DANISH CENTER FOR APPLIED MATHEMATICS AND MECHANICS

PROGRAMME, LIST OF PARTICIPANTS and ABSTRACTS

DCAMM
20th Internal Symposium

Wednesday, March 11-
Friday, March 13,
2026

GOLF HOTEL
VIBORG

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MM

TECHNICAL UNIVERSITY OF DENMARK -
AALBORG UNIVERSITY - AARHUS UNIVERSITY –
UNIVERSITY OF SOUTHERN DENMARK

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Organizing Committee:
Erik Lund, Lars Pilgaard Mikkelsen, Jan Becker Høgsberg and Gerda Helene Fogt

Organization:
DCAMM

Important information regarding the presentations:

The presentation language is English.

PhD students early in their projects (first year) present their research in the poster session, which is divided into two parts:

1. An oral presentation: maximum 2 minutes and 2 slides in pdf, introducing the poster.
2. The actual poster session, where the poster is displayed: The posters should be in vertical A0 format. Please include a picture of yourself in the poster and list the supervisors. You must print and bring the poster yourself.

Second- and third-year PhD students give a dedicated 15 min oral presentation, with 10 minutes for the presentation and 5 minutes for questions and discussion.

All presenters are requested to send their electronic presentations to Lars Pilgaard Mikkelsen (lapm@dtu.dk) no later than 12.00 on Friday 6 March 2026, including the two slides for the 2 min poster oral poster session, submitted in pdf format to avoid delays and technical problems between the presentations.

All presentations will be available on a computer provided in the conference room. Acceptable formats for the dedicated 15 min oral presentations (10+5min) are Microsoft PowerPoint files (.ppt, .pptx), Adobe Portable Document files (.pdf) and multimedia files which can be viewed by Windows Media player.

Extra details regarding the 2 min oral poster presentation

It is important that an oral poster presentation does not exceed 2 minutes and 2 slides. In the following, a 10-point template is provided for inspiration on how to approach the presentation. Each point should only occupy two-three sentences, so that the total duration does not exceed the allowed 2 minutes. Note that the chairman will interrupt the presentation exactly at the 2-min mark. So come prepared!

1. Context: General context of the PhD project

2. Specific problem: The main problem addressed by the PhD project

3. Idea: The main idea of how the problem will be addressed

4. Solution: The overall solution strategy

5. How it works 1: What is done initially (e.g. the main method)

6. How it works 2: What is done next (e.g. a specific model)

7. How it works 3: What is done afterwards (e.g. how the model is/will be used)

8. Proof: Some (preliminary/expected) result(s)

9. Vision: How will the project continue and progress?

10. Branding: Tell the audience which person and poster to visit.

Programme for Wednesday afternoon, March 11th, 2026

11:30 Arrival

12:00 - 13:00 Lunch

13:00 - 13:05 Welcome and practical information, JAN B. HØGSBERG (DTU, Dept. of Civil and Mechanical Engineering, 5 minutes)

13:05 – 14:50 COMPOSITES AND STRUCTURES
(Chairman: Ulrik Borg, SDU, Dept. of Mechanical and Electrical Engineering)

PINELOPI MAGEIRA (DTU, Dept. of Wind and Energy Systems, 15 minutes)
Finite element 3D homogenized model of long fiber reinforced unidirectional composites

RICCARDO GROSSELLE (AAU, Dept. of Materials and Production, 15 minutes)
Towards simulating delamination in unidirectional composites using physics-informed machine learning

NIKLAS KRISTIAN KRONBORG STAGSTED (AAU, Dept. of Materials and Production, 15 minutes)
The effect of loading history on the traction field and crack tip shielding of fibre bridging in delaminations

MORTEN FOGTMANN KRISTIANSEN (AU, Dept. of Mechanical and Production Engineering, 15 minutes)
Fatigue in composites materials: Load-controlled and strain-controlled tests of biaxial non-crimp glass-fiber-reinforced polymers

SØREN SØLUND WAHLGREN (AU, Dept. of Mechanical and Production Engineering, 15 minutes)
On the transition from arc debonding to tunneling at fiber-matrix interfaces

PHAN HOANG DAO NGUYEN (AU, Dept. of Mechanical and Production Engineering, 15 minutes)
Segmented rim design for high performance flywheel energy storage system

DANIEL STRACK (AU, Dept. of Mechanical and Production Engineering, 15 minutes)
Cracking bones and beyond, finite element simulation to assess fracture risk of vertebral bones.

14:50 - 15:15 Coffee break

15:15 – 16:45 DYNAMICS
(Chairman: Luis David Avendaño-Valencia, SDU, Dept. of Mechanical and Electrical Engineering)

AMIN SOLTANI (AU, Dept. of Mechanical and Production Engineering, 15 minutes)
Rising bubble dynamics in porous media

ARUNABHA MAJUMDER (AAU, Dept. of Mechanical and Production Engineering, 15 minutes)
Design and control of a hybrid actuated should exoskeleton for motion assistance

ALI SOLTANI (AU, Dept. of Mechanical and Production Engineering, 15 minutes)
Model selection in symbolic regression

ALI MOHAMMADI QARAGOEZ (AU, Dept. of Mechanical and Production Engineering, 15 minutes)
Symbolic regression of control Lyapunov functions

ELMA RAMIC (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)
Motion sickness among offshore wind technicians on smaller working vessels

17:00 – 17:45 POSTER PRESENTATIONS
(Chairman: Lars Vabbersgaard Andersen, AU, Dept. of Civil and Architectural Engineering)

17:45 – 18:45 POSTER SESSION

For PhD's started after 1 March 2025 (17)

AU Dept. of Civil and Architectural Engineering (3)

(1) JAKOB DEGN LARSEN
Phase-field modeling for fracture mechanics using open-source software

(2) MATILDE BRUUN SØRENSEN
Optimal experimental design for hydrodynamic loading estimation in floating structures

(3) MATHIAS THING
Loading estimation for multibody dynamic problems

AU Dept. of Mechanical and Production Engineering (5)

(4) EMILIE TAGE ANDRESEN
Thermofluid Modeling of Direct Air Capture Systems

(5) PETER MØLLMANN
Data-driven material characterization via scratch testing

(6) SARA NAFISI
Carbon-negative bio composites: Early-stage material optimization and characterization

(7) AMAL AMEEN SEENATH
Tribological characterization and performance of novel bio-lubricants: Evaluating friction and wear protection

(8) FAEZEH SEMNANI
Data-driven monitoring of bearing lubrication for efficient and sustainable machinery

AAU Dept. of Mathematics (2)

(9) CHRISTIAN BAK WINTHER
A population balance approach to cavitation modeling

(10) JAKOB TORE KAMMEYER NIELSEN
Higher-order finite-element boundary-integral methods for computational electromagnetics

DTU Dept. of Civil and Mechanical Engineering (4)

(11) MATHIS JONATHAN HÖRMANN
Topology optimization of micro-flows under uncertainty: A stochastic gradient approach

(12) LAURITS NICOLAISEN
An investigation into physics-informed autoencoders for model order reduction of broadband vibroacoustic problems

(13) BRANDON PARKS
Topology optimization of surgical procedures

(14) JONATHAN TAULO PEDERSEN-BJERGAARD
Manufacturing-aware topology optimization of short-fiber reinforced structures produced by material extrusion additive manufacturing

SDU Dept. of Mechanical and Electrical Engineering (3)

(15) MORTEN BJERRE JONATHANSEN
Advanced design for high temperature-difference heat exchangers using computational morphogenesis

(16) CHRISTIAN BUUR KEJ
Strengthening European shipbuilding capabilities through advanced automation solutions

(17) JONAS PALMGREN
Decision-support tool for sustainable ship propulsion

19:00 - Dinner

Programme for Thursday morning, March 12th, 2026

07:00 - 09:00 Breakfast

09.00 – 10:50 STRUCTURES
(Chairman: Federico Ferrari, DTU, Dept. of Civil and Mechanical Engineering)

JOHAN TOFTEKÆR & JEROEN GROEN (Vattenfall, 20 minutes)
Data-driven design optimization of offshore wind turbine support structures

JACK RAHBEK STEENGAARD (SDU, Dept. of Mechanical and Electrical Engineering & Kverneland, 15 minutes)
Frequency-based fatigue assessment of welded structures

SAI TEJA BOMMAVARAM (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)
Phase-field modeling of high-cycle fatigue in welds

NANNA BERGMANN WINTHER (AAU, Dept. of Materials and Production, 15 minutes)
Non-proportional fatigue: When welded steel joints breaks in weird ways

KHALED ABDELGAWAD (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)
Scanning strategy and building orientation influence on the generated residual stress during LBPF additive manufacturing of Ti6Al4V

MORTEN ANDERSEN (AU, Dept. of Mechanical and Production Engineering, 15 minutes)
Pressurized cells: From self-buckling of cylinders to pressurized cellular solids

JIAYI KAYEE LI (AU, Dept. of Civil and Architectural Engineering, 15 minutes)
Achieving circular timber construction through structural components built from reclaimed wood: A pivotal experimental feasibility study

10:50 – 11:15 Coffee break

11:15 – 12:00 INVITED PRESENTATION
(Chairman: Jan B. Høgsberg DTU, Dept. of Civil and Mechanical Engineering)

CHRISTIAN F. NIORDSON (DTU, Dept. of Civil and Mechanical Engineering, 45 minutes)
From Cavities to Catastrophe: Mechanics of Ductile Failure Across Scales

12:00 - 13:00 Lunch

13:00 – 17:00 Social Event

19:00 - Banquet

Programme for Friday morning, March 13th, 2026

07:00 - 09:00 Breakfast

09:00 – 10:00 GEOMETRY AND OPTIMIZATION
(Chairman: Anton Evgrafov, AAU, Dept. of Mathematics)

ANDER CHOCARRO SALABERRIA (DTU Compute, Dept. of Applied Mathematics and Computer Science, 15 minutes)
Mathematics of freeform surface stackability

MARC ISERN HACKER (DTU Compute, Dept. of Applied Mathematics and Computer Science, 15 minutes)
Modelling with 3D elastic curves

PEDRO JOSE DE FREITAS (DTU, Dept. of Civil and Mechanical Engineering & Vestas, 15 minutes)
Parametric optimization of pre-tensioned bolted connections

HAIYANG LEI (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)
Topology optimisation of turbulent flows using a parametric level-set method with implicit wall functions

10:00 - 10:30 Coffee break

10:30 – 12:15 STRUCTURES
(Chairman: Guiseppe Abbiati, AU, Dept. of Civil and Architectural Engineering)

LASZLO MANGLIAR (AU, Dept. of Civil and Architectural Engineering, 15 minutes)
Numerical strategies for modelling connections at substructure interfaces

NIKOLAJ BJERGE (AU, Dept. of Civil and Architectural Engineering & COWI, 15 minutes)
Impact of anchor stiffness on the response of mooring systems for floating wind turbines

SEBASTIAN DAMSGAARD (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)
Dynamics of hybrid gas foil thrust bearings

ANDY PETERSEN (DTU, Dept. of Civil and Mechanical Engineering & Everllence, 15 minutes)
Modelling of piston rings for two stroke marine engines

MATÍAS REUMAY (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)
Attenuation of fluid-flow induced instabilities via actively-lubricated bearings

CASPER AASKOV DRANGSFELDT (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)
Probabilistic structural health monitoring of ship gearboxes under time-variant operation: concept and application

FREDERIK NORDTORP KRISTIANSEN (AU, Dept. of Civil and Architectural Engineering, 15 minutes)
Real-time hybrid testing of multibody dynamic systems

12:15 - 13:15 Lunch

Programme for Friday afternoon, March 13th, 2026

13:15 – 14:30 OPTIMIZATION
(Chairman: Mahdi Akbar, AU, Dept. of Mechanical and Production Engineering)

AMIRHOSSEIN BAYAT (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)
Towards turbulent topology optimization for high heat flux cooling with implicitly defined wall functions

MAGNUS APPEL (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)
Parallel-in-time methods for topology optimisation of transient heat flow

PHILIP ELBEK (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)
Topology optimization with stochastic geometric perturbations for waveguide design

VICTOR PISINGER (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)
Topology optimization of quantum opto-mechanical systems

MARKUS GÜMOES HOLM (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)
Simple parameterizations for extremal elastic microstructures

14:30 – 14:45 Closing of the DCAMM Symposium

14:45 Departure from the hotel

List of Participants

DTU Construct
Dept. of Civil and Mechanical Engineering:
Andreasen, Casper S.
Auth, Kim Louisa
Basterrech, Sebastian
Bommavaram, Sai Teja *
Christiansen, Rasmus E.
Damsgaard, Sebastian Vikær*
De Freitas, Pedro José*
Elbek, Philip*
Fard, Alireza Taherzadeh
Felle Olsen, Tim
Ferrari, Federico
Fogt, Gerda Helene
Gedeon, Johannes
Holm, Markus Gümoes*
Hörmann, Mahtis *
Høgsberg, Jan B.
Legarth, Brian Nyvang
Nicolaisen, Laurits *
Nielsen, Chris Valentin
Niordson, Christian F.
Parks, Brandon *
Pedersen, Niels L.
Pedersen, Preben Terndrup
Pedersen-Bjergaard, Jonathan Taulo*
Petersen, Andy *
Pisinger, Victor *
Poulios, Konstantinos
Rende, Bruno
Reumay, Matias *
Richardt, Jens
Sigmund, Ole
Steffensen, Mikkel Tandrup
Wang, Junpeng
Aage, Niels

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Bendsøe, Martin
Brøns, Morten
Hacker, Marc Isern *
Hjorth, Poul G.
Salaberria, Ander C. *
Sørensen, Mads Peter
Thygesen, Uffe Høgsbro

DTU Wind
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Mageira, Pinelopi*
Mikkelsen, Lars Pilgaard

Aalborg University
Dept. of Materials and Production
Andreasen, Jens Henrik
Andersen, Michael Skipper
Bai, Shaoping
Broberg, Peter Hede
Grosselle, Riccardo*
Lindgaard, Esben
Lund, Erik
Majumder, Arunabha *
Nega, Biruk
Sorokin, Sergey
Stagsted, Niklas*
Winther, Nanna*

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Aschemoneit, Fynn
Evgrafov, Anton
Nielsen, Jakob Tore K.*
Winther, Christian Bak *

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Andersen, Lars Vabbersgaard
Bjerge, Nikolaj *
Kristiansen, Frederik N.*
Larsen, Jakob Degn *
Li, Jiayi Kayee *
Mangliar, Laszio *
Prada, Felipe
Stamenov, David
Sørensen, Mathilde Bruun *
Thing, Mathias *
Wahlgren, Søren Sølund *

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Aghababaei, Ramin
Abkar, Mahdi
Andersen, Morten *
Andresen, Emilie T.*
Ballini, Enrico
Doll, Ulrich
Kristiansen, Morten F.*
Møllman, Peter *
Nafisi, Sara *
Nguyen, Phan Hoang Dao *
Nozarian, Sina
Qaragoez, Ali Mohammadi *
Seenath, Amal Ameen *
Semnani, Faezeh *
Soltani, Ali *
Soltani, Amin *
Strack, Daniel *

University of Southern Denmark
Dept. of Mechanical and Electrical Engineering
Alexandersen, Joe
Abdelgawad, Khaled*
Appel, Magnus *
Avendano Valencia, Luis
Bayat, Amirhossein*
Borg, Ulrik
Drangsfeldt, Casper Aa.*
Jonathansen, Morten B.*
Kanbur, Baris Burak
Lei, Haiyang *
Li, Hao
Lützen, Marie
Malekan, Mohammad
Nataj, Roghayeh (Sarah) E.
Palmgren, Jonas *
Ramic, Elma*
Soleimani, Hossein
Steengaard, Jack Rahek*
Wiggers, Sine L.

§8-members:
Boll, Jens, Grundfos
Christiansen, Christian Kim, DTU Eng.Technology
Felter, Christian, JVL A/S
Gaitanaros, Stavros, DTU Eng.Technology
Groen, Jeroen, Vattenfall
Jensen, Peter Dørffler L., MGS Design & Develop.A/S
Nielsen, Kim Lau, Coloplast
Ringgaard, Kasper, Vestas Wind Systems A/S
Skovsgåard, Simon Peter H., Envision Energy DK
Thomsen, Dan Kielsholm, Universal Robots
Toftekær, Johan, Vattenfall
Wang, Fengwen, Coloplast

	Ph.d.	**Andre**
DTU Construct	12	22
DTU Compute	2	5
DTU Wind	1	1
AAU, MP	4	8
AAU, Math	2	2
AU, CAE	8	4
AU, MPE	12	5
MEE, SDU	9	10
§8-members	1	12
	51	69
I alt		120

* Ph.D.-student

Programme for Wednesday afternoon, March 11^{h}, 2026

13:05 – 14:50 COMPOSITES AND STRUCTURES
(Chairman: Ulrik Borg, SDU, Dept. of Mechanical and Electrical Engineering)

PINELOPI MAGEIRA (DTU, Dept. of Wind and Energy Systems, 15 minutes)
Finite element 3D homogenized model of long fiber reinforced unidirectional composites
Pultruded unidirectional composites are used in wind turbine blades as the main load-carrying components of the spar, due to their excellent mechanical performance. Nevertheless, its compressive strength is critical, since its reduction, for example due to manufacturing variations, can increase the risk of structural failure. Developing accurate finite element models to predict the compressive strength remains an active research area.Poulios and Niordson (2016) developed a 2D homogenized finite element model in the Python FE library GetFEM, based on an elastic-plastic incremental fiber/matrix formulation, using the Ramberg-Osgood model for matrix plastic behaviour. The model was validated against 2D micro-mechanical models loaded in compression, where the adoption of the fiber bending effect was demonstrated to give a meshindependent solution. Mageira et al. (2025) adapted it to include real fiber orientation data from X-ray CT scans, enabling compressive strength prediction based on fiber orientation variations.
A 3D version is being developed to predict more accurately the compressive response, considering the out-of-plane effects. Here, preliminary results of the 3D model are presented. The predictions are compared with both a fiber/matrix discretized model and predictions from the 2D version. Different volume fractions and loading conditions are considered, including a comparison of the computational cost.
Supervisor: Lars P. Mikkelsen

RICCARDO GROSSELLE (AAU, Dept. of Materials and Production, 15 minutes)
Towards simulating delamination in unidirectional composites using physics-informed machine learning
The CraCS research group (cracs.aau.dk), Department of Materials and Production, Aalborg University, Denmark
For large composite structures such as wind turbine blades, delamination represents one of the most critical failure modes, involving crack propagation between adjacent layers that severely degrades the mechanical performance of the structure. Conventional numerical approaches, such as cohesive zone models, can capture delamination behaviour but often require costly fine discretisations and extensive parameter calibration. A promising alternative to reduce this computational cost is offered by physics-informed machine learning methods, which combine the efficiency of data-driven models with physical constraints derived from the underlying governing equations.
This work proposes a proof-of-concept machine-learning surrogate that predicts the interlaminar traction field along the entire crack interface, based on scalar parameters describing the specimen geometry, material properties, crack length, and loading conditions. The surrogate is embedded within a commercial finite element software, enabling delamination simulations without explicitly introducing cohesive elements. Physical consistency is

weakly enforced by augmenting the surrogate loss function with the value of the J-Integral. This effort demonstrates a viable pathway toward hybrid physics-machine-learning formulations for interlaminar fracture modelling.
Supervisors: Brian L.V. Bak, Esben Lindgaard

NIKLAS KRISTIAN KRONBORG STAGSTED (AAU, Dept. of Materials and Production, 15 minutes)
The effect of loading history on the traction field and crack tip shielding of fibre bridging in delaminations
The CraCS research group (cracs.aau.dk). Department of Materials and Production, Aalborg University, Denmark
The loads on wind turbine blades change, whichever way the wind blows. To bridge a gap in knowledge of how changing load levels influence the growth of delaminations, the newly developed ExTraction method is used to investigate the effect of fibre bridging under changing load levels. A primary failure mode of laminated composites such as wind turbine blades, are delaminations, forming as cracks between the layers of the laminate. Delaminations in fibre-reinforced polymer composites exhibit fibre bridging, where fibres bridge the gap between the crack faces, effectively shielding the crack tip and increasing resistance against crack growth. Understanding how loading of laminated composites influence growth of delaminations is paramount in the effort to better utilise laminated composites. Specifically, experiments involving transitions in fatigue load amplitude have shown significantly increased crack growth compared to current prediction models. Using an inverse approach, fitting a parameterised traction field applied to a FE model to experimentally measured strain fields, the ExTraction method enables characterisation of the traction field and crack tip shielding from fibre bridging. These capabilities are used to investigate the effect of fibre bridging across transitions in load amplitude, so that future models may remain accurate, whichever way the wind blows.
Supervisors: Brian Lau Verndal Bak, Esben Lindgaard, Simon Mosbjerg Jensen

MORTEN FOGTMANN KRISTIANSEN (AU, Dept. of Mechanical and Production Engineering, 15 minutes)
Fatigue in composites materials: Load-controlled and strain-controlled tests of biaxial non-crimp glass-fiber-reinforced polymers
This talk addresses fatigue in composite materials used in wind turbine rotor blades, where long service lifetimes and highly variable cyclic loadings make fatigue one of the structural design drivers.
Results from experimental fatigue tests using different testing strategies are presented, and methods for analyzing the test data are proposed and compared. The material studied is a non-crimp biaxial glass-fiber–reinforced polymer representative of modern blade materials. The experimental program includes quasi-static tensile tests, load-controlled fatigue tests, and strain-controlled fatigue tests.
It is common practice that load-controlled fatigue data are converted to strain-based fatigue curves by assuming constant material stiffness. For composite materials, stiffness degradation and creep during fatigue tests challenge the accuracy of this approach. Stiffness degradation and creep effects are particularly important when analyzing fatigue tests of biaxial materials.
To address these challenges, an alternative analysis method is proposed that transforms load-controlled fatigue data into strain-based fatigue curves using an equivalent fatigue strain. Mean load effects are corrected using a linear

Goodman diagram. Strain based fatigue lifetime predictions from load-controlled tests are compared with measured lifetime results from strain-controlled tests, showing improved agreement compared with conventional methods.
Supervisor: Henrik Myhre Jensen

SØREN SØLUND WAHLGREN (AU, Dept. of Mechanical and Production Engineering, 15 minutes)

On the transition from arc debonding to tunneling at fiber-matrix Interfaces

Fiber–matrix debonding is a key damage mechanism in fiber-reinforced composites and often develops through a combination of circumferential growth around the fiber and longitudinal tunnelling along the interface. In this work, a micromechanical framework is presented to analyze the transition between these two debonding modes using an interface fracture mechanics approach.

