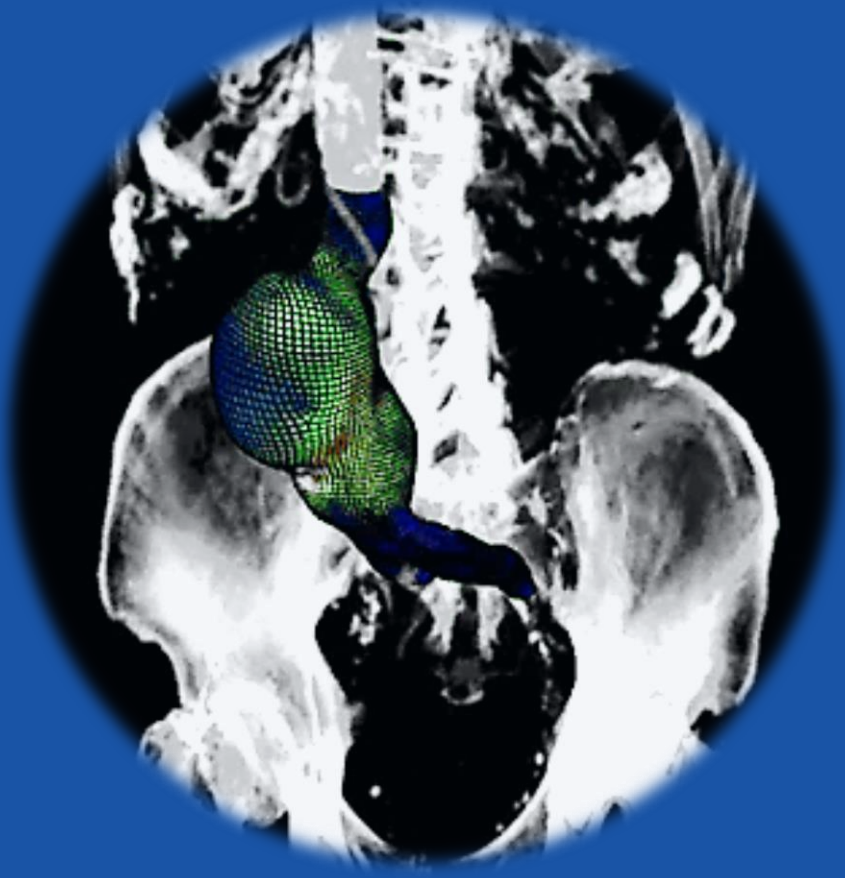
Summer school

Computational Tissue Biomechanics

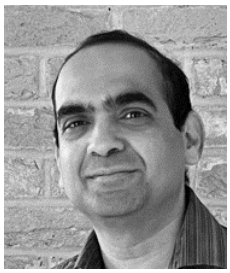
Making Sense of Data



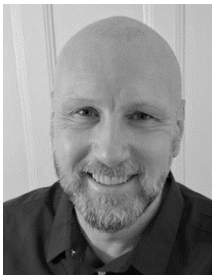
Stockholm, August 17th to 22nd 2025

Faculty

Gerard A. Ateshian is the Andrew Walz Professor of Mechanical Engineering (ME) at Columbia University in New York City, NY, USA. His primary research is in the field of soft tissue mechanics, with an emphasis on cartilage mechanics, lubrication, and tissue engineering, the formulation of growth theories for biological tissues, and the development of treatment modalities for osteoarthritis. In collaboration with Prof. Clark Hung from the Department of Biomedical Engineering at Columbia, he has translated his findings on cartilage mechanics to the field of functional cartilage tissue engineering. Together with Prof. Jeffrey Weiss at the University of Utah, he has developed open-source computational tools that facilitate the modeling of tissue mechanics, transport, and growth processes (febio.org).



Vikram Deshpande joined the faculty of Engineering at the University of Cambridge as a lecturer in 2001 and was promoted to a professorship in Materials Engineering in 2010. He has also served on the faculties at the University of California, Santa Barbara and at the Technical University of Eindhoven. With his students and collaborators, he has worked primarily in experimental and theoretical solid mechanics including cell mechanics. His recognitions include the 2020 Rodney Hill Prize in Solid Mechanics, the 2022 Prager Medal and the 2022 ASME Koiter medal. He has been elected Fellow of the Royal Society, London, the UK Royal Academy of Engineering, and an International Member of the US National Academy of Engineering (NAE).



