First part – theoretical concepts

1.- With lines, join items from left column with those on the right one, (5).

<table>
<thead>
<tr>
<th>Selection of stiffener spacing</th>
<th>Solid mechanics</th>
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<tbody>
<tr>
<td>Structural detail design</td>
<td>Rule-based design</td>
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<tr>
<td>Structural analysis</td>
<td>Sizing of brackets</td>
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<tr>
<td>Rational design</td>
<td>Stress levels</td>
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</table>

2.- Mention one advantage of the Rule-based design of ship structure compared to Rational design, (5):

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3.- Mention one disadvantage of the Rule-based design of ship structure compared to Rational design (5):

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…………………………………………………………………………………………………………………

4.- Because of weight and reactions at 3 bearings separated 1.5 meters between them, at a certain cross section of a shafting system, a bending moment of 1200 N-m results. The maximum normal stress cannot exceed 140 N/mm². The nominal diameter of the shaft is a random variable with Normal distribution, \( N(\bar{D} = 4.25 cm; \sigma_D = 0.05 cm) \). What is an equivalent proposition to calculate the probability of failure, (10)?

a. \( P[D'<3.73] \)  
b. \( P[D'<2.73] \)  
c. \( P[D>4.25 cm] \)  
d. \( P[D'>2.73] \)
5.- For a tanker ship \((L: 109 \text{ m}, B: 16.5 \text{ m}, D: 8.3 \text{ m}, DWT: 6500 \text{ ton}, \Delta: 9600 \text{ ton}, T: 6.75 \text{ m})\), the midship bending moment has a response amplitude operator showed in the figure on the right; also for a certain sea state, a simplified spectral density function is estimated, see figure on the left. What is the \textit{RMS} value of the random variable bending moment, \((10)\)?

\[
\begin{array}{cccc}
\text{Wave spectral density} & \text{Response amplitude operator} \\
\end{array}
\]

\(\begin{array}{c}
0 & 0.1 & 0.2 & 0.3 & 0.4 & 0.5 & 0.6 & 0.7 & 0.8 \\
0 & 1 & 2 & 3 & 4 & 5 & 6 \\
\end{array}\)

\(\begin{array}{c}
0 & 20 & 40 & 60 & 80 & 100 & 120 \\
0 & 1 & 2 & 3 & 4 & 5 & 6 \\
\end{array}\)

\[S_{n} m^2-sec \]

\[R A O \ ton-m/m \]

- a. \(\sigma_{BM} = 98.3 \text{ m} \)
- b. \(\sigma_{BM} = 118 \text{ ton-m} \)
- c. \(\sigma_{BM} = 1183 \text{ m} \)
- d. \(\sigma_{BM} = 503 \text{ ton-m} \)

6.- The total pressure on the bottom of a tanker ship \((L: 109 \text{ m}, B: 16.5 \text{ m}, D: 8.3 \text{ m}, DWT: 6500 \text{ ton}, \Delta: 9600 \text{ ton}, T: 6.75 \text{ m})\) is calculated as 80.9 kN/m\(^2\). What is the value for the dynamic part of that value, \((10)\)?

\[p_{dy} = 13.1 \text{ N/mm}^2\]

\[p_{dy} = 13.1 \text{ kN/m}^2\]

\[p_{dy} = 131 \text{ N/mm}^2\]

\[p_{dy} = 235 \text{ N/mm}^2\]

\[I\text{ certify that during this exam I have complied with code of ethics of our university.}\]
1.- The following frame is composed by a steel cable, 9 mm in diameter, and, a tube ($D_o$: 50 mm, $D_i$: 44 mm), and it is designed to lift a weight of 1 ton. The tube is horizontal, while the cable is connected to a pin, and forms an angle of 45 degrees with the horizontal. You are asked to analyze this frame to determine how structurally safe it is, (15).

2.- A simplified ship (L: 80 m, B: 10 m) with parabolic waterplane and vertical sides is to be quasi-statically analyzed while it sail in waves: $B(x) = B\left(1 - \left(\frac{2x}{L}\right)^2\right) \, [m], -40m < x < 40m$

Its hull weight distribution is simplified as: $w(x) = -0.005x^2 + 8.5, \, \text{ton/m}, \, -40m < x < 40m$

Consider that the cargo and machinery are represented by three concentrated forces, and are located as shown in the attached figure.

Calculate the maximum shear force when a simple wave sinusoidal wave of 3.0 m height acts on the ship hull, (25).

3.- Consider a boom resting on simple supports on the deck of a fishing vessel which operates at 13 knots in a sea state with significative height of 1.23 m. This element is built from steel tube: $D_o$: 20 cm and 4 mm in thickness, and, it is 8 m long. When the ship oscillates in waves a heave acceleration of $0.30g$ is developed. Calculate the maximum deflection that the boom supports due to the inertial load, (15).

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