For a tuna melt sandwich, melt a small amount of butter over low heat in a skillet or electric grill. Place two slices of bread over the melted butter, and spread drained tuna on one slice and cheese on the other. Cover, and keep at low heat. When the cheese is melted, close the sandwich.

1. Compute (5 points each):

(a) \[ \int_2^3 (4x^3 + 3x^2 + 6) \, dx \]

(b) \[ \int_0^1 2xe^{x^2} \, dx \]

(c) \[ \int \sin (3x)e^{4x} \, dx \]

(d) \[ \int_1^{\sqrt{3}} \sqrt{4 - x^2} \, dx \]

(e) \[ \int \frac{(2x + 1)}{(x + 2)(x - 1)} \, dx \]

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

2. Compute the area that lies between the curves (10 points):

\[ y = x^2 \quad \text{and} \quad y = x \quad \text{for} \quad x \in [0, 1] \]

3. (10 points) Compute the volume obtained by rotating the region bounded by the curve \( y = x^2 \) between \( x = 2 \) and \( x = 6 \) about the \( x \)-axis.

4. (10 points) Find the length of the curve \( y = \ln (x) - \frac{x^2}{8} \) from \( x = 1 \) to \( x = 2 \). Recall that the formula for arc-length is \( L = \int_a^b \sqrt{1 + (f'(x))^2} \, dx \).

5. (10 points) A spring has a natural length of 1 meter. A force of 24 Newtons stretches the spring to a length of 1.8 meters. What is the force constant in Hooke’s law? How much work is needed to stretch the spring 3 meters beyond its natural length?
6. \textit{(10 points)} Suppose that as a highly successful middle-aged college professor at a mid-level state university. You look at your retirement account and see that it contains $700,000. The account consistently has earned 6\% interest annually as if it were compounded continuously. You plan to retire in 5 years. How much do you think will have accumulated in the account?

7. Find the limit if it exists \textit{(5 points)}:

(a) \[
\lim_{n \to \infty} \frac{n^2 - 3n + 2}{3n^2 - 2n + 4}
\]

(b) \[
\lim_{n \to \infty} \sqrt[n]{\frac{n}{n - 1}}
\]

(c) \[
\lim_{n \to \infty} [(-1)^n + 1]
\]

(d) \[
\lim_{n \to \infty} \left(1 + \frac{7}{n}\right)^n
\]

8. Find the sum \textit{(5 points)}:

\[
1 + \frac{1}{6} + \frac{1}{36} + \frac{1}{216} + \cdots + \frac{1}{6^n} + \cdots
\]

9. Use any test that you like to determine if the given series converges \textit{(5 points each)}.

(a) \[
\sum_{n=1}^{\infty} \frac{1}{n^{101/100}}
\]

(b) \[
\sum_{n=1}^{\infty} \frac{1}{3n + 2}
\]

(c) \[
\sum_{n=1}^{\infty} \frac{1}{5^n + 1}
\]

(d) \[
\sum_{n=1}^{\infty} \frac{2^n}{n!}
\]

(e) \[
\sum_{n=2}^{\infty} \frac{(-1)^n}{2n}
\]
10. Compute the interval of convergence for the series \((10 \text{ points})\):

\[
\sum_{n=0}^{\infty} \frac{x^n}{n \cdot 3^n}
\]

11. \((10 \text{ points})\) Use substitution to find the Taylor series about \(x=0\) (MacLaurin series) of the function \(f(x) = xe^x\).

12. \((5 \text{ points})\) Give a parametrization of the ellipse \(\frac{x^2}{16} + \frac{y^2}{25} = 1\) that starts at \((4,0)\) and travels once clockwise in the interval \(t \in [0, 2\pi]\).

13. \((10 \text{ points})\) Compute the area enclosed by the polar graph: \(r = \cos(\theta)\) for \(\theta \in [-\pi/2, \pi/2]\).