

Ying-Kuan (Rick) Tsai

Assistant Professor of Mechanical Engineering

Ingram School of Engineering · Texas State University

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PROFESSIONAL APPOINTMENTS

Assistant Professor

Texas State University, Ingram School of Engineering

Design Integration and Systems Optimization Laboratory (DISO Lab)

Aug. 2026 – present

San Marcos, TX, USA

Postdoctoral Scholar

Northwestern University, Department of Mechanical Engineering

Integrated Design Automation Laboratory (IDEAL)

- Advisor: Prof. Wei Chen

Feb. 2024 – Jul. 2026

Evanston, IL, USA

EDUCATION

Ph.D. in Mechanical Engineering

Texas A&M University (TAMU)

- Dissertation: *Control Co-Design using Parametric Optimization* (advised by Dr. Richard Malak)
- Academy for Future Faculty Certificate, The Center for the Integration of Research, Teaching, and Learning (CIRTL)
- Received 2 Graduate Teaching Fellowships

Aug. 2019 – Dec. 2023

College Station, TX, USA

M.S. in Mechanical Engineering

National Taiwan University (NTU)

- Thesis: *Uncertainty Estimation and Performance Optimization for Vertical Articulated and Parallel Robot Manipulators* (advised by Dr. Kuei-Yuan Chan)
- Thesis Awards: (1) Honorable Mention Award by HIWIN Technologies Corp.; (2) Outstanding Master's Thesis by The Chinese Society of Mechanism and Machine Theory

Sep. 2016 – Jun. 2018

Taipei, Taiwan

B.S. in Mechanical Engineering

National Taiwan University of Science and Technology (NTUST)

- 1st Prize, Creo Parametric Expert Modeling Competition held by PTC Inc. (advised by Dr. Ching-An Lin)
- GPA: 3.77 / 4.0; Rank: 7th / 133 (top 5%)

Sep. 2012 – Jun. 2016

Taipei, Taiwan

HONORS & AWARDS

Poster Award, Multifunctional Materials and Structures Gordon Research Conference 2026	Feb. 2026
Recognized for an outstanding research poster selected by the conference committee.	
Paper of Distinction, ASME IDETC-CIE 2025	Aug. 2025
Top 10 papers selected from 101 accepted papers by the conference committee. See [C4] in Publications.	
Outstanding Paper Award, North American Manufacturing Research Conference (NAMRC)	Jun. 2025
Top 2 papers selected from 269 accepted papers by the conference committee. See [J8] in Publications.	
Charles W. Crawford Graduate Fellowship, Department of Mechanical Engineering, TAMU	Aug. 2023
Selected based on proven academic and research performance and demonstrated leadership. (USD \$3,000)	
Graduate Teaching Fellowship, College of Engineering, TAMU	Aug. 2023
Awarded to Ph.D. candidates in recognition of excellence in teaching and academic performance. (USD \$2,000)	
Graduate Student Travel Award, Department of Mechanical Engineering, TAMU	Mar. 2023
Graduate student award supporting travel to conferences and other professional meetings.	
Graduate Teaching Fellowship, Department of Mechanical Engineering, TAMU	Jan. 2023
Awarded to Ph.D. candidates in recognition of excellence in teaching and academic performance. (USD \$2,000)	
Student Living Scholarship, The Michaