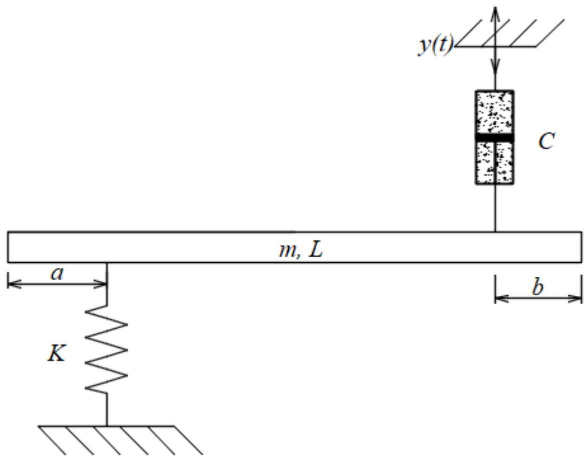
Faculty of Maritime Engineering and Marine Sciences

Mechanical Vibrations

Exam 2 – V-dof, hydrodyn. properties, beam vibrations Jan. 27th, 2023

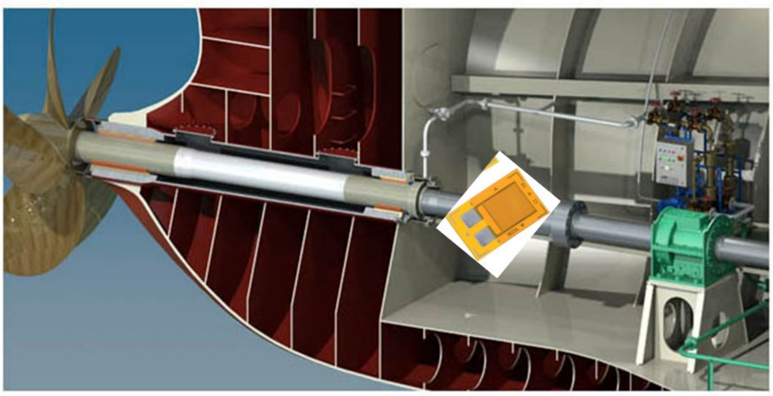
Student: ……………………………………………………………………………

1. Consider the oscillation in the plane of a rigid bar with uniform distributed mass, *m*, and length *L*. It is supported by a spring and also it has installed a damper, as shown in the figure. Because of vibration from a close motor, the support point of the damper is moving vertically with harmonic motion *y(t)*. Deduce the equations of motion of the bar and express them in matrix form. (25)



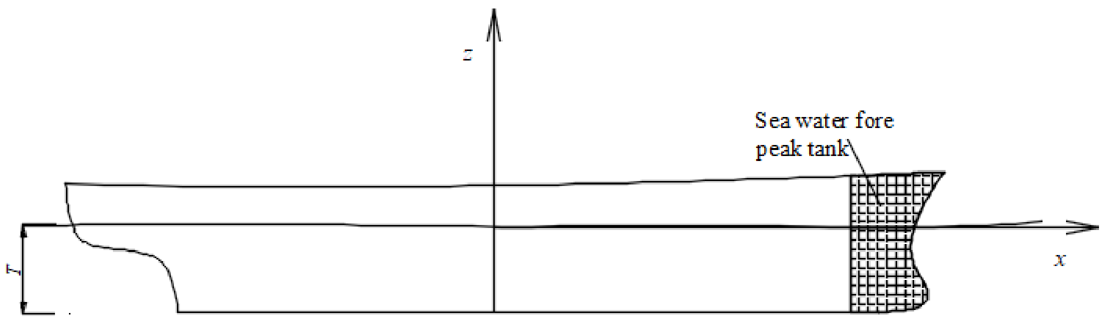
2. Torsional excitation from the propeller in a marine propulsion system is to be estimated from the measurement of the shear strain in the shaft. When the shaft is rotating at 300 rpm and considering that the propeller has 5 blades, the following Holzer table is prepared for the forced oscillation of the system. From the shear strain in the propeller shaft, the amplitude of the vibratory torque in this element is measured as 3500 N-m. You are asked to estimate the amplitude of the oscillatory torque absorbed by the propeller, which is causing the torsional vibration in the propulsion system. (30)

i	J_i	Ci	$-J_i\omega^2+i\omega C_i$		Θ_i		$(-J_i\omega^2+i\omega C_i)\Theta_i$		$\Sigma(-J_i\omega^2+i\omega C_i)\Theta_i$		K_i	G_i	$[\Sigma(-J_j\omega^2+iwC_j)\Theta_j]/(K_k+iwG_k)$	
	kgm^2	Nms			Radians						Nm/rad	Nms		
1	0.98	120	-2.42E+04	1.88E+04	1.000	0.000	-2.42E+04	1.88E+04	-2.42E+04	1.88E+04	5.40E+06	0.00E+00	-4.48E-03	3.49E-03
2	0.98	120	-2.42E+04	1.88E+04	0.996	0.003	-2.41E+04	1.87E+04	-4.83E+04	3.75E+04	5.40E+06	0.00E+00	-8.95E-03	6.95E-03
3	0.98	120	-2.42E+04	1.88E+04	0.987	0.010	-2.41E+04	1.83E+04	-7.24E+04	5.59E+04	5.40E+06	0.00E+00	-1.34E-02	1.03E-02
4	0.98	120	-2.42E+04	1.88E+04	0.973	0.021	-2.39E+04	1.78E+04	-9.63E+04	7.37E+04	5.40E+06	0.00E+00	-1.78E-02	1.37E-02
5	60	0	-1.48E+06	0.00E+00	0.955	0.034	-1.41E+06	-5.10E+04	-1.51E+06	2.27E+04	5.40E+06	0.00E+00	-2.80E-01	4.21E-03
6	0.5	0	-1.23E+04	0.00E+00	0.676	0.039	-8.33E+03	-4.77E+02	-1.52E+06	2.23E+04	1.00E+05	0.00E+00	-1.52E+01	2.23E-01
7	0.8	0	-1.97E+04	0.00E+00	-14.514	0.261	2.86E+05	-5.16E+03	-1.23E+06	1.71E+04	5.00E+05	0.00E+00	-2.46E+00	3.42E-02
8	40	2200	-9.87E+05	3.46E+05	-16.979	0.295	1.67E+07	-6.16E+06	1.54E+07	-6.14E+06				



3. In *SiMar* lab of FIMCM-ESPOL a simple experiment is to be developed with a plastic tube which will be oscillating vertically in calm water to determine its natural frequency. Initially the tube is floating steadily with a draft equal to the radius of the circular section, with no trim. Tube length is 1 m, and its diameter is 20 cm. To compare with experimental results you have to estimate the period of oscillation when the tube is freely oscillating with pure heave motion. (15)

4. A ship hull with a displacement of 16700 tons and 135 meter long is vibrating in resonance excited by the propeller at blade rate (N_{Prop};120 rpm, Z: 5, P/D: 1.05). To solve the problem it is suggested to fill the fore peak of the ship with sea water, with a weight of approximately 10% of the vessel's displacement. Deduce the characteristic equation of free vertical hull vibration which later may be used to calculate the natural frequency; the equation must clearly show the parameters involved for the required calculation. Assume the ship hull is a prismatic beam and the water in the tank has negligible mass moment of inertia. (30)



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I certify that during this exam I have complied with the Code of ethics of our university.

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