11-01-11, Rev 1

Course Description

Rail Vehicle Dynamics (SD2313), 8 credits

Academic year 2010/2011, period 3 (January - March 2011)

Teachers

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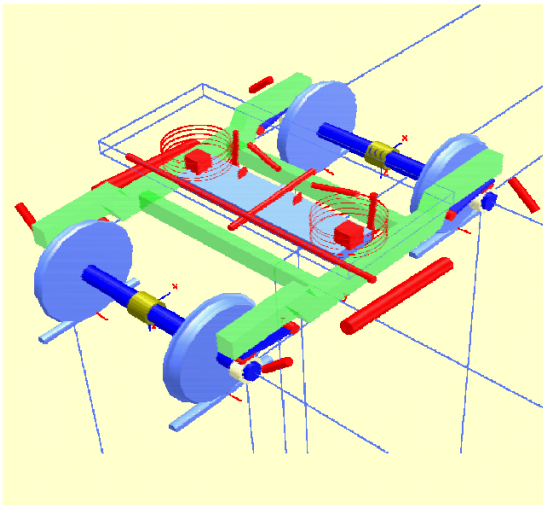

Aims of the course

The overall aim of the course is to become prepared to work as a Vehicle Dynamics engineer in industry or for a railway operator/authority. You shall be familiar to the different problems involved in dynamic vehicle/track interaction and be capable of actively choosing system parameters that result in good vehicle performance and low wear of components both in vehicle and track.

Specifically that means:

- You shall be able to list the vehicle and track components that influence the dynamic behaviour and to explain their roll in the system.
- You shall be able to use the equations derived in the course to calculate permissible vehicle speeds on given lines or necessary line characteristics like curve radius and superelevation curves for a given traffic.
- To be able to use Multibody System Programs which are common in industry today, to understand the theory behind them and judge the results you
  - shall know how to derive the differential equations of a dynamic system.
  - shall be capable of solving as well linear homogeneous differential equations (without excitation) as those for systems with harmonic excitation. You shall be able to analyse the results, i.e. determine eigenfrequencies and frequency response functions and explain them. You should be familiar to this already from basic courses in mechanics.
- In rail vehicle dynamics the concept of hunting and stability is important. You shall be able to explain the mathematical reason why a railway vehicle can become unstable.
- You shall be able to derive the equations for quasistatic curving of a vehicle and to explain the wheel-rail forces arising for different positions of the wheelset on the track.
- Good vehicle stability and curving performance are in principle contradictory. You have to be able to list parameters that lead to good stability or curving respectively. Especially you shall be able to explain the importance of the wheel rail geometry – e.g. concept of conicity – to both phenomena. You shall be able to discuss the implications of suggested parameters to the usability of a vehicle for certain traffic tasks.
- You have to be able to explain how ride comfort in a railway vehicle is evaluated and to discuss the differences between different comfort measures used today.
- Wheel and rail components shall be deteriorated as little as possible. Wear calculations are a good guidance to judge the “track friendliness” of a vehicle. You shall be able to explain how wear between wheel and rail usually is calculated and how parameters can be chosen to minimize it.

Previous knowledge

This course is more theoretical than the basic course “Railway Vehicle Technology” given by our department. Therefore basic knowledge in linear algebra, ordinary differential equations, mechanics and vibration theory is necessary.

Literature

Course book and binder on Rail Vehicle Dynamics, incl. exercises, assignments and project task. Parts of the course material will be distributed during the course.

Price: B.Sc/M.Sc programme students: 300 SEK
Other persons: 600 SEK

The literature is sold at the first lecture or at the Div. of Rail Vehicles, Teknikringen 8, 2nd floor.

Course assessment

The course assessment builds on several parts that are related to the aims listed above.

Assignment 1

Analysis of vertical dynamics of a simple vehicle model, cf. Chapter 5 in the course book. In a first step you have to derive the equations of motion necessary for solving the task and to answer further introductory questions. When you have done this and the correctness has been checked by your teacher you will get a Matlab code to solve the problem. Calculate the specific tasks given and analyse the results by answering the given questions.

The assignment is introduced on Tuesday 26 Jan., cf. course plan. **Deadline** for the assignment report is **Monday 14 Feb at 17.00**. If this deadline is met the report can give **up to 3 bonus credits** added to the written exam.

Assignment 2

Stability analysis of a wheelset, cf. Chapters 7 and 8 in course book. With help of MATLAB eigenvalues and the critical speed of the system wheelset suspended in a track following bogie frame shall be determined. Further the system has to be extended to study the influence of the simplifying assumption of a track following bogie frame on the critical speed.