The framework is based on the classical plane problem of a circular inclusion embedded in an infinite matrix with a partially debonded interface. By assuming steady-state tunnelling, the inherently threedimensional tunnelling process is reduced to an energetically equivalent plane problem, allowing tunnelling debonding to be analyzed directly from two-dimensional solutions. Finite element analyses under planestrain uniaxial tension are performed to overcome limitations of existing analytical solutions, which are typically restricted by debond angles. Configurations with one or two symmetric debonds are studied for representative carbon-fiber/epoxy and glass-fiber/epoxy systems, as well as a homogeneous reference case.

Energy release rates and mode-mixity phase angles are evaluated as functions of the debond arc angle and used to predict critical stresses for both circumferential and tunnelling debonding using mixed-mode fracture criteria. The results show that debonds initially grow circumferentially, but transition to unstable tunnelling beyond a characteristic arc angle. This transition is strongly influenced by elastic mismatch, fracture criterion, and debond configuration, and is consistent with experimental observations in composite materials.
Supervisor: Michal Kazimierz Budzik

PHAN HOANG DAO NGUYEN (AU, Dept. of Mechanical and Production Engineering, 15 minutes)

Segmented rim design for high performance flywheel energy storage system

The use of flywheel energy storage systems (FESS) is well-established in short-duration operations, such as grid stabilization and frequency regulation, due to their high-power density, rapid dynamic response, and long service life. To extend their use to broader applications and achieve competitive energy capacity-to-cost ratios, a fundamental redesign of the rotor is required, as conventional single-material flywheels, both metallic and composite, are limited by stress constraints and inefficient material utilization. Press-fitted multi-rim composite designs address this problem but suffer from circumferential stress accumulation, rim detachment risks, and manufacturing complexity.

To overcome these limitations, a novel rotor architecture termed the Segmented Rim Flywheel (SRF) is introduced. Unlike press-fitted designs, the SRF employs multiple thin composite rims separated by strategic air gaps

rather than interference fits. According to analytical and numerical models, the SRF can achieve twice the energy capacity of a conventional single-rim flywheel with an identical outer dimension. The improvement results due to the configuration's ability to significantly reduce both radial and axial tensile stresses, enabling the rotor to approach its circumferential strength limit. Therefore, the flywheel can operate at higher rotational speeds. Overall, the SRF concept represents a promising next-generation flywheel system capable of delivering high energy storage.
Supervisors: Søren Peter Madsen/Michal K. Budzik

DANIEL STRACK (AU, Dept. of Mechanical and Production Engineering, 15 minutes)
Cracking bones and beyond, finite element simulation to assess fracture risk of vertebral bones
Osteoporosis is a prevalent and underdiagnosed disease that weakens bone and increases fracture risk, affecting nearly 0.5 million people in Denmark. Current diagnosis and fracture-risk assessment rely on dual-energy X-ray absorptiometry (DXA) derived Bone Mineral Density (BMD) and the Fracture Risk Assessment (FRAX) tool. However, both approaches often fail to identify individuals with a high fracture risk: up to 50% of patients who sustain fragility fractures are classified as non-osteoporotic by BMD at the time of fracture.
This PhD work develops automated, image-driven 3D finite element analysis (FEA) workflows to enable robust, higher-throughput, clinically oriented assessment of vertebral bone fracture risk. In patient-specific vertebral models, we systematically investigate how the choice and number of material property sets influence computational cost and practical feasibility. We further correlate FEA-derived vertebral strength with X-ray dark-field imaging biomarkers, exploring a combined imaging-biomechanics framework. In a retrospective cohort, we evaluate FEA-based fracture prediction at the level of individual vertebrae and quantify how discriminative performance depends on model parameters and spinal level.
Ongoing work extends these models by incorporating adjacent soft tissues to better approximate physiological load transfer, with the aim of further improving individual-level fracture risk prediction and supporting more targeted, clinically actionable prevention strategies.
Supervisor: Subburaj Karupppasamy

14:50 - 15:15 Coffee break

15:15 – 16:45 DYNAMICS
(Chairman: Luis David Avandaño-Valencia, SDU, Dept. of Mechanical and Electrical Engineering)

AMIN SOLTANI (AU, Dept. of Mechanical and Production Engineering, 15 minutes)

Rising bubble dynamics in porous media

Direct numerical simulations using a Volume-of-Fluid method are performed to investigate the buoyancy-driven rise of a single gas bubble through an idealized porous medium composed of a staggered array of parallel cylinders. The effects of the pore-to-bubble diameter ratio (Dp/D = 2.5–7) and Bond number (Bo = 0.1–4) are examined at Galilei numbers Ga = 40 and 100. Bubble trajectories, velocities, and deformations are analyzed and compared with those of free-rising bubbles under identical conditions.

The results show strong sensitivity of bubble trajectories to the initial position, with significant lateral drift at low Bo and small pore sizes, leading to a substantial reduction in the mean vertical velocity due to the impact of the cylinders. For (Ga,Bo) = (100, 4), a transition from geometry-driven to wakedriven path oscillations is observed at Dp/D ≈ 3.5. Bubble deformation is governed by collisions with cylinders and capillary effects, resulting in distinct interface dynamics across parameter ranges.

Supervisor: Pourya Forooghi

ARUNABHA MAJUMDER (AAU, Dept. of Mechanical and Production Engineering, 15 minutes)

Design and control of a hybrid actuated should exoskeleton for motion assistance

Work-Related Musculoskeletal Disorders (WMSDs) are highly prevalent among industrial workers, with the shoulder being one of the commonly affected regions, due to repetitive overhead tasks, forceful exertions and sustained awkward postures. Wearable exoskeletons represent a potential solution to these biomechanical challenges, but existing designs relying solely on active or passive actuation often lack adaptability and compliance. This study proposes a novel hybrid shoulder exoskeleton integrating a passive variable-stiffness mechanism (VSM) torque generator and an active motor working in parallel, providing efficient and adaptive support for flexion movement under varying impedance workloads. The system operates in three distinct modes: fully active, fully passive, and a hybrid active/passive mode. The mechanical design parameters for the VSM torque generator were optimized using a genetic algorithm (GA) to minimize the discrepancy in assistive torque between the human arm and the exoskeleton, and the resulting torque-deflection profile was experimentally validated against the theoretical model. A learning-based Assist-As-Needed (AAN) controller was implemented for the active part, utilizing joint position feedback to provide interactive impedance modulation with minimal mechatronics. The controller was validated through human-in-the-loop experiments during specific arm maneuvers. This hybrid exoskeleton combines passive efficiency with active control, providing a novel approach to reducing physical strain while ensuring stability.

Supervisor: Shaoping Bai

ALI SOLTANI (AU, Dept. of Mechanical and Production Engineering, 15 minutes)

Model selection in symbolic regression

Robust model selection is a key step in symbolic regression pipelines, helping ensure that the final equation achieves low expected predictive error. Prior work has proposed a range of selection strategies and criteria, including hold-out validation, Akaike's Information Criterion (AIC), the Bayesian Information Criterion (BIC), and description length based measures (MDL). In practice, however, model choice is often guided by heuristic selection from the final Pareto front. Despite extensive discussion of individual criteria, a clear picture of their relative performance in symbolic regression is still lacking.

In this study, we also proposed a new method called in-sample error (Err_in), and systematically compare several model selection approaches across a set of symbolic regression problem instances. We use synthetic benchmark functions to generate datasets with controlled sample sizes and noise levels. Across most settings, MDL-based selection more consistently identifies the ground-truth model among earlier ranked candidates than the alternatives. It also achieves the lowest average test error in all but one benchmark function and tends to select more compact expressions. Overall, our results indicate that MDL provides the most reliable performance across accuracy, recovery of ground truth, and model parsimony.

Supervisor: Alessandro Lucantonio

ALI MOHAMMADI QARAGOEZ (AU, Dept. of Mechanical and Production Engineering, 15 minutes)

Symbolic regression of control Lyapunov functions

Stabilizing nonlinear systems while achieving satisfactory closed-loop performance often requires solving in-tractable optimal control problems or constructing suitable Control Lyapunov Functions (CLFs), both of which remain challenging in practice. This work proposes a symbolic regression (SR) framework for the automatic discovery of analytic CLFs and the synthesis of stabilizing controllers via Sontag's universal feedback formula, providing explicit stability certificates. The SR procedure explores a broad class of mathematical expressions and evaluates candidate CLFs using a fitness function that encodes Lyapunov stability conditions together with performance-related criteria. The proposed method is assessed on four nonlinear benchmark systems and compared against standard baseline controllers, including linear–quadratic regulation (LQR) and neural Lyapunov-based controllers. Across all benchmarks, the symbolic regression approach consistently identifies com-pact and interpretable CLFs that guarantee stabilization from a wide range of initial conditions. Moreover, the resulting controllers achieve performance that is competitive with neural policies and often superior to LQR when operating away from the linearization region. These results demonstrate that symbolic regression offers a practical and certifiable approach to nonlinear control design, serving as a complementary alternative to polynomial/SOS-based techniques and neural network methods.

Supervisor: Alessandro Lucantonio

ELMA RAMIC (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)

Motion sickness among offshore wind technicians on smaller working vessels

The daily tasks of offshore wind technicians are both mentally and physically demanding. Despite strict physical and mental fitness requirements, one critical factor that may compromise their ready-to-work level is motion sickness, a prevalent issue among offshore wind workers. This is particularly relevant upon arrival at the wind farm, as wind farms are often located far from shore and technicians are transported offshore in smaller working vessels.

While the widely employed Motion Sickness Incidence (MSI) metric remains the standard for quantifying motion sickness, its focus on vertical motion and emesis limits its applicability to smaller working vessels commonly used in the offshore wind sector. This project addresses these limitations by developing a tool capable of predicting motion sickness symptom severities based on wave conditions, operational parameters, and vessel motion. Due to the interdisciplinary nature of the topic, the project relies on a large and diverse dataset that, combined with various methodologies, will form the foundation of the proposed system.

The presentation at DCAMM Symposium 2026 will provide an overview of the project and progress made so far. Observations from ongoing data collection will be presented, along with completed analyses and planned future steps in the tool's development

Supervisor: Marie Lützen

17:00 – 17:45 POSTER PRESENTATIONS
(Chairman: Lars V. Andersen, AU, Dept. of Civil and Architectural Eng.)

