PROGRAM, DELTAGERLISTE og ABSTRAKTS

PROGRAM, LIST OF PARTICIPANTS and ABSTRACTS

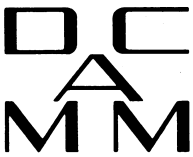
til

DCAMM
11. interne symposium

Mandag d. 19. marts til
Onsdag d. 21. marts 2007

på

SAS RADISSON HOTEL
SILKEBORG



TECHNICAL UNIVERSITY OF DENMARK
and AALBORG UNIVERSITY

PROGRAM og DELTAGERLISTE

PROGRAM and LIST OF PARTICIPANTS

til

DCAMM
11. interne symposium

Mandag d. 19. marts 2007 til
Onsdag d. 21. marts 2007

på

Radisson SAS Hotel i Papirfabrikken
SILKEBORG

Arrangør:
DCAMM og the DCAMM Research School

INDHOLDSFORTEGNELSE

Organisationskomite:
Erik Lund, Ole Sigmund og Mathias Stolpe

Teknisk Assistance:
Betina Kornstad

Vigtig information:

Præsentationssprog kan være dansk eller engelsk men slides/overheads bør skrives på engelsk således at udenlandske deltagere også kan følge med.

For 1. og 2. års ph.d.-studerende er der afsat 10 minutter til foredrag og 5 minutters diskussion. For 3. års ph.d.-studerende og andre er der 15 minutter og 5 minutters diskussion.

For at undgå forsinkelser og tekniske problemer mellem præsentationerne opfordres samtlige foredragsholdere til at sende deres præsentationer til Mathias Stolpe (m.stolpe@mat.dtu.dk) onsdag den 14. marts 2007 før klokken 12.00. Samtlige præsentationer vil være til rådighed på en computer i konferencelokalet. De formater som accepteres er Microsoft PowerPoint filer (.ppt), Adobe Portable Document filer (.pdf) og multimedia filer som kan vises med Windows Media Player eller QuickTime player.

Foredragsholdere der ikke indsender præsentationer til Mathias Stolpe henvises til at benytte transparenter og overheadprojektor.

Important information:

The language of presentation may be Danish or English but the slides/transparencies should be written in English such that foreign participants may follow the presentations.

First and second year Ph.D. students are given 10 minutes for their presentation and 5 minutes for discussion. Third year Ph.D. students and all others are given 15 minutes for their presentation and 5 minutes for discussions.

All presenters are requested to send the electronic presentations to Mathias Stolpe (m.stolpe@mat.dtu.dk) no later than 12.00 on Wednesday March 14, 2007. This is to avoid delays and technical problems between the presentations. All presentations will be available on a provided computer in the conference room. Acceptable formats are Microsoft PowerPoint files (.ppt), Adobe Portable Document files (.pdf) and multimedia files which can be viewed by Windows Media or QuickTime player.

Presenters who do no deliver their electronic presentations to Mathias Stolpe are referred to use transparencies and an overhead projector.

Program for mandag eftermiddag, 19. marts

11:30 Ankomst og Check-in
12:00 - 13:00 Frokost

1 - MODELLERING OG NUMERISKE METODER
(Chairman: PER GROVE THOMSEN)

13:00 – 15:00 JAN HØGSBERG (MEK, DTU) (20 min)
Energy dissipation control of hysteretic dampers

MICHAEL S. ANDERSEN (IME, AAU) (15 min)
Numerical modeling of kinematically over-and under-determinate musculoskeletal systems

NIELS L. PEDERSEN (MEK, DTU) (20 min)
Stiffness analysis of bolt-assembly

JAKOB LEMVIG (MAT, DTU) (15 min)
Wavelet frame analysis

STEEN MARKVORSEN (MAT, DTU) (20 min)
Observing integrals of heat kernels from a distance

MICHAEL VINCENT JENSEN (MEK, DTU) (15 min)
Energy optimization of propulsion plants for container ships

ANDERS A. LARSEN (MAT, DTU) (15 min)
Optimization of thermal aspects of friction stir welding – initial studies using a space mapping technique

15:00 - 15:30 Kaffepause

2 - BØLGER
(Chairman: JØRGEN JUNCHER JENSEN)

15:30-17:10 SOIZIC DESCHAMPS (MEK, DTU) (15 min)
Propulsion of ships in waves

OLE LINDBERG (MEK, DTU) (15 min)
Efficient solution of the fully non-linear water wave problem

MARIA B. DÜHRING (MEK, DTU) (15 min)
Surface acoustic wave devices

ANDERS R. RASMUSSEN (MAT, DTU) (15 min)
Nonlinear phenomena in acoustics

JESPER RASMUSSEN (MAT, DTU) (15 min)
Boundary control

MADS P. SØRENSEN (MAT, DTU) (20 min)
Gap structures in the phonon spectrum of a linear chain with varying masses

17:10-17:20 MARTIN P. BENDSØE: News from DCAMM Research School
18:30 Middag

Program for tirsdag formiddag, 20. marts

08:00 - 09:00 Morgenmad

2 – DYNAMIK OG OPTIMAL KONTROL
(Chairman: STEEN KRENK)

09:00 - 11:00 KEALEY DIAS (MAT, DTU) (15 min)
Complex polynomial vector fields

NIKOLAJ NORDKVIST (MAT, DTU) (20 min)
Control algorithms for underactuated mechanical systems on lie groups

JENS STARKE (MAT, DTU) (20 min)
Self-organized control of distributed robotic systems

POUL HJORT (MAT, DTU) (20 min)
Isomolonomics

PER G. THOMSEN (IMM, DTU) (20 min)
Parameter estimation in dynamic systems

NIELS TROLDBORG (MEK, DTU) (20 min)
Numerical simulation of wake of wind turbine in prescribed atmospheric boundary layer

11:00 - 11:30 Kaffepause

4 - VINDMØLLEDYNAMIK
(Chairman: ERIK LUND)

11:30 - 13:00 MORTEN H. HANSEN (RISØ, DTU) (20 min)
How hard can it be to pitch a wind turbine blade?

THOMAS BUHL (RISØ, DTU) (20 min)
Load alleviation through adaptive trailing edge control surfaces

WEI JUN ZHU (MEK, DTU) (20 min)
Aero-Acoustic computations for wind turbines

VALERY L. OKULOV (MEK, DTU) (20 min)
Vortex dynamics: Why left is right and right is null

13:00 - 14:00 Frokost

Program for tirsdag eftermiddag, 20. marts

5 - OPTIMERING
(Chairman: PAULI PEDERSEN)

14:00 - 16:30 ALLAN GERSBORG-HANSEN (MEK, DTU) (20 min)
Linux software for large topology optimisation problems

GIL HO YOON (MEK, DTU) (20 min)
Topology optimization for electrostatic system

MARIE-LOUISE H. RASMUSSEN (MAT, DTU) (15 min)
Strength of problem formulations in topology optimization

LEON S. JOHANSEN (IME, AAU) (15 min)
Design and optimisation through use of adaptive models

MICHAEL BOGOMOLNY (MAT, DTU) (20 min)
Optimal design aspects of resistance welding

ROMAN STAINKO (MAT, DTU) (20 min)
Tailoring group velocity by topology optimization

JOHN RASMUSSEN (IME, AAU) (20 min)
Can anybody do the limbo?

16:30 - 19:00 Rundvisning på Silkeborg Kunstmuseum

19:30 - Festmiddag

Program for onsdag formiddag, 21. marts

08:00 - 09:00 Morgenmad

6 – MATERIALEMEKANIK
(Chairman: NIELS OLHOFF)

09:00 - 11:00 CHRISTIAN BERGGREN (MEK, DTU) (20 min)
Buckling strength of square composite plates with geometrical imperfections – preliminary result

KIM L. NIELSEN (MEK, DTU) (15 min)
Transient 3D analysis of viscoplastic structures

LARS P. MIKKELSEN (RISØ, DTU) (20 min)
Eksempler på anvendelse af en gradientafhængig plasticitetsteori i en kommerciel finite element kode

BENT SØRENSEN (RISØ, DTU) (20 min)
Micromechanical model of cross-over fibre bridging – prediction of mixed mode bridging laws

MARTIN JOHANNES (IME, AAU) (15 min)
Thermoelastic stress analysis of sandwich structures with core junctions

KASPER K. KRATMANN (IME, AAU) (15 min)
Determination of fibre misalignment in pultruded UD CFRP

11:00 - 11:15 Kaffepause

7 – VINDMØLLER OG MOTORER
(Chairman: MARTIN P. BENDSØE)

11:15 - 13:00 TROELS D. PEDERSEN (MEK, DTU) (15 min)
Application of dimethyl ether in homogeneous charge compression ignition combustion engines

SAJJAD HAIDER (MEK, DTU) (15 min)
Modelling Two-Stroke Diesel Engines

ROBERT MIKKELSEN (MEK, DTU) (20 min)
Navier-strokes modellering af vindmølleparker

LARS C. T. OVERGAARD (IME, AAU) (20 min)
Delamination modelling with mixed-mode de-cohesive element formulation

ANDERS L. HANSEN (IME, AAU) (15 min)
Hierarchical FEM of wind turbine blades

CHRISTIAN BANG-MØLLER (MEK, DTU) (15 min)
Design of DMFC system for mobile applications

13:00 - 14:00 Frokost

Program for onsdag eftermiddag, 21. marts.

