

APPLIED STRESS ANALYSIS II

Academic year 2007-2008
Lectures
Classroom and laboratory exercises

Fall Semester
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Organization of the course

The course is based on a total of 42 hours of lectures plus 32 hours of classroom or laboratory exercises, with the following timetable:

Lecture	Tuesday	10.30-12.30	Room 5B
	Friday	8.30-10.30	Room 5B
Exercises	Friday	8.30-10.30	Room 5B

Aims of the course

The main aim of the course is to give the students a deeper insight of the methods used for the dynamic stress analysis used in mechanical design. The course is concluded with the study of two applications, namely the dynamic stress analysis of rotors and of the crankshafts of reciprocating engines.

Textbooks

G. Genta, Vibration of structures and machines, Springer, New York, 1998.

CALENDAR (Dates are subject to change)

Part 1: An overview of dynamic analysis of discrete systems

Lecture 1	Mechanical design. Static and dynamic stress analysis. Classical and numerical approach.
September 18	Automatic computation in design. Numerical simulation. Computer aided engineering (CAE).
Lecture 2	Discrete linear systems: equations of motion in the configuration space; equations in Lagrange form. State space. Block diagrams.
September 21	
Lecture 3	Free behavior of single and multi-d.o.f. systems. Modal uncoupling.
September 25	
Lecture 4	Structural damping; systems with frequency dependent parameters. Forced response to harmonic excitation.
September 28	
Lecture 5	Modal participation factors. Forced response to non harmonic excitation; short account of random vibrations.
October 2	
Exercises 1	Dynamic behavior of an automotive suspension: equations of motion.
September 21	
Exercises 2	Dynamic behavior of an automotive suspension: transfer functions
September 28	
Exercises 3	Dynamic behavior of an automotive suspension: design for fatigue.
October 5	
Exercises 4	Dynamic behavior of an automotive suspension: active suspension.
October 5	

Part 2: Dynamic behavior of continuous systems and discretization techniques

Lecture 6	Beams and bars. Euler-Bernoulli beams. Modes of continuous systems.
October 9	
Lecture 7	Timoshenko beams. Effect of axial forces on flexural behaviour of beams; vibrating strings.
October 12	
Lecture 8	Discretization methods. Assumed modes and lumped parameter methods. Transfer matrices methods: Myklestad and Holzer Methods.
October 16	
Lecture 9	Finite element method in dynamics.
October 19	

Lecture 10 October 23	Static, dynamic and Guyan reduction.
Lecture 11 October 26	Time domain and frequency domain solutions; numerical simulation.
Lab 1 October 12	Vibration of beams.
Exercises 5 October 19	Dynamic analysis using the Finite Element Method.
Lab. 2 October 26	Numerical and experimental study of a vibrating beam.
Lab 3 November 9	Numerical and experimental study of a vibrating beam.
Exercises 6 November 16	Dynamic analysis of a vibrating structure (follows).
Exercises 7 November 23	Dynamic analysis of a vibrating structure (follows).

Part 3: Dynamics of rotating machines

Lecture 12 October 30	Vibrations of rotors: Campbell diagram, critical speeds and fields of instability. Undamped Jeffcott rotor.
Lecture 13 November 6	Damped Jeffcott rotor.
Lecture 14 November 9	Rotor with 4 degrees of freedom, gyroscopic effect.
Lecture 15 November 13	Rotors with many degrees of freedom.
Lecture 16 November 16	Nonisotropic machines. Rotors on hydrodynamic bearings.
Lecture 17 November 20	Balancing of rotors.
Lab. 4. November 23	Experimental rotordynamics.
Exercises 8 November 30	Rotordynamics.
Exercises 9 November 30	Rotordynamics (follows).
Exercises 10 December 7	Rotordynamics (follows).
Exercises 11 December 14	Rotordynamics (follows).

Part 4 Dynamics of reciprocating machines

Lecture 18 November 27	Equivalent system, dynamics of crank mechanisms, simplified equations of motion, free vibrations.
Lecture 19 December 4	Torsional critical speeds, forced vibrations.
Lecture 20 December 7	Damping of torsional vibrations..
Exercises 12 December 14	Torsional vibrations of a crankshaft (follows).

Part 5 An outline on the dynamics of nonlinear systems

Lecture 21 December 11	Basics on nonlinear systems
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