Ship theory of seaworthiness

1. Statics of the vessel; general assumptions
   1.1.   The coordinate systems for ship's hull theoretical form drawing; ship's particulars
   1.2. Terms and integral characteristics of elements of ship's hull theoretical form; methods of numerical integration

2. Ship floatability
   2.1. General concepts, the forces acting on a floating vessel
   2.2. Calculation of the elements of the underwater volume of vessel on the water with no heel and with no trim; curve of areas of waterplanes; hydrostatic curves
   2.3. Calculation of the elements of underwater volume of vessel on the water with trim; Bonjean diagram and trim chart
   2.4. Calculation of the elements of underwater volume of vessel on the water with heel and with trim
   2.5. Calculation of double-hulled and multihull vessels buoyancy elements, of floating docks and floating drilling rigs

3. Stability of vessel
   3.1. The concept of stability of the vessel
   3.2. The static stability; righting moment and a static stability arm; diagram of a static stability
   3.3. The initial stability; formulas of the metacentric stability
   3.4. Dynamic stability; work of righting moment and dynamic stability arm; diagram of the dynamic stability
   3.5. Tipping moment; diagram of the dynamic and average moments
   3.6. Assessment of stability at high angles of heel
   3.7. Interpolation curves, cross curves of stability and universal charts
   3.8. Approximate formulas for process of the diagrams of static and dynamic stability
   3.9. Accounting of the ship's superstructures effects on the static stability diagram
   3.10. Assessment of the vessel stability, taking into account the trim
   3.11. The calculation of the vessel static stability diagram on a passing waves
   3.12. The influence of operational factors on vessel stability; effect of moving cargo
   3.13. Effect of liquid cargo and suspended loads for stability of the vessel
   3.14. The influence of bulk cargo on stability of the vessel
   3.15. Features of the vessel's stability when receiving cargo
   3.16. Effect of icing on the stability of the ship (and water salinity on icing)
   3.17. The rate of vessel inclination and damping
   3.18. The influence of the main dimensions proportions on stability of the vessel
   3.19. The practical tasks of the vessel's stability evaluating; list of the vessel when moving with the circulation and with concentration of the passengers on one side (with asymmetric loading)
   3.20. List of the vessel under the action of tug towline and action of fishing gear
   3.21. The stability of the vessel when docking, when landing on the rocks, when lifting of the stern; inclination of the floating crane with a load
   3.22. Experimental study of the vessels stability; inclining experiment to determine the characteristics of the vessel stability
   3.23. Regulation of the vessels stability
   3.24. Documented account the vessel's stability during operation; use the document on the vessel's stability (Information on the stability of the vessel)

4. Ship insubmersibility
4.1. The general concept of ship insubmersibility; categories of the hull compartments assuming their flooding; permeability (volume occupancy) coefficients of the compartments and methods of assessment of insubmersibility
4.2. Assessment of insubmersibility characteristics when flooding of the small compartment
4.3. Diagram of ship insubmersibility
4.4. Assessment of the characteristics of ship insubmersibility when flooding of the group of compartments; table of insubmersibility
4.5. Assessment of the characteristics of ship insubmersibility when flooding of a large compartment
4.6. Calculation of performance and drawing of diagrams damaged stability of the vessel, which has flooded compartments; stability improvement of vessel damaged
4.7. Curve of the limiting permissible length of compartments flooded
4.8. Regulation of insubmersibility; record keeping of ship insubmersibility (Information on ship insubmersibility)

5. Ship launch
5.1. The problem of calculating of ship launch; ship launch longitudinal
5.2. The study of ship launch longitudinal
5.3. Diagram of ship launch
5.4. The method of successive approximations for calculation of indexes of the ship launch longitudinal
5.5. The influence of the elements of the launching gear and pressure on launching gear in the critical position when ship launch and when the ship rising; speed of the ship launch longitudinal
5.6. Calculation of the characteristics of the retarding mechanism for the ship on the slipway
5.7. The transverse launch of the vessel
5.8. Experimental study of the vessels launches

6. Ship rolling
6.1. Types of pitching; the basic concepts
6.2. Coordinate systems used to assess of the vessel rolling characteristics
6.3. Hydrodynamic basic theory and calculation of pitching
6.4. Linear and nonlinear theory of rolling