8 - STRØMNINGER
(Chairman: POUL SCHEEL-LARSEN)

14:00 - 15:30 CLARA VELTE (MEK, DTU) (15 min)
Simulation and control of wind turbine flows using vortex generators

WIEBKE BRIX (MEK, DTU) (15 min)
Coupling between air and refrigerant flows in an evaporator

MICHAEL WINTER (IME, AAU) (15 min)
Optimization-based analysis of cable nets for fishing

GARBRIEL G. MARTÍNEZ (MEK, DTU) (15 min)
3D modeling of laminar-tubulent transition on wind turbine blades

JIMMY KJÆRSGAARD-RASMUSSEN (MEK, DTU) (15 min)
Multiphase flow evaluation

15:30 - 16:00 Kaffe

16:00 Afrejse fra Radisson SAS hotel

DCAMM Symposium, Silkeborg, 19.-21. marts 2007

MEK-FM:

Jimmy Kjærgaard-Rasmussen*	Poul Scheel Larsen	Garbriel G. Martínez*
Knud Erik Meyer	Robert Mikkelsen	Valery Okulov
Niels Troldborg*	Clara Velte*	Wei Jun Zhu*

MEK-SKK:

Christian Berggreen	Harry Bingham	Soizic Deschamps*
Ove Ditlevsen	Jan Høgsberg	Jørgen J. Jensen
Steen Krenk	Ole Lindberg*	Preben T. Pedersen

MEK-ET:

Christian Bang-Møller*	Wiebke Brix*	Sajjad Haider*
Michael V. Jensen*	Troels D. Pedersen*	Jesper Schramm

MAT:

Martin P. Bendsøe	Rainer Berkemer	Michael Bogomolny
Bodil Branner	Kealey Dias*	Jens Gravesen
Søren K. Hansen	Poul Hjorth	Anders A. Larsen*
Jakob Lemvig*	Steen Markvorsen	Nikolaj Nordkvist*
Anders R. Rasmussen*	Jesper Rasmussen*	M.-L. Rasmussen*
Peter Røgen	Roman Stainko	Jens Starke
Mathias Stolpe	Mads Peter Sørensen	

MEK-FAM:

Maria B. Dühring*	Allan Gersborg-Hansen	Jakob S. Jensen
Betina Kornstad	Brian N. Legarth	Kim L. Nielsen*
Christian Niordson	Frithiof Niordson	Niels L. Pedersen
Pauli Pedersen	Ann Bettina Richelsen	Ole Sigmund
Gil Ho Yoon		

IMM:

Tamas Kurics*	Per G. Thomsen

§8-medlemmer:

Andreas Back-Pedersen	Thomas Buhl	Morten H. Hansen
Lars P. Mikkelsen	Bent F. Sørensen	

IME-Aalborg Universitet:

Michael S. Andersen*	Yeoshua Frostig	Anders L. Hansen*
Lars Jensen	Martin Johannes*	Leon S. Johansen*
Kasper K. Kratmann*	Erik Lund	Niels Olhoff
Lars C. T. Overgaard	John Rasmussen	Jens Chr. Rauhe
Jan Schjødt-Thomsen	Sergey Sorokin	Ole T. Thomsen
Michael Winther*	Jun Yan*	

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MEK-FM	5	4	
MEK-SKK	2	7	
MEK-ET	5	1	
MAT	7	13	
MEK-FAM	2	11	
IMM	1	1	
§8	0	5	
IME-AAU	7	10	
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Program for mandag eftermiddag, 19. marts

1 - MODELLERING OG NUMERISKE METODER
(Chairman: PER GROVE THOMSEN)

13:00 – 15:00 JAN HØGSBERG (MEK, DTU) (20 min)
MICHAEL S. ANDERSEN (IME, AAU) (15 min)
NIELS L. PEDERSEN (MEK, DTU) (20 min)
JAKOB LEMVIG (MAT, DTU) (15 min)
STEEN MARKVORSEN (MAT, DTU) (20 min)
MICHAEL VINCENT JENSEN (MEK, DTU) (15 min)
ANDERS A. LARSEN (MAT, DTU) (15 min)

JAN HØGSBERG (MEK, DTU) (20 min)
Energy Dissipation Control of Hysteretic Dampers.
The efficiency of a damper depends on the amount of energy dissipation during a typical cycle experienced by the damper. For viscous dampers this leads to substantial frequency dependence, which typically implies that optimal tuning of a passive viscous damper is valid only for a particular vibration mode. In contrast the energy dissipated by a hysteretic damper is by independent of frequency. However, efficiency of a hysteretic damper depends strongly on the amplitude of the damper motion. This means that hysteretic type of dampers have the potential to be optimal with respect to several vibration modes, provided that the inherent amplitude dependence is eliminated by a proper control procedure. In the case of irregular damper response, the amplitude can be interpreted as the displacement range of closed loops, which leads to the idea of rainflow counting in fatigue analysis. The present paper presents a estimation and control procedure where the sequence of closed loops is evaluated by the rainflow counting method, and the relation between the extremes of the various loops are stored in a one-step array. The information stored in this array is simultaneously used to predict the amplitude of the closed loops and at the same time to control the damper force level of the hysteretic damper. The efficiency of this learning based procedure is illustrated for damping of a cable by a semi-active Magneto-Rheological (MR) damper.

MICHAEL S. ANDERSEN (IME, AAU) (15 min)
Numerical Modeling of Kinematical Over- and Under-Determinate Musculoskeletal Systems.
This Ph.D project is a spin-off of the AnyBody research project1, initiated in 1998, which aims at developing detailed simulation models of musculoskeletal systems. When developed, the models can be used to estimate muscle activities, joint reaction forces, etc. when the body is put into various working environments, such as bicycling or gait.
This project deals with the development of a general interface between motion capture and musculoskeletal modeling. This includes the development of algorithms to handle kinematical over- and under- determinate systems, automatic model scaling, local marker coordinate determination and advanced filtering techniques.
The common denominator for these problems is that they can be formulated as optimization problems.

The mathematical structures of these optimization problems are unfortunately very different, and most require special handling in order to find the optimal solution efficiently. For instance, the model scaling and local marker coordinate determination problems result in large-scale optimization problems even for small-scale mechanical systems but can be solved efficiently when the structure of the problem is utilized. The work has so far resulted in the development of two algorithms to deal with the kinematical over-determinacy problem [1]. The first of these methods is based on the application of an Unscented Kalman filter to reduce the effects of noise in the measurements. The second method is based on solving a constrained weighted least-square optimization problem. Both methods are formulated in a general manner, enabling position analysis of any mechanical system subject to holonomic constraints. The latter method was later extended to also include exact velocity and acceleration analysis [2]. Recently, a general methodology to scale models and determine local marker coordinates from a motion capture experiment was developed [3]. The method is formulated as a large-scale optimization problem with all model coordinates and Lagrange multipliers at all samples as unknowns. It was shown that the problem can be solved efficiently due to the special structure of the problem. Finally, the methods have been applied to a practical problem to create patient-specific models used to investigate cruciate ligament injuries [4].

REFERENCES

1. Andersen MS, et al. *Marker-based motion reconstruction of constrained rigid-segment systems.* Proceedings of 9th International Symposium on 3D Analysis of Human Movement, France, 2006.

2. Andersen MS, et al. *Kinematic analysis of over-determinate systems.* Proceedings of 19thNSCM, Sweden, 2006.

3. Andersen MS, et al. *Scaling and local marker coordinate determination for musculoskeletal systems.* Digital Human Modeling for Design and Engineering, USA, 2007. (Submitted)

4. Andersen MS, et al. *Marker position determination and kinematic analysis of a patient-specific musculoskeletal lunge model.* ISB World Congress, Taiwan, 2007. (Submitted)

NIELS L. PEDERSEN (MEK, DTU) (20 min)

Stiffness analysis of bolt-plate assembly.

Bolt connections are among the most important connections used in structures. The stiffnesses of the bolt and of the connected members is the primary quantities that controls the lifetime of the connection. The stiffness of the bolt can be estimated rather easily in contrast to the member stiffness, but with FE and contact analysis, it is possible to find the stiffness of the member. In the case of many connections and for practical applications it is not suitable to make a full FE (finite element) analysis. The purpose of the present paper is to find simplified expressions for the stiffness of the member also including the case when the width of the member is limited. The calculation of the stiffness is based on the FEM and we express the stiffness as a function of the elastic energy in the structure, whereby the definition of the displacements related to the stiffness is circumvented. The contact analysis is performed using a method where iterations are not necessary, and the results are compared to alternative available results. New practical presentations are suggested.

JAKOB LEMVIG (MAT, DTU) (15 min)

Wavelet frame analysis.

Wavelet analysis has become a standard tool in many engineering disciplines, e.g. electrical engineering and seismic geology, but also in mathematics and approximation theory. The wavelet transform is essentially based on the same idea as the (short-time) Fourier transform; both these transforms yield time-frequency analysis of some signal or image. Wavelets are used to compress images in JPEG 2000 to image files that tend to be 20-50% smaller than their JPEG counterpart which uses a cosine Fourier transform. The standard wavelet transform is based on an orthonormal wavelet basis. However, frequently it is an impossible task to find a wavelet basis that suits all our needs (like invertibility of the transform, good time-frequency localization of the wavelet, high approximation properties, symmetry, etc.). Wavelet frames are a redundant counterpart of wavelet bases and serve as a potential way to overcome the limitations of wavelet bases. Frames are more flexible than bases in the way that the redundancy gives us more freedom and hence a better chance of satisfying our needs. The talk discusses a this generalization of the standard wavelet analysis and how this generalization affects the fast wavelet algorithm. If time permits, some more theoretical aspects of the theory of wavelet frames will be presented.

STEEN MARKVORSEN (MAT, DTU) (20 min)

Observing integrals of heat kernels from a distance.

Heat kernels have integrals such as Brownian motion mean exit time, potential capacity, and torsional rigidity. We show how to obtain bounds on these values – essentially by observing their behaviour in terms of the distance function from a point and then comparing with corresponding values in tailor-made warped product spaces. The results will be illustrated by applications to the so-called 'type' problem: How to decide if a given manifold or surface is transient (hyperbolic) or recurrent (parabolic). Specific examples of minimal surfaces and constant pressure dry foams will be shown and discussed as test cases. The talk is based on joint work with Vicente Palmer.

MICHAEL VINCENT JENSEN (MEK, DTU) (15 min)

Energy optimization of propulsion plants for container ships.

The very large container vessels of today consume considerable amounts of fuel during their propulsion, although the main engines of the ships are state-of-the-art technology with high efficiencies just below 50%. Due to increasing oil prices and care for the environment it is relevant to search for possibilities to further increase the fuel utilization in the propulsion plants of these vessels.

A propulsion plant of a Post-Panamax class container ship has been considered, which includes a Waste Heat Recovery system (WHR). A simulation model has been developed in order to investigate the energy utilization of the plant, and results showed that the WHR system increases the energy utilization of the plant around 8%. Furthermore, using the model, different modifications of the propulsion plant have been investigated in order to obtain higher fuel utilization. Another measure to improve the fuel utilization is further development of the large two stroke diesel engine, which is the central part of the propulsion plant. These engines are highly developed, but still better understanding of in-cylinder phenomena is of importance. Thus in-cylinder heat transfer is a subject of interest, which includes temperature and velocity distribution in the boundary layer of the cylinder liner, heat radiation and conduction, combustion and a swirling flow field - all under cyclic varying conditions.

ANDERS A. LARSEN (MAT, DTU) (15 min)

Optimization of thermal aspects of friction stir welding – initial studies using a space mapping technique.

Friction Stir Welding (FSW) is a relative new welding method invented by The Welding Institute, UK in 1991. It is a solid phase process which gives it a range of advantages compared to conventional methods like arc welding. For instance it is very good for welding aluminium and other materials that are hard to weld. Even dissimilar materials can be joined. These properties make it very interesting for the automotive and aerospace industry where aluminium alloys are used extensively. A number of different parameters affect the process, including welding speed, rotational speed, tool design and others. These variables also govern the heat input to the work piece. The temperature field around the tool is of great importance for the microstructure and is thus an interesting area for optimization. This work focuses on optimizing the temperature field by finding optimal values for the translational welding speed and the heat input. The optimization is performed on a finite element model of the process using traditional gradient based optimization. Another approach that is especially useful for optimizing computationally expensive models is the space mapping method. It has previously been applied to problems in electromagnetics and sheet metal forming. In space mapping a mapping is established between an accurate but expensive model and a coarse but faster model. Both models include the same design variables so that the optimization is performed using the coarse model and thus requiring only few fine model evaluations. The mapping links the design variables such that the two models yield the same response. The method is used on a thermal model of the FSW process.

Program for mandag eftermiddag, 19. marts

2 - BØLGER
(Chairman: JØRGEN JUNCHER JENSEN)

15:30 – 17:10 SOIZIC DESCHAMPS (MEK, DTU) (15 min)
OLE LINDBERG (MEK, DTU) (15 min)
MARIA B. DÜHRING (MEK, DTU) (15 min)
ANDERS R. RASMUSSEN (MAT, DTU) (15 min)
JESPER RASMUSSEN (MAT, DTU) (15 min)
MADS P. SØRENSEN (MAT, DTU) (20 min)

SOIZIC DESCHAMPS (MEK, DTU) (15 min)
Propulsion of Ships in Waves.
The goal of this project is to build an accurate model for a ship in waves with emphasis on the drift forces and hence added resistance in waves. The model can be characterized by:

- Fully three-dimensional flow field
- At all three forces and three moments can be calculated
- Time domain

A potential flow description of the water flow over the ship will be used. This allows a very accurate description of the free-surface (non-linear) and the position of the ship which will both be updated during the calculations that will be carried out in the time domain.
The project is divided into three parts. First some experiments will be carried out at Force Technology. The results obtained will be used to check the validity of the model. Then some calculations will be made with the software I-Ship. This software uses strip theory to calculate the motions of the ship and the added resistance. Eventually the program AEGIR will be used to compute the three forces and moments. This program is a panel method that employs a NURBS based high-order boundary element method. The boundary conditions in AEGIR can be imposed in either linear or nonlinear form.

OLE LINDBERG (MEK, DTU) (15 min)
Efficient solution of the fully non-linear water wave problem.
This project considers the numerical solution of the fully non-linear water wave problem in three-dimensions, solved by means of a potential flow approximation, where the fluid compressibility and viscosity is ignored and the flow is assumed to be irrotational. The model consists of four equations: The flow in the bulk of the fluid is governed by Laplace-equation for the velocity potential, a no flow condition through the sea bed, atmospheric pressure at the free-surface and a no flow through the free-surface. Finite difference approximations of arbitrary order are used for the spatial derivatives and the time-derivatives are approximated by a fourth order Runge-Kutta method. A sigma coordinate-transform is used to transform the Laplace-equation and the condition at the sea bed to a time independent computational domain. The resultant linear system of equations is solved by a multigrid preconditioned Generalized Minimum Residual (GMRES) iterative scheme. The preconditioning system is of second order. The main focus of this talk will be on the preconditioning, which is the key to obtain an overall scaling of the computational effort which is directly proportional to N, the total number of grid points distributed over the fluid volume.

There are several features of the problem that rule out the possibility of using standard multigrid methods. The fact that the bottom equation consists of first order derivatives only, the use of cells with very large aspect ratios, and deep and shallow water flow within the same physical domain. All these features give rise to very large anisotropy in the problem. Different smoothing methods and coarsening methods are tested in order to obtain a robust and efficient solver. Among these are the Galerkin coarse-grid approximation, point and line-relaxation, semi-coarsening, operator dependent prolongation, multiple semi-coarse grids, collective relaxation and lexicographical vs. red-black ordering of the grid points.

MARIA B. DÜHRING (MEK, DTU) (15 min)
Surface Acoustic Wave Devices.
The work of this project is concerned with the simulation of surface acoustic waves (SAW) and topology optimization of SAW devices. SAWs are elastic vibrations that propagate along a material surface and are extensively used in electromechanical filters and resonators in telecommunication. A new application is modulation of optical waves in waveguides. This presentation elaborates on how a SAW is generated by interdigital transducers using a 2D model of a piezoelectric, inhomogeneous material implemented in the high-level programming language Comsol Multiphysics. The SAW is send through a model of a Mach-Zehnder interferometer (MZI). This is an optical device consisting if one waveguide that is split into two waveguide arms which are assembled again later on. By applying the mechanical field from a SAW the light in the two arms can be modulated and interfere constructively and destructively at the output waveguide and the MZI can thus be used as an optical switch. It is explained how the mechanical model of the SAW is coupled to a model of the optical waves such that the change in effective refractive index introduced in the MZI arms by the SAW can be calculated. Results of a parameter study of the geometry are presented to show that it is possible to improve the modulation of the light. It is discussed how topology optimization can be employed such that further improvements of the modulation can be achieved.