JAKOB DEGN LARSEN (AU, Dept. of Civil and Architectural Engineering)
Phase-field modeling for fracture mechanics using open-source software
Phase-field fracture methods have become a widely used approach for modelling crack nucleation, propagation, and interaction, but their practical implementation places non-trivial demands on finite element frameworks.
In this work, we present a structured review of open-source finite element frameworks in which phase-field fracture formulations have been implemented and reported in the literature. The comparison focuses on architectural and workflow aspects of the frameworks—such as programming paradigms, solver integration, and user interaction—as they arise in reported phase-field fracture implementations. The aim is to provide an overview that can support industrial and educational users in evaluating and selecting suitable open-source software for fracture simulations.
Phase-field fracture is chosen as a case study because it exposes specific requirements on the finite element infrastructure, such as the treatment of history variables, local versus nodal fields, and the coupling of nonlinear solvers. In addition to the literature review, we report ongoing work toward implementing phasefield fracture in Code_Aster, where no such implementation currently is found. A working model has been developed, but architectural constraints – particularly the restriction to nodal external parameters fields provided to constitutive laws – currently limit standard phase-field fracture formulations and motivate ongoing discussions with the code developers.
Supervisor: Giuseppe Abbiati

MATILDE BRUUN SØRENSEN (AU, Dept. of Civil and Architectural Engineering)
Optimal experimental design for hydrodynamic loading estimation in floating structures
Moored floating structures with flexible constraints exhibit low natural frequencies in surge, sway, and yaw; consequently, the horizontal response is driven not by wave-frequency excitation but by second-order (differ-ence-frequency) loads arising from nonlinear wave interactions, producing large slow-drift motions. A key quantity governing this behavior is the low-frequency damping, which strongly influences the response ampli-tude. Linear potential-flow models tend to overestimate slow-drift motions since little energy is radiated at low frequencies and dissipation is instead dominated by viscous effects and wave-drift damping, which are difficult to quantify analytically. As a result, low-frequency damping is commonly inferred from ocean basin experi-ments, although existing approaches often suffer from poor observability and bias.
The present work addresses this challenge by developing a parameter-estimation method tailored to output-only systems. By interpreting repeated basin experiments as a single-input multiple-output (SIMO) system, the proposed estimator exploits cross-spectral relationships among responses that share a common but un-measured wave excitation. This framework yields consistent estimates of low-frequency added mass and damping and reduces sensitivity to uninformative frequency bands, improving robustness when measured re-sponses contain both wave-frequency and low-frequency components.
Supervisor: Giuseppe Abbiati

MATHIAS THING (AU, Dept. of Civil and Architectural Engineering)
Loading estimation for multibody dynamic problems
This work is about the problem of loading estimation in multibody dynamic systems, with focus on nonlinear models and limited sensing conditions. The knowledge of accurate external loading is important for the performance of digital twins, virtual sensing, and structural monitoring, yet such loads are often unmeasured in practice. The proposed method formulates the governing equations using a multibody dynamics framework and treats unknown loads as additional augmented states. Prior to estimation, input identifiability is assessed to ensure that the loading can be uniquely reconstructed from the available response measurements. Identifiability is evaluated using extended observability concepts and data-driven metrics, providing a necessary condition for reliable estimation. Joint input–state estimation is then performed using augmented Bayesian filtering techniques, enabling real-time estimation of system states and applied loads in a probabilistic framework. The methodology is applied on multibody benchmark models, including simplified wind turbine systems subjected to time-varying excitation. Numerical results show that accurate loading estimation can be achieved using limited acceleration measurements, given that identifiability conditions are satisfied. Overall the presented framework provides a systematic and computationally efficient approach for loading estimation in multibody dynamic problems, supporting the development of digital twins and data-driven monitoring strategies.
Supervisor: Giuseppe Abbiati

EMILIE TAGE ANDRESEN (AU, Dept. of Mechanical and Production Engineering)
Thermofluid Modeling of Direct Air Capture Systems
While progress is being made to limit ongoing CO_2 emissions, atmospheric CO_2 concentrations are already high. In response, Direct Air Capture (DAC) offers a way to remove previously emitted CO_2 and tackle emissions from hard-to-abate sources where point-source capture is not possible. However, DAC still faces challenges, such as high capital and operating costs, that must be overcome for it to become a viable solution. One way to achieve this is by using existing infrastructure and integrating the process into industrial cooling towers, combined with an electrochemical CO_2 release technology. The cooling tower will act as an air–liquid contactor, and an absorbent added to the cooling water will bind CO_2. Subsequently, the CO_2 is released electrochemically at ambient temperature while the absorbent is regenerated using electricity under mild conditions.
The objective of this PhD project is to develop an advanced thermofluid model that quantifies CO_2 absorption in industrial cooling towers, as well as to provide an improved understanding of the process, which depends on complex interactions between fluid dynamics, mass transfer, thermal gradients, and mixing. High-fidelity computational fluid dynamics (CFD) will be used to model the absorption process, and surrogate models will be developed for both the CO_2 absorption and electrochemical release stages. The models will then be used to link these stages to a full process to conduct a techno-economic assessment (TEA) and guide scale-up and system design.
Supervisor: Mahdi Abkar

PETER MØLLMANN (AU, Dept. of Mechanical and Production Engineering)
Data-driven material characterization via scratch testing
The accurate characterisation of the elasto-plastic response of materials is important for ensuring the reliability, safety, and performance of various engineering designs and structures. Conventional characterisation methods often rely on specialised experimental setups and inverse identification procedures, which can be time-consuming and frequently destroy the material specimen. This work aims to establish a new approach for determining the elasto-plastic response of metallic materials by combining scratch testing with machine learning. Scratch testing is a minimally destructive experimental approach mainly used for evaluating the mechanical and tribological properties of surfaces. In this study, finite element simulations of scratch tests are performed to systematically generate a dataset covering a wide range of elasto-plastic material parameters.
This simulated data is then used to train machine learning models that link the scratch response to the material parameters. A key component of the methodology is the use of symbolic regression, which can find semi-analytical expressions linking scratch response to elasto-plastic material parameters. This approach aims to improve interpretability and physical insight compared to purely data-driven models. Overall, the proposed framework aims to provide an alternative approach for elasto-plastic material characterisation based on scratch testing and data-driven modelling.
Supervisor: Ramin Aghababaei

SARA NAFISI (AU, Dept. of Mechanical and Production Engineering)
Carbon-negative bio composites: Early-stage material optimization and characterization
The construction and industrial packaging sectors are among the largest contributors to global carbon emissions, motivating the development of material systems that combine mechanical performance with genuine carbon negativity and circularity. This PhD project investigates a new class of fully bio-based, carbon-negative composite materials derived from renewable constituents such as resin, wax and sawdust. The objective is to establish clear composition–processing–property relationships that enable these materials to serve as mechanical alternatives to conventional polymeric and wood-based composites.
At its early stage, the project focuses on material formulation and preliminary mechanical characterization. Composite variants are produced by systematically varying constituent ratios and processing conditions, resulting in materials spanning a wide range of stiffness and ductility. Initial mechanical tests show promising tensile and compressive performance compared to traditional laminated wood products, while the resin–wax matrix exhibits superplastic behavior at moderate temperatures, enabling improved formability relative to many existing bio-based composites.
Future work will include systematic mechanical testing, surface and bulk characterization, and assessment of processing routes such as casting and molding to evaluate anisotropy and scalability. These efforts will be supported by microstructural analysis and lifecycle-oriented evaluation to align mechanical optimization with carbon sequestration and recyclability for construction and industrial packaging applications.
Supervisor: Ramin Aghababaei

AMAL AMEEN SEENATH (AU, Dept. of Mechanical and Production Engineering)
Tribological characterization and performance of novel bio-lubricants: Evaluating friction and wear protection
The growing demand for sustainable mechanical systems has increased interest in bio-lubricants as environmentally responsible alternatives to petroleum-based greases. Because these lubricants originate from renewable or biodegradable sources, they offer reduced toxicity and a lower environmental impact; however, their practical implementation requires a clear understanding of their behaviour under realistic operating conditions. In the initial phase of this project, a customized test rig is being set up to study lubrication behaviour in rolling-bearing contacts, where a stable lubricant film is essential for reducing friction and preventing wear. By measuring force, temperature, vibration, acoustic emission, and dielectric signals from the interfaces allows the evaluation of the oil-film thickness that influences overall bearing performance. Building on the initial test rig development, the project proceeds in evaluating a set of water-based, biodegradable, and plant-oil-derived bio-lubricants for the use in bearings, together with selected lithium-based greases for benchmarking. Initial screening and tribological characterization will be carried out at the laboratory scale using a standard equipment's to evaluate the friction coefficient, wear rates, viscosity and oxidative stability of the lubricants under controlled temperature and load conditions. Only bio-lubricants that demonstrate low friction coefficients and low wear rates while maintaining the oxidative and viscosity stability under varying operating parameters compared to lithium-based greases will progress to real condition testing on the built test rig, where multi-sensor data involving force, temperature, vibration, acoustic emission, and signal processing will be used to analyse lubrication-film thicknesses and degradation mechanisms. Their physical and chemical characteristics, including viscosity–temperature response, thermal and oxidative stability, and contamination, will be observed to determine their operational limits. This work directly supports the broader project goal of developing a smart lubrication monitoring system capable of identifying over- and under-lubrication based on indirect sensing and advanced signal processing.
Supervisor: Ramin Aghababaei

FAEZEH SEMNANI (AU, Dept. of Mechanical and Production Engineering)
Data-driven monitoring of bearing lubrication for efficient and sustainable machinery
Monitoring lubrication conditions in bearings is crucial for ensuring the reliable and efficient operation of rotating machinery. Insufficient or degraded lubrication can increase friction and wear, and eventually leading to failures, production downtime, and significant maintenance costs. A key indicator of lubrication performance is film thickness; however, it is challenging to measured directly during operation. Additionally, most existing monitoring systems are reactive, identifying problems only after damage has already initiated. Hence, a proactive and predictive real-time monitoring approach is required to detect early signs of lubrication issues and prevent failures before happening. The first step is to design, build, and calibrate a test rig for bearings, allowing us to collect clean and systematic data These include load, friction, temperature, vibration, ultrasonic, and acoustic signals, from multiple sensors. Next, we will design and conduct a series of accelerated experiments with different lubricants and under various operating conditions to create a comprehensive dataset. The acquired data will be analyzed using signal

processing techniques combined with lubrication and contact theories to identify lubrication states and track changes in film thickness. Data-driven models will also be developed to classify lubrication regimes. The overall goal is to develop a "digital fingerprint" for predictive bearing monitoring.
Supervisor: Ramin Aghababaei

CHRISTIAN BAK WINTHER (AAU, Dept. of Mathematics)
A population balance approach to cavitation modeling
Keywords: Cavitation Population Balance Method, Multiphase Flows, Cavitation modeling, Population Balance method, Underwater Radiated Noise, Sub-Grid modeling
Problem statement State-of-the-art numerical models for simulating cavitation around propellers rely on multiphase CFD, where the vapor cavities are depicted by one single scalar transport equation (SSTE-approach). The phase-transition, i.e. evaporation and condensation, is evaluated within the transport equation's source term, typically based on a highlysimplified Rayleigh-Plesset equation [1].
It seems unreasonable that the core property of interest, namely the microscopic bubble-dynamics, are well-approximated in one single source term. Thus, it is desirable to increase the sub-grid resolution of bubble dispersions, while keeping the computational demands at a reasonable level.
Cavitation Population Balance Method A novel multi-transport-equation cavitation method is introduced: The Cavitation Population Balance Method (CPBM). With CPBM sub-grid resolution can be controlled through the number of employed transport equations, each representing a certain size range of bubbles. Figure 1 illustrates the method: The dispersion of bubbles within each computational cell is modeled as a local number density, enabling per-scale modeling of bubble dynamics. The coupling to the momentum field is done by the standard homogeneous mixture model, where the density and viscosity are evaluated based on the local vapor volume fraction.
Results & Impact The CPBM is demonstrated on an unsteady cavitating airfoil and compared to a conventional SSTE formulation. The simulations are used to investigate how size-resolved bubble transport influences the predicted cavitation dynamics, vapor volume fraction fields, and pressure fluctuations. The study illustrates how CPBM enables the modeling of additional physics not possible in single-equation models, and discusses the implications for future coupling to turbulence and underwater radiated noise predictions.

