd choice
(d) text for 4th choice
(e) text for 5th choice
(f) none of the above
Multiple-choice:
Each of these problems is worth 3 points. For each problem, choose the best answer and mark your response on the bubble sheet. Your scratch work for these problems will not be graded.

9. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
   (a) text for 1st choice
   (b) text for 2nd choice
   (c) text for 3rd choice
   (d) text for 4th choice
   (e) text for 5th choice
   (f) none of the above

10. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
    (a) text for 1st choice
    (b) text for 2nd choice
    (c) text for 3rd choice
    (d) text for 4th choice
    (e) text for 5th choice
    (f) none of the above

11. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
    (a) text for 1st choice
    (b) text for 2nd choice
    (c) text for 3rd choice
    (d) text for 4th choice
    (e) text for 5th choice
    (f) none of the above

12. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
    (a) text for 1st choice
    (b) text for 2nd choice
    (c) text for 3rd choice
    (d) text for 4th choice
    (e) text for 5th choice
    (f) none of the above
**Multiple-choice:**
Each of these problems is worth 3 points. For each problem, choose the best answer and mark your response on the bubble sheet. Your scratch work for these problems will not be graded.

13. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
   (a) text for 1st choice
   (b) text for 2nd choice
   (c) text for 3rd choice
   (d) text for 4th choice
   (e) text for 5th choice
   (f) none of the above

14. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
   (a) text for 1st choice
   (b) text for 2nd choice
   (c) text for 3rd choice
   (d) text for 4th choice
   (e) text for 5th choice
   (f) none of the above

15. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
   (a) text for 1st choice
   (b) text for 2nd choice
   (c) text for 3rd choice
   (d) text for 4th choice
   (e) text for 5th choice
   (f) none of the above

16. This is a multiple-choice problem. Choose the best answer and mark your response on the bubble sheet. You don’t have to show work, and any work you do write will not be graded.
   (a) text for 1st choice
   (b) text for 2nd choice
   (c) text for 3rd choice
   (d) text for 4th choice
   (e) text for 5th choice
   (f) none of the above
### Graph analysis:
Each part of this problem is worth 1 point (9 points total) and will be graded with no partial credit. Write your responses in the table. Your scratch work for this problem will not be graded.

**17.** Consider the function $f$ and its derivatives below.

\[ f(x) = \cdots, \quad f'(x) = \cdots, \quad f''(x) = \cdots \]

(The exam will have explicit functions in the line above.)

Find where $f$ is increasing, decreasing, concave up, and concave down. Use interval notation in your answers. Also, find all horizontal and vertical asymptotes of $f$, and the $x$-coordinate of each relative extremum and inflection point of $f$. Write “NONE” as your answer, if appropriate.

(Note that all answers in the table below must be exact. No decimal approximations.)

<table>
<thead>
<tr>
<th>Increasing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreasing</td>
<td></td>
</tr>
<tr>
<td>Concave up</td>
<td></td>
</tr>
<tr>
<td>Concave down</td>
<td></td>
</tr>
<tr>
<td>Equations of horizontal asymptotes</td>
<td></td>
</tr>
<tr>
<td>Equations of vertical asymptotes</td>
<td></td>
</tr>
<tr>
<td>$x$-coordinates of relative maxima</td>
<td></td>
</tr>
<tr>
<td>$x$-coordinates of relative minima</td>
<td></td>
</tr>
<tr>
<td>$x$-coordinates of inflection points</td>
<td></td>
</tr>
</tbody>
</table>
Show-all-work:
For this problem, you must show all work, and your work will be graded. Your work should be clear and use proper notation. Insufficiently supported answers may receive no credit.

This problem is worth 7 points.

18. This problem requires you to show work, and you will be given partial credit based on your work. Insufficiently supported answers may receive no credit. There may also be multiple parts to this problem, which may or may not be related.

There may be extra instructions here on how to format your final answer.

\[
\text{Final answer } = \ \\
\]
Show-all-work:
For this problem, you must show all work, and your work will be graded. Your work should be clear and use proper notation. Insufficiently supported answers may receive no credit.

This problem is worth 6 points.

19. This problem requires you to show work, and you will be given partial credit based on your work. Insufficiently supported answers may receive no credit. There may also be multiple parts to this problem, which may or may not be related.

There may be extra instructions here on how to format your final answer.

Final answer =
Show-all-work:
For this problem, you must show all work, and your work will be graded. Your work should be clear and use proper notation. Insufficiently supported answers may receive no credit.
This problem is worth 6 points.

20. This problem requires you to show work, and you will be given partial credit based on your work. Insufficiently supported answers may receive no credit. There may also be multiple parts to this problem, which may or may not be related.

There may be extra instructions here on how to format your final answer.

Final answer =
Show-all-work:
For this problem, you must show all work, and your work will be graded. Your work should be clear and use proper notation. Insufficiently supported answers may receive no credit.

This problem is worth 6 points.

21. This problem requires you to show work, and you will be given partial credit based on your work. Insufficiently supported answers may receive no credit. There may also be multiple parts to this problem, which may or may not be related.

There may be extra instructions here on how to format your final answer.

Final answer =
Show-all-work:
For this problem, you must show all work, and your work will be graded. Your work should be clear and use proper notation. Insufficiently supported answers may receive no credit.

This problem is worth 6 points.

22. This problem requires you to show work, and you will be given partial credit based on your work. Insufficiently supported answers may receive no credit. There may also be multiple parts to this problem, which may or may not be related.

There may be extra instructions here on how to format your final answer.

Final answer =
Show-all-work:
For this problem, you must show all work, and your work will be graded. Your work should be clear and use proper notation. Insufficiently supported answers may receive no credit.
This problem is worth 6 points.

23. This problem requires you to show work, and you will be given partial credit based on your work. Insufficiently supported answers may receive no credit. There may also be multiple parts to this problem, which may or may not be related.

There may be extra instructions here on how to format your final answer.

Final answer =
Show-all-work:
For this problem, you must show all work, and your work will be graded. Your work should be clear and use proper notation. Insufficiently supported answers may receive no credit.

This problem is worth 6 points.

24. This problem requires you to show work, and you will be given partial credit based on your work. Insufficiently supported answers may receive no credit. There may also be multiple parts to this problem, which may or may not be related.

There may be extra instructions here on how to format your final answer.

\[
\text{Final answer = } \quad \]

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