ANDERS R. RASMUSSEN (MAT, DTU) (15 min)
Nonlinear Phenomena in Acoustics.
Two nonlinear acoustical phenomena are presented: (A) An exact traveling wave front solution to the classical equation of nonlinear acoustics is derived from a generalized traveling wave assumption. Studies of nonlinear wave front interactions are presented. It is demonstrated that collisions of two wave fronts result in two new waves, which travel at a different velocity and have a different amplitude. (B) Acoustic streaming is unidirectional circulation set up in a fluid by an acoustic field, due to momentum transfer from field to the liquid. The classical theory is outlined. Some applications of acoustic streaming within the field of microfluidics are given.

JESPER RASMUSSEN (MAT, DTU) (15 min)

Boundary control.

Given the classical scalar wave equation with initial conditions in a bounded domain, can you in some way act on the boundary such that the system is steered to zero in time T? The answer: YES in the infinite dimensional setting with the Hilbert uniqueness method, HUM, you can! The problem of approximating HUM is non-trivial and it is the topic of my PhD project. The approximation involves discretization and one must require that this discrete, finite dimensional approximation converges (as the discretization scale h tends to zero) to the "true" continuous control. This is however most often NOT the case! This issue and possible remedies are studied. Further, for a wave equation an inverse problem is considered: Can we determine a forcing term on the wave equation from additional measurements on the boundary? This problem can also be dealt with by HUM ! But again: what happens for the approximations in the limit when the discretization parameter tends to zero?

MADS P. SØRENSEN (MAT, DTU) (20 min)

Gap Structures in the Phonon Spectrum of a Linear Chain with Varying Masses.

The phonon spectrum of a one-dimensional lattice with masses varying incommensurately with the underlying lattice is studied by a discrete version of a multi-scale perturbation theory. From the resonances in the higher order correction terms, we determine the location of the gaps in the spectrum. These resonances also provide a gap labeling in terms of two integers. Approximate analytic expressions are found predicting the behavior of the integrated density of states close to the two widest gaps, and the exponential growth rate of the displacements within the gap. In the continuum limit the equation of motion of the discrete model reduces to the Mathieu equation.

Program for tirsdag formiddag, 20. marts

3 – DYNAMIK OG OPTIMAL KONTROL
(Chairman: STEEN KRENK)

09:00 – 11:00 KEALEY DIAS (MAT, DTU) (15 min)
NIKOLAJ NORDKVIST (MAT, DTU) (20 min)
JENS STARKE (MAT, DTU) (20 min)
POUL HJORT (MAT, DTU) (20 min)
PER G. THOMSEN (IMM, DTU) (20 min)
NIELS TROLDBORG (MEK, DTU) (20 min)

KEALEY DIAS (MAT, DTU) (15 min)
Complex Polynomial Vector Fields.
The two branches of dynamical systems, continuous and discrete, correspond to the study of differential equations (vector fields) and iteration of mappings respectively. In holomorphic dynamics, the systems studied are restricted to those described by holomorphic (complex analytic) functions or meromorphic (allowing poles as singularities) functions. There already exists a well-developed theory for iterative holomorphic dynamical systems, and successful relations found between iteration theory and flows of vector fields have been one of the main motivations for the recent interest in holomorphic vector fields. Since the class of complex polynomial vector fields in the plane is natural to consider, it is remarkable that its study has only begun very recently. There are numerous fundamental questions that are still open, both in the general classification of these vector fields, the decomposition of parameter spaces into structurally stable domains, and a description of the bifurcations. For this reason, the talk will focus on these questions for complex polynomial vector fields.

NIKOLAJ NORDKVIST (MAT, DTU) (20 min)
Control Algorithms for Underactuated Mechanical Systems on Lie Groups.
Algorithms to control a class of invariant underactuated mechanical systems on Lie groups are presented. In particular the design of small-amplitude control forces to accelerate along, decelerate along, and stabilize relative equilibria is described. These systems are not linearly controllable. Hence, averaging analysis and Lie group theory play a crucial role in the mathematical approach as they take into account the nonlinearity of the systems. The theory is illustrated by applying the algorithms numerically to an underactuated planar rigid body and a satellite with two thrusters.

JENS STARKE (MAT, DTU) (20 min)
Self-Organized Control of Distributed Robotic systems.
Time-dependent robot-target assignment problems with several autonomous robots and several targets are considered as model of flexible manufacturing systems. Each manufacturing target has to be served in a given time interval by one and only one robot and the total working costs have to be minimized (or total winnings maximized). A specifically constructed dynamical system approach (coupled selection equations) is used which guarantees feasiblitiy of the assignment solutions.

This type of control is based on pattern formation principles known in physics, chemistry and biology and results in fault resistant and robust behaviour. The performance of the suggested control is demonstrated and visualized with a computer simulation of autonomous space robots building a space station by distributed transporting several parts from a space shuttle to defined positions at the space station.

POUL HJORT (MAT, DTU) (20 min)
Isomolonomics.
The conservation laws of classical mechanics, i.e., the conservation of linear and angular momentum for a body, are often erroneously used to infer the impossibility of, say, a body changing its orientation relative to an inertial frame when no external forces are acting.
This is a correct inference for a rigid body, but for a non-rigid body it is possible to alter the rotational state using internal forces only. A cat righting itself in mid-air and landing on its feet even if dropped upside down is a famous example of this. Even more surprising, the position of the center of mass may also be changed, if the imbedding space is not flat. It is possible for a deformable body to `swim' across a curved frictionless manifold.

PER G. THOMSEN (IMM, DTU) (20 min)
Parameter Estimation in Dynamic Systems.

NIELS TROLDBORG (MEK, DTU) (20 min)
Numerical Simulation of Wake of Wind turbine in Prescribed Atmospheric Boundary Layer.
The wake of a wind turbine operating in a prescribed turbulent atmospheric boundary layer is investigated using a numerical method combining large eddy simulations with an actuator line technique where each blade is represented by a line of body forces determined from tabulated airfoil data.
The atmospheric boundary layer is modelled as consisting of an arbitrary steady wind shear profile superposed turbulent fluctuations. The wind shear profile is prescribed by applying momentum sources to all computational nodes in the domain containing the wind turbine, while turbulence is generated by introducing time varying body forces in a plane upstream the rotor.
Results are presented for a wind turbine exposed both to a uniform inflow as well as to a number of representative atmospheric boundary layer conditions including turbulence and wind direction change. In each case the induced wake vortex system is analysed in order to identify the influence of an unsteady inflow.

Program for tirsdag formiddag, 20. marts

4 - VINDMØLLEDYNAMIK
(Chairman: ERIK LUND)

11:30 - 13:00 MORTEN H. HANSEN (RISØ, DTU) (20 min)
THOMAS BUHL (RISØ, DTU) (20 min)
WEI JUN ZHU (MEK, DTU) (20 min)
VALERY L. OKULOV (MEK, DTU) (20 min)

MORTEN H. HANSEN (RISØ, DTU) (20 min)
How hard can it be to pitch a wind turbine blade?
The aerodynamic loading of a wind turbine blade can be regulated by turning (pitching) the blade about its longitudinal axis (the pitch axis). Collective pitch of all blades of a turbine is used for regulating the rotor speed, and thereby the power production of the turbine. Cyclic and individual pitch controls are used for reduction of fatigue and extreme loads on the blades and other turbine components. The frequency range for collective pitch actions is relatively low for large turbines, where rotor speed variations are slow due to the large inertia. However, the frequency range of load reducing pitch control actions may be relatively high compared to the large inertia and first natural frequencies of modern multi-MW turbine blades. The required actuator torque to pitch the blades in this frequency range and the risk of critical interactions with blade modes may therefore limit the use of pitch control for load reduction. To illustrate these issues, a hydraulic pitch actuator with a PI-controller is modeled and tuned for pitch control of the blade of a 5 MW turbine. It is shown that the hydraulic actuator introduces a new mode in the system, which may become unstable if the gains or the blade pitch inertia are too high. The blade pitch inertia depends on the blade bending amplitude due to the aerodynamic loads that change with wind speed. The damping and frequency of the pitch actuator mode therefore changes during turbine operation, and it is investigated what happens if the frequencies of the pitch actuator and blade torsional modes coincide.

THOMAS BUHL (RISØ, DTU) (20 min)
Load Alleviation through Adaptive Trailing Edge Control Surfaces.
The wind field experienced by wind turbine blades is turbulent which causes fluctuating loads during normal operation. Yaw conditions, shear flow and the effect of the tower gives further fluctuating loads dependent on the rotational speed. Birds, like the common buzzard, can vary the geometry of their wings and can often appear frozen in the sky, despite the turbulence of the wind. Alleviating the fluctuating loads would lead to great cost benefits for the wind turbine industry if these systems do not add considerable extra cost.
Today modern load alleviation on multi Mega-Watt (MW) turbines is in the form of cyclic pitch control. Recent work show that the blade flap fatigue loads at the root can be reduced by up to 15% with cyclic pitch control while using individual pitch control can reduce the blade flap fatigue loads at the root by up to 28%. However, these control strategies comprises pitches the whole wing which today might be up to 62 m.

