Vehicle and Maritime Engineering

Study plan for third-cycle subject

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**Subject title**

Vehicle and Maritime Engineering (Farkostteknik)

**Subject description and programme outcomes**

**Scientific field**

Sweden has a long and successful tradition in the field of vehicle and maritime engineering, in both the civilian and military sectors. The industry spans a wide range, with research, development and manufacture of trucks, forestry and agricultural machinery, passenger cars, buses, ships, boats, tracked vehicles, trains, trams and aircraft. Large quantities of equipment and partial systems are developed and made for these by domestic suppliers.

The doctoral program Vehicle and Maritime Engineering aims to gather doctoral students at KTH with a scientific foundation in subjects concerning land and marine vehicles, their development, design, manufacture, use and maintenance as part of a sustainable transport system. Education at research level is conducted principally in the following six main areas, but other areas may also be possible.

**Vehicle Engineering**

In the research area of Vehicle Engineering, the mechanical and dynamic properties of terrestrial vehicles are studied. The area comprises modeling and analysis of the behavior of vehicles as well as their dynamic interaction with driver and the surrounding area. The research in the area deals above all with driving properties, comfort of driver, goods and chassis, driver-vehicle interaction, and strategies for steering, braking and propulsion of different types of vehicle on main highways and off-road. In addition, the research deals with modeling and analysis of the properties of various vehicle components, such as (logic) control systems, suspension, autonomous wheel corners, and tyres. Since vehicles are characterized by strongly non-linear properties, the research also deals with methods for analysis and control of non-linear dynamic systems. A common feature of research work in the field is the combination of theoretical analysis, numerical calculation and experimental work.

**Vehicle Aerodynamics**

Vehicle aerodynamics deals with the study of the air flow round terrestrial vehicles and accompanying loads and moments. The most important difference between vehicle aerodynamics and aircraft aerodynamics is that vehicle aerodynamics needs to factor in the effect of the ground. Furthermore, the flow is three-dimensional in character, which means that the two-dimensional approximations that can be used in aerodynamics are rarely applicable to terrestrial vehicles. The commonest issue in vehicle aerodynamics is reduction of air resistance, but in recent years the significance of transient aerodynamics, for example, transient loads from wind gusts, has received growing interest. The focus of research at KTH is on using large-scale calculations in which turbulence is modeled with computationally efficient but thorough methods to study transient events and on using different mode decomposition methods to analyze wake structures. Our ambition is to conduct vehicle aerodynamic research using a multidisciplinary approach, for instance by cooperating with vehicle dynamics and technical acoustics.

**Rail Vehicle Technology**
The research field of rail vehicles comprises the scientific basis for design, operation and maintenance of different types of rail vehicles and trains. It also includes interaction with rail traffic infrastructure. The principal focus of study is on the way in which rail vehicles interact mechanically with rail overhead lines (for electrical operation). In the former case, phenomena such as risk of derailment, ride stability, wheel-rail wear and ride comfort are studied. In the latter case, the contact forces power-takeoff-overhead wire and accompanying movements are analyzed. In both cases, higher speeds (passenger traffic) entail ever greater technical challenges and for the rail, one trend is towards higher axle loads (goods traffic). The research area also encompasses studies of rail traffic energy consumption and accompanying environmental impact. The research is consistently conducted on both theoretical and experimental bases and in close cooperation with companies and authorities in the field.

**Lightweight Structures**

Lightweight structures is a generic and application-specific research area based on materials technology, structural mechanics, process engineering and design. The scientific goal is to develop understanding of specific phenomena in these areas and in the interface between them. Above all, studies focus on new unconventional materials and structures and their use in applications where low weight is a requirement. Particular topics of study are polymer fiber composites, bio-based materials, foam and structural topologies, that is, materials that are all anisotropic and inhomogeneous. In this case, performance is regarded as a general concept referring both to functionality and use, expressed in terms of energy consumption, environmental impact and life-cycle cost.

**Naval Architecture**

Research in this field as conducted at KTH is characterized by an interdisciplinary approach to issues around ships and other marine systems along with their interaction with both water and the atmosphere and their impact on the surroundings in a broader sense. The work is carried out from a systems perspective, mainly for high-speed craft in waves, issues of dynamic stability for modern merchant ships, alternative propulsion systems and unmanned underwater systems. This involves working with analysis and modeling of performance, wave environment, loads, structure response and seakeeping, and also includes studies of operability, working environment and system monitoring. A strong link is emphasized between analysis and experiment.

