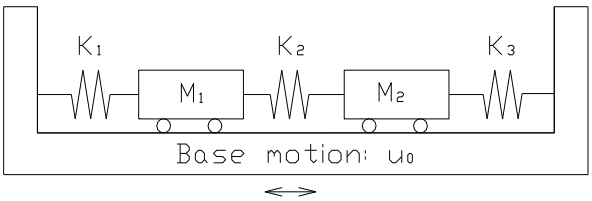
**College of Maritime Engineering, and Biological, Oceanical and Natural Resource Sciences**

**Ship Vibrations**

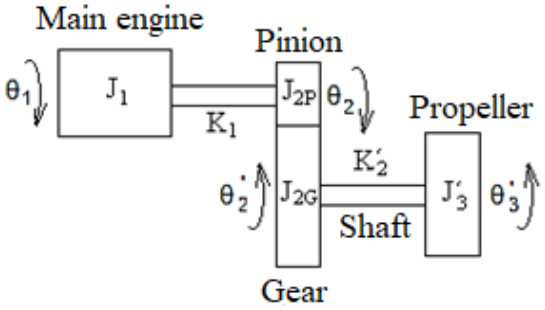
Second Evaluation August 28th, 2017

Student: .....

**1.-** Deduce the motion equations of a system composed by two blocks with masses $M_1$ y $M_2$, that can move horizontally over a base, and are linked by springs between them and to the vertical sides of the base, as shown in the figure. The base follows a horizontal harmonic motion: : $u_o = Ue^{i\omega t}$. Present your solution is matrix form. (15)




**2.-** Consider the simplified model of a ship propulsion system, which includes an engine, a reduction gear, shaft, and propeller. Due to the high stiffness of the crankshaft, the model of the engine is a single disk. The diameter of the pinion is 15 cm, and its mass polar moment of inertia is 0.1 kg m$^2$, and, reduction gear 2.5:1, as shown in the figure:

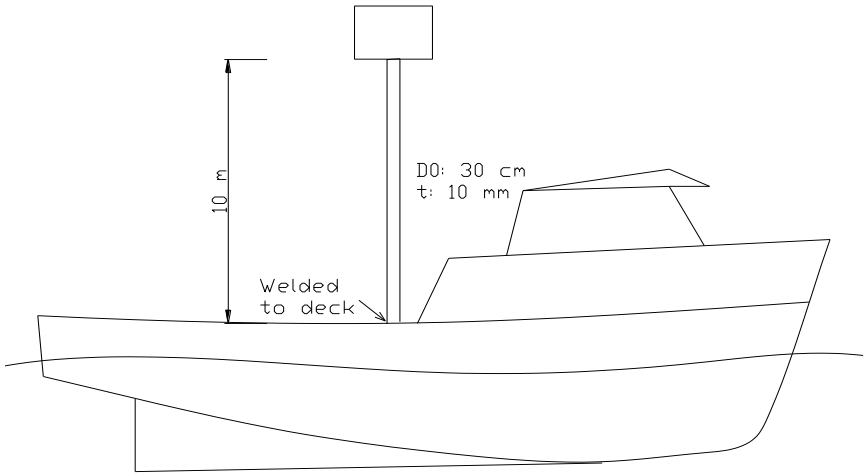



In the following table it has been calculated the forced response, considering the reduction gear, for a frequency 20 rad/sec. If the amplitude of the exciting torque is 24500 N-m, calculate the amplitude of the contact force between the teeth of pinion and gear. (30)

| **Holzer Forced** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\omega$: | 20 | 1/s | | | | | | | | | | |
| ***j*** | ***$J_j$*** | ***$C_j$*** | ***$\theta_j$ Real*** | ***$\theta_j$ Imag*** | ***$(-J\omega^2+i\omega C)\theta_j$ R*** | ***$(-J\omega^2+i\omega C)\theta_j$ I*** | ***Σ Real*** | ***Σ Imag*** | ***K*** | ***G*** | ***Σ/(K+iωG) R*** | ***Σ/(K+iωG) I*** |
| | **kg m s$^2$** | **kg m s** | | | **kg-m** | **kg-m** | **kg-m** | **kg-m** | **kg -m** | | | |
| 1 | 2.00 | 0 | -0.0102 | -0.0293 | 8.13 | 23.42 | 8.1 | 23.4 | 159345 | 0 | 5.10E-05 | 1.47E-04 |
| 2 | 0.07 | 0 | -0.0102 | -0.0294 | 0.30 | 0.85 | 8.4 | 24.3 | 4249 | 0 | 1.98E-03 | 5.71E-03 |
| 3 | 20.32 | 1270.3 | -0.0122 | -0.0351 | 991.58 | -24.27 | 1000.0 | 0.0 | | | | |

**3.-** Deduce the equation of motion of a pendulum, with length $L$, and a sphere with R radius installed at its lower end, with mass $M$, deeply submerged in an ideal fluid, with density $\rho$. Emphasize on the assumptions you have employed. (20)

**4.-** You are asked to analyze in a simplified manner the free vibration of a fishing vessel mast, with an observation site at the top, 300 kg in mass. The mast is built from a steel tube 30 cm of external diameter, 10 mm in thickness and 10 meter height. The mast is welded to the deck plate as it is shown in the following figure. One of the principal values is obtained as $\beta_i L$=4.1360572; confirm that it is indeed a principal value, and determine to which one of the natural frequencies the mentioned value corresponds. (35)

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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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