Please PRINT your name on the cover of your exam booklet and indicate if you are handing-in more than one booklet. Write clearly and cross-out work not to be graded.

ALL ANSWERS GO IN THE EXAM BOOK. **NO CALCULATORS ALLOWED.**
Simplify where possible, but leave all answers in **exact** form unless otherwise indicated.

1. Evaluate the following integrals: (30 pts.)

   (a)
   $$\int \cos^3 x \ \sin^2 x \ dx$$

   (b)
   $$\int_1^4 \sqrt{t} \ \ln t \ dt$$

   (c)
   $$\int \frac{1}{1 - x^2} \ dx, \quad \text{for} \quad -1 < x < 1$$

2. Tritium-3 decays at a rate proportional to the amount at time t. A 100 mg sample of (20 pts.) tritium-3 decayed to 94.5% of its original amount after a year.

   (a) What is the half-life of tritium-3?

   (b) How long would it take the sample to decay to 20% of its original amount?

3. Find the derivative, $\frac{dy}{dx}$, of each of the following functions $y(x)$ and **simplify** your (30 pts.) answers:

   (a) $y = \arctan(e^x)$ (i.e. $y = \tan^{-1}(e^x)$)

   (b) $y = x^{\sqrt{x}}$

   (c) $2^{\ln x}$

4. Given
   $$\int_1^\infty x^2 e^{-x^3} \ dx$$

   Determine if it is convergent or divergent. If it is convergent, find its value; if it is (20 pts.) divergent, show (by calculation) or explain (by comparison) why.

5. **Extra credit:** find $(f^{-1})'(a)$ if $f(x) = x^5 - x^3 + 2x$ and $a = 2$. (+5 pts.)