The full blade experiences several different inflow conditions throughout its span. Hence a local control surface reacting on the local inflow conditions would lead to larger load alleviation potential. Furthermore, the local control surfaces are able to react faster than the pitch system since the masses involved are smaller. This presentation gives an overview of the Danish national project ADAPWING partly sponsored by the Danish Research Council. The project objective is through numerical and experimental studies to investigate the potential of using adaptive trailing edge geometry on wind turbine blades as load alleviation. A new 2D aerodynamic model is developed to handle arbitrary camberline shapes. The 2D model is implemented in a 2D simple spring/damper code and in a 3D aeroelastic code based on modal shapes. The numerical investigations show a huge load reduction potential very dependent on time delay. To validate the numerical results, wind tunnel experiments are carried out. These tests shows load reduction potential of up to 82%.

WEI JUN ZHU (MEK, DTU) (20 min)

Aero-Acoustic Computations for Wind Turbines.

The newly developed high-order finite-difference aero-acoustic solver is designed to accurately predict flow generated noise, such as noise from wind turbine blades. To predict noise, the splitting technique developed in [1] is used. It consists of viscous incompressible flow equations and inviscid acoustic equations. Dispersion-Relation-Reserving (DRP) finite difference schemes [2] and compact finite difference schemes [3] are studied in details. The classical fourth-order Runge-Kutta time scheme is applied to the acoustic equations for time discritization. The incompressible flow equations are solved using the in-house flow solver EllipSys2D/3D which is second-order finite volume code. The acoustic solution is found by solving the acoustic equations using high-order finite difference schemes. The incompressible flow equations and acoustic equations are solved together at same time levels where results from incompressible equations are inputs to the acoustic equations.

References:

[1] Shen, W. Z., and Sørensen, J. N., 2001, "Aero-acoustic modelling of turbulent airfoil flows", *AIAA Journal*, vol. 39, No. 6, pp. 1057-1064.

[2] Tam, C. and Webb, J., 1993, "Dispersion-relation-preserving finite difference schemes for computational acoustics," *J. Comput. Phys.*, Vol. 107, pp. 262–281.

[3] Lele, S., 1992, "Compact finite difference schemes with spectral-like resolution," *J. Comput. Phys.*, Vol. 103, pp. 16–42.

VALERY L. OKULOV (MEK, DTU) (20 min)

Vortex dynamics: Why left is right and right is null.

The unique phenomenon (vortex breakdown) of vortex dynamics is addressed. The phenomenon was considered as a spontaneous transition from right-handed to left-handed helical symmetry of the vorticity field. The difference between vortex structures with right- and left-handed helical symmetry implies different signs of torsion or local helical pitch of the vortex lines (a positive pitch denotes a right-handed helical vortex and a negative pitch a left-handed one). In this research we try to find an answer to the question about possibility of an existence of another transition: from a left- to right-symmetry to base an existence of the right helix.

Program for tirsdag eftermiddag, 20. marts

5 - OPTIMERING
(Chairman: PAULI PEDERSEN)

14:00 – 16:30 ALLAN GERSBORG-HANSEN (MEK, DTU) (20 min)
GIL HO YOON (MEK, DTU) (20 min)
MARIE-LOUISE H. RASMUSSEN (MAT, DTU) (15 min)
LEON S. JOHANSEN (IME, AAU) (15 min)
ANDERS A. LARSEN (MAT, DTU) (15 min)
MICHAEL BOGOMOLNY (MAT, DTU) (20 min)
ROMAN STAINKO (MAT, DTU) (20 min)
JOHN RASMUSSEN (IME, AAU) (20 min)

ALLAN GERSBORG-HANSEN (MEK, DTU) (20 min)
Linux software for large topology optimization problems.
Recently the commercial finite element tool-box COMSOL has proven to be an excellent platform for development of the topology optimization method, teaching and other multi-physics modeling problems. This is mainly due to COMSOL's flexibility and symbolic infrastructure which puts focus on the modeling of the physics using partial differential equations (PDEs) rather than the numerical implementation. However, COMSOL lacks computational performance for large scale 3D problems, which are typically solved using an iterative strategy on a multi processor computer. Although COMSOL is a rapidly evolving product, which allows a parallel solution of the PDE, it lacks the important feature that the matrix-generation part of the computations is localized to each processor. This is well-known to be critical for obtaining a useful speedup on a Linux cluster and it motivates the search for a COMSOL-like package for large topology optimization problems. One candidate for such software is developed for Linux by Sandia Nat'l Lab in the USA being the *Sundance* system. *Sundance* also uses a symbolic representation of the PDE and a scalable numerical solution is achieved by employing the underlying *Trilinos* library. This talk investigates the efficiency of *Sundance* for large topology optimization problems.

GIL HO YOON (MEK, DTU) (20 min)
Topology Optimization for Electrostatic System.
A new topology optimization scheme for electromechanical system is presented in this paper. The most common used method is the staggering analysis calculating electric field and displacements in separated domains. Not knowing boundaries of separated domains in prior makes it problematic to perform topology optimization using this staggering analysis method. To resolve this problem, we proposed to use a monolithic approach. Moreover, the relationship between the electrostatic force and displacements is determined using continuum mechanics theory. Based on these ideas, we can perform the topology optimization for electrostatic structures. Additionally, we address some issues of localization of the actuation area in design domain and feature size control to avoid too small features.

MARIE-LOUISE H. RASMUSSEN (MAT, DTU) (15 min)

Strength of problem formulations in topology optimization.

Discrete topology optimization problems based on a Simultaneous ANalysis and Design (SAND) approach give rise to non-convex problem formulations. These are reformulated to mixed-integer linear programs and solved to guaranteed global optima using a branch-and-bound method. However, in branch-and-bound, a relaxation of the reformulation is solved, which has a weak representation of the original feasible domain and, therefore, entails long solution times. The representation is strengthened by extending the problem with so-called valid inequalities and Combinatorial Benders' and projected Chv{\'a}tal-Gomory cuts. We demonstrate how in most cases solution times of the extended problem decrease drastically. Moreover, we solve the problem instances on parallel computers, where the valid inequalities and cuts give the positive impact of, in general, improving the speed up of the parallelized branch-and-bound method.

LEON S. JOHANSEN (IME, AAU) (15 min)

Design and Optimization through use of adaptive models.

In this work the objective is to optimize geometrically linear/ geometrically nonlinear laminated composite structures against delamination failure.

In this work prediction of delamination onset in laminated composite structures involves stress and/or strain based criteria, i.e., it is assumed that the process of degradation begins when the stresses and/or strains satisfy certain damage initiation criteria. In this work a criterion involving the transverse normal stress and the two transverse shear stresses is used. Initially, the laminated composite structure is modeled using a finite element model consisting only of **E**quivalent **S**ingle **L**ayer solid shell elements. Based on stress failure criteria, the most critical area of the structure is refined by modeling each layer of the laminated structure using 3D continuum based shell elements. At the interfaces between ESL elements and the refined area localized Lagrange multipliers are introduced. Thus, the analysis model is adaptively refined for the optimization process, such that reliable predictions of delamination onset can be obtained.

Having identified critical zones for delamination onset, the refined model is used as reference model for an optimization problem with regard to delamination failure. The design variables of the problem may be fiber angles of each layer. A gradient based optimization approach is applied. Design sensitivity analysis of the geometrically linear/ nonlinear problem is performed using the direct differentiation approach, and the mathematical programming problem is solved using Sequential Linear Programming.

MICHAEL BOGOMOLNY (MAT, DTU) (20 min)

Optimal Design Aspects of Resistance Welding.

Resistance welding is one of the most productive and economically competitive joining processes that is widely applied in the manufacturing industry e.g. automotive, aerospace, electronics, electrical and other metal working industries for joining similar as well as dissimilar metals. The resistance welding process can be simulated with four coupled numerical models: an electrical model, a thermal model, a metallurgical model and a mechanical model [1]. The main industrial problem in the design of the resistance welding process is to provide the appropriate parameters like force, current and time. The purpose of this recent study is to illustrate the possibility of using optimization for the design of the resistance welding process. Two kinds of the optimization problems are considered sizing and shape design.

The sizing optimization problem is multi-objective, and the objective functions are intended to reduce the heating energy and to reach the required melted nugget's dimensions. The constraints of the problem are the nugget's dimensions and the limited electrode temperature that provide longer life-time of the electrode; this is critical for the industrial processes. The shape design has been concentrated on obtaining of the electrode's shape to provide efficient resistance welding.