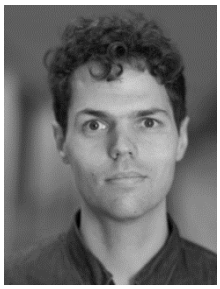
T.Christian Gasser is Professor of Biomechanics at KTH Royal Institute of Technology, Stockholm, as well as Adjunct Professor at University of Southern Denmark, Denmark. He holds a Master of Mechanical Engineering (1997) and a PhD in Civil Engineering (2001), both from Graz University of Technology, Austria. In 2008 Gasser accomplished his Habilitation in Solid Mechanics/Biomechanics at KTH. The development and application of advanced numerical techniques to solve realistic (bio)engineering and clinical problems, is Dr. Gasser's main research objective.

Svein Kleiven is Professor at KTH Royal Institute of Technology, Stockholm, Sweden He holds a PhD in Biomechanics, BSc in Automotive Eng., MSc in Mechanical Engineering. He is Director of the Doctoral Programs in Technology and Health and Applied Medical Engineering at KTH, and the Director of a Joint Doctoral Program between Karolinska Institute and KTH in Medical Technology. Dr. Kleiven's research primarily focuses on head and neck injury prevention and improving the clinical neuro-surgery treatment results with simulations and innovations.

Artem Kulachenko is a Professor of Solid Mechanics at KTH Royal Institute of Technology in Stockholm, Sweden. He obtained his PhD in Solid Mechanics from Mid Sweden University in collaboration with KTH, subsequently working at Finland's Technical Research Centre (VTT). His research focuses on the mechanics of fiber networks, mechanical degradation of battery materials, and biomechanical applications, employing advanced computational and data-driven methods.

Hanna Isaksson is Professor at the Department of Biomedical Engineering at Lund University. She obtained her PhD in Biomedical Engineering from Eindhoven University of Technology, the Netherlands. Prior to joining Lund University in 2010, Dr Isaksson spend three years as a post-doctoral researcher at the Biophysics of Bone and Cartilage research group at the University of Eastern Finland. Isaksson's research area is musculoskeletal tissue mechanics and mechanobiology, focusing on bone damage and fracture mechanisms, cartilage mechanics and computational modeling of osteoarthritis, as well as tendon biomechanics and mechanobiology of tendon repair.

David Marlevi is an Assistant Professor at the Dept. Molecular Medicine and Surgery at Karolinska Institutet (KI). After graduating from the joint PhD program in Medical Techology at Royal Institute of Technology (KTH) and KI he spent two years as a postdoctoral fellow at the Massachusetts Institute of Technology (MIT). In 2021, Dr. Marlevi returned to Sweden and KI, and in 2023 he received a European Research Council (ERC) Starting Grant, with large-scale efforts now commencing on the development of full-field phase-contrast magnetic resonance imaging (4D Flow MRI) for functional hemodynamic mapping across the heart, aorta, and brain.



Marco Viceconti is a full professor of Biomechanics in the Department of Industrial Engineering of the Alma Mater Studiorum – University of Bologna and Director of the Medical Technology Lab of the Rizzoli Orthopaedic Institute. He started his career as a researcher in biomechanics in 1989 at the University of Florida – Madison, under the supervision of Prof Alì Seireg. Over the years, he worked on various topics related to neuromusculoskeletal biomechanics, but in the last 20 years, he focused primarily on In Silico medicine, where patient-specific physics-based computer models are used as clinical decision support systems. He served as President of the European Society of Biomechanics and of the European Alliance for Medical and Biological Engineering and Science. He is currently one of 25 members of the World Council of Biomechanics.

Marta Alloisio supervises the experimental tissue characterization laboratory work. She holds a MSc in Biomedical Engineering from Politecnico Milano and joined KTH as a PhD student in Solid Mechanics/Biomechanics in 2021. She works on the identification and simulation of fracture in vascular tissue.

Andrii Grytsan is a technical sales engineer at COMSOL, working with academic customers in Sweden. He holds a PhD in Solid Mechanics/Biomechanics from KTH. After spending one year at Sheffield University as a postdoctoral researcher, he returned to Sweden and worked for five years as a consultant concerning structural simulations. He then joined COMSOL in 2022.

Course aim, method, and content

The course introduces and applies state-of-the-art tools in the continuum mechanical analysis of biological tissues. It is designed for master students and PhD students having a decent background in mechanical engineering and solid mechanics. The course integrates theoretical, numerical, and experimental concepts in the description and analysis of biological tissues. Lectures (24 hours) are combined with dedicated Q&A sessions / case studies (7 hours), hands-on laboratory (4 hours) and Finite Element Method (FEM) modeling and constitutive model implementation work (4 hours) towards the integration of theoretical and practical knowledge. Practical tasks are carried out in groups of approximately 12 students and are supervised. The course material will be distributed during the lectures and the content then assessed through a multiple-choice questionary to be answered in groups of four students. Upon positive evaluation, a course certificate is handed out, matching the requirement to acquire 2.0 ECTS points from the student's home university. Besides the educational aspect, the course actively fosters interaction among participants, see the program for some of such activities.