The assignment is introduced on Friday 11 Feb., cf. course plan. **Deadline** for the assignment report is **Friday 4 March at 17.00**. If this deadline is met the report can give **up to 3 bonus credits** added to the written exam.

Assignments 1 and 2 are documented individually by a written report.

Project task

Computer simulations of the dynamics of a fast train are carried out. The task is carried out and documented in groups of 2-3 persons. The task comprises three full days that are compulsory.

Deadline for the report is **Friday 1 April at 17.00**. If the deadline is met, the report can give **up to 4.0 bonus credits** added to the written exam.

Written exam

The time available for the written exam is five hours. You are allowed to use hand calculator, general collections of formulas and the document of course-specific formulas (release it from the binder). A maximum of 40 credits can be achieved; for pass at least 20 credits are required.

Supplementary exam

If you got the mark Fx you get the possibility of a supplementary written exam. Such an exam will comprise of parts where you obviously need to improve. Usually 5 credits can be achieved, while 3 credits are needed for passed. Time available is one hour.

The supplementary exam must be written within six weeks after the result has been announced. After that period mark Fx will be changed to F (not passed).

Final mark

The two assignments and the project task are compulsory and can at most give 5.0 bonus credits. The bonus credits are added to the credits of the passed written exam, i.e. you must always have at least 20 credits (pass) at the written exam; e.g. 17 credits on the written exam and 3 bonus credits is not sufficient for the mark E.

0.0 - 17.9 credits:	mark F	
18.0 – 19.9 credits:	mark Fx	not passed
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20.0 – 25.9 credits:	mark E	passed
26.0 – 31.9 credits:	mark D	
32.0 – 37.9 credits:	mark C	
38.0 – 43.9 credits:	mark B	
44.0 – 50.0 credits:	mark A	

Exercises

The course binder contains exercises to all chapters. You are strongly recommended to go through them in parallel to the lectures to deepen the understanding of the course content. The binder also contains answers and solutions to the exercises. Of course you are welcome to raise questions on the exercises whenever you wish.

Course plan SD2313 – Rail Vehicle Dynamics 2011

Date, time		Room	Chapter, etc.		Teacher
Mon 17/1	10-12	Q15	1,2	Introduction, Track components	SSt,MB
Wed 19/1	10-12	Q22	2,3	Track components, Vehicles	MB
Thu 20/1	08-10	Q24	4	Vehicle-track Interaction	SSt
Mon 24/1	13-15	E53	5	Dynamic analysis techniques	SSt
Wed 26/1	10-12	Q24	5, A1	Dynamic analysis techniques, ass. 1	SSt,DW
Thu 27/1	08-10	Q24	6	Advanced vehicle modelling	MB
Mon 31/1	13-15	E33	6	Advanced vehicle modelling	MB
Wed 2/2	13-15	Q26	7	Wheel-rail guidance mechanisms	SSt
Thu 3/2	08-10	Q24	7,8	Guidance mechanisms, Creep	SSt
Mon 7/2	10-12	Q24	8	Creep forces	SSt
Thu 10/2	08-10	Q24	8	Creep forces, stability	SSt
Fri 11/2	10-12	Q17	8, A2	Curving, assignment 2	SSt, AO
Mon 14/2	10-12	Q24	9	Track forces and derailment	MB
Wed 16/2	10-12	Q24	12,13	Gauging, Examples of w-r interaction	SSt
Wed 23/2	10-12	Q24	10	Wheel-Rail Wear	MB
Thu 24/2	08-10	Q11	11	Ride Comfort	MB
Mon 28/2	10-12	Q24	14	Dynamic calculations	MB
Wed 2/3	10-12	Q22	15	Experimental techniques and validation	MB
Mon 7/3	8-17	XQ23		Projekt task	SSt
Tue 8/3	8-17	XQ23		Projekt task	SSt
Fri 11/3	8-17	XQ32		Projekt task	SSt
Sat 19/3	9-14	V35		Written Exam	

Locations: Q-rooms, Osquldas väg 6
E-rooms, Lindstedtsvägen 3
A map of the Campus can be found at
http://www.nada.kth.se/cvap/ssab03/kth_campus.pdf

Course evaluation

Since continuous adoption of the course setup to experiences from previous years is intended it is important for us that you fill in the questionnaire that will be distributed at the end of the course.

Study visit

Full day probably in April-May. The exact day and also the places to visit will be discussed during the course.