References

[1] I.O. Santos, W. Zhang, V.M. Goncalves, N. Bay, P.A.F. Martins, "Weld bonding of stainless steel", *Int. J. of Machine Tools & Manufacture*, vol. 44 (2004), pp. 1431-1439.

[2] W. Zhang, "Design and Implementation of Software for Resistance Welding Process Simulations", *SAE 2003 World Congress*, Detroit, USA, 2003.

[3] Svanberg K. – The method of moving asymptotes – a new method for structural optimization. *Int. J. for Num. Meth. In Eng.* 1987, 24; pp. 359-373.

[4] A Matlab implementation, mmasub, of the MMA optimization algorithm [3] can be obtained (free of charge for academic purposes) from Krister Svanberg, KTH, Sweden. Email: krille@math.kth.se.

ROMAN STAINKO (MAT, DTU) (20 min)

Tailoring group velocity by topology optimisation.

Interesting phenomena of photonic crystals (PhCs), like bandgaps and waveguiding, have lead to a tremendous increase of research interest in this area. High-end functionalities in electro-optical circuits urge to optimize these structures. So far mostly trial and error methods have been applied to improve the behaviour of the PhCs components, like e.g. to maximize the bandgap of PhCs or to reduce the losses of waveguides in PhCs. Recently also topology optimization was applied to synthesize e.g. high transmission waveguide bends and junctions. In this work we extend the topology optimization method not only to create a bandgap around an a-priorily chosen guided mode, but also to have the possibility to tailor the group velocity of the guided mode in the slow-light regime below the light line. To achieve that goal we do not solve the eigenvalue problem given by the Helmholtz equation but rather excite the system for a given wave vector and a given frequency. Then we maximize the confinement factor of the resulting field in the defect core with respect to the given excitement, wave vector and frequency. By choosing several pairs of frequencies and wave vectors the optimization progress yields a guided mode that is defined by these pairs. In the presentation we will discuss the modelling of the method as well as the numerical aspects of the optimization. We will finish with some examples and animations, showing the potential of the new method.

JOHN RASMUSSEN (IME, AAU) (20 min)

Can AnyBody do the Limbo?

Optimization plays an integral role in many aspects of biomechanics due to the presumption that living organisms constantly strive to make the best of their resources. This likely applies in long-term genetic development as well as in the instantaneous choices we make to perform a movement one way or the other. The latter is relatively poorly understood, and optimization technology may allow us firstly to decode the motives, i.e. the objective function, behind our movement patterns, and secondly to employ this knowledge to predict how humans will behave in different environments.

The AnyBody Modeling System is used to investigate if an optimality criterion can predict human posture and movement. The presentation reports a preliminary study where a simple approximation of a human body is set up to do a limbo dance, i.e. pass under a low stick with minimum effort.

Program for onsdag formiddag, 21. marts

6 – MATERIALEMEKANIK
(Chairman: NIELS OLHOFF)

09:00 – 11:00 CHRISTIAN BERGGREN (MEK, DTU) (20 min)
KIM L. NIELSEN (MEK, DTU) (15 min)
LARS P. MIKKELSEN (RISØ, DTU) (20 min)
BENT SØRENSEN (RISØ, DTU) (20 min)
MARTIN JOHANNES (IME, AAU) (15 min)
KASPER K. KRATMANN (IME, AAU) (15 min)

CHRISTIAN BERGGREN (MEK, DTU) (20 min)
Buckling strength of square composite plates with geometrical imperfections – preliminary results.
Tests have been performed on square composite plates under in-plane compression. The plates had a width-to-thickness ratio close to the value for which the elastic critical load and the load for compressive fibre failure over a complete section would be equal, giving the maximum sensitivity to initial geometric imperfections. Some of the plates were manufactured with no intentional imperfections or defects, others with an intentional initial out-of-plane geometric imperfection. An advanced digital photogrammetry measurement system was used to monitor deformations of the tested plates. The responses were also calculated by means of geometrically non-linear finite element analysis. With the assumption of rotationally fixed edges, the calculated elastic critical loads were significantly higher than those deduced from the measurements. Closer examination revealed that the loaded edges of the plates rotated significantly during the tests. It was found necessary to include in the analysis the observed variation of edge rotation with applied in-plane displacement. Although material non-linearity was not modelled, some conclusions concerning the failure sequence were drawn from the analyses.

KIM L. NIELSEN (MEK, DTU) (15 min)
Transient 3D analysis of Viscoplastic structure.
The work presented is handed in as part of a master thesis at the Department of Mechanical Engineering, DTU. The purpose of the project is to model a head-on collision between a flexible car and a rigid column in 3D, using the finite element method. The collision is assumed to occur at low speed (15m/s) and the displacement is here assumed to be concentrated in the front of the car. To simplify the model only a part of the car frame is considered in the FE-model, while the remaining part of the car is introduced in the model as a rigid mass acting on the discretized frame. To enhance the accuracy of the description of the impact, the model is build on finite strain theory. Combined with an elastic-viscoplastic material model this fully account for both geometrical and material non-linearities, as well as a strain-rate dependence in the material. Furthermore, the time dependence in the model is introduced by a transient formulation of the FE-model and thereby solved in an explicit Newmark-β scheme. An analysis of the effect of different system parameters on the response of the impact was then carried out. To evaluate the impact both the distribution of energy in the system and the acceleration acting on a given passenger was considered.

For comparing the impacts the acceleration on the passenger was quantified according to by a Head Injury Criteria (HIC) and a Gadd severity index (Gadd). Here HIC and Gadd are measures of the chance to incur injuries in the head and chest region, respectively.

LARS P. MIKKELSEN (RISØ, DTU) (20 min)

Eksempler på anvendelse af en gradient afhængig plasticitetsteori i en kommerciel finite element kode.

En variation af de plastiske deformationer indenfor et lille område er afhængig af materialets underliggende mikrostruktur. En afhængighed der ikke vil blive fanget i en traditionel finite element simulering da materialet her traditionelt vil blive modelleret som et homogent kontinuum. Til at afhjælpe dette er der i de seneste par årtier blevet udviklet materialemodeller der kan tage hensyn til effekten af en sådan underliggende mikrostruktur på deformationstilstanden. Dette gøres uden faktisk at skulle modellere mikrostukturen men derimod ved at implementere en eller flere materialelængdeskalaer som ekstra parametre. Denne angrebsvinkel er især relevant når det er mikrostrukturens indflydelse på den makroskopiske opførsel der ønskes bestem. Som eksempel kan nævnes modellering af mikro- og nano indtrykstest samt forudsigelse af revnevækst langs stærkt bundne grænseflader. I det præsenteret arbejde, vil implementeringen af en sådan gradient afhængig plasticitets teori i den kommercielle finite element kode ABAQUS blive beskrevet. Desuden vil anvendelser af modellen blive demonstreret.

BENT SØRENSEN (RISØ, DTU) (20 min)

Micromechanical model of cross-over fibre bridging – prediction of mixed mode bridging laws.

The fracture resistance of fibre composites can be greatly enhanced by crack bridging. *In-situ* observations of mixed mode crack growth in a unidirectional carbon fibre/epoxy composite reveal crack bridging by single fibres and by beam-like ligaments consisting of several fibres. Based on the observed bridging mechanism, a micromechanical model is developed for the prediction of macroscopic mixed mode bridging laws (stress-opening laws). The model predicts a high normal stress for very small openings, decreasing rapidly with increasing normal and tangential crack opening displacements. In contrast, the shear stress increases rapidly, approaching a constant value with increasing normal and tangential openings. The solutions for the bridging laws and the resulting toughening due to the bridging stresses are obtained in closed analytical form.

MARTIN JOHANNES (IME, AAU) (15 min)

Thermoelastic Stress Analysis of Sandwich Structures with Core Junctions.

The work concerns local effects occurring in the vicinity of junctions between different cores in sandwich beams subjected to cyclic tensile in-plane or transverse loading. It is known from analytical and numerical modelling that these effects display themselves by an increase of the bending stresses in the faces as well as the core shear and transverse normal stresses at the junction, but an accurate prediction especially for the core stresses is still an unsolved problem. In the present work the local effects were studied experimentally by means of thermoelastic stress analysis (TSA) for two types of sandwich beams with aluminium and GFRP face sheets, respectively, and core junctions with polymer foams of different densities and aluminium edge stiffeners.

