INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date 24/02/2012 AN Time 2 Hrs Full Marks: 30 No. of Students:25

Spring Semester, 2011-2012 Deptt. Ocean Engineering and Naval Architecture

Sub. No. NA60014 Subject Name: Hydroelasticity 5th year Dual Degree MTech/4th Year B.Tech/RS

Answer any four questions. All questions are of equal marks

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1. (a) Define the terms aeroelasicity and hydroelasticity. Find the differences between aeroelasticity and hydroelasticity.
   (b) Determine the first four natural frequencies and the corresponding mode shapes of an elastic beam of length a, which is freely floating. Give an example of such a structure in Ocean engineering.

2. Derive the mathematical formulation of the linearised free surface condition in terms of the velocity potential when a thin elastic plate is floating on the water surface in water of finite depth using Euler Bernouli's Beam equation as the plate equation. Thus, derive the dispersion relation for flexural gravity waves.

3 Consider the static deflection of a string fixed at two ends at x = 0 and L and under a continuously distributed load p(x) per unit length. The deflection $\eta(x)$ satisfies the differential equation $T\eta'' = p(x), 0 < x, \xi < L$. Find the expression for the deflection of the string. (Hints. Apply Green's function technique with $\eta(0) = \eta(L) = 0$. It may be noted that in structural mechanics, Green function has long been called the influence function and the symmetry property is called the principle of reciprocity).

4 Consider the equation of the forced motion of a vibratory system given by

$$m\ddot{x} + kx = f(x,t)$$

Assuming that the forcing term $f(x,t) = F_0 \sin \Omega t$ where Ω is not related with the natural frequency $\omega = \sqrt{k/m}$. Discuss various aspect of the motion. How the resonating pattern will change with the introduction of the damping term. (Hint: Eqn. of motion is $m\ddot{x} + c\dot{x} + kx = f(x,t)$ in the presence of damping).

5 Formulate in detail the scattering of surface water waves by a vertical flexible plate in finite water depth which is fixed at the bottom and oscillate freely near the free surface. Thus, discuss the solution procedure to obtain the free surface elevation and the plate deflection.