7. Fundamentals of linear hydrodynamic theory of ships rolling assessment
7.1. Differentiation of the hydrodynamic forces
7.2. Hydrostatic forces and moments
7.3. Inertial-damping forces and moments; general properties of the added masses and damping factors
7.4. The forces and moments perturbing ship rolling
7.5. Methods for determining of the water flow rate potential
7.6. Differential equations of linear rolling of the vessel
7.7. The differentiation of certain types of the vessel rolling of in the linear theory
7.8. The hydrodynamic models of vessel rolling

8. Calculation on the linear theory of characteristics of cross-rolling of the vessel on a regular waves
8.1. General concepts; structure of the forces causing lateral rolling of the vessel in rough seas

8.2. Inertial damping force of the wave nature, acting on the hull in the plane of submerged cross- circuit
8.3. The results of experimental studies of the inertial damping moments in rolling
8.4. Inertial damping forces and moments acting on the running vessel
8.5. Practical methods of calculation of the characteristics of the external load on the vessel defining transverse rolling
8.6. Restoring force, restoring moment and the main part of disturbing force and disturbing moment in the transverse rolling
8.7. Hydrodynamic components of disturbing force and disturbing moment
8.8. Lateral rolling of ship in calm water with no progress
8.9. Lateral rolling of ship hove, located to the lag of the wave
8.10. Effect of speed and course angle for lateral rolling of ship
8.11. Features of floating rigs rolling

9. The calculation based on the linear theory of the longitudinal surge of the vessel
9.1. Determination of hydrodynamic and restoring forces in the longitudinal surge of vessel
9.2. Disturbing forces and moments in longitudinal surge of vessel
9.3. Linear equations of longitudinal surge of vessel in rough seas
9.4. Determination of the frequency characteristics of longitudinal surge of vessel
9.5. Natural and partial frequency of vessel longitudinal surge

10. Characteristics and features of the kinematics of irregular rolling of the vessel in rough seas
10.1. Equations of the irregular rolling of the vessel; spectral density of the irregular rolling
10.2. Statistical characteristics of irregular rolling of the vessel
10.3. The linearization method in the calculation of nonlinear irregular roll of a vessel
10.4. Using charts to determine the characteristics of the vessel rolling
10.5. Kinematics of a fixed point of the vessel rolling
10.6. The kinematics of the joint roll of two vessels
10.7. Assessment of the ship deck flooding and the possibility of slamming at motion
10.8. The choice of the calculated spectrum of irregular waves to assess the characteristics of a vessel rolling

11. Fundamentals of nonlinear theory and assessment of finite-amplitude rolling
11.1. Types of nonlinearities in the dynamics and their physical causes
11.2. Methods for determining the nonlinear hydrodynamic forces
11.3. Unfolding of non-linear forms in powers of small parameters
11.4. Subdivision of the general hydro-mechanical problem in to the local tasks
11.5. Rolling of finite amplitude in the calm water; calculation of the period of rolling with the vessel's stability diagram; frequency curve of rolling
11.6. Nonlinear rolling of the vessel on a regular agitation; structural formulas for the hydrodynamic forces and moments
11.7. Computational models for restoring and disturbing forces and moments on a vessel in waves
11.8. Differential equations of rolling in absolute and relative coordinates, and methods for their solution
11.9. The main resonance and parametric resonance of ship rolling in a regular waves
11.10. Typical problems of calculation of the nonlinear rolling of ship in regular waves
11.11. Calculation of static characteristics of the nonlinear rolling of ship in regular waves