Indirect calibration tests on the constituent materials were used to get the calibration constants necessary for calculating stress data from thermal data. Reference data obtained from finite element modelling was used for comparison with the experimentally obtained results. For each loading case, two TSA test set-ups were used. In tests examining the sandwich face surface stresses by scanning the top or bottom side of the sandwich beam, the TSA was able to capture the overall nominal surface stresses in the regions that were undisturbed by the discontinuities. A local variation of face surface stresses in the vicinity of the core junctions was indicated by the TSA, but of different magnitude than predicted by the FEM. The second test type was scanning along the sandwich beams' longitudinal edges. Here, the quality of the data was significantly affected by signal noise from motion effects for the bending loading case, even when employing a motion compensation software. For the tensile in-plane loading case, the effects of motion were less pronounced, but signal noise still proved to be a major obstacle for uncovering the local stress variations.

KASPER K. KRATMANN (IME, AAU) (15 min)

Determination of fibre misalignment in pultruded UD CFRP.

In large composite structures compressive strength can often be the limiting design factor as failure typically occurs at 50-60% of the tensile strength. It is today widely accepted that compressive failure in aligned fibre composites is due to micro buckling of the fibres. Previous studies indicate that micro buckling is initiated near imperfections such as voids and misaligned fibres.

Different approaches of determining and quantifying fibre misalignment in pultruded unidirectional carbon fibre reinforced plastics are reviewed. The Multiple Field Image Analysis (MFIA) method is chosen and briefly described. The MFIA algorithm has been made more efficient allowing much larger amounts of data to be analyzed within reasonable time compared to previous algorithms. The size of the analyzed domains and specimen preparation hereof is described. Different input parameters for the MFIA algorithm are discussed. Finally results of an MFIA is presented and discussed.

Program for onsdag formiddag, 21. marts

7 – VINDMØLLER OG MOTORER
(Chairman: MARTIN P. BENDSØE)

11:15 – 13:00 TROELS D. PEDERSEN (MEK, DTU) (15 min)
SAJJAD HAIDER (MEK, DTU) (15 min)
ROBERT MIKKELSEN (MEK, DTU) (20 min)
LARS C. T. OVERGAARD (IME, AAU) (20 min)
ANDERS L. HANSEN (IME, AAU) (15 min)
CHRISTIAN BANG-MØLLER (MEK, DTU) (15 min)

TROELS D. PEDERSEN (MEK, DTU) (15 min)
Application of Dimethyl Ether (DME) in Homogeneous Charge Compression Ignition (HCCI) Combustion Engines.
The HCCI combustion engine utilizes an alternative combustion process, which radically differs from that of both Compression Ignition (CI) and Spark Ignition (SI) reciprocating combustion engines. The motivation for using the HCCI combustion is that is allows an engine to have high fuel efficiency, while keeping emissions of particulate matter and nitric oxides at a minimum. In an HCCI engine, a lean and homogeneous (premixed) blend of fuel and air is inducted into the cylinder as in a normal SI engine. The combustion is however not initiated by a spark from a spark plug, but by auto ignition as in a CI engine. Combustion will occur almost simultaneously and homogeneously within the cylinder. The combustion is thus much faster than a conventional SI combustion process, and might in some cases be comparable to engine knock which is known to destroy engines. Therefore, the main challenge of HCCI is to obtain control of the combustion timing and combustion rate. DME is a promising fuel for the HCCI combustion process, as it has excellent combustion properties. It is easy to ignite, since auto ignition occurs at the same temperature as diesel and with less ignition delay. Since DME is a gas, it is also easy to obtain the homogeneous combustion that is the key to avoid formation of particulate matter. Finally, being a synthetic fuel, DME may be produced from a variety of sources other than oil, such as coal, natural gas, or biomass.

SAJJAD HAIDER (MEK, DTU) (15 min)
Modelling Two-Stroke Diesel Engines.
With the increased concerns of environmental pollution in the marine environment, the engine manufacturers have to develop the marine engine technology to meet the required emission limits. For this PhD study, the focus is on large 2-stroke Diesel engines for ship propulsion. A multi-dimensional CFD modelling approach for in-cylinder reacting flow is used to understand the combustion phenomena and pollution formation in swirling flow. The key aspects of the model include modelling multiphase flow, turbulence, combustion reaction kinetics and boundary layer phenomena. The main targets to achieve are:

- Effects of Fuel Injection and Swirl-Flow on Overall Combustion Process
- Kinetics of Combustion Reaction
- Kinetics of Soot Formation
- Heat Flux Distribution in the Engine Cylinder.

ROBERT MIKKELSEN (MEK, DTU) (20 min)

Navier-Stokes modellering af vindmølleparker.

Vindmøller placeret i møllefarme eller parker påvirker hinanden nedstrøms via den slipstrøm der producers af møller placeret opstrøms, i form af øgede laster og reduceret produktion. Således opererer møllerne i forreste række ved optimale forhold, mens møller i de resterende rækker er mere eller mindre påvirket af skygge virkning, alt afhængig af den givne vindsektor. Møllernes interaktion er i det følgende modeleret med aktuator linje og aktuator disk metoderne, der repræsenterer de enkelte møllens aerodynamiske belastning. Aktuator linje/disk teknikkerne er implementeret i EllipSys3D koden der simulerer det fulde 3D flow felt, ved løsning Navier-Stokes ligninger koblet med en LES turbulens model. Effekt produktionen for en mindre møllefarm er estimeret for udvalgte vind sektorer med mere eller mindre skygge virkning. Simuleringer påviser tydeligt skygge effekter og den instationære karakter af de opblandede turbulente slipstrømme langt nede i møllefarmen.

LARS C. T. OVERGAARD (IME, AAU) (20 min)

Delamination Modeling with Mixed-Mode De-Cohesive Element Formulation.

1 Introduction

The title of the PhD programme is “Structural Instability Phenomena in Wind Turbine Blades” in relations to material and geometric instabilities. One of the overall objectives is to be able to conduct delamination studies of a prepreg-layered composite wind turbine section. The objective of the present presentation is to present the work do in relations to this subject. The work involves the use of a solid-shell and implementation of a mixed-mode de-cohesive element formulation, which is based on the work of Camanho and co-workers [1].

2 Mixed-mode De-cohesive Element Formulation

The de-cohesive element formulation is an indirect use of linear elastic fracture mechanics in a damage mechanics framework. The implementation of the de-cohesive element formulation is verified by comparing results from analytical solutions and experimental values. A generic constitutive formulation is used so that new mixed-mode constitutive softening laws easily can be implemented.

3 Solution Strategy

Constitutive softening models are associated with severe solution difficulties. Thus an efficient and robust solution strategy for dealing with large three-dimensional structures is needed and implemented. For this type of problem a subplane control approach with a full Newton method is the most feasible solution strategy. Experience has shown the apparent best method, for the implemented element, to be an extended version of the proposed approach by Crisfield and Alfano [2], which is improved w.r.t. robustness and efficiency.

4 Status of Work

A blade builder program is constructed so that blade models can be generated fairly quickly with solid-shell and de-cohesive elements. The de-cohesive elements will overlap or be layered due to the material lay-up and mesh discritization method, which has proven to be a problem. A routine has been implemented to remedy this. Next step is to find a mesh density that is feasible in order to solve the large wind turbine problem. In the future the aim is to be capable of performing interdisciplinary damage mechanics and stability analysis.

References
[1] A. Turon, P.P. Camanho, J. Costa, C.G. Dávila. "*An interface damage model for the simulation of delamination under variable-mode ratio in composite materials*" NASA/ TM–2004–213277, October 2004.
[2] G. Alfano and M.A. Crisfeld., "*Solution strategies for the delamination analysis based on a combination of local-control arc-length and line searches*" International Journal for Numerical Methods in Engineering, 58, pp. 999-1048, 2003.

ANDERS L. HANSEN (IME, AAU) (15 min)
Hierarchical FEM of Wind Turbine Blades.
The subject of the Ph.D. is analysis of large composite structures with respect to prediction of failure development by use of the finite element method. The overall aim of the project is to develop a general computational design tool for estimation of failure in composite structures. Such a design tool can be used in the industry to design optimized and more reliable composite structures than possible today. Failure in composite structures is often caused by local damage effects, e.g. delamination. A hierarchical FEM approach is used to model both the global structural response and the local response near load critical regions. The global response is modeled by solid shell elements with in-plane and transverse stress components. Based on stress/strain based initiation criteria, load critical regions are automatically refined through the thickness, and cohesive elements are embedded between the solid-shell element layers in order to simulate delamination. The hierarchical finite element design tool will be implemented in an in-house developed FE software, named MUST. At present, a 3D solid-shell element has been developed together with an adaptive mesh generator by use of the Lagrange multipliers method. Currently, the solid-shell element formulation is expanded to include geometrical non-linearity. Cohesive elements and different cohesive zone models describing initiation and propagation of mixed mode delamination have been implemented in MUST. FE models of crack test specimens will be used to investigate the precision of the cohesive zone method by comparison with experimental data. This work will be done in collaboration with Bent F. Sørensen, Materials Research Department, Risø. A FE model of a wind turbine blade will be used to investigate the influence of imperfections on the strength of the structure. Likewise, the interaction between buckling and material damage will be investigated on this model. Finally, the developed design tool will be evaluated by comparison with experimental results, e.g. from a collapse test of a section of a wind turbine blade.

