Faculty of Maritime Engineering and Marine Sciences

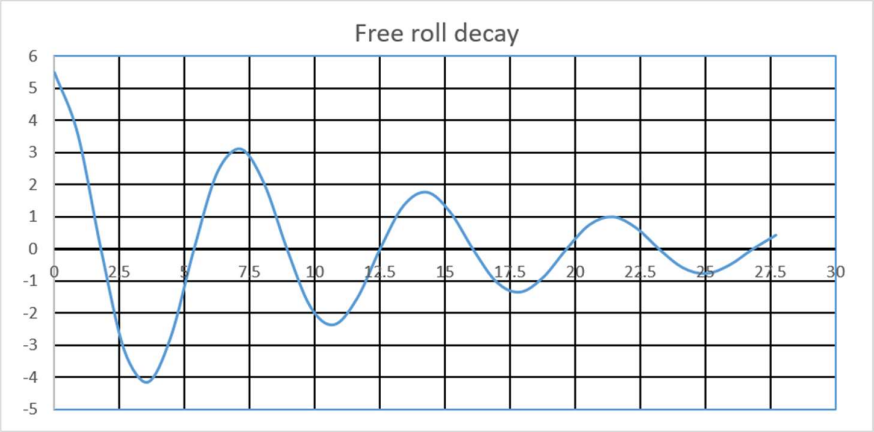
Ship Dynamics

2nd evaluation: Roll and irregular response **Aug. 24th, 2026**

Student: ……..……..…..…….. **ID:** ……..…… **Completion time**: ……..…

Closed books. Identify your steps with the parameter you are going to calculate and write only on one side of the pages. Please make sure that the units are properly handled.

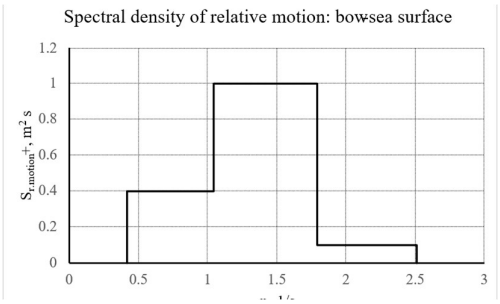
1. Roll motion of a fishing vessel (L_{wl}: 38 m, B: 9 m, D: 5 m, T: 4 m, C_b: 0.6) in regular waves is going to be analyzed. With a model of the ship, free decaying roll oscillation test is performed with the following results:

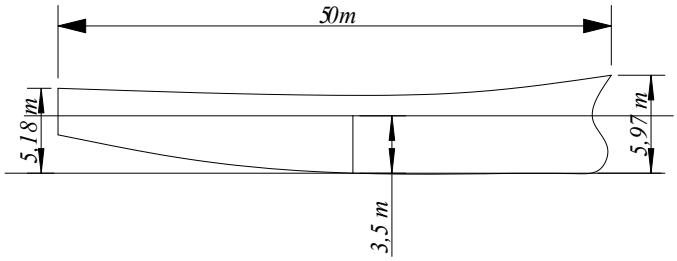


In a simplified way, the moment exerted by the waves is estimated as $\Delta\ GM\ \alpha$, where the slope of the wave α is acting from the beam. To design the foundation of a hydraulic motor located on the side of the ship, calculate its vertical acceleration due to the ship motion, when a single sinusoidal wave of 0.60 m in amplitude in resonant condition acts on the ship. The metacentric height is estimated as 0.50 m. (35)

2. Consider that the surface elevation z in Ecuadorian waters in a certain sea state is a random variable with Normal probability distribution (see its expression at the end of the exam), with standard deviation σ=0.50 m. The surface elevation is recorded using a buoy floating with a scan rate of 100 scans/sec. Since it is quite possible that these measurements can be contaminated, as a way of checking, calculate the number of registered values in the range 0.62-0.82 meters that you expect to have if the experiment is run for 10 minutes. (25)

3. Consider that you have the following spectral density function of the relative vertical motion between a ship and the sea surface elevation, at the bow of the vessel (*L: 50, B: 10, D: 5 m, Δ : 1100 tons, U: 12 knots*) in long crested sea state 4, see next figure. The maximum recommended value for deck wetness is 30 in one hour for this type of vessel developing point-to-point transit, and we would like to check if this ship satisfies this requirement. Calculate the average frequency between local crests, and then the probability of freeboard exceedance. Does this ship satisfy the previously mentioned restriction? In the attached plan, you can observe the characteristics of the floating vessel. (40)





Normal & Rayleigh probability density functions: $p_\varsigma(z) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(z-\mu)^2}{2\sigma^2}}$, $p_{\tilde{\varsigma}}(z) = \frac{z}{\sigma^2} e^{-\left(\frac{z^2}{2\sigma^2}\right)}$

Parameters of Spectral density fn.: $m_n = \int_0^\infty d\omega\ \omega^n\ S^+(\omega_e),\ n = 0, 2, 4, \ldots,\ \omega_c = \sqrt{\frac{m_4}{m_2}},\ \varepsilon = \sqrt{1 - \frac{m_2^2}{m_0 m_4}}$

Positive Standard Normal Z Table

Left-tail cumulative standard normal table. Each value gives P(Z < z). Use the left column for the first decimal place and the top row for the second decimal place.

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

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