Problem 1:
Gamma function is defined as
\[ \Gamma(x) = \int_0^\infty e^{-y} y^{x-1} dy \]
Evaluate \( \Gamma\left(\frac{1}{2}\right) \). [Hint: Use substitution \( u = \sqrt{y} \).]

Problem 2:
Find the volume of \( n \)-dimensional sphere of radius \( R \), \( V^{(n)}(R) = ? \)

Problem 3:
If Gauss Law is valid in a 4-dimensional space – electric flux through the Gauss surface is equal to \( \rho^{(4)}(\vec{x})/\epsilon_0 \), then find the expression for the electric field for a point charge particle with charge \( q \), at a point \( r \) away from the charge.

Problem 4:
Find the following integral with the introduction of \( e^{-\alpha x} \) factor.
\[ I = \int_0^\infty \frac{\sin x}{x^2} dx \]

Problem 5:
Find the residues of the following functions at the indicated points:

a) \[ \frac{1}{(3z + 2)(2 - z)} \quad z = -\frac{2}{3} \quad z = 2 \]
b) \[ \frac{z + 2}{4z^2 + 1} \quad z = \frac{1}{2} \quad z = -\frac{1}{2} \]
c) \[ \frac{e^{2z} - 1}{z^2} \quad z = 0 \]
d) \[ \frac{z - 2}{z^2(1 - 2z)^2} \quad z = 0 \quad z = \frac{1}{2} \]

Problem 6:
Evaluate the following integrals using contour integration:

a) \[ \int_{-\infty}^{\infty} \frac{x^2}{1 + x^4} dx \]
b) \[ \int_{-\infty}^{\infty} \frac{\cos x}{x^2 + a^2} dx \quad (a > 0) \]
c) \[ \int_{-\infty}^{\infty} \frac{x \sin x}{x^2 + a^2} dx \quad (a > 0) \]

Problem 7:
Show that
\[ \int_{-\infty}^{\infty} \frac{e^{ax}}{e^x + 1} dx = \frac{\pi}{\sin \pi a} \quad \text{for } 0 < a < 1 \]