Reminders...

**Online Quizzes** are open. **Online Quiz 3** closes Saturday.

**Test 2** is coming soon.

**Homework 04** is posted for next Monday.

**EMCFs** are due each MWF.
<table>
<thead>
<tr>
<th>20</th>
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<th>22.</th>
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<tbody>
<tr>
<td>20</td>
<td>21</td>
<td>MLK Day</td>
<td>UH events this week</td>
<td>Notes, video notes, video</td>
<td>Exam 1 and PTI close</td>
<td>Quiz 1 closes (7.1-7.2)</td>
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<td>22.</td>
<td>UH events this week</td>
<td>Last day to add</td>
<td>EMCF03 due at 9am-key</td>
<td>Homework 1 due in lab/workshop</td>
<td>Notes, video notes, video</td>
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<td>Notes, video notes, video</td>
<td>EMCF03 due at 9am-key</td>
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<td>EMCF04 due at 9am-key</td>
<td>Homework 2 posted</td>
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<td>Quiz 1 closes (7.1-7.2)</td>
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<td>27</td>
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<td>Free Access ends today!! Purchase your Access Code!!</td>
<td>EMCF05 due at 9am-key</td>
<td>UH events this week</td>
<td>EMCF06 due at 9am-key</td>
<td>Quiz 2 closes (7.3-7.5)</td>
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<td>EMCF06 due at 9am-key</td>
<td>Notes: page, 4-per video notes, video</td>
<td>Register on CourseWare for Exam 2</td>
<td>Help with selected problems in 7.7 and 7.8</td>
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<td>32</td>
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<td>Homework 3 posted</td>
<td>Last day to drop without receiving a W</td>
<td>February 1</td>
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<td>Quiz 2 closes (7.3-7.5)</td>
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<td>Blank Slides: page, 4-per</td>
<td>EMCF08 due at 9am</td>
<td>EMCF09 due at 9am</td>
<td>Exam 2 starts</td>
<td>Quiz 3 closes (7.6-7.8)</td>
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<td>37</td>
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<td>Homework 3 due in lab/workshop</td>
<td>Homework 4 posted</td>
<td>EMCF09 due at 9am</td>
<td>Check the dates on CourseWare</td>
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<td>EMCF10 due at 9am</td>
<td>Homework 4 posted</td>
<td>EMCF10 due at 9am</td>
<td>Quiz in lab/workshop</td>
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<td>41</td>
<td>42</td>
<td>Quiz 3 closes (7.6-7.8)</td>
<td>EMCF08 due at 9am</td>
<td>Quiz 4 closes (8.1-8.3)</td>
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</table>
Please tell your high school friends and former teachers about our High School Mathematics Contest

February 9th
University of Houston

http://mathcontest.uh.edu
Popper Number 04

Use a No. 2 Pencil. Do Not Write Outside of This Box.
Popper Number 04

1. Give the slope of the normal line to the graph of $f(x) = \arctan(2^x)$ at the point where $x = 0$.

2. The function $f$ is invertible. Also, the tangent line to the graph of $f$ at $x = -2$ is given by $y = -3x + 5$. Give the slope of the tangent line to the graph of $f^{-1}$ at $x = 11$.

3. Give the slope of the tangent line to the graph of $F(x) = \sinh(x^2)$ at the point where $x = 2$. 
More Integration by Parts
Comments Through Examples...

\[
\int \ln(x+1) \, dx = \underbrace{u \, dv}_{\text{integration by parts}} - \int \frac{1}{x+1} \, dx
\]

\[
u = \ln(x+1) \quad du = \frac{1}{x+1} \, dx
\]

\[
dv = dx \quad v = x + 1
\]

\[
\int x \arctan(x) \, dx = \text{See today's video or the notes from last time.}
\]

\[
\frac{1}{3} \int 3x^2 e^{x^3} \, dx = \frac{1}{3} e^{x^3} + C
\]

Not a "parts" problem.

\[
u = x^3 \quad du = 3x^2 \, dx
\]
Today...

