

✓

**BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR**  
**M. E. (Engineering Mechanics) 1<sup>st</sup> Semester Final Examination, December 2011**  
**Theory of Hydraulic Models I (AM-908)**

Time: 3 hours

Full Marks: 70

- a) Attempt ANY FOUR questions  
b) All questions carry equal marks and two marks reserved for neatness.
- 

**Q. 1. a)** List all variables that may influence the motion of a moving body fully submerged in a fluid and by dimensional analysis derive an expression for resistance of its motion.

**b)** A fluid of density  $\rho$  and viscosity  $\mu$  flows through a pipe of diameter  $d$ . Show that the resistance per unit area of surface is given by,  $F = \rho v^2 \phi(R_e)$ .

**Q. 2. a)** A uniform wind in a desert lifts sand into the air. Assuming that all sand grains have the same diameter, list the variables that determine the weight of sand in the air, per unit area of land surface. Make a dimensional analysis of the problem.

**b)** List the variables that determine the terminal velocity of a falling raindrop. Determine the most general dimensionally homogeneous form of an equation that expresses this relationship.

**Q. 3.** Determine the dimensional matrix and compute the dimensionless products of variables volume  $Q$ , acceleration  $A$ , velocity  $V$ , power  $P$ , momentum  $M$  and angular velocity  $N$ .

**Q. 4.** A body at  $10^{\circ}\text{C}$  is dropped into a large bath of liquid which is maintained at a uniform temperature of  $100^{\circ}\text{C}$ . In 5 min, the temperature at a point in the body rises to  $40^{\circ}\text{C}$ . In how many more minutes will the temperature rise from  $40^{\circ}\text{C}$  to  $98^{\circ}\text{C}$ ? Derive the expression used here.

**Q. 5.** Write short notes on

i) Buckingham's  $\pi$ -theorem ii) Scale effects in model iii) Weber Number iv) Dynamic similarity.