



The 51st Tire Mechanics Short Course

The 51st Tire Mechanics Short Course will be held concurrently with the International Tire Exhibition and Conference in John S. Knight Center in Akron, Ohio on September 12-16, 2022.

September 12 – 16, 2022

John S. Knight Center, Akron, Ohio USA

This five-day educational and developmental course will provide engineers and scientists with an in-depth, intense study of the developments surrounding tire engineering. The course is designed for practicing engineers, chemists, and scientists concerned with tires and vehicles, and those who have an engineering or science background at the Bachelor of Science level.

The basic and practical aspects of the mechanics of pneumatic tires will be introduced by internationally renowned experts in tire mechanics. Extensive and detailed course notes prepared by each instructor will be provided for all participants along with a 700-page e-book, **The Pneumatic Tire**, edited by Professors Gent and Walter.

Those who complete this course will receive a certificate from The University of Akron.

Monday, September 12, 2022

9:00 a.m. - 9:30 a.m. WELCOME AND INTRODUCTION

Dr. Benjamin T.F. Chung
Department of Mechanical Engineering
The University of Akron, USA

9:30 a.m. - 4:30 p.m. (Complimentary Lunch, 12:00 noon - 1:00 p.m.) THE TIRE AS A VEHICLE COMPONENT

Dr. Gerald Potts
GRP Consulting
Akron, OH, USA

Today's pneumatic tire must serve four functions: (1) support a moving load; (2) generate steering forces; (3) generate driving and braking forces; and (4) provide isolation from road irregularities. In examining the complex mechanism involved in satisfying the four requirements, participants will study the tire's importance in



determining overall vehicle performance; for no matter what level of complexity is designed into a vehicle, its only communication with the road is through tires, which must be tough and strong, yet flexible.

1. Basic Functions
2. Lateral Force Tire Models
3. Cornering Transients
4. Vehicle Ride Characteristics

Tuesday, September 13, 2022

9:00 a.m. – 4:00 p.m. (Complimentary Lunch, 12:00 noon – 1:00 p.m.)

TIRE COMPONENTS, TIRE COMPOUNDS AND TIRE MATERIALS

Dr. Annette Lechtenböhmer
Goodyear Innovation Center, Luxembourg; (retired)
Associate Editor of Tire Science and Technology Journal

The lecture gives an overview on the tire components, the demands to their compounds and the use of materials in these compounds. It attempts to make the connection between the role of components in a tire, the compound requirements to these components and the raw materials and cure which results in the desired compound properties. The lecture wants to close the loop between the raw materials and reinforcements used, the compound properties, tire preparation and cure and final tire properties.

The lecture will cover:

1. Components of a tire and demands
2. Tire compounds and their materials, including polymers, fillers, additives, sulfur and curatives
3. Tire structure and composites, textile cords, wire, carcasses, beads and belts
4. Processing, including mixing, calendaring, extrusion
5. Tire building
6. Tire curing

4:00 p.m. – 5:00 p.m. Visit to the ITEC Exhibition

5:00 p.m. – 6:30 p.m. Complimentary Reception with ITEC Attendees



Wednesday, September 14, 2022

9:00 a.m. – 4:00 p.m. (Complimentary Lunch, 12:00 noon – 1:00 p.m.)

TIRE STRESS AND DEFORMATION ANALYSIS

Dr. Michael Trinko

Technical Center, The Goodyear Tire and Rubber Co., Akron, OH USA (retired)

Several topics related to understanding tire behavior are covered which give a basic understanding of tire mechanics. The properties of the anisotropic cord rubber composite have primary control of the overall performance characteristics of pneumatic tires. To optimize a given tire performance, knowledge of the combined cord rubber composite material properties is necessary and will be covered in this part of the course. Finally, we will examine results of rolling tire analyses and how these were obtained.

1. Analytical Techniques (Classical Methods)
 - A. Equilibrium tire design
 - B. Cord loads, belt loads, sidewall loads
 - C. Air diffusion calculation
 - D. Beads load, bead contact forces
 - E. Experimental Techniques
2. Composite Material Properties Calculation
3. Footprint Contact Behavior
4. Cord Loads for Traction, Cornering
5. Rolling Tire Modeling Approaches

4:00 p.m. – 5:30 p.m. Visit to the ITEC Exhibition

4:30 p.m. – 5:30 p.m. Complimentary Brews & Bite

Thursday, September 15, 2022

9:00 a.m. – 4:00 p.m. (Complimentary Lunch, 12:00 noon – 1:00 p.m.)

IMPACT OF RUBBER AND REINFORCEMENT PROPERTIES ON TIRE FOOTPRINT MECHANICS

Dr. Mahmoud Assaad, Computational Mechanics

The Goodyear Tire & Rubber Co.

