1. Find and provide a sketch showing all values of the following:
   (a) $i^i$
   (b) $(-1)^{\sqrt{2}}$
   (c) $(1 + i)^{2-i}$

2. Prove the following:
   (a) If $z \neq 1$, show that:
   $$1 + z + z^2 + \cdots + z^n = \frac{1 - z^{n+1}}{1 - z}.$$
   (b) Use part (a) to prove Lagrange’s Identity
   $$1 + \cos(\theta) + \cos(2\theta) + \cdots + \cos(n\theta) = \frac{1}{2} + \frac{\sin((n + \frac{1}{2})\theta)}{2\sin(\theta/2)}$$
   where $0 \leq \theta \leq 2\pi$.

3. Consider the following function
   $$f(z) = \frac{(z \operatorname{Re}(z))}{|z|} \quad \text{when} \ z \neq 0 \ \text{and} \ f(0) = 1.$$
   Is it continuous at 0? Either prove it is or explain why it isn’t.

4. Let $C$ be the right half-circle of radius 2 beginning at the point $-2i$ and ending at $2i$. Find:
   $$\int_C z^{1/2} \, dz$$
   where $z^{1/2}$ is the principal branch.

5. Let $f$ be a nonconstant analytic function in the closed disk $R = \{z : |z| \leq 1\}$. Suppose that $|f(z)| = K$ for all $z$ on the circle of radius 1. Prove that $f$ must have a 0 in the interior of $R$.

6. Find the Maclaurin series for $f(z) = e^z \cos(z)$ and state where it is guaranteed to converge.

7. Compute the following integrals:
   (a) $$\int_{-\infty}^{\infty} \frac{x}{x^3 - 8} \, dx$$
(b) \[ \int_{0}^{2\pi} \frac{\cos(2\theta)}{5 - 4 \cos(\theta)} \, d\theta. \]

8. Determine the function \( T(x, y) \) describing the steady state temperatures in the first quadrant \((x > 0, y > 0)\) that satisfies the following boundary conditions:

\[
\begin{align*}
T(x, 0) &= 10 \quad \text{for} \ x > 1, \\
T(x, 0) &= 20 \quad \text{for} \ 0 < x < 1, \\
T(0, y) &= 20 \quad \text{for} \ 0 \leq y < 1, \\
T(0, y) &= 10 \quad \text{for} \ y > 1.
\end{align*}
\]