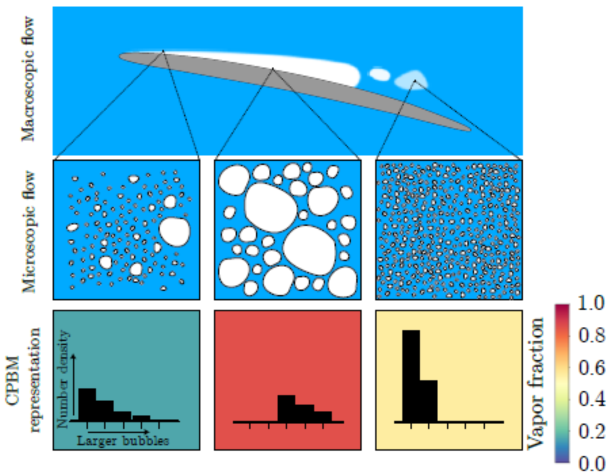

Figure 1. Indicative illustration of the flow representation in the CPBM. Top row: Macroscopic flow over cavitating hydrofoil. Middle row: Physical microscopic bubbles in selected areas. Bottom row: CPBM representations of the microscopic flow. Histogram shows the size distribution of bubbles. Each cell is colored by the derived vapor fraction.

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Supervisor: Fynn Jerome Aschmoneit

JAKOB TORE KAMMEYER NIELSEN (AAU Dept. of Mathematics)

Higher-order finite-element boundary-integral methods for computational electromagnetics

The aim of this project is to develop a Higher-Order Finite-Element Boundary-Integral (HO-FEBI) method for analysing complex radiating antenna structures. Existing numerical methods struggle as antennas evolve with increasing material complexity and integration into electrically large structures. We therefore propose a method that synergistically combines the Higher-Order Method of Moments (MoM) and the Finite Element Method (FEM), leveraging their complementary strengths and recent individual advancements. This method will enable the accurate and efficient simulation of advanced antenna systems, including on-chip antennas for PCB-based arrays, which are critical for emerging applications in communications, radar and low Earth orbit satellites. The method will be compatible with TICRA's existing methods and enhance the design capabilities of future antenna systems.

Supervisor: Anton Evgrafov

MATHIS JONATHAN HÖRMANN (DTU, Dept. of Civil and Mechanical Engineering)

Topology optimization of micro-flows under uncertainty: A stochastic gradient approach

In micro-flow systems, uncertainties such as inflow variability and manufacturing deviations can significantly undermine performance. To address this, we utilize a stochastic-gradient enhanced topology optimization framework that embeds uncertainty directly in the design loop. By handling uncertainty as a stochastic-gradient problem, using one random configuration per iteration while retaining historical estimates of objectives and sensitivities, the method attains near-deterministic computational cost with robust performance. For uncertain inflow conditions, the optimized layouts exhibit behavior analogous to viscous-loss minimization: multiple inflow channels naturally coalesce into a single trunk to suppress variability and are subsequently redistributed to deliver uniform outflow across outlets. When additional uncertainties such as blockages or manufacturing variability are introduced, the resulting structures deviate from deterministic designs. The same one-sample-per-iteration with historical tracking scheme supports scalable robustness studies across these scenarios, demonstrating the adaptability of the proposed approach. For potential applications, such as microfluidic devices, lab-on-a-chip systems, and compact heat exchangers, where reliability under unpredictable conditions is essential this method bridges the gap between idealized optimization and real-world performance.

Supervisor: Casper Schousboe Andreasen

LAURITS NICOLAISEN (DTU, Dept. of Civil and Mechanical Engineering)

An investigation into physics-informed autoencoders for model order reduction of broadband vibroacoustic problems

When performing numerical simulations of vibroacoustic systems, it is often desired to obtain solutions for a broad range of frequencies. Whenever the problems become large, computing these solutions takes a substantial amount of time. To reduce simulations time, model order reduction methods can pose as a viable solution, to obtain approximate solutions to the full system by realizing important features in a low-dimensional space. Therefore, we make an investigation into utilizing physics-informed autoencoders for model order reduction of a full order finite element model using linear triangular elements, with the aim to illuminate how to achieve satisfactory results. These provide a low-dimensional space which we will interpolate in using the rational approximation method, Adaptive Antoulas-Anderson. We have tested this on a 2-dimensional axis-symmetric speakerphone box setup for a very broad range of frequencies - 10Hz to 10kHz. Herein, we study how much data is required, as each datapoint requires a full finite element solution. This method is compared to both a full order finite element solution and a known viable reduction method for second order systems – the Second Order Arnoldi method.

Supervisor: Niels Aage

BRANDON PARKS (DTU, Dept. of Civil and Mechanical Engineering)

Topology optimization of surgical procedures

Suture placement and tightening decisions are commonly made intraoperatively based on surgeon experience, despite the strongly nonlinear mechanical response of skin and the highly discrete nature of suture loading. This work presents a gradient-based topology optimization framework for distributing surgical sutures to close an incision while reducing adverse strain concentrations in the surrounding tissue. The skin is modeled as a compressible hyperelastic continuum under finite strains and discretized using a standard Galerkin finite element formulation. Sutures are represented by augmenting the system's principle of virtual work with spring-like penalty terms. Design variables modulate the local suture penalty stiffnesses, enabling a continuous relaxation of discrete suture decisions. The resulting constrained optimization problem minimizes a p-mean aggregation of von Mises strains in the skin region surrounding the wound, subject to structural equilibrium and a design variable-interpolated closure requirement, a suture-count (volume-type) constraint, and a novel constraint on deformed wound area to prevent unacceptable reopening and gapping. The Method of Moving Asymptotes (MMA) is employed together with a mesh-independent design variable filter to promote discrete and realistic suture patterns. Parametric studies varying wound aspect ratios and allowable suture count illustrate how the proposed formulation identifies suture layouts that satisfy closure while redistributing strain away from critical regions. Preliminary results show optimized suture locations similar to those used in vivo.

Supervisor: Niels Aage

JONATHAN TAULO PEDERSEN-BJERGAARD (DTU, Dept. of Civil and Mechanical Engineering)
Manufacturing-aware topology optimization of short-fiber reinforced structures produced by material extrusion additive manufacturing
We present a manufacturing-aware topology optimization framework for fiber-reinforced structures fabricated using Material EXtrusion Additive Manufacturing (MEX-AM). The process considers short fibers suspended in a two-component thermosetting polymer, avoiding common issues associated with continuous fibers such as discontinuity, folding, and twisting [1]. Recent studies show that fiber microstructure within deposited strands can be controlled by rotating the printing nozzle during deposition which allows for tailored microstructures [2].
To investigate this effect, a three-dimensional Computational Fluid Dynamics model is developed in OpenFOAM using a moving overset mesh. Multiphase flow is resolved via the volume-of-fluid method, while fiber transport and orientation are described using the Advani-Tucker model [3]. The resulting fiber orientation distribution is linked to nozzle rotation speed and it is shown that fibers align with the deposition direction in the absence of rotation, whereas high rotation speeds yield close to isotropic properties. A material model is proposed in which the material's constitutive properties are governed by nozzle rotation speed.
This material model is integrated with topology optimization, where nozzle rotation speed acts as a design variable controlling the local constitutive behavior. The approach is demonstrated on simple problems, showing that rotation is advantageous in regions with complex stress states.
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Supervisor: Casper Schousboe Andreasen

MORTEN BJERRE JONATHANSEN (SDU, Dept. of Mechanical and Electrical Engineering)
Advanced design for high temperature-difference heat exchangers using computational morphogenesis
This study employs computational morphogenesis to advance the structural design of heat exchangers operating under extreme temperature differentials. Unlike conventional simulation, which serves primarily to validate predefined geometries, computational morphogenesis functions as a generative framework, optimizing material distribution to satisfy complex physical constraints.
The central hypothesis is that using computational morphogenesis can give a fundamental insight into thermomechanical loads at high temperature gradients and the interplay between thermomechanics and vibration in pressure containing structures. This insight is critical for enabling novel applications and enhancing material efficiency.

This research first aims to determine which topology optimization framework provides the most robust convergence for problems characterized by large temperature gradients and strict stress limitations. Subsequently, it investigates to what extent multi-material architectures can be leveraged to resolve the structural conflicts inherent in pressure-containing heat exchange systems. The study then analyzes how the introduction of pressure loads influences the optimal trade-off between thermal efficiency and dynamic structural stability. Finally, it asks whether critical thermomechanical stresses can be effectively mitigated through the geometric reconfiguration of the heat exchanger's outer boundary.
Supervisor: Joe Alexandersen

CHRISTIAN BUUR KEJ (SDU, Dept. of Mechanical and Electrical Engineering)
Strengthening European shipbuilding capabilities through advanced automation solutions
Due to high labour costs, ship production has been outsourced to countries with lower wages, leading to a significant reduction in European shipbuilding capacity.
The competitiveness of European shipyards is further challenged by labour shortages, as it is becoming increasingly difficult to secure the required skilled workforce.
Revitalisation of European shipbuilding capacities requires both political incentives and technological advancements. The aforementioned challenges must be addressed in order to ensure the competitiveness of future European shipbuilding activities.
The present project is part of the SDU Center for Large Structure Production (LSP), which aims to mitigate the challenges faced by the European shipbuilding industry by advancing the level of automation in shipbuilding activities. A novel, multi-purpose robotic work cell is being developed, which will be able to handle various shipbuilding operations within the same multi-robot workspace, thus addressing the challenges faced by the industry.
The poster presentation at the DCAMM symposium will provide a general overview of the development of the robotic work cell. Furthermore, state-of-the-art technologies for robotic welding, manipulation and assembly of panels used in ship construction will be presented based on a literature survey. This knowledge will provide a foundation for future work, where steps will towards robotic assembly of ship modules will be discussed.
Supervisors: Christian Slette, Marie Lützen

JONAS PALMGREN (SDU, Dept. of Mechanical and Electrical Engineering)
Decision-support tool for sustainable ship propulsion
The shipping sector is facing challenges for CO2 emission reduction to comply with the emission targets set by the International Marine Organization (IMO) and the EU. In response, both organizations have imposed strict sustainable regulations on shipping. As a result, sustainable fuels and new technologies have been integrated into propulsion system designs, increasing their complexity for ocean-going vessels. Consequently, shipping stakeholders face growing challenges in identifying cost-effective and sustainable design solutions for both new builds and retrofits.
Implementing these decarbonization regulations into a decision-support tool and examining propulsion systems will provide stakeholders with strategic pathways for fuel transitions, technology retrofits, and investment timing, to attain cost effective compliance and support the sustainable transition of the

shipping sector. The tool adopts a modular structure to ensure flexibility, ease pf maintenance, and future expansion.
To address uncertainties in economic parameters and regulatory development, the tool will be applied in a scenario-based analysis. These scenarios will be constructed based on the future regulatory framework and expert input from industry stakeholders. By incorporating uncertainty into the assessment, the tool enhances the robustness of its recommendations and supports informed, long-term decision-making for the sustainable transition of the shipping sector.
Supervisor: Marie Lützen

17:45 – 18:45 POSTER SESSION

19:00 - Dinner

Programme for Thursday morning, March 12th, 2026

07:00 - 09:00 Breakfast

09.00 – 10:50 STRUCTURES
(Chairman: Federico Ferrari, DTU, Dept. of Civil and Mechanical Engineering)

JOHAN TOFTEKÆR & JEROEN GROEN (Vattenfall, 20 minutes)

Data-driven design optimization of offshore wind turbine support structures

In this talk we will present Vattenfall's state-of-the-art engineering methods used for the design optimization, structural health monitoring and lifetime prediction of offshore wind turbine support structures.