Recommended literature

Gerard A. Ateshian

Gerard A. Ateshian, Brandon K. Zimmerman, Continuum Thermodynamics of Constrained Reactive Mixtures, Journal of Biomechanical Engineering 144 / 041011-1, https://doi.org/10.1115/1.4053084

Gerard A. Ateshian, Course notes on Constitutive Modelling, KTH Summer School on Computational Tissue Biomechanics, 2024.

Artem Kulachenko

Brunton, S. L., & Kutz, J. N. (2022). Data-driven science and engineering: Machine learning, dynamical systems, and control (2nd ed.). Cambridge University Press. (https://databookuw.com/databookV2.pdf)

Burkov, A. (2019). The hundred-page machine learning book. (https://www.amazon.se/-/en/Andriy-Burkov/dp/199957950X)

Vikram Deshpande

Z. Wang, S. Das, A. Joshi, A. J. D. Shaikeea, V. S. Deshpande. 3D observations discover a new paradigm in rubber elasticity, PNAS, 2024.

Chase Hartquista, Shu Wanga, Xuanhe Zhaoa, Local volume changes in deformed elastomers with mobile chains, PNAS, 2024

T.Christian Gasser

Gasser T.C., Vascular Biomechanics- Concepts, Models, and Applications, Springer, ISBN 978-3-030-70965-5, 2021.

Svein Kleiven

Kleiven, S. (2013). Why most traumatic brain injuries are not caused by linear acceleration but skull fractures are. Frontiers in bioengineering and biotechnology, 1, 15.

Wang, L.M., & Kuhl, E. (2023, May). Mechanics of axon growth and damage: A systematic review of computational models. In Seminars in Cell & Developmental Biology (Vol. 140, pp. 13-21). Academic Press.

Wu, Y.H., Rosset, S., Lee, T.R., Dragunow, M., Park, T., & Shim, V. (2021). In vitro models of traumatic brain injury: A systematic review. Journal of Neurotrauma, 38(17), 2336-2372.

Hanna Isaksson

Korhonen R.K. and Saarakkala S. (2011). Biomechanics and Modeling of Skeletal Soft Tissues, Theoretical Biomechanics, Dr Vaclav Klika (Ed.), ISBN: 978-953-307-851-9, InTech.

Özkaya N., Leger D., Goldsheyder D., Nordin M.. Fundamentals of Biomechanics - Equilibrium, Motion, and Deformation, Springer, 2017.

David Marlevi

Paul Suetens. Fundamentals of Medical Imaging, Cambridge University Press. 2009.

Marco Viceconti

Grassi L, Schileo E, Taddei F, Zani L, Juszczyk M, Cristofolini L, Viceconti M. Accuracy of finite element predictions in sideways load configurations for the proximal human femur. J Biomech. 2012 Jan 10;45(2):394-9.

Viceconti, M., Qasim, M., Bhattacharya, P. et al. Are CT-Based Finite Element Model Predictions of Femoral Bone Strengthening Clinically Useful? Curr Osteoporos Rep 16, 216–223 (2018).

Program

Sunday, Aug. 17th	
17.30-18.30	Boat tour through The Royal National City Park and registration

Monday, Aug. 18th	
8.15-10.15	Gasser: Comp. Continuum Biomechanics
10.15-10.45	Coffee break
10.45-12.45	Ateshian: Constitutive modeling
12.45-14.00	Lunch break
14.00-15.15	Ask the expert: Gasser/Ateshian
15.30-18.00	In-vitro tissue testing (group 1)
15.30-18.00	FEM modelling (group 2)
16.00-17.00	Guided tour around KTH campus (group 3)

Tuesday, Aug. 19th	
8.15-10.15	Kulachenko: Data Analysis
10.15-10.45	Coffee break
10.45-12.45	Gasser: Vascular tissue
12.45-14.00	Lunch break
14.00-15.15	Ask the expert: Kulachenko/Gasser
15.30-18.00	In-vitro tissue testing (group 2)
15.30-18.00	FEM modelling (group 3)
16.00-17.00	Guided tour in Nobel Prize Museum (group 1)

