College of Maritime Engineering and Marine Sciences

First Evaluation – Mechanical Vibrations **Nov. 18th, 2024**

Student: ..... ESPOL ID: .....

Closed books

1.- With two vibration sensors, the motion of the forward and aft ends of a ship is measured when it navigates in regular waves. Main characteristics of the vessel are: L_{bp}= 40 m, B= 7.40 m, D= 3.70 m, T= 1.86 m, Δ=241 tons, and the period of oscillation is 1.93 sec. In the vertical direction results show that at the forward and aft perpendiculars the ship moves as (positive upward):

$$\zeta_{Forward} = 1.999\cos(\omega t + 173.66^o), \quad [m], \text{ and,}$$

$$\zeta_{Aft} = 1.379\cos(\omega t + 62.2^o), \quad [m].$$

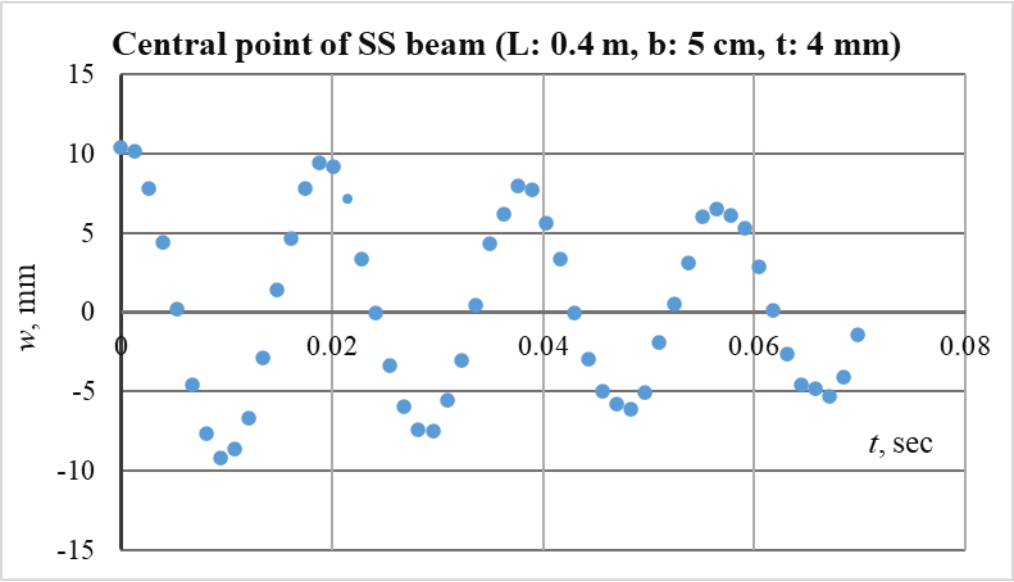
Express in complex notation the angular motion of the ship in the vertical plane (pitch), and specify its maximum value. (20)

2.- A steel flat bar, seated on its longer side, simply supported on both ends is set vibrate freely with the register shown in the attached figure. It is desired to calculate the effective mass when the beam is modelled as a 1 dof system, with the effective mass located at the central point between supports. From Ship's Structure class, it is known that when a force F is applied at the center of a SS beam, the following expression is obtained for the deflection function:

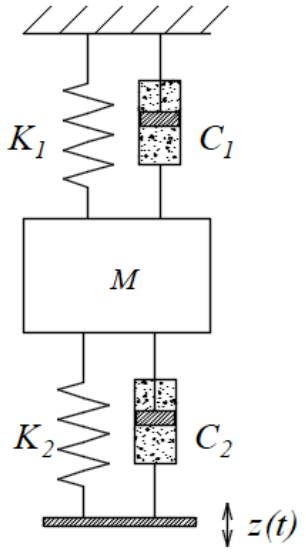
$$EI_c v(x) = \frac{F\left(x-\frac{L}{2}\right)^3 S\left[x-\frac{L}{2}\right]}{6} - \frac{Fx^3}{12} + \frac{F}{16}L^2 x$$

.

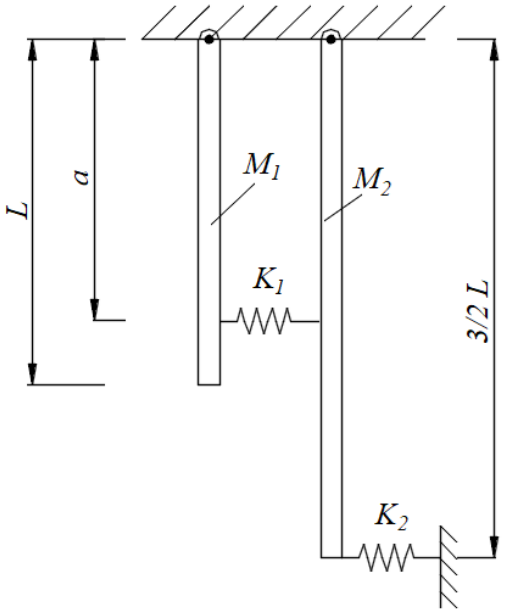
Express your answer as a percentage of the mass of the beam. Structural steel properties are: E: 2.06E11 Pa, ν: 0.3, γ: 76440 N/m^3. (30)



3.- The following is a simplified model for the vertical response of a cargo box which is seated on a vibrating foundation. You are asked to calculate the amplitude of the system's response in resonant situation. The following characteristics are to be applied: $K_1=2K_2=10$ N/mm, $\xi_1=\xi_2=0.12$ and $M=50$ kg. The harmonic base motion has an amplitude of 1.5 mm. (25)



4.- Consider the oscillation in the plane of the system shown in the figure. Deduce the equations of motion and express it in matrix form. All parameters in the equations must be expressed in terms of the characteristics shown in the figure. (25)



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I certify that during this exam I have complied with the Code of Ethics of ESPOL.

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