(1) Compute \( \oint_C \frac{e^{2z}}{z^4 (2-z)^2} \) for

(a) \( C: z(t) = \frac{1}{2} e^{it}, \quad 0 \leq t \leq 2\pi \)

(b) \( C: z(t) = \frac{t}{2} e^{it} - i, \quad 0 \leq t \leq 2\pi \)

(c) \( C: z(t) = \frac{1}{4} e^{it} + i, \quad 0 \leq t \leq 2\pi \)

(d) \( C: z(t) = 2e^{it}, \quad 0 \leq t \leq 2\pi \)

(2) Evaluate using a single residue "infinity moved to zero" \( \oint_C \frac{z+2}{z^2 z (z+2) (z+3)} \)

(3) Find the Maclaurin series of \( f(z) = \frac{z}{(z+2)^2} \)

(4) Find the Maclaurin series of \( f(z) = \log(1+z) \)

(5) Find the Laurent series of \( \frac{1}{(2-z)(3-z)} \)

valid in (a) \( 0 \leq \Im z \leq 2 \) (b) \( 2 \frac{\pi}{3} \leq \Im z \leq 3 \) (c) \( |Re z| > 3 \)
(6) Use multiplication of power series to find the first 3 non-zero terms of the Maclaurin series of
\[ f(x) = \frac{\sin x}{x-1} \]

(7) (a) Use division of power series to find the first 3 non-zero terms of the Laurent series of
\[ f(x) = \frac{1}{e^{x} - 1} \quad \text{valid in } 0 < |x| < 2\pi 

(b) Compute \[ \sum_{n=1}^{\infty} \frac{1}{e^{2n} - 1} \]

(8) Compute \[ \sum_{n=1}^{\infty} \frac{2^n \exp \left( \frac{1}{n} \right) d\bar{z}}{121} = 3 \]

(9) Compute \[ \sum_{n=1}^{\infty} \frac{\cos z}{2 + \pi} \quad \text{valid in } |z| < 1 \]

(b) Compute \[ \sum_{n=1}^{\infty} \frac{\cos z}{(2-\pi)(2+\pi)} \quad \text{valid in } |z| < 7 \]

(10) Compute \[ \sum_{n=1}^{\infty} \frac{\log z}{2^n + 1} \quad \text{valid in } |z| < \frac{1}{2} \]
(17) Compute \( \int \cot(bz) \; dz \)

\( b = 4 \)

(18) Compute the real integral using residues

\( \int_0^\infty \frac{dx}{x^4 + 1} \)

be sure to justify each step fully.

(19) Compute the real integral using residues

\( \int_0^\infty \frac{\cos(5x) \; dx}{x^2 + 1} \)

be sure to justify each step fully.