The interdependency between structural geometry, loads and geotechnical responses requires a fully integrated design loop, which considers everything from transport, installation, fatigue, natural frequencies to ultimate and accidental load case scenarios. Rapid design evaluations are enabled by geotechnical modelling and a frequency domain load scaling model, calibrated on aeroelastic simulations.

Each of Vattenfall's installed offshore wind turbines consists of a measurement
system, which with operational modal analysis helps to find mismatches between design assumptions and reality and establish a digital twin for every turbine. These updated models combined with measured accelerations allow for a continuous monitoring of structural responses and among others, real-time calculation of accumulated fatigue damages. The observed damages are gradually replacing design assumptions and combined with environmental and operational forecast models used to perform data-driven lifetime predictions.

Moreover, the systematic collection of data allows for a comprehensive assessment of the original design assumptions helping Vattenfall to continuously improve the design of new offshore windfarms, reducing the gap between design and real-life behaviour.

JACK RAHBEK STEENGAARD (SDU, Dept. of Mechanical and Electrical Engineering & Kverneland, 15 minutes)

Frequency-based fatigue assessment of welded structures

Most failures of machinery are due to fatigue caused by cyclic loading [1]. The topic of fatigue has been studied to avoid these failures, and fatigue assessments are traditionally performed in the time-domain, but the process is time-consuming [2]. Frequency-domain methods make fatigue assessments based on the power spectral density (PSD), which reduces the computational demand. However, these methods are approximations, and the accuracy of the methods depends on the specific application in terms of PSD and S-N curve slope [3]. In this study, well-known frequency-based methods are compared for circumstances relevant to weld fatigue. Furthermore, some methods are only applicable to single-slope S-N curves, and most studies only consider single-slope curves, but the S-N curves of welded steel joints are mostly bilinear [4]. Therefore, the methods' applicability to bilinear S-N curves is discussed, and some methods are extended to be applicable to bilinear S-N curves. The study concludes on the best approach to make fatigue assessments of welded joints in the frequency-domain.

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Supervisor: Marie Lützen, Luis David Avendaño-Valencia

SAI TEJA BOMMAVARAM (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)

Phase-field modeling of high-cycle fatigue in welds

Welding connections are adopted across various industries for their cost effectiveness, versatility, and structural efficiency. However, the residual stress state developed during welding can compromise reliability and integrity, an issue highly relevant for offshore wind structures. Consequently, it is essential to understand and predict the influence of this residual state when assessing fatigue life in welded components.

We present a numerical framework that incorporates welding residual stresses into a high-cycle phase-field fatigue fracture model [1]. The residual stress state is obtained through sequential thermo-mechanical analysis using the Abaqus welding interface (AWI) plugin and introduced as the initial condition for the fatigue fracture simulation. Only the elastic component of the welding residual state is retained to drive the fatigue response, excluding the plastic parameters.

The proposed numerical framework facilitates the evaluation of crack growth rates under scenarios involving both the presence and absence of the welding residual stress. This enables a quantitative assessment of the adverse influence on the fatigue life in welded components. The investigation is carried out through two-dimensional numerical simulations.

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Supervisor: Christian F. Niordson

NANNA BERGMANN WINTHER (AAU, Dept. of Materials and Production, 15 minutes)

Non-proportional fatigue: When welded steel joints breaks in weird ways

Steel does not always fail because of one single overload. Often it fails because of millions of small repeats. That is fatigue: where damage grows quietly until a crack becomes a final failure. Now add a twist: Real components can be loaded in various ways, e.g., by waves and winds acting on offshore wind turbine constructions, these loads are naturally nonsynchronous. That is non-proportional loading, and it can break welded joints in unexpected ways.

This presentation shows the results from the experimental campaign where welded tube joints were subjected to combined non-proportional loading (both phase and frequency shifts), what happened to the fatigue lifetime behavior, and why several standard assessment approaches struggled to capture the extra damage.
Supervisor: Jens Henrik Andreasen

KHALED ABDELGAWAD (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)
Scanning strategy and building orientation influence on the generated residual stress during LBPF additive manufacturing of Ti6Al4V
This study presents a finite element model to investigate the residual stress development in Ti6Al4V components fabricated by Laser Powder Bed Fusion (LPBF).
The research specifically analyzes the influence of scanning strategy, namely the Scanning Rotation Angle (SRA) and hatch overlap ratio, on thermomechanical behaviour during multi-layer deposition. Simulation results demonstrate that these parameters critically govern heat accumulation and dissipation, thereby controlling the distribution of residual stresses. An optimized scanning rotation angle of 67° was found to prevent the alignment of scanning tracks, reducing crack occurrence potential. Furthermore, an overlap ratio between 10% and 30% proved most effective, while higher ratios increased residual stress due to excessive heat buildup. This optimized parameter set minimized defects such as residual stress and porosity on the experimental aspect. The model's predictions for melt pool geometry showed strong agreement with established analytical models for length and depth, validating its thermomechanical accuracy. The findings underscore that strategic control of LPBF process parameters is essential for mitigating residual stresses. This work provides a validated numerical framework for optimizing scanning strategies to enhance the structural integrity and reliability of additively manufactured titanium alloy components.
Supervisors: Mohammad Malekan, Pei Li

MORTEN ANDERSEN (AU, Dept. of Mechanical and Production Engineering, 15 minutes)
Pressurized cells: From self-buckling of cylinders to pressurized cellular solids
Pressurized cellular structures are ubiquitous in nature and inspire the design of soft robotics and shape-morphing structures. These structures have recently garnered significant attention and inspired the field of biomimetic materials. Motivated by the internal cells of leaves, the mesophyll, and its internal turgor pressure, we seek to understand how the internal pressure of cylinders can enhance or compromise the structural stability in these slender structures under their own weight. Via dimensionless structural analysis utilizing both Saint Venant-Kirchhoff and Neo-Hookean material models, we rationalize the influence of the applied internal pressure on self-weight buckling via numerical simulations, scaling analysis, and experiments, obtaining results that highlight the coupling between geometric properties and the structural response of the system. These insights may inform the design of pressure-stabilized structures.
This work was supported by a Research Grant from HFSP (Ref.-No: RGP010/2023)
Supervisor: Matteo Pezzulla

JIAYI KAYEE LI (AU, Dept. of Civil and Architectural Engineering, 15 minutes)

Achieving circular timber construction through structural components built from reclaimed wood: A pivotal experimental feasibility study

The reuse of structural timber is a critical pathway towards achieving circularity in the built environment. This study investigates the structural viability of transforming reclaimed timber plates into new laminated stiffened panels through an integrated digital to-physical workflow. The research bridges the gap between computational optimisation and real-world implementation by combining topology-based structural design with material recovery, fabrication adaptation, and full-scale experimental validation. Reclaimed three-layer timber plates were sourced, digitally characterised, and reassembled into a full scale prototype based on an optimised stiffener layout adapted to the irregular geometry of available segments. A four-point bending test was conducted to assess load-bearing capacity, stiffness, and failure behaviour. The prototype achieved an ultimate load of approximately 64.9 kN, strongly demonstrating the structural viability of reclaimed timber for engineered components. However, early delamination revealed the critical influence of bonding quality and fabrication accuracy on global stiffness and failure modes. The results confirm that reclaimed wood can perform structurally when coupled with appropriate design adaptation and manufacturing control. This research fills a gap in the literature by providing a comprehensive experimental validation of circular wood-based panels manufactured entirely from recycled materials, offering practical guidance for the development of renewable timber building systems.

Supervisor: Lars Vabbersgaard Andersen

10:50 – 11:15 Coffee break

11:15 – 12:00 INVITED PRESENTATION

(Chairman: Jan B. Høgsberg DTU, Dept. of Civil and Mechanical Engineering)

CHRISTIAN F. NIORDSON (DTU, Dept. of Civil and Mechanical Engineering, 45 minutes)

From Cavities to Catastrophe: Mechanics of Ductile Failure Across Scales

Ductile failure in metals arises from a multiscale interaction between microstructure, plastic flow, hydrostatic stress, and the growth of internal cavities. Since the first microscopic observations of dimpled fracture surfaces in the 1960s, it has been understood that ductile fracture follows from void nucleation, growth, and coalescence. The continuing challenge is to turn this physical picture into models that can reliably predict failure at the structural scale.

This lecture examines ductile failure from a mechanics perspective. It focuses on how void growth is driven by stress triaxiality and how non-uniform stress fields develop within the inhomogeneous polycrystalline microstructure. Crystal plasticity finite element simulations based on experimentally measured grain structures are used to quantify local stress amplification and to show how local peaks in hydrostatic stress determine where voids grow.

The discussion then turns to two central modeling challenges: the influence of void size and the role of spatial randomness. Micron-scale cavities exhibit systematic deviations from classical porous plasticity predictions, pointing to the importance of length-scale effects. In addition, stochastic analyses of

representative volume elements show how random void distributions alter the macroscopic yield response and introduce variability into failure predictions.
The central message is that ductile fracture is a fundamentally multiscale mechanics problem. By combining modern experiments with microstructure-resolved simulations, we move closer to models that connect cavity-scale mechanisms to structural failure.

