1. Find the integrals:
   a) \[ \int (e^{\sin x})^2 \cos x \, dx \]
   b) \[ \int x\sqrt{x-1} \, dx \]

2. Integrate \[ \int \frac{t^2}{(t^2-1)(t-2)} \, dt \]
3. Integrate \[ \int x \ln x \, dx \]

4. A certain compound transforms from state A to state B at a (per minute) rate proportional to the concentration of B in the mixture:
   \[ \frac{dc_A}{dt} = -0.02c_B \]
   where \( c_A \) and \( c_B \) are the concentrations of A and B respectively (and, assuming no other material is present, \( c_A + c_B = 1 \)). If at time \( t = 0 \) the mixture is 90% in state A how long will it take to be 10% A?

5. Find the limit. Show your work.
   a) \( \lim_{x \to 1} \frac{\ln x}{\sin(\pi x)} = \)
   b) \( \lim_{x \to 0} \frac{xe^x}{e^{2x} - 1} = \)
   c) \( \lim_{x \to \infty} \frac{3x^6 + 7x^4}{2(x^3 + 1)^3} = \)

6. Do the integrals converge? If so, evaluate:
   a) \( \int_0^\infty xe^{-x} \, dx \)
   b) \( \int_2^\infty \frac{dx}{x(\ln x)^{23}} \)

7. Do the series converge or diverge? Give a valid reason for your answer.
   a) \[ \sum_{n=1}^\infty \frac{n^2 + 1}{(n+1)^3} \]
   b) \[ \sum_{n=1}^\infty \frac{\ln n}{2^n} \]
   c) \[ \sum_{n=1}^\infty \frac{(n! + 1)^2}{(n+1)!^2} \]

8. Find the vertices of the conic given by the equation \( 4x^2 - y^2 + 8x - 4y + 12 = 0 \).

9. Find the area of the region enclosed by the curve given in polar coordinates by \( r = 2e^{\theta} \), \( 0 \leq \theta \leq 2\pi \) and the segment of the x axis between \( x = 2 \) and \( x = 2e^{2\pi} \).

10. a) Find the general solution of the homogeneous differential equation \( y'' - 3y' + 2y = 0 \).
    b) Find a particular solution of the homogeneous differential equation \( y'' - 3y' + 2y = \sin x \).