1. (10 pts.) Sketch the locus of each of the following equations in the complex plane.
(a) $|z - i| = |z + 1|$
(b) $\arg(z - i) = -\pi/4$

2. (10 pts.) Let $f(z) = e^z$. Parametrize and sketch each of the following lines.
Then find and sketch their image under $f$.
(a) $\text{Re } z = -2$
(b) $\text{Im } z = 2$

3. (20 pts.) Find the Taylor series expansion of each of the following functions at the given center $c$. In each case determine and sketch the disc of convergence.
(a) $\frac{1}{3 + z}$, $c = 0$
(b) $\frac{1}{3 + z}$, $c = 1$
(c) $\log(z)$, $c = 2$
(d) $\frac{z^7}{e^{z^2}}$, $c = 0$

4. (10 pts.) Consider $f : \mathbb{C} \to \mathbb{C}$.
(a) Suppose $f(z) = -i \log(z)$. Describe geometrically the local behavior of $f$ in the vicinity of $z = 1 - i$.
(b) Suppose $f$ is a global expansion by a factor of $1/2$ composed with a clockwise rotation by $\pi/2$. Write down a formula for $f(z)$.

5. (10 pts.) Find all points in the complex plane, where each of the following functions of $z = x + iy$ is complex differentiable.
In each case, at the points where the function is complex differentiable, find the derivative.
(a) $\frac{1}{x - iy}$
(b) $e^{-y}(\cos x + i \sin x)$

6. (10 pts.) Find all roots of $f$ in the unit disc and determine their multiplicity.
(a) $f(z) = \cos(4z) + 1$
(b) $f(z) = e^{4z} + i$

7. (10 pts.) Integrate $f(z) \, dz$ along the straight line segment from $i - 1$ to $1$.
(a) $f(z) = \text{Im } z$
(b) $f(z) = zz$

8. (20 pts.) Integrate around the unit circle once counterclockwise.
(a) $\int \frac{dz}{i - 2z}$
(b) $\int \frac{dz}{z^3 - 2z^2}$
(c) $\int \frac{\cos(z^2)}{z^7} \, dz$
(d) $\int \frac{dz}{z \cos z - z}$

9. (10 pts.) Show that all three roots of $p(z) = z^3 - z - 4$ lie in the annulus $1 < |z| < 2$. 

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