

Exam # 1 2 March 2009

Ocean Turbulence MAR 610 / MNE 490 Professor L. Goodman

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1. (50 pts) A certain flow field has x, y, z velocity components

$$u = z, \quad v = 0, \quad w = 1 \quad \text{units of } \left(\frac{\text{m}}{\text{sec}}\right).$$

- (a) What are the three components of the vorticity vector $\vec{\omega}$ at the position $x = 0, y = 0, z = 1$?
 (b) What are the three components of the vorticity vector $\vec{\omega}$ at $x = 1, y = .5, z = 1$?
 (c) What are the units of vorticity?
 (d) Write down the Lagrangian positions (x, y, z) as a function of time for a fluid element which is initially $(t = 0)$ at $X = 0, Y = 0, Z = 0$.

2. (50 pts) Suppose the turbulent acceleration field $\frac{\partial u'}{\partial t}$ has the one sided angular frequency

autospectrum $\Phi_{g1s}(\omega)$ shown below.

- (a) What is the value of A?
 (b) What is the variance of the acceleration $\langle (\frac{\partial u'}{\partial t})^2 \rangle$?
 (c) Draw the spectrum of u' ? Indicate its values at $\omega = 0, 3, 6$.
 (d) What is the variance of u' , $\langle (u')^2 \rangle$?
 (e) What is the integral scale τ_I ?
 (f) What is the Taylor microscale τ_μ ?