12:00 - 13:00 Lunch

13:00 – 17:00 Social Event

19:00 - Banquet

Programme for Friday morning, March 13th, 2026

07:00 - 09:00 Breakfast

09:00 – 10:00 GEOMETRY AND OPTIMIZATION
(Chairman: Anton Evgrafov, AAU, Dept. of Mathematics)

ANDER CHOCARRO SALABERRIA (DTU Compute, Dept. of Applied Mathematics and Computer Science, 15 minutes)

Mathematics of freeform surface stackability

Surface stackability, the property of surfaces to be decomposed into stackable components (essentially, geometrically similar panels), is largely unexplored. We develop a mathematical framework as well as computational design tools for freeform surface stackability, unlocking the potential for advanced digital fabrication workflows (such as hot blade cutting) as well as optimizing the logistics of packing, transportation and efficient material use in architecture. To achieve this, the relationship between local surface properties and volumes is explored, such as curvature variation and volume sectional curvature, surface curves and volume foliations, etc. We identify minimizing paths for volume/curvature variation to define surface vector/cross fields for discretization and optimization. Several methods for rationalizing freeform surfaces are examined for optimal stackability search, and different settings are considered: enforcing smoothness, stacking adjacent or non-adjacent elements, flipping elements, introducing auxiliary slices for better stacking, etc. We formulate an optimization problem to enhance stackability, considering objective functions like total volume and curvature variation. Constraints include fabrication considerations, e.g. panel regularity and consistent similarity between consecutive panels. Specially relevant surface types are addressed, including ruled, developable, periodic and Weingarten surfaces. We assess their stackability and provide optimal decompositions for various fabrication methods.

Supervisor: David Brander

MARC ISERN HACKER (DTU Compute, Dept. of Applied Mathematics and Computer Science, 15 minutes)

Modelling with 3D elastic curves

Hot blade cutting utilizes a heated elastic rod - called a blade - that is bent and twisted by two robotic arms to introduce freeform cuts through foam blocks. This is a generalization of the well-known method of hotwire cutting, where instead of a curved rod, a straight wire is used. Hot blade cutting facilitates the efficient and highspeed production of doubly curved architectural elements. Such cut out elements inherently satisfy stackability i.e. the property of surfaces to be decomposed into stackable components (see the talk on “Mathematics of Surface Stackability”).

Planar elastic curves have been used for rationalizing doubly curved surfaces, but they do not fully exploit the potential of 3D elastic curves. In this talk, we present an analytic representation of an elastic space curve, equivalent to the spherical pendulum equation, leading to a 10-parameter description of the space of 3D elastic curve segments. We introduce a numerically stable method for recovering the 10 parameters from a given elastic curve segment. Using this, we give a fast and stable method to approximate an arbitrary space curve segment by a 3D elastic curve segment.

Supervisor: David Brander

PEDRO JOSE DE FREITAS (DTU, Dept. of Civil and Mechanical Engineering & Vestas, 15 minutes)

Parametric optimization of pre-tensioned bolted connections

This work introduces a computational framework for automated design optimization of pre-tensioned bolted connections, targeting material cost minimization while satisfying critical structural requirements. The methodology combines finite element analysis with gradient-based optimization to obtain optimized geometries that balance competing performance criteria.

A finite element model captures the essential physics of pre-tensioned connections, including the dual load case setup (pre-tension and external loading) and interface behavior through bonding constraints. An explicit geometry parameterization strategy enables smooth morphing between design configurations while preserving mesh quality throughout the optimization process. The adjoint method combined with symbolic differentiation provides efficient sensitivity analysis for the comprehensive constraint formulation, which includes ultimate strength limits, fatigue endurance criteria, interface mechanics, and geometric regularity. The optimization results reveal systematic design trade-offs between bolt and flange dimensions as functions of material cost ratios, strength properties, and loading conditions. Notably, the framework captures important nonlinear scaling effects: ultimate load increases demand disproportionate bolt sizing due to the bolt's dual role in load transfer and flange clamping, while fatigue load increases exhibit similar nonlinearities driven by size effects in S-N curves. Analysis of critical constraint activity patterns provides insights into the governing failure modes and their evolution across the design space.

The modular architecture of the framework facilitates extension to broader classes of bolted connection problems and its incorporation in optimization procedures of structural systems with bolted connections, providing a foundation for automated design of complex structures.

Supervisor: Niels Aage

HAIYANG LEI (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)

Topology optimisation of turbulent flows using a parametric level-set method with implicit wall functions

Turbulent flow is widely present in various industrial applications, and its flow properties are crucial to system efficiency and reliability. However, due to the strong nonlinearity of turbulent flow and the limitations of traditional turbulence topology optimization methods in handling precise wall boundary conditions, a significant performance gap exists between the optimized structure and the reconstructed model. Topology optimization for turbulent flow still faces many challenges. This paper proposes a parametric level-set TO framework for turbulent flows, in which implicit wall function is introduced. In this research, fixed coarse mesh is applied during the topology optimization process. Various two-dimensional design problems are investigated to demonstrate the effectiveness of the proposed approach, including a classical U-bend benchmark and lift-to-drag trade-off optimization problems. Preliminary results indicate that the proposed framework consistently maintains a relatively well-defined fluid-solid interface, which enables the stable application of implicit wall functions and leads to enhanced robustness during iterations. Besides, the proposed framework exhibits strong robustness and stability, even at high Reynolds numbers up to Re=10^6, and remains effective on relatively coarse meshes.

The proposed topology optimization framework is implemented through a coupled COMSOL
Multiphysics and MATLAB environment.
Supervisor: Joe Alexandersen

10:00 - 10:30 Coffee break

10:30 – 12:15 STRUCTURES
(Chairman: Guiseppe Abbiati, AU, Dept. of Civil and Architectural Engineering)

LASZLO MANGLIAR (AU, Dept. of Civil and Architectural Engineering, 15 minutes)
Numerical strategies for modelling connections at substructure interfaces
Modular timber construction holds clear potential for sustainable and circular building by facilitating development, fabrication, and assembly. However, modular buildings are still commonly documented as conventional assemblies of individual members, which limits the benefits of modularity and constrains reuse opportunities. To address this limitation, a hierarchical framework has been proposed that reorganises structural documentation around component-level verification, enabling a product-based approach to structural engineering.
Implementing such a hierarchical documentation framework requires numerical models that clearly separate component, connection, and assembly behaviour, while remaining compatible with practical verification workflows. The study addresses this requirement by examining alternative numerical strategies for modelling connections in modular timber systems as interfaces between substructures.
Three principal strategies are considered: embedding connection behaviour within the component substructure, representing connections as nonlinear interface laws acting at attachment degrees of freedom, and modelling connections as explicit joint substructures.
Using numerical experiments, the study investigates how the different interface attachment definitions influence global structural response, local stress transfer, and the robustness of reduced substructure models. The aim is to establish modelling guidelines that support realistic connection–material interaction while preserving the modularity, reduction efficiency, and reusability of component-level representations.
Supervisor: Lars Vabbersgaard Andersen

NIKOLAJ BJERGE (AU, Dept. of Civil and Architectural Engineering & COWI, 15 minutes)
Impact of anchor stiffness on the response of mooring systems for floating wind turbines
Anchoring is a quiet bottleneck for floating offshore wind farms: global coupled
models predict mooring loads, while geotechnical design is often checked separately with the anchor idealised as a rigid pin. This work quantifies when that rigid-anchor assumption is acceptable for shared suction-caisson anchors and proposes a reproducible workflow linking farm-scale simulations to geotechnical verification. A three-turbine cluster (IEA-15-240-RWT on the UMaine VolturnUS-S semisubmersible) with catenary moorings in 200 m water depth is analysed in drained sand. Baseline loads are obtained from FAST.Farm (OpenFAST–MoorDyn) with rigid anchor terminations. Mudline

actions are transferred to padeye level using an embedded-chain model, and suction-caisson capacity is evaluated via 3D finiteelement limit analysis to build normalised H–V interaction envelopes. The resulting caisson geometry is assigned equivalent horizontal and vertical translational stiffness and re-simulated with compliant terminations to quantify load redistribution. For the aligned deterministic wind–wave case (Uhub=8 m/s, Hs=6 m, Tp=12 s), translational compliance changes steady padeye demand only modestly (≈1–2%). However, mudline-only checks can be non-conservative because embedded-chain load transfer introduces a large vertical padeye component, especially for shared anchors. The workflow provides a practical decision basis for when anchor stiffness must be represented explicitly.
Supervisors: Andrea Franza, Lars Vabbersgaard Andersen, Felipe Prada, Søren Dam Nielsen, Søren Peder Hyldal Sørensen

SEBASTIAN DAMSGAARD (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)
Dynamics of hybrid gas foil thrust bearings
Hybrid Gas Foil Thrust Bearings (HGFTBs) are compliant, self-acting hydrodynamic bearings with hydrostatic lubrication. Gas Foil Thrust Bearings (GFTBs) support axial loads in high-speed, extreme-temperature, sterile and oil-free turbomachinery. Conventional GFTBs are limited to small, high-speed horizontal rotor systems, where axial force balancing, often via impeller thrust, is crucial for minimizing bearing loads. Adding hydrostatic injection significantly extends their operational range, enabling vertical rotors to achieve lift-off at zero speed, reducing start-stop wear and initial friction. Hydrostatic lubrication also permits larger GFTBs to operate at lower speeds while maintaining a sufficient film height. However, the dynamic characteristics of vertical rotors supported by HGFTBs remain poorly documented, even though such knowledge is crucial for understanding potential instabilities and failure modes. This presentation introduces a strongly coupled Elasto-Hydro-Hybrid model for a large, heavily loaded HGFTB. Various numerical injection strategies are compared across four bearing configurations. Transient behavior during startup and shutdown is analyzed, showing that hybridization reduces damping, and that foil-structural damping becomes significant at high speeds. It is also shown how nonlinear effects are reduced using a compliant bearing.
Supervisor: Ilmar Santos

ANDY PETERSEN (DTU, Dept. of Civil and Mechanical Engineering & Everllence, 15 minutes)
Modelling of piston rings for two stroke marine engines
Piston rings are critical components in combustion engines, ensuring effective sealing of the combustion chamber to maintain pressure and generate power. Their operation involves extreme conditions, including high and fluctuating thermal loads. A key challenge lies in minimizing friction against the cylinder liner while preserving sealing performance. Lubrication of piston rings is particularly complex due to their oscillating motion, which introduces periods of zero velocity and reversing direction.
In large bore two-stroke marine engines, this challenge is amplified by the crosshead design, which eliminates the possibility of an oil sump. Lubrication oil must therefore be injected directly and cannot be recycled, making precise control of oil quantity essential. Experimental investigations under these conditions are costly, highlighting the value of advanced modeling approaches.

