• Turn off and put away cell phones, graphing calculators, books, and notebooks.

• You may use one $8 \frac{1}{2} \times 11$ sheet of handwritten notes and a non-graphing calculator. Do not share notes or calculators.

• In order to receive credit, you must show your work and explain your reasoning, and give exact answers. You do not need to simplify answers algebraically.

• Place a box around **YOUR FINAL ANSWER** to each question.

• If you need more room, use the backs of the pages and indicate to the grader where to find your work.

• Raise your hand if you have a question or need more paper.

Please do not open the test until everyone has a copy and the start of the test is announced.
1. (10 points) A parallelepiped in the first octant has edges $\vec{OP}$, $\vec{OQ}$, and $\vec{OR}$ going from the origin $O(0, 0, 0)$ to the vertices $P(4, 0, 0)$, $Q(1, 3, 0)$, and $R(2, 1, 2)$.

(a) Find the volume of the parallelepiped.

(b) Find the sine of the angle between the edges $\vec{OQ}$ and $\vec{OR}$. 
2. (13 points) Let $f(x) = xe^{3x}$.

(a) Find the Taylor Series based at $b = 2$ for $f(x)$.

(b) Find $f^{(20)}(0)$. 

3. (13 points)(a) Find the Taylor Series based at \(b = 0\) for

\[
g(x) = \frac{1}{5 - x} + \frac{x}{1 + 4x^2}.
\]

(b) Find the interval of convergence for this Taylor Series.
4. (14 points) Consider the function \( f(x) = \sin \frac{x}{2} \).

(a) Find the third order Taylor polynomial \( T_3(x) \) based at \( b = \pi \) for \( f(x) \).

(b) Use the Taylor inequality to find an upper bound on the error \( |f(x) - T_3(x)| \) on the interval \([\pi/2, 3\pi/2]\).