Integrating Powers and Products of Trigonometric Functions

Section 8.3 - Part I

Products of Sine and Cosine
Integrals of

\[ \cos^m(x), \ \sin^m(x), \ \cos^m(x)\sin^n(x) \]

Examples:

\[ \int \sin^2(x)\,dx = \]

\[ \int \cos^4(x)\,dx = \]

\[ \int \cos^4(x)\sin^3(x)\,dx = \]

\[ \int \cos^4(x)\sin^2(x)\,dx = \]
Identities:

\[\cos^2(x) + \sin^2(x) = 1\]

\[\cos^2(x) = \frac{1 + \cos(2x)}{2}\]

\[\sin^2(x) = \frac{1 - \cos(2x)}{2}\]
Example: \[ \int \sin^2(x) \, dx = \int \left( \frac{1}{2} - \frac{1}{2} \cos(2x) \right) \, dx \]

\[ \sin^2(x) = \frac{1}{2} - \frac{1}{2} \cos(2x) \]

\[ = \frac{1}{2} x - \frac{1}{4} \sin(2x) + C \]
Example: \( \int \cos^4(x) \, dx = \int (\cos^2(x))^2 \, dx \)

\( \cos^2(x) = \frac{1}{2} + \frac{1}{2} \cos(2x) \)

\(= \int \left(\frac{1}{4} + \frac{1}{2} \cos(2x) + \frac{1}{4} \cos^2(2x)\right) \, dx \)

\(= \frac{1}{4} x + \frac{1}{4} \sin(2x) + \frac{1}{4} \int \cos^2(2x) \, dx \)

\(\cos^2(u) = \frac{1}{2} + \frac{1}{2} \cos(2u) \)

\(= \frac{1}{4} x + \frac{1}{4} \sin(2x) + \frac{1}{4} \int \left(\frac{1}{2} + \frac{1}{2} \cos(4x)\right) \, dx \)

\(= \frac{1}{4} x + \frac{1}{4} \sin(2x) + \frac{1}{8} x - \frac{1}{3} \sin(4x) + C \)

\(= \frac{3}{8} x + \frac{1}{4} \sin(2x) + \frac{1}{3} \sin(4x) + C \)

\(= \int \cos^4(x) \, dx = \frac{3}{8} x + \frac{1}{4} \sin(2x) + \frac{1}{3} \sin(4x) + C \)
Popper Number 04

4. The answer is $-7/3$.

5. The answer is 0.
Example: \[ \int \cos^3(x)\sin^2(x)dx = \]

\[ = \int \cos^4(x)(1 - \cos^2(x))dx \]

\[ = \int \cos^4(x)dx - \int \cos^6(x)dx \]

\[ = \int \cos^4(x)dx - \int \left(\cos^2(x)\right)^3dx \]

\[ = \int \cos^4(x)dx - \int \left(\frac{1}{2} + \frac{1}{2}\cos(2x)\right)^3dx \]

\[ = \int \cos^4(x)dx - \int \left(\frac{1}{8} + \frac{3}{8}\cos(2x) + \frac{3}{8}\cos^2(2x) + \frac{1}{8}\cos^3(2x)\right)dx \]

\[ = \int \cos^4(x)dx - \left(\frac{1}{8}x + \frac{3}{16}\sin(2x) - \frac{3}{8}x - \frac{3}{16}\sin(4x)\right) + \frac{1}{8}\int \cos^3(2x)dx \]

\[ = \int \cos^4(x)dx - \frac{1}{8}\int \cos^3(2x)dx \]

\[ = \int \cos^4(x)dx - \frac{1}{8}\int (1 - \sin^2(2x))\cos(2x)dx \]

\[ = \int \cos^4(x)dx - \frac{1}{8}\int \sin(2x)dx + \frac{1}{8} \int \cos^3(2x)\cos(2x)dx \]

\[ = \int \cos^4(x)dx - \frac{1}{8}\sin(2x) + \frac{1}{8} \int \cos^3(2x)dx + C \]
Example: \[ \int \cos^4(x) \sin^3(x) \, dx = \]

\[ = \int \cos^4(x) \sin^2(x) \sin(x) \, dx \]

\[ = \int \cos^4(x) (1 - \cos^2(x)) \sin(x) \, dx \]

\[ = \int \cos^4(x) \sin(x) \, dx - \int \cos^6(x) \sin(x) \, dx \]

\[ = -\frac{\cos^5(x)}{5} + \frac{\cos^7(x)}{7} + C \]
Strategy for products of sine and cosine with even powers:

\[ \cos^2(u) = \frac{1}{2} + \frac{1}{2} \cos(2u) \]

\[ \sin^2(u) = \frac{1}{2} - \frac{1}{2} \cos(2u) \]

Strategy for products of sine and cosine with one odd power:

Split off one of the odd powers. Change everything else to the other one and integrate.