**Technical Acoustics**

Technical Acoustics, or the understanding of how sound and vibrations are generated and propagated in solid and fluid media, is an important part of technical mechanics with applications ranging from aeronautical, vehicle and marine engineering to energy technology and medicine. Important research areas concern sound generation and sound propagation in flow systems and in complex materials with the aim of creating better models and enabling more efficient technical solutions. Trends in the research are moving towards combining advanced numerical and experimental methods and towards increased interdisciplinary collaboration. The field will have considerable significance in the development of sustainable solutions for future transport systems.

**Description of possible specialisation**

The subject has no specialisations.

**Specification of how the programme outcomes are to be achieved**

The objective is for the students to be well prepared, after their research training, for their future independent roles in the community, both nationally and internationally. After completing the training, the student will be able to:

- describe and explain theories and empirical results in his/her field,
- formulate concrete research questions within the subject area,
- use scientific methods and develop new knowledge through scientific studies,
- critically analyze and evaluate applied methods and results from his/her own scientific studies and those of others,
- present and discuss research results in the scientific community,
- present research in a pedagogical manner outside the scientific community in educational contexts,
- assess ethical aspects of research in the subject area and act accordingly,
- identify needs for new research,
participate in interdisciplinary collaborations in the problem area,
analyze the role of research in societal development.

Current research

Programme structure

Education at researcher level consists of a course part and a thesis part, with internal credit scales defined by KTH's in-house degree regulations for degrees at doctoral level.

According to the Swedish National Agency for Higher Education Degree Ordinance (1993:100) 6 chapter 31, the education is to be carried out under the guidance of two supervisors, a main supervisor and one or more deputy supervisors. The education must follow an approved individual study plan which is approved by the person responsible for research training at the School. The individual study plan must be adapted to the prior knowledge of the student and to the specialization of the thesis. Review of the individual study plan must be carried out by the doctoral student in consultation with the main supervisor at least once a year.

The student is assumed to pursue his/her research with the objective of subsequently writing technical documents which will later form the basis of the thesis. These reports are sent for publication to international journals within the relevant field with peer-reviewing. One or more reports may also be published as conference proceedings, in which case the student is also assumed to present his/her work orally at an international technology conference.

Compulsory and recommended courses

The course part of the research studies must consist predominantly of technological courses. The courses are selected in consultation with a supervisor in accordance with the needs regarded as existing for the actual research work in order to enable the student to acquire both depth and breadth of knowledge and skills in the subject area. Thus, some courses will be necessary for the accomplishment of the research task while others are chosen to provide greater breadth in the field. In certain cases, after agreement with the main supervisor, courses may be included from earlier education. The conditions for the course part are stipulated in KTH's local degree regulations for degrees at research level. A list of the research skills courses of the program, advanced courses and other courses are to be found in Appendix 3.

Recommended in-depth courses

- **HN3002 The Ergonomics of Muskuloskeletal Healt 7.5 hp.**
- **SD315V Automotive Acoustics with Focus on Combustion Noise 5.0 hp.**
- **4B5108 Structure Borne Sound 0.0 hp.**
- **SD3413 Mechanics of Composite Materials and Structures 0.0 hp.**
- **SD3705 High-speed Craft Structural Design 6.0 hp.**
- **SD2625 Computational Road Vehicle Aerodynamics 3.0 hp.**
- **6L5006 Applied Dynamic Finite Element Analysis 6.0 hp.**
- **SD3416 Analysis and Design of Sandwich Structures 0.0 hp.**
- **6L5025 Technology and Health 7.5 hp.**
- **SD3422 Mechanics of Cellular Solids 0.0 hp.**
- **4B5400 Multi Degree of Freedom Vehicle Dynamics 6.0 hp.**
- **SD3601 Computational Aeroacoustics (4 - 8hp) 0.0 hp.**
- **4B5110 Fluid Structure Interaction 0.0 hp.**
- **4B5313 Rail Vehicle Dynamics 7.5 hp.**
- **SD3411 Finite Element Method 0.0 hp.**
- **4B5113 Non-Linear Vibrations 7.5 hp.**
- **4B5303 Railway Systems and Rail Vehicles 9.0 hp.**
- **4B5106 Theoretical Acoustics 0.0 hp.**
- **4B5307 Wheel-rail Contact 9.0 hp.**
- **SD3415 Advanced Composites Manufacturing 0.0 hp.**
- **4B5402 Vehicle engineering, literature 6.0 hp.**
- **4B5104 Aeroacoustics 0.0 hp.**
- **4B5109 Statistical Energy Analysis 6.0 hp.**
- **4B5401 Vehicle dynamics, literature 9.0 hp.**
**Recommended research proficiency courses**

