Advanced Environmental Hydraulics I

2012 Final Examination

December 12, 2012

1. Circle the correct answer, True (T) or False (F) for each of the following statements (5 points for correct answer, 0 point for no answer, minus 2 point for wrong answer).

(1) Taylor's one-dimensional dispersion equation can be applied after balance of advection and transverse diffusion is achieved. T F

(2) Reynolds analogy states that the mixing coefficients for momentum and mass are the same. T F

(3) For the sinusoidal oscillatory flow, when $T >> T_c$ there will be no dispersion due to the velocity profile. (T = period of oscillation; T_c = time needed for complete mixing) T F

(4) Transverse mixing coefficient in 2D contaminant transport model should be derived considering dispersion effect by shear flow due to transverse variation of *v*-velocity. T F

(5) The irregularities in real streams decrease both the length of the initial period and the longitudinal dispersion coefficient. T F

2. Answer questions about turbulent mixing coefficient. (25 points)

(a) Derive depth varying vertical mixing coefficient

$$\varepsilon_v = \kappa d u^* \frac{z}{d}\left(1-\frac{z}{d}\right)$$

(b) Derive depth-averaged coefficient of vertical mixing coefficient.

$$\overline{\varepsilon_v} = \frac{\kappa}{6} d u^* = 0.067 d u^*$$

3. Answer questions about longitudinal dispersion for 1D contaminant transport model. (25 points)
(a) Explain why Elder's result does not apply to longitudinal dispersion for 1D model.

(b) Propose the appropriate theory for longitudinal dispersion coefficient for 1D model.

4. An industry discharges effluent containing conservative contaminant into a wide straight stream. The stream is 6 m deep, the mean velocity is 0.8 m/s, and the slope is 0.0001. Assume that the effluent is completely mixed over the vertical and calculate how far out into the stream the pipe outlet should be placed to ensure that a zone projecting 15 m out from the bank would be essentially free from the contaminant at a distance of 300 m downstream of the outlet. Perform your calculations (a) to favor the interests of industry discharging the effluent, and (b) to favor the interests of another industrial user who will locate a water intake along the bank in the contaminant-free zone 300 m downstream from the outlet. (25 points)