CHRISTIAN BANG-MØLLER (MEK, DTU) (15 min)
Design of DMFC System for Mobile Applications.
IRD A/S is the leading company in Denmark within research, development and production of PEM-based direct methanol fuel cells (DMFC) and DMFC-based systems. As a part of a strategy with production of total solutions IRD A/S has a great deal of interest in the development of a portable DMFC-based power module. As a contribution to the development of such a power module, this master thesis incorporates system design, thermodynamic modelling, component dimensioning/identification and experimental research of the functionality and methanol emissions, in relations to this power module. The system layout has emerged from preliminary considerations of system design along with thermodynamic modelling.

The functionality of the fuel cell system has been demonstrated by experimental testing in a constructed experimental set-up. A stationary thermodynamic model outlines the fuel cell system by modelling consumption, production and like in the DMFC stack along with distribution of heat loss and production etc. The results from the model are used for dimensioning of components. In the experimental investigations, focus has mainly been on determining the amount of methanol emissions. With a circulated 1 M methanol/water solution these investigations has shown that the emissions released together with CO_2 can be reduced from 8 to 2 vol-% methanol by reducing the temperature of the exhaust flow from 70 ºC to 30 ºC. In the thermodynamic model of the power module this corresponds to a reduction in methanol emission from 7.5 wt-% to under 1 wt-% of supplied methanol. Apart from this, experiments have shown the potential for determining the methanol concentration in the methanol solution using measurements of methanol emissions in the CO_2-release.

Program for onsdag eftermiddag, 21. marts.

8 - STRØMNINGER
(Chairman: POUL SCHEEL-LARSEN)

14:00 – 15:30 CLARA VELTE (MEK, DTU) (15 min)
WIEBKE BRIX (MEK, DTU) (15 min)
MICHAEL WINTER (IME, AAU) (15 min)
GARBRIEL G. MARTÍNEZ (MEK, DTU) (15 min)
JIMMY KJÆRSGAARD-RASMUSSEN (MEK, DTU) (15 min)

CLARA VELTE (MEK, DTU) (15 min)
Simulation and control of Wind Turbine Flows using Vortex Generators.
The operating conditions of wind turbines are affected by varying wind characteristics as well as blade geometry. Wind speed, direction and turbulence levels can fluctuate significantly. This causes wind turbines to often operate with flow separation on at least some part of the blades. By the use of small winglets on the surface of the blades that are placed at an inclination to the mean flow direction, separation can be obstructed or even prevented. These devices, called Vortex Generators, create line vortices that transfer high momentum from the mean flow into the boundary layer, which leads to an enhancement in wall shear stress, thereby obstructing separation. The model used in this study is a bump (2D profile shaped as a circular segment) in a low speed wind tunnel (custom designed for the current experiments) with a turbulent boundary layer. The bump gives rise to a pressure distribution and flow separation which is similar to the conditions on the suction side of an airfoil. The flow is investigated using an experimental technique called Stereoscopic Particle Image Velocimetry (SPIV), which provides the experimenter with measurements of the three velocity components in a 2D plane. In the present work, data from measurements of the flow in the clean bump configuration and the configuration with vortex generators attached is presented. The objective of these measurements is to investigate the effect of the presence of the vortex generators on the adverse pressure gradient boundary layer. These measurements are also used for code validation of the DTU-Risø in-house code Ellipsys3D and different ways of modeling the effect of the vortex generators.

WIEBKE BRIX (MEK, DTU) (15 min)
Coupling Between Air and Refrigerant Flows in an Evaporator.
In a refrigeration system the evaporator is responsible to transfer heat from the surroundings to the refrigerant, which evaporates on one side of the heat exchanger. The fluid medium on the other side, i.e. the surroundings, is usually air. In some types of evaporators for refrigeration systems the refrigerant flow is divided into many parallel channels at the evaporator header. For an optimum use of the heat transfer area, an even distribution of the refrigerant between the different channels is preferable. However, in reality there might be large differences between the refrigerant mass flows in the channels, which results in a decrease on the performance and efficiency of the heat exchanger. This maldistribution of the refrigerant occurs, amongst others, due to an uneven heat load on the outside. If one channel is exposed to a higher heat load than the other channels, a faster evaporation will happen in this channel.

Due to the higher gas fraction the pressure drop increases, and this then results in a decrease of the mass flow rate in this channel. The flow distribution of the refrigerant will thus be inappropriate compared to the airflow distribution and therefore the performance is reduced. Using a combination of physical and empirical modelling we analyse the above described problem in order to understand the importance of the phenomenon.

MICHAEL WINTER (IME, AAU) (15 min)

Optimization-based Analysis of Cable Nets for Fishing.

The present Ph.D. study deals with the analysis of large netting structures for commercial fishing, including both pelagic (mid-water) and bottom trawls. The analysis is performed by sequentially minimizing the total potential energy of the structure subject to updates of the hydrodynamic forces and possible bottom contact conditions. When developing a new trawl design it is essential to know the in-service towing resistance and the geometric shape. Determination of these properties has traditionally been based on empirical or semi-empirical methodology, implying that the prediction of these properties has been limited to designs of similar type. Thus, if a new trawl design differs substantially from any known type, e.g., with regard to mesh size or twine diameter, then a traditional net maker/designer cannot predict the properties based on experience. The characteristics of a new trawl design necessarily need to be verified experimentally by scale model testing in a flume- or towing tank, or by full scale testing at sea. This is both time consuming and financially straining. In addition, scale model testing is associated with substantial uncertainty due to scaling errors. Hence, the development of new, improved trawl designs has been long winded and slow without any major changes relative to well proven designs. It is the aim of the present work to develop an optimization-based method for analysis of trawl nets for fishing that can be implemented in a fast and efficient numerical code, capable of determining the equilibrium configuration in terms of the positions of the knots of a large netting structure subject to hydrodynamic loading and bottom contact conditions. The netting material is modeled by a discrete, finite cable network consisting of lumped masses interconnected by elastic springs, approximating the masses of the twines and their netting knots, and the elasticity of the twines. Based on analytical expressions of the internal elastic energy of the netting and the potential energy of the external forces, we solve the problem of determining the equilibrium positions of the knots by minimizing the total potential energy of the system with respect to the positions of the knots. The external forces are the hydrodynamic drag and lift forces on the net structure from the water flow and forces from possible bottom contact. These forces depend on the configuration (i.e., the positions of the knots) of the structure, and are not conservative. To cater for this, we have developed a nested approach of successive iterations where the knot positions are computed in an inner loop of iterations subject to fixed values and orientations of the external forces (considered as dead loads), and where these forces are updated for each new iteration in the outer loop of the numerical procedure.

GARBRIEL G. MARTÍNEZ (MEK, DTU) (15 min)

3D Modeling of Laminar-Turbulent Transition on Wind Turbine Blades.

Accurate modeling and simulation of the transition process from laminar to turbulent flow is important for a precise design of wind turbine blades. Most of the actual CFD codes assume that the boundary layer is completely turbulent, giving as a result inaccurate prediction of loads and performance.

Depending on the level of turbulence in the incoming flow two different types of scenarios can be found. If the level is relatively low, the flow will pass through linear amplification of the waves, natural transition will occur. If it is higher, non linear behavior will take place immediately and bypass transition will be present. This scenario is the most commonly found. The laminar/turbulent transition process is related to the stability of the boundary layer, three dimensional and rotational effects; Coriolis and cross flow must be included in the Stability analisys. To study the amplification of the waves hydrodynamic stability approach will be used, a database with the a 3D family of velocity profiles will be used as an input to the Orr-Sommerfeldt (O-S), and, as a result the stability characteristics of all relevant boundary layer shapes will be mapped and stored in an effective database.

JIMMY KJÆRSGAARD-RASMUSSEN (MEK, DTU) (15 min)

Multiphase Flow Evaluation.

The oil and gas sector is a rapidly developing industry. Enhanced oil recovery is facilitated by modelling of reservoirs. The data sets used in such modeling are limited in both precision and size. Developing a method for evaluation of multiphase flow in wellbores will provide valuable data to reservoir engineers. The first part of this project has been to find a suitable method for evaluation of the multiphase flow. Several methods were proposed. A scheme was devised to find the three most suited methods. One of the final technologies is electrical capacitance tomography (ECT). A central part of the project will be testing the selected technologies at a standard test site which has also been devised. At this point in the project numerical work has been done for the ECT method. Capacitance circuits are being constructed at Welltec and will soon be ready for initial test. The first part of the test facility is being assembled in the test hall at Welltec.