12. Problems of dynamic stability assessment and ship rolling, related with safety of navigation

12.1. The equations describing the motion of the vessel under the action of wind load in rough seas

12.2. Righting moment as a characteristic of the vessel's stability in rough seas

12.3. The calculation of wind loads on the vessel

12.4. Dynamical inclining of the vessel by the wind load

12.5. Probabilistic assessment of wind loads on a ship in irregular waves

12.6. The results of calculating the statistical characteristics of ship stability on irregular waves

13. Marine stabilizers

13.1. Passive U-shaped tanks (Frahm antirolling tanks of 1-st kind)

13.2. Stabilizing tanks with a free surface in the connecting channel (type "Flume" or "Ulstein")

13.3. Open resonantly-adjected tanks (Frahm antirolling tanks of 2-st kind)

13.4. Stabilizing tanks running characteristics of the initial stability of the vessel

13.5. Active and partially active tanks in the stabilizing systems of ship rolling

13.6. Passive hydrodynamic stabilizers of ship rolling

13.7. Active hydrodynamic stabilizers of ship rolling

13.8. Hydrodynamic stabilizers of ship longitudinal surge

14. Experimental methods for study of ship rolling

14.1. Study the characteristics of rolling models of ships in calm water and in rough seas

14.2. Features of model tests of ships equipped with rolling stabilizers

14.3. Full-scale test studies of ship rolling

14.4. Features of full-scale test studies of ships, equipped with rolling stabilizers

15. General information about the resistance for vessels movement

15.1. The subject and brief historical outline

15.2. Resistance for vessels movement and components of the resistance

15.3. General formulas for calculating the resistance for vessels movement and towing capacity

15.4. Characteristic features of the resistance changes

15.5 Determination of water resistance for vessels movement on the characteristics of the hydrodynamic trace

15.6. Wetted surface of the vessel and the determination of the wetted surface area

16. Viscous resistance of the water

16.1. The boundary layer and hydrodynamic trace of the vessel

16.2. The equations of water motion in the plane and axially symmetric boundary layers

16.3. Calculation of the plane and axial symmetric laminar boundary layers

16.4. Calculation of turbulent boundary layer of plates, profiles, and solids of revolution

16.5. Laminar-turbulent transition of plane and axially symmetric boundary layers

16.6. Methods of calculation of boundary layer flow around a ship

16.7. Comparison of calculated and experimental characteristics of the three-dimensional boundary layer

16.8. Frictional resistance of plates

16.9. Viscous resistance of well-streamlined shapes and solids of revolution

16.10. Viscous resistance of bluff bodies

16.11. Viscous resistance of the vessel

16.12. Effect of general roughness on the viscous resistance

16.13. Effect of local roughness on the viscous resistance
16.14. Resistance to cuts and niches
16.15. Effect of fouling the hull plating on viscous resistance of the vessel
16.16. Methods to reduce viscous resistance
16.17. Influence of polymer additives on the flow structure in boundary layer and on the viscous resistance
16.19. Air resistance for the vessel movement

17. Wave resistance
17.1. Wave generation of the running vessel
17.2. Properties of the wave resistance
17.3. Calculation of the hydrodynamic flow of ships and other objects with the account of the wave generation
17.4. Determination of the wave resistance of the linear theory
17.5. Qualification of the wave generation theory and of the evaluation of vessel wave resistance
17.6. Verification of the theory of wave resistance
17.7. Application of the theory of wave resistance
17.8. Ways to reduce the wave resistance of ship

18. Water resistance to the movement of vessel in shallow water and in the channel
18.1. Resistance to the movement of vessel in shallow water
18.2. Theoretical study of resistance to the movement of vessel in shallow water
18.3. Resistance to the movement of vessel in channel
18.4. Theoretical study of resistance to the movement of vessel in channel

19. Resistance of the water to the vessel movement in rough sea
19.1. Effect of sea waves on water resistance and speed of the vessel
19.2. Theoretical calculation of the additional resistance to movement of the ship in rough seas

20. Experimental methods for water resistance determining to motion of the vessel
20.1. Experimental hydrodynamic tanks
20.2. Models for testing in experimental tanks
20.3. Research of the resistance in reverse movement
20.4. Full-scale tests of vessels
20.5. Recalculation of the resistance model for full-scale vessel
20.6. Methods of experimental determination of water resistance main components

21. Methods of approximate calculation of the vessel water resistance
21.1. The classification of approximate methods of water resistance calculating
21.2. Methods of approximate calculation of the residuary resistance
21.3. Determination of water resistance by applying a prototype

22. The dependence of water resistance on the shape of the hull
22.1. The choice of ship's hull shape
22.2. The effect of variations of displacement and main dimensions on ship water resistance
22.3. The fullness ratios and their influence on resistance
22.4. Shapes of ship's hulls contours
22.5. Variants of hull shape of ships for inland and mixed cruising
22.6. Projecting parts and their influence on the resistance to movement of the vessel

23. Effect of hydrodynamic interaction of vessel hulls on water resistance
23.1. Water resistance of multihull vessels
23.2. Water resistance of vessels' convoys

24. Water resistance of vessel in definite circumstances
24.1. Water resistance of vessel running with acceleration
24.2. Resistance to vessel movement in ice

25. Hydrodynamics of high-speed planing boats
25.1. Fundamentals of hydrodynamics of planing
25.2. Boat water resistance, moving into the semi-displacement regime
25.3. Theoretical study of planning resistance
25.4. Calculation of the resistance to movement of water planes
25.5. The components of the resistance of planing boats; method of calculating the resistance based on tests of models of planing boats
25.6. The influence of the main characteristics of hulls of planing boats on their resistance and choice of the optimal proportions o the main characteristics of hulls
25.7. Hydrodynamic characteristics of planing plans
25.8. Control of hydrodynamic characteristics of planing plans; calculation of the resistance of planing vessels with transom plates
25.9. Seaworthiness of planing boats