In this presentation, I will describe the physics required to model piston rings in large bore two-stroke marine engines and demonstrate how these can be integrated into a multi-physical 3D model capable of capturing the dynamic behavior observed in operation. The proposed framework captures thermal, tribological, and dynamic interactions, enabling accurate prediction of operational performance and supporting the design of efficient, reliable piston ring systems.
Supervisor: Casper Schousboe Andreasen

MATÍAS REUMAY (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)
Attenuation of fluid-flow induced instabilities via actively-lubricated bearings
Annular seals in turbomachinery may generate significant dynamic forces, leading to fluid flow-induced instabilities, which detrimentally affect system performance. One way to reduce such instabilities is the use of tilting-pad journal bearings with active oil radial injection. This work experimentally investigates the feasibility of control schemes applied to actively-lubricated tilting-pad journal bearings, to counteract destabilising seal-induced forces in a rotor-bearing-foundation system. The theoretical prediction of the global system dynamics is obtained by: i) Obtaining and coupling the rotor and foundation dynamics. ii) Integrating seal forces as crosscoupling stiffnesses to both the rotor and foundation. iii) To add the fluid film bearing dynamic properties, calculated through the linearization of the thermo-elastohydrodynamic bearing model with the inclusion of the servo valve dynamics. v) Closed-loop control system design for the oil radial injection at high-pressure using LQG controller. Instabilities are experimentally generated in a test rig using an active magnetic bearing, which applies controlled destabilising forces based on rotor lateral displacement. Both theoretical and experimental results demonstrate that modalbased controllers effectively decrease the onset of fluid-induced instabilities, validating the potential of active lubrication in stabilising rotor-bearing-foundation systems.
Supervisor: Ilmar Santos

CASPER AASKOV DRANGSFELDT (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)
Probabilistic structural health monitoring of ship gearboxes under time-variant operation: concept and application
Vibration-based Structural Health Monitoring (SHM) aims to enhance the reliability of engineering systems by continuously assessing their condition through vibration data. Central to SHM is the definition of a baseline representing the undamaged condition, against which persistent deviations may indicate structural changes or damage. In practice, however, deployment is challenging when systems operate under discrete operational regimes, each exhibiting distinct dynamic behaviour, requiring its own baseline. Additional uncertainty from environmental influences, varying loads, and human decision-making further increases variability. Distinguishing this variability from structural changes remains a key challenge, particularly during early deployment when data are sparse and not yet representative of the full operational spectrum.
In this work, the concept of a probabilistic Multi-Model framework is presented for robust, uncertainty-informed SHM under discrete operational variability. The framework (i) assigns incoming measurements to the most likely operating regime and (ii) evaluates the structural condition at the

regime level, with each regime represented by its own local baseline. The probabilistic formulation enables sequential updating as new data becomes available, making the frame-
work suitable even under limited data availability. The applicability is demonstrated using data from a working vessel in operation, representing a complex maritime system characterized by discrete operating conditions.
Supervisor: Marie Lützen, Luis David Avendaño-Valencia

FREDERIK NORDTORP KRISTIANSEN (AU, Dept. of Civil and Architectural Engineering)
Real-time hybrid testing of multibody dynamic systems
Large multibody dynamic systems, such as wind turbines, cranes, and spacecraft, are impractical to test at full scale, motivating hybrid testing in which a system is divided into a numerical model and a physical experiment. When this coupling is performed in real time, actuation and communication delays can cause instability. This issue is particularly challenging for multibody dynamic systems, where nonlinear equations of motion limit the applicability of conventional delay compensation methods based on linear transfer functions.
Here, we present a real-time hybrid testing framework with delay compensation based on model predictive control, which optimizes delayed commands to maintain force equilibrium and motion compatibility between the physical and numerical substructures. The proposed framework is validated experimentally using a real-time hybrid test of a three-dimensional multibody dynamic system with six degrees of freedom. The physical component is tested on a multi-axial simulation table. The results show that the proposed delay compensation strategy maintains stable interaction despite nonlinear dynamics. This work demonstrates that model predictive control provides a robust and effective approach for stabilizing real-time hybrid tests of multibody dynamic systems.
Supervisor: Giuseppe Abbiati

12:15 - 13:15 Lunch

Programme for Friday afternoon, March 13th, 2026

13:15 – 14:30 OPTIMIZATION
(Chairman: Mahdi Akbar, AU, Dept. of Mechanical and Production Engineering)

AMIRHOSSEIN BAYAT (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)
Towards turbulent topology optimization for high heat flux cooling with implicitly defined wall functions
Turbulent flow outperforms laminar flow for heat transfer. However, turbulent density based topology optimization remains relatively underdeveloped [1], due to the high computational cost, which is partly because of the difficulty of implementing proper boundary conditions (wall functions)
[2]. In practice, it is not necessary to fully resolve all the sub-layers in RANS and LES models; instead, one can use wall functions. Mature wall-function models can accurately estimate the near-wall velocity and significantly reduce the computational cost. Despite this potential, incorporating wall functions into density-based topology optimization has been challenging. In density based topology optimization the evolving geometry does not provide a clear, well-defined wall on which to impose the boundary conditions.
In this work, we propose a new implicit approach for applying wall-function boundary conditions directly within the design domain in RANS k-ε turbulent model. By substantially leveraging the design freedom of the density-based topology optimization model while maintaining the complexity of the turbulent flow model at a much lower computational cost, the proposed approach helps pave the way for using turbulent topology optimization in everyday engineering design workflows and in problems that are closer to real-world operating conditions.
References
[1] Joe Alexandersen and Casper Schousboe Andreasen. “A review of topology optimization for fluid-based problems”. In: Fluids 5.1 (2020), p. 29.
[2] Amirhossein Bayat, Hao Li, and Joe Alexandersen. “Density-based topology optimization for Navier-Stokes flow with free-slip boundary conditions”. In: (2025). hal-05131366.

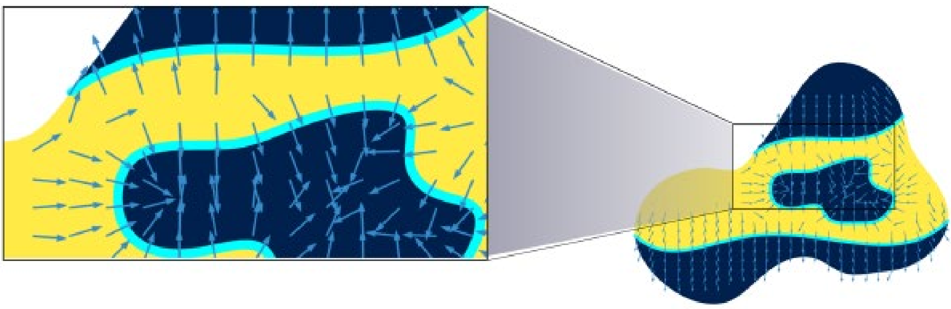

Figure 1: Implicity defined wall and normals schematic
Supervisor: Joe Alexandersen

MAGNUS APPEL (SDU, Dept. of Mechanical and Electrical Engineering, 15 minutes)
Parallel-in-time methods for topology optimisation of transient heat flow
Topology optimisation for time-dependent problems is a very time-consuming process due to the demand for simulating the system at every optimisation iteration.Our project addresses this by using parallel-in-time (PinT) methods, and transient heat conduction is considered as a test problem. This presentation

covers two of these PinT methods: the Parareal method and Space-Time MultiGrid (STMG) methods.
Parareal is a non-intrusive PinT method, meaning that is it easy to apply to existing time-stepping code. Preliminary tests revealed that Parareal requires many iterations to achieve accurate results, which reduces the speedup. To mitigate this, a one-shot approach was used. The resulting method achieved a peak speedup of 5× using 16 threads.
STMG methods are multigrid methods applied to space-time domains. A large part of our work went into finding good semi-coarsening strategies for STMG applied to problems with large contrast in the material parameters, because this is important for achieving fast convergence. Our space-time-parallel STMG implementation can reach speedups of 20-50× relative to a space-parallel time-stepping method, at the expense of 5-10× the core-hours. The method has been applied to problems with up to 4.2 billion degrees of freedom, for which it can perform topology optimisation in approximately one hour.
Supervisor: Joe Alexandersen

PHILIP ELBEK (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)
Topology optimization with stochastic geometric perturbations for waveguide design
Photonic devices are known to be sensitive to perturbations of the design geometry, and obtaining devices that perform sufficiently requires either trial and error or specialized control of the manufacturing. We present a density based stochastic topology optimization method that obtains photonic devices that theoretically are much more robust to non-uniform geometric perturbations compared to traditional optimization methods [1]. The scalar Helmholtz equation, describing out-of-plane polarized light with time-harmonic behavior, is discretized using Q4 elements, and eigenmodes and effective indices are computed to accurately control the input and output of guided modes and attenuation in the PML layers. As demonstration, the first guided mode in the input channel is converted to the second guided mode in the output channel. The results show that the stochastic approach provides simpler design geometries while still being much more robust to perturbations of both input frequency and geometry. More efficient stochastic optimization methods will also be demonstrated, although the results are not final. More efficient methods make it feasible to solve more complex problems, such as the full 3D Maxwell's equations.
References:
[1] Elbek, Philip; Christiansen, Rasmus; Aage, Niels; Sigmund, Ole (2025). Tailoring robust photonic components using stochastic topology optimization. Optica Open. Preprint.https://doi.org/10.1364/opticaopen.30675803.v2
Supervisor: Ole Sigmund

VICTOR PISINGER (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)
Topology optimization of quantum opto-mechanical systems
Quantum Opto-mechanical resonators are nanoscale oscillators that are responsive to ultra-weak perturbations, offering exquisite sensitivity in measurement applications and are promising building blocks for quantum technologies including quantum memory. The next generation of Quantum Opto-mechanical systems require high opto-mechanical coupling with ultra-high Quality factors, wide phononic bandgaps and high manufacturing yield.
This work presents a density-based topology-optimization framework for designing prestressed opto-mechanical resonators in which the dissipation dilution technique is enhanced through engineered geometric nonuniformities. The resonator is embedded with an array of nanopillars that function as a

phononic crystal, enabling tailored dispersion properties while preserving strong opto-mechanical coupling. Robust approaches are included to improve the manufacturing yield and algorithm stability.
By jointly optimizing the spatial distribution of prestress through the resonator topology and tuning of the phononic crystal through the location of the nano pillars, we demonstrate substantial improvements in mechanical quality factor, suppression of radiative loss channels, and the emergence of wide tunable band-gaps.
Supervisor: Ole Sigmund

MARKUS GÜMOES HOLM (DTU, Dept. of Civil and Mechanical Engineering, 15 minutes)
Simple parameterizations for extremal elastic microstructures
Extremal single-inclusion microstructures, commonly referred to as Vigdergauz structures, are known to attain the theoretical maximum stiffness predicted by the Hashin–Shtrikman bounds and simultaneously minimize stress concentrations. Traditionally, their geometries have been represented either through multi-term series expansions or through bitmap-based parameterizations obtained via topology optimization. This work introduces a compact and fully analytic description of Vigdergauz-like extremal microstructures constructed using smooth-maximum unions of simple signed distance functions. For two-dimensional configurations with elastic square symmetry or isotropy, the near-optimal geometry can be defined using only two parameters. For three-dimensional microstructures, two parameters also suffice to describe closed-walled and open-walled elastic cubic-symmetric architectures, although only the closed-walled architectures remain extremal. The global and highly compact nature of these parameterizations offers several advantages. They enable efficient modeling without the need for high-resolution grids, facilitate smooth control of graded relative densities, and integrate naturally with gradient-based optimization frameworks, including topology optimization. Overall, the proposed parameterizations provide a simple yet powerful means of representing extremal microstructures, opening new possibilities for design, optimization, and fabrication of high-performance mechanical metamaterials.
Supervisor: Ole Sigmund

14:30 – 14:45 Closing of the DCAMM Symposium

14:45 Departure from the hotel

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