MEC-E2002 – Ship Buoyancy and Stability **Exam 11.12.2018**

1. List the factors that affect intact stability of a ship. Consider both initial stability and stability at large heel angles. How these factors are affected by the main dimensions of the ship, namely length, breadth, draft and depth? (6 p.)

2. How large percentage of the volume of an iceberg is above the sea level, when the density of sea water is 1025 kg/m^3 and density of ice is 907 kg/m^3? (4 p.)

3. A ship has a volume of displacement 10 000 m^3 at draft of 5.5 m. Vertical centre of buoyancy is 3.7 m above base line and vertical centre of gravity is 8.8 m. Transverse surface moment of inertia of the waterplane is 60 000 m^4 and density of water is 1025 kg/m^3.

   a. What is the metacentric height? (2 p.)
   b. How large external static heeling moment is needed to cause a heel angle of 3°? (2 p.)

4. A wall-sided ship has a negative initial metacentric height. Evaluate the angle of loll and the effective metacentric height at this heel angle. (4 p.)

   The equation for the righting lever for a wall-sided ship is:

   $$\overline{GZ}(\phi) = \overline{GM_0}\sin\phi + \overline{B_0M_0}\frac{\tan^2\phi}{2}\sin\phi$$

   hint: $\frac{d}{dx}\tan x = \frac{1}{\cos^2 x}$

5. Prove that the maximum dynamic heel angle due to a step-wise external moment is exactly twice as large as a static heel angle under equal static heeling moment, when the righting lever is linearly dependent on the heel angle, i.e. $\overline{GZ}(\phi) \equiv h(\phi) = \overline{GM_0}\phi$. Use the simplified roll equation (without damping): $I'_{xx}\ddot{\phi} + \Delta h(\phi) = M_{ext}$ (6 p.)

6. Describe the probabilistic damage stability framework in SOLAS. What are the assumptions and different factors that are used in the calculations? What are the differences in the calculations between passenger and cargo ships? (6 p.)