• Complete all questions.

• You may use a calculator, and you should have one, during this examination. Other electronic devices are not allowed, and should be turned off for the duration of the exam.

• You may use one double-sided, hand-written, 8.5 by 11 inch page of notes.

• Show all work for full credit.

• You have 80 minutes to complete the exam.
1. Evaluate the integrals.

(a) \[ \int \sin^3 x \cos^{19} x \, dx \]

(b) \[ \int \sin^5 x \cos x \ln \sin x \, dx \]
2. Evaluate the integrals.

(a) \[ \int \frac{x^5}{\sqrt{x^2 - 9}} \, dx \]

(b) \[ \int \frac{x^3}{x^2 + 3x - 4} \, dx \]
3. Evaluate the following integrals.

(a) \[ \int x^9 e^x \, dx \]

(b) \[ \int \frac{dx}{x^2 - 12x + 41} \]
4. Evaluate each of the following integrals. Either give the value of the integral or show that it is divergent.

(a) \[ \int_0^{\ln 6} \frac{1}{e^x - 1} \, dx \]

(b) \[ \int_2^{\infty} \frac{dx}{x^2 \sqrt{x^2 + 1}} \]
5. A tank is shaped like the solid of revolution created by revolving the region in the first-quadrant bounded by \( y = x^5, y = 32 \), and the \( y \)-axis about the \( y \)-axis. Assume units are meters.

If the tank is filled with a liquid with density of 750 kg/m\(^3\), how much work is done in pumping all of the liquid in the tank to a point 8 meters above the top of the tank? Acceleration due to gravity of 9.8 m/s\(^2\).

6. For what value of \( k > 0 \) does the function

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

have the minimum possible average value on the interval \([0, 1]\)?