Wednesday, Aug. 20th	
8.15-10.15	Viceconti: Bone
10.15-10.45	Coffee break
10.45-12.45	Isaksson: Tendon, Ligament, Cartilage
12.45-14.00	Lunch break
14.00-15.15	Ask the expert: Viceconti/Isaksson
15.30-18.00	In-vitro tissue testing (group 3)
15.30-18.00	FEM modelling (group 4)
16.00-17.00	Guided tour around KTH campus (group 1,2)

Thursday, Aug. 21st	
8.15-10.15	Marlevi: The basics of non-invasive clinical imaging modalities
10.15-10.45	Coffee break
10.45-12.45	Deshpande: ex-vivo tomography
12.45-14.00	Lunch break
14.00-15.15	Ask the expert: Marlevi/ Deshpande
15.30-18.00	In-vitro tissue testing (group 4)
15.30-18.00	FEM modelling (group 1)
16.00-17.00	Guided tour in Nobel Prize Museum (group 2,3)
19.30-22.15	Dinner

Friday, Aug. 22nd	
8.15-10.15	Kleiven: Brain/head
10.15-10.45	Coffee break
10.45-11.15	Ask the expert: Kleiven
11.15-13.30	Lunch break
13.30-15.00	Multiple choice test in groups of four students
15.30-18.00	
15.30-18.00	
20.00-	Pub night

Venue

The school takes place at KTH main campus in the north of Stockholm city. The stop “Tekniska högsskolan” on the subway line 14 (red line) is right in front of KTH main campus. In addition, the commuter train stain station “Östra station” and a number of bus stops are also close to KTH main campus. Detailed information is found at https://sl.se/en/in-english, the website of Stockholm public transportation. E-scouters are also a convenient means of transportation.

Lectures will be in Gradångsalen, Tekinikringen 1, right in the center of KTH campus. The main entrance to the building is shown beside. To reach the lecture room you enter the building, and signs will then help you to find the lecture room.

Laboratory work is carried out at KTH Solid Mechanics Unit. The seminar room at the 2nd floor (room no. 4303) is used for the experimental tissue testing, and the track room “Spår hållfasthetslära” at the ground floor (room no. 6248) is used for FEM modeling work. To reach both facilities, it is convenient to use the entrance Teknikringen 8D, 114 28 Stockholm, see the image to the right.

Traveling from/to the airport

The cheapest way from the airport to the city center is to take a flight bus. The bus departs directly outside the airport and a one-way ticket to the city center is 129SEK. It is convenient to buy a ticket before entering the bus directly through the website. It is NOT possible to buy a ticket with cash, either on the bus nor at ticket machines.

Social program

Boat tour through The Royal National City Park. The tour starts at August 17th, 17.30 at Strömkajen, Stromma biljettkiosk (SK), Stockholm and takes approximately one hour. The tour is guided and your ticked includes a coffee/tea and cinnamon bun. The trip allows you to mingle and meet the other attendees before the school then starts on Monday.

Guided tour around KTH campus. Starts at the entrance to KTH campus, Drottning Kristinas väg 4, 114 28 Stockholm. The tour takes approximately one hour and is free of charge The meeting point is shown beside.

Guided tour in the Nobel Prize Museum. The museum is in a building called Börshuset (shown besides) at Stortorget 2, Gamla stan, Stockholm. It is about 35 minutes walking distance from KTH. Alternatively, one can take the subway 14 (direction south), leave at the station "Gamla stan" and walk a few minutes to the museum. Your ticket including the charge for the personal guide is covered by the registration fee.

Pub night (at own expenses) at the bar flying horse, Odengatan 44 113 51 Stockholm, a pub in walking distance from the event.

Dinner (for registered attendees only) to be defined according to the number of participants.

Registration Fee

	Early bird[a]	regular
Lectures [b]	270 Euro	320 Euro
Hands-on laboratory	190 Euro	240 Euro
Dinner	90 Euro	

a) Registration received before May 1st 2025
b) Same rates apply for joining the zoom live stream

The registration fee (including tax) is to be paid up front and through Axaco Event System. An 85% refund will be granted when the written cancellation request is sent to gasser@kth.se and received not later than July 20th 2025, thereafter no refund will be granted.

Support and Contact

Housing support. Housing close to KTH is generally very competitive and it is recommended to book as early as possible. The following platforms can be useful

https://www.trivago.com/
https://www.airbnb.com/
https://www.booking.com/
…

and in special cases we can help with finding and verifying housing options.

Emergency contact.
Swedish emergency number: 112
KTH emergency number: +46 8 790 7700
Summer school contact: +43 660 462 1923 (Gasser)