Akron, OH. USA

The viscoelastic behavior of the rubber compounds and the reinforcing cords influences the stability of the tire footprint shape. Additional physical properties such as the strain dependency of both constituents and their thermal stability contribute to the contact pressure distribution. The resultant tire forces and moments transmitted to the vehicle are measured using tri-axial force pin transducers or pressure sensitive mats. The interaction between the materials behavior and the tire global response controls the mechanics of tire abrasibility and wear characteristics.

The following topics will be discussed:

1. Rubber viscoelasticity, Static, Dynamic, and Fracture Properties
2. Fibers and Cords: load-displacement, creep, stress relaxation, and shrinkage
3. Footprint Mechanics and Tire Forces and Moments

Friday, September 16, 2022

8:00 a.m. - 3:00 p.m. (Complimentary Lunch, 12:00 noon - 1:00 p.m.)

VIRTUAL TIRE MODELING for IMPROVED PERFORMANCE

Dr. Ronald Kennedy, Center for Tire Research (CenTire) (retired),
The University of Akron and Virginia Tech.
Blacksburg, Va. USA
Associate Editor of Tire Science and Technology Journal

Simulations are increasingly being used in companies' virtual design processes to develop a tire more effectively and efficiently with desired performance attributes. These simulation methods run the gamut from simple empirical or analytical models to highly detailed finite element models. These increasing levels of modeling will be described along with examples, with extended focus on the finite element modeling method. Various finite element modeling techniques will be shown as part of the tire performance simulation examples.

1. Review of tire modeling methods, with examples
2. Introduction to tire finite element analysis (FEA)
3. Application of FEA to tire performance prediction
 - a. Tire/road contact
 - b. Rolling resistance
 - c. Tread wear
 - d. Durability
 - e. Hydroplaning



3:00 p.m. - 3:30 p.m.

COURSE EVALUATIONS AND DISTRIBUTION OF COURSE CERTIFICATES

Dr. Benjamin T.F. Chung, Department of Mechanical Engineering, The University of Akron, Akron, OH USA

FOR COURSE INFORMATION

Dr. Benjamin T. F. Chung
Department of Mechanical Engineering
The University of Akron
Akron, OH 44325-3903 USA
Tel: 330-972-7739
bchung@uakron.edu

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rnevents@crain.com



Biographical Notes

Dr. Mahmoud C. Assaad

In 1983, Dr. Assaad earned his Ph.D. degree in Engineering Science and Mechanics as major and Applied Mathematics as minor from Iowa State University, Ames, Iowa. In 1979, he received a M.S. degree in Structural Engineering from the same university. In 1990, he received a M.S. degree in Polymer Science from The University of Akron (Akron, Ohio). In 1983, he joined The Goodyear Tire & Rubber Company. His current research interests include development of Multi-physics simulation of tire performance including structural, thermal and oxidative response. He is a lecturer at the Goodyear Institute of Technology. He was an Adjunct Assistant Professor in the Civil Engineering Department at The University of Akron and was also a lecturer at The University of Toledo. He Co-authored the composite segment of The Pneumatic Tire e-book, taught short courses on Plastics and Elastomers in Engineering Design in Italy, Luxembourg, and Germany. He was an invited speaker to the Gordon Conference on Fibers Science and to the 2009 "The Annual Workshops Materials' Days at the University of Rostock", Germany. Dr. Assaad was a recipient of the special Achievement Award from NASA for his meritorious accomplishments, dedicated work, and special efforts. He was the Winner of the "2008 Create the Future Design Contest" in the machinery/equipment category and served as a technical chairman for the 26th Anniversary of The Tire Society Conference. Dr. Assaad holds over 60 U.S., European patents and trade secrets.

Dr. Benjamin T.F. Chung

Dr. Benjamin T.F. Chung earned his Ph.D. degree in Mechanical Engineering at Kansas State University. He joined The University of Akron as an Assistant Professor in 1969, served as Chair of Mechanical Engineering Department from 1984 to 1999 and was awarded the endowed Chair of the F. Theodore Harrington Professor of Mechanical Engineering in 1993. He has chaired the Tire Mechanics symposium or short course in the past 30 years. Dr. Chung is a five-time recipient of the Outstanding Achievement Award from the Board of Trustees, a recipient of the Louis Hill Award from the College of Engineering, and the Outstanding Research Awards from both the College of Engineering and the University Alumni Association. His honors outside the campus include the Norbert Wiener Award from MCB University Press in London, Life Fellow from the American Society of Mechanical Engineers, Outstanding Alumni Award from the National Cheng Kung University, Taiwan, Outstanding Reviewer for the Journal of Heat Transfer, Contribution and Board Space Act Award from NASA Glenn Research Center, and more recently, Lifetime Achievement Award from Tire Technology International. Being an author and co-author of two book chapters, and 190 technical papers, Dr. Chung has directed 32 M.S. theses, 18 Ph.D. dissertations, and three post-doctoral fellows. He served as Associate Editor of the *ASME Journal of Heat Transfer* and Editorial Advisory Board member for John Wiley & Sons Inc. Currently, he is F. Theodore Harrington Professor Emeritus, an Editorial



Board Member of *The Open Thermodynamics Journal*, *The International Journal of Applied Engineering Research*, and *The Open Conference Proceedings Journal*.

