KTH Naval Architecture

SD2721 SHIP DESIGN 9 ECTS
SD2725 INTRODUCTION TO MARINE TECHNOLOGY 6 ECTS

COURSE PM

2020 / v.1

In this course you will be faced with the challenge of designing a ship for solving a certain transport scenario. In parallel you will learn about basic ship theory such as hydrostatics, stability, resistance and propulsion, and develop your own modelling software. This PM specifies course material, learning objectives, examination, schedule with details about the topics for the different lectures, detailed reading instructions, and expected deliveries and deadlines. Detailed instructions for the different course modules and assignments are given in separate documents. Please notice that the course structure presupposes that you follow the scheduled teaching, make good use of un-scheduled time, read the course material, deliver as expected and keep the deadlines. Read the PM carefully and get back to it regularly through the course for the planning of your studies and progress. Good luck & enjoy!

COURSE MATERIAL

The major parts of the course are covered in:

- Garme (2012), *Ship Resistance & Powering*, KTH.
- Rosén (2017a), *Ship Hydrostatics & Stability*, KTH.
- Rosén (2017b), *Framework for Systems Engineering & Engineering Design*, KTH.

and for SD2721 also in:

- Kuttenkeuler (2015), *Propeller Analysis*, KTH.
- Part of (approx. 15 pages) Oltedal and Lützhöft (2018) *Maritime safety management,* Routledge.
- Part of (approx. 15 pages) Kuo (2007) *Safety management and its maritime application*, The Nautical Institute.
- Part of: Papanikolaou, ed. (2009) Risk-Based Ship Design
- IMO (2013) *Revised guidelines for formal safety assessment (FSA) for use in the IMO rule-making process* (MSC-MEPC.2/Circ.12), International Maritime Organization.

Some additional material is also taken from:

- DNVGL (2015), *Rules for Classification of Ships*, Part 3, Chapter 1, Det Norske Veritas.
- DNVGL (2016), *Technology Outlook 2025*.
- IMO (2008), *2008 IS Code*, Resolution MSC.267(85), International Maritime Organization.
- IMO (2012), *International Shipping Facts and Figures*, International Maritime Organization.
- Molland (2008), *The Maritime Engineering Reference Book*, Elsevier.
- Transportstyrelsen (2009), TSFS 2009:114, Transportstyrelsens författningssamling.
- UNDP (2015), *Sustainable Development Goals*, United Nations.

Some additional material will also be provided at the lectures and in the specifications of the different assignments and projects that you will work with during the course. Detailed reading instructions are provided in the schedule in the end of this PM.

TEACHERS

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COVID-19 – CHANGES

Approx 1/3 of lectures are held digitally on-line.
We try to avoid rush-hour starts.
Digital On-line activities are sometimes pre-recorded in order to allow for individual planning. See Canvas for links to pre-recorded lectures.
Written test format now a combination of home exam and individual oral exam via Zoom.

LEARNING OBJECTIVES

The objective is that the student after finishing the course shall be able to:

1. Demonstrate methodological knowledge and understanding in ship hydrostatics, stability, resistance, and propulsion. In detail the student shall be able to:
   a. explain the principles of ship hydrostatics and intact stability and key concepts and terms such as: hydrostatic pressure, buoyancy, displacement, freeboard, centre of buoyancy, centre of gravity, hydrostatic equilibrium, draft, trim, heel, metacentric height, righting lever arm, righting moment;
   b. explain the principles of numerical modelling of ship hydrostatics and stability;
   c. explain the principles of ship resistance and propulsion and key concepts and terms such as: the different components of ship drag and propulsion efficiency, power, Froude's scaling law;
   d. explain the principles of systematic series and semi-empirical methods for prediction of ships' resistance and choice of standard propellers;
   e. SD2721 only: explain blade element momentum theory and its application in the analysis of ship propellers and discuss its strengths and limitations.
2. Demonstrate ability to model, simulate, predict and evaluate ships' hydrostatics, stability, resistance, propulsion, and energy efficiency, even on the basis of limited information. In detail the student shall be able to:
   a. estimate ships' mass and centre of gravity; displacement for a given draft; draft and displacement for a given mass; and metacentric height; on the basis of limited information and hand calculations;
   b. model ship hydrostatics and stability numerically by implementing related theory in Matlab;
   c. evaluate ships' stability properties in relation to international regulations and other relevant criteria;
   d. determine a ship's vertical centre of gravity based on an inclination test;
   e. account for free liquid surfaces influence on ship stability;
   f. determine a ship's full scale resistance based on model experiment results;
   g. calculate ships' resistance based on systematic series and semi-empirical methods and from this determine needed installed power for a certain speed;
   h. choose a standard propeller for a ship based on systematic propeller series;
   i. evaluate ship's energy and resource efficiency in terms of fuel consumption and C02-emissions;
   j. SD2721 only: model propellers' performance by implementing blade element momentum theory in Matlab.
3. Demonstrate ability to critically, independently and creatively develop a conceptual design of a ship (or other technical system for maritime application) that addresses a certain need or opportunity, taking into account relevant scientific, social, environmental and economic aspects. In detail the student shall be able to:
   a. analyse a given design scenario and the involved stakeholders; formulate and analyse relevant requirements, concept of operations and system functions & features; explore, evaluate and define relevant system concepts;
   b. make the conceptual design of a ship (or other technical system for maritime application) in terms of main dimensions, general arrangement, hull geometry, choice of installed power and propeller, and verify its fulfilment of relevant requirements based on application of the theory, methods, models and criteria referred in learning objectives 1 and 2.
   c. SD2721 only: analyse safety aspects of the intended operation and from identified safety issues (risk) propose changes to design or operation in order to decrease the risk.

4. Give an account of the international shipping market, different ship types, and involved key stakeholders.
5. Discuss the opportunities for seaborne transportation in a sustainable society and describe the shipping-related environmental problems and measures for tackling them.
6. Demonstrate ability to plan and carry out engineering tasks within given frames using appropriate methods and to evaluate this work.
7. Demonstrate ability to clearly present and discuss engineering conclusions and the knowledge and arguments behind them, in dialogue with different groups, orally and in writing, in national and international contexts.

EXAMINATION

The student's performance is examined in relation to the learning objectives. As specified in Table 1, the examination is performed in different modules, 1-2 for SD2725 and 1-4 for SD2721. Each module is corresponding to a certain share of the course ECTS and is evaluating the student's performance in relation to a certain set of the learning objectives. The written test consists of two parts:

- a problem part performed as a home exam where a pocket calculator and hard copies of the texts Rosén (2017a) and Garme (2012) are allowed to use, and
- a theory part that is performed individually as an oral exam via Zoom, this will also include questions on the student's solutions of the problem part of the exam.

To pass the written test you need to pass both parts of the test. The points on the problem part will decide your module grade for examination module 1 (P_1).

The student's performance in each examination module will be evaluated and reflected on the following scale: P_i =0 (fail), =1 (sufficient), =2 (good), =3 (excellent). To pass the course a student is required to acquire at least P_i=1 in each examination module (in each of the modules 1-2 for SD2725, in all modules 1-4 for SD2721). The student's final mark is based on the acquired weighted average module grade according to Table 2 (N=2 for SD2725, N=4 for SD2721).

Table 1 : Examination modules.

	Examination module	$ECTS_i$	P_i	Learning objectives	Course
1	Written test	3	0 to 3	1 a-d; 2 a-i, 4, 5, 7	SD2721 & SD2725
2	Ship design project report	3	0 to 3	2 a-c, f-i, 3 a-b, 5-7	SD2721 & SD2725
3	Propeller theory & modelling	1	0 to 3	1 e, 2 j, 6, 7	SD2721 only
4	Safety management project	2	0 to 3	1 a-d, 3 a-c, 5-7	SD2721 only

Table 2 : Final mark vs average module grade.

$\bar{P}$	Mark
≥2.83	A
≥2.33	B
≥1.83	C
≥1.33	D
≥1.00	E

$$\bar{P} = \frac{\sum_{i=1}^{N} (ECTS_i \cdot P_i)}{\sum_{i=1}^{N} ECTS_i}$$

SCHEDULE 2020

Notice that changes of the schedule might occur; please keep yourself updated.

Links for online live activities via zoom will be distributed separately.

W35

Mon w35 2020-08-24

15:00 - 17:00 Hugin Introduction, HL

Tue w35 2020-08-25

08:00 - 10:00 Digital Theory Lectures on Canvas: TL1, TL2 & TL3.1, Read Rosén (2017a) Section 2.1-2.5, HL

10:00 - 12:00 Hugin Hydrostatics & stability 2, Read Molland (2008) pp 45-59, HL

W36

Tue w36 2020-09-01

08:00 - 10:00 Hugin Design review 1, HL

Wed w36 2020-09-02

08:00 - 10:00 Digital Theory Lectures on Canvas: TL3.2 & TL4, HL, Read: Rosén (2017) Ship Hydrostatics and Stability Section 2.6 and HYDROSTATICS & STABILITY MODELLING EXERCISES

10:00 - 12:00 Flexible Modelling workshop 1(2) **Laptops w. MatLab**, Read SHIP HYDROSTATICS & STABILITY MODELLING EXERCISES

W37

Mon w37 2020-09-07

15:00 - 17:00 Hugin Resistance & powering 1, Read Garme (2012) pp 3-19 & 52-54, KG

Tue w37 2020-09-08

08:00 - 10:00 Digital Resistance & powering 2, Read Garme (2012) pp 20-37, KG

Wed w37 2020-09-09

10:00 - 12:00 Hugin Resistance & powering 3, Read Garme (2012) pp 38-50, KG

W38

Tue w38 2020-09-15

08:00 - 10:00 Hugin Sustainable development workshop, Read UNDP (2015) & DNVGL (2016) pp 42-51 & text in green frames in IMO (2012), AR

Wed w38 2020-09-16

08:00 - 10:00 Digital Modelling workshop 2(2) **Laptops with MatLab**, Read Rosén (2017a) pp 2.22-2.35 & IMO (2008) pp 11-13

10:00 - 12:00 Hugin Ship design, Read Rosén (2017b) & skim IMO 2008, HL

W39

Tue w39 2020-09-22

08:00 - 10:00 Digital Resistance & powering 4, KG

Wed w39 2020-09-23

09:00 - 10:00 Digital Pre-recorded lecture TL5.1 and TL5.2, Read: Rosén (2017) Ship Hydrostatics and Stability Section 2.8 – 2.9, HL

09:00 - 11:00 Hugin Ship design, Guest Lecture, Staffan Sjöling SSPA, HL

11:00 - 12:00 Hugin Ship design, HL

W40

Tue w40 2020-09-29

08:00 - 10:00 Own work with *Exercises and examples – Ship design and stability*

10:00 - 13:00 F3 PhD Thesis defence, Pahansen de Alwis, Towards consonance in working conditions, health and performance aboard high-performance marine craft

Wed w40 2020-09-30

08:00 - 10:00 Digital Re-cap pre written test and Ship design, peer review, HL

W41

Mon w41 2020-10-05

15:00 - 17:00 Hugin Written test (on-line), HL

Tue w41 2020-10-06

08:00 - 10:00 Digital Design review 2, part 1, HL

Wed w41 2020-10-07

08:00 - 10:00 Digital Design review 2, part 2, HL

W42

Mon w44 2020-10-26 08:15 Digital Deadline: Final ship design report

The detailed schedule for SD2721 in study period 2 will be provided separately.