- 1N5126 Risk Communication - Theory and Practice 7.5 hp.
- 1N5105 Essay in Popular Science 3.0 hp.
- 1N5110 Advanced Course in Writing for a Popular Audience 4.5 hp.
- AK3024 Introduction to Theory of Science and Research Methodology, for Graduate Students in Technology and Natural Sciences 4.5 hp.
- 1N5125 Philosophy of Risk 7.5 hp.
- 1N5504 Research Communication 7.5 hp.

**Other recommended courses**

- LH200V Basic Communication and Teaching 3.0 hp.
- SD3421 Design and Construction Tasks 0.0 hp.
- LH201V Learning and Teaching 7.5 hp.
- SD3420 Literature Studies 0.0 hp.

**Thesis**

The thesis is a compulsory part of the training at research level. The thesis may be what is known as a compilation thesis or a monograph. Normally, a thesis in Vehicle and Maritime Engineering is of the compilation type. The thesis is written in English.

**Licentiate thesis**

A thesis for the Licentiate degree must contain new scientific knowledge or a new application of existing scientific knowledge. The latter means that the application is carried out in a new field and is developed through theoretical and/or experimental research work. The thesis must also contain an overview of previous research in the chosen research field. Regardless of whether the licentiate thesis is presented as a monograph or a compilation of scientific articles, it must normally be of such quality that it is judged to correspond to two articles that can be published in international journals or presented at international conferences.

**Doctoral thesis**

A thesis for the degree of doctor must contain new scientific knowledge or a new application of existing scientific knowledge. The latter means that the application is carried out in a new field and is developed through theoretical and/or experimental research work. The thesis must also contain an overview of earlier research in the chosen research field. Regardless of whether the doctoral thesis is presented as a monograph or a compilation of scientific articles, it must normally be of such quality and originality that it is judged able to constitute the basis for at least four articles that can be published in peer-reviewed international journals. Published and accepted articles are judged equally, as are conference articles which have undergone peer review. If unpublished articles are appended to the thesis, the main supervisor must judge whether they fulfill the main requirement.

**Entry requirements and selection**

**General and special admission requirements and prior knowledge**

Admission to training at research level in Vehicle and Maritime Engineering follows the basic national requirements for admission to research studies and KTH’s requirements for special eligibility according to the admissions regulations for education at research level at KTH.

Students applying for the training at research level in Vehicle and Maritime Engineering are selected according to the knowledge profile demanded for the specific doctoral project. Students who have shown great interest and aptitude for the subject are particularly considered at admission. Further important qualities are personal ability in communication and initiative. The assessment of these qualities is made by the intended supervisor. Good knowledge of English (both spoken and written) is a requirement and in certain cases, Swedish is also required. The ability to work experimentally may be an explicit demand.
Selection is made among the applicants based on the knowledge profile sought for the specific doctoral project as formulated in conjunction with the advertisement of vacant study places. Particularly interesting in this assessment are previous study results in courses of an advanced nature taken as part of a first academic degree or independently conducted scientific work. Apart from eligibility, the basis for the selection is degree of maturity and ability to make independent judgments and to carry out critical analyses. For admission to training in the doctoral program in Vehicle and Maritime Engineering, it is furthermore required that:

- supervisors are available,
- funding can be secured,
- a place can be provided in a research group, and
- access is available to other resources and infrastructure necessary for the education.

Decisions on admission to and selection of applicants for the education at research level are made by the head of the School, or by someone delegated by the head of the School, in consultation with the main supervisor.

**Selection rules and procedures**

**The programme’s degrees and examinations**

**Degree of Licentiate and Degree of Doctor (PhD)**

**The programme’s examinations**

Courses at research level must include an oral or written test of knowledge. The design of the examination must in individual cases be such that the examiner can be satisfied that the student has fulfilled the learning outcomes of the course. Decisions to include courses taken prior to admission to the education at research level are taken in accordance with the in-house regulations and guidelines specified for doctoral degrees and for licentiate degrees in KTH's overarching regulatory framework.