26. Hydrodynamics of hydrofoils and hydrofoil boats
26.1. Fundamentals of hydrofoil hydrodynamics
26.2. Hydrodynamic calculations of characteristics of hydrofoil boat lifting complex; hydrodynamic calculations of hydrofoil boat lifting complex according to the model tests
26.3. Calculation of characteristics of hydrofoil, streamlined without cavitation
26.4. Accounting for the effects of cavitation on hydrodynamic characteristics of hydrofoil
26.5. Calculation of characteristics of control tools of the hydrofoil lifting force
26.6. Effect of the mutual influence of hydrofoils
26.7. Hydrodynamic characteristics of hydrofoil supports
26.8. Calculation of hydrofoil boat hydrodynamic resistance
26.9. Methods for assessing seaworthy and controllability of hydrofoil boat
26.10. The equations of longitudinal motion of hydrofoil boat
26.11. The equations of lateral motion of hydrofoil boat
26.12. Assessment of transverse and longitudinal stability of hydrofoil boat
26.13. Assessment of stability of motion of hydrofoil boat
26.14. Calculation of the characteristics of hydrofoil boat steady circulation
26.15. Calculation of longitudinal surge and overloads acting the hydrofoil boat in regular waves
26.16. Calculation of rolling and overloads acting the hydrofoil boat in irregular waves

27. Hydrodynamics of hovercrafts
27.1. Main characteristics of the air-cushion
27.2. Skirt of air-cushion and how they work in the lifting complex of hovercraft
27.3. Computational and experimental methods for determining the characteristics of air-cushion flexible skirt
27.4. Determination of energy expenses on the maintenance of the air-cushion
27.5. The components of resistance to movement of hovercraft and principles of simulation of resistance
27.6. Resistance to the movement of hovercrafts of amphibious class in calm water

27.7. Water resistance of sidewall air-cushion crafts in calm water

27.8. Additional resistance of hovercraft in movement in a seaway

27.9. Determination of static stability of hovercraft

27.10. The equations of motion of hovercraft in rough seas

27.11. The influence of air compressibility on the dynamics of hovercraft

27.12. Calculation in the linear and nonlinear representation of the characteristics of hovercraft rolling when motion across the regular waves and at the position of a lag to the wave

27.13. Stability of air-cushion height and self-oscillation of hovercraft

27.14. The effect on rolling of dimensions and characteristics of forcing fans of sidewall air-cusion vehicle

27.15. Stabilization of sidewall air-cusion vehicle in sea waves

27.16. The equations of lateral motion of hovercraft

27.17. Hydro and aerodynamic characteristics of hovercraft

27.18. Stability of running hovercraft, maneuverability, roll on the circulation and control in the wind

27.19. Criteria for the stability of lateral movement of hovercraft in calm seas with the wind

28. Cavitating propellers

28.1. Features of action and calculation of the characteristics of cavitating propellers

28.2. The interaction of the speed vessels propellers with elements of supporting force of hydrofoils

28.3. Systematic testing of cavitating propellers

28.4. Effect of basic geometric elements of cavitating propellers for their hydrodynamic characteristics

28.5. Design of isolated cavitating propellers

28.6. Calculation of cavitating propellers in oblique flow

28.7. Design of propellers in the angular steerable pods

28.8. Calculation of the propulsion of speed vessels and development of passport diagrams of cavitating propellers

29. Design of water-jet propulsors and calculation of hydrodynamical characteristics

29.1. The main functions determining the hydrodynamic characteristics of the axial water-jet propulsors

29.2. The interaction of water-jet propulsor to the hull

29.3. Intake devices of the axial water-jet propulsors

29.4. Impellers of water-jet propulsors

29.5. The nozzle of water-jet propulsor

29.6. The projecting calculation of water-jet propulsors of vessels with dynamic principles of support and development of the rating diagram

29.7. Reversing-steering devices of water-jet propulsors

29.8. Ventilated water-jet propulsor

30. Air movers (propellers)

30.1. Analysis of propellers efficiency

30.2. Projecting calculation of the characteristics of an air propulsion system

31. Controllability of displacement vessels

31.1. Ship as a controllable system

31.2. Control tools of the vessel