Dr. Ronald Kennedy

Dr. Ron Kennedy served as the Managing Director of the Center for Tire Research (CenTiRe), an industry/university consortium involving Virginia Tech, The University of Akron, and tire and tire-related companies. Before joining CenTiRe, he worked for 37 years in the tire industry at Firestone, Bridgestone/Firestone, and Hankook Tire performing tire finite element methods development and software programming, simulation systems development, advanced tire design, and tire factory uniformity studies. His work has covered the range of tire performance areas, manufacturing, and design. Dr. Kennedy is currently an Associate Editor of the *Journal of Tire Science and Technology*. He has numerous technical publications and presentations and has been awarded the Arch T. Colwell Merit Award from SAE, the Tire Society Superior Paper Award and an Honorable Mention Award, the CEO Award and President's Award from Bridgestone/Firestone. Dr. Kennedy was the Plenary Speaker at the 2017 Tire Society Conference and gave the Keynote Address at the 2018 ACS Rubber Division Meeting. Ronald Kennedy received his BS and MS degrees in Engineering Mechanics from the University of Wisconsin, and his Ph.D. in Mechanical Engineering from The University of Akron.

Dr. Annette Lechtenböhmer

Dr. Annette Lechtenböhmer, a citizen of Germany, finished her studies of chemistry at Westfälische Wilhelms-Universität Münster, Germany, with a Ph.D. in Physical Chemistry in 1981. After two post doctorates, she was employed at the Goodyear Innovation Center in Luxemburg, she filled positions within compounding and compound testing. She achieved the title of Senior Research Associate of Material Science. During her 35 years of experience in the rubber industry, she has accumulated profound knowledge of compound development, compound testing and test principles, viscoelasticity, compound processing, testing for material modelling and structure of tires, quality control and production. Her positions required close cooperation with other steps of tire development, production, tire design, construction, raw material suppliers, and scientific institutes and universities.

In addition to her industry experience, she taught at Universität Hannover on "Tire Technology" for many years and lectured on "Elastomer Technology" at Luxemburg University. She holds several Patents and Trade Secrets. She is a member of Tire Society, German Chemical Society and German Rubber Society. She retired from Goodyear in 2020 but maintains her dedication to promote rubber and tire science. She continues teaching and serving as an Associate-editor of the *Tire Science and Technology Journal*. In June 2020, she will be presented an award from the German Rubber Society at the International Rubber Conference for her special performances in research, technology, and economy.



Dr. Joseph Padovan

Dr. Joseph Padovan has developed his career as a balance of industrial, consultative, research and educational/teaching experiences. He earned a Ph.D. in Mechanical Engineering at the Polytechnic Institute of New York University. His direct industrial activities were with Curtiss Wright Corp - Aircraft Engine Division, United Technologies - Pratt & Whitney Aircraft Engines Division, and most recently at Goodyear Tire & Rubber Company as a Corporate RD&E Fellow. At Goodyear, he headed the Tire Physics/Mechanics group, one of whose special emphasis areas included tire dynamic performance, product fatigue life assessment, thermomechanochemistry of elastomeric composites materials, wear and traction, sensor development, new experimental methods, noise, hydroplaning and advanced FEA modeling. Consulting activities have been for a variety of industries and government agencies, i.e. Automotive, Aerospace, Biomedical (joints, heart pumps, wiring leads, and Orthotic devices), Chemical-Material, Steel / Bearings, Tire and Rubber/Plastics, as well as NASA (Glenn, Langley), The Air Force, The Army and Navy. From these sources, a multitude of Federal (NSF, NASA, and Military), State (ODOT, EPIC) and industrially funded research projects have been undertaken. His teaching activities were at The University of Akron where he was a Distinguished Professor of Mechanical & Polymer Engineering. Additionally, Joe gives numerous short courses (Tire Mechanics, FEA, Wear and Fatigue, Elastomeric Materials) on site, at conferences or through University Extension services, i.e. UA and The University of Wisconsin. Overall, his work has led to 220+ refereed journal publications, 210+ conference presentations, several patents and 50+ Ph.D. and 50+ MS Advisees. Recently he received a 2014 Tire Technology International Lifetime Achievement Award.

Dr. Gerald Potts

Dr. Gerald Potts obtained his Ph.D. degree in Mechanical Engineering from Kansas State University. Upon graduation in 1970, he joined the Firestone Tire and Rubber Co. as a Research Scientist and Group Leader of the Dynamics Research Laboratory. In 1978, he became the Manager of Tire/Wheel Testing Systems at MTS Systems Corporation where he led the initial development of the Flat-Trace â tire test machine. Two years later, he was employed by the General Motors Institute as an Associate Professor of Mechanical Engineering teaching Vehicle Dynamics and Mechanical Vibrations. In the meantime, he established his own company, G.R. Potts Associates, Inc. From 1984 to 1991, then becoming President of TMSI specializing in tire high speed uniformity test systems, tire rolling resistance testers, On LEVEL tire test systems and vehicle crash testing. In 2013, he sold TMSI to MESNAC Americas, LLC, and remains as President of TMSI LLC. Dr. Potts has traveled and lectured to engineering groups, world-wide, having delivered a Plenary Lecture at the 2006 Indian Rubber Institute Conference in Cochin, India. He holds ten patents, has been an Adjunct Professor of Mechanical Engineering at The University of



Akron since 1974, and was awarded a Lifetime Achievement Award by Tire Technology International at the 2014 Conference and Exhibition in Cologne, Germany.

Dr. Michael Trinko

Dr. Michael Trinko holds his Ph.D. degree in Engineering Mechanics from the University of Wisconsin. He has devoted three decades (1972-2003) of his career to tire analysis and tire development for the Technical Center of the Goodyear Tire & Rubber Co. where he served as a Research and Development Associate. While at Goodyear, he initiated, developed and led Technical Leadership Courses for the technical staff. Dr. Trinko holds two patents relating to tire technology and has authored a section of "The Pneumatic Tire" published by NHSTA. He has presented numerous papers, all related to tire mechanics, in government sectors, at universities and professional societies. He served as the Chairman of the Industrial Advisory Committee of the NASA Tire Modeling Program, Session Chair for SAE meetings and Program Chair for the Tire Society Conference, Treasurer for The Tire Society, and Associate Editor of the *Journal of Tire Science and Technology*. Dr. Trinko was recognized with the Lifetime Achievement Award at the 2014 International Tire Technology Conference.

Dr. Joseph D. Walter

Dr. Joseph D. Walter is presently a member of the faculty of The University of Akron where he teaches graduate and undergraduate courses in both the Mechanical and Civil Engineering departments. Prior to joining academia, Dr. Walter was the Managing Director of Bridgestone's Technical Center Europe in Rome, Italy, and served on the Board of Directors of Bridgestone Europe. He has served as a Mechanical Engineering evaluator for the Accreditation Board for Engineering and Technology, (ABET), and has also served on several committees of the National Academy of Sciences addressing fuel efficient cars (1992) and energy efficient tires (2005). Dr. Walter received his Ph.D. degree from Virginia Tech and an M.B.A. from The University of Akron. He is a member of several professional organizations, including the Society of Automotive Engineers and the Rubber Division of the American Chemical Society.

Previous Comments

“This was a high value professional course taught by an experienced faculty; an absolutely essential course for those who want to excel in the tire industry.”

– Prakash Chandra Sohara, Hasetri India

“The University of Akron Tire Mechanics Symposium is very informative and provides an idea where the tire technology is heading today. It is very useful in day-to-day work.”

– Haran Periyathamby, The Goodyear Tire & Rubber Company

“This symposium is equally valuable to the expert and to the novice; the expert can interpret his micro expertise into the macro world of tires, while the novice can get a kick-start in developing his own expertise.”

– J. K. Valaitis, Valaitis Consulting, Inc.

“An excellent course-well runs. Most people at Bentley Motors involved with tires have now completed the course”

– Dr. Andrew McKinlay, Bentley Motors Limited, England.

“Very good speakers and very nice presentation styles. It was great to have instructors with so much experience (adds a personal touch) who had seen so much change in Tire industry”

– Jannifer McIntyre, Ph.D. student, Dubbin Institute of Technology, Germany

“Great course and truly unique in the world”

– John Dick, Senior Scientist, Alpha Technologies, USA

“Good! I would like to study at the University of Akron”

– Marcin Bortlik, Field Engineers Manager, Bridgestone Sales Polska, Poland

“This course gave me a great and deep look into not only tire mechanics, but physics and chemistry also”

– Sergey Olshansky, Product Planning Manager, JSC Cordiant, Russia

“Many thanks for giving me good foundations about tires and a lot of information about the basic and practical aspects of the tire mechanics. They will be useful for my future tasks and job responsibility”

– Agus Mulyono, Tire Designer, Pt. Gajah Tunggal, Indonesia