Answer all questions. Make sure that you explain all your steps and justify your answers.

9. (a) [2pts] Do Prob. 8 of section 2.4, p. 77 of textbook.
   (b) [4pts] Do Prob. 10 of section 2.4, p. 78 of textbook.
   (c) [4pts] Do Prob. 12, p. 78 of textbook.

10. Show that each of the following given functions is harmonic (in the region where it is defined). Find its harmonic conjugate \( v \), i.e., a \( v \) such that \( f(z) = u + iv \) is analytic. Express \( f(z) \) as a function of \( z \) in each case. [5pts each]
    (a) \( u = xy - x + y \); (b) \( u = 3x^2y - y^3 \).


12. (10pts) Let \( f(z) = u(x, y) + iv(x, y) \) be analytic in the domain \( D \). Show that
    \[
    \left( \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} \right) \sqrt{u(x, y)^2 + v(x, y)^2} \geq 0 \quad \text{in} \ D
    \]
    (where the positive square root is taken). When does the equality hold?

13. (5pts each) Find the partial fraction decomposition for each of the following functions:
    (a) \( \frac{2 + i}{z(z + 1)(z + 3)} \), (b) \( \frac{z}{(z^2 + 1)^2} \).

14. Determine all possible values of the following quantities in the form \( a + ib \); \( a \) and \( b \) are real.
    (a) [3pts] \( \text{Ln}(-\sqrt{3} - i) \), (b) [3pts] \( (i)^{\sqrt{2}} \), (c) [4pts] \( (1 + i)^{-1+i} \).

15. (2.5pts each) (a) Do Prob. 10 of section 3.2, p. 115 of textbook.
    (b) Solve the equation \( \text{Log}(z^2 - 1) = i\pi/4 \)
    (c) Solve the equation \( e^{3z} + 2e^z + i = 0 \).
    (d) Solve the equation \( \sin z = \cos z \).

16. Discuss the branch cut situation for: [5pts each]
    (a) \( f(z) = [(z - 1)/(z + 1)]^{1/2} \)
    (b) \( g(z) = \sqrt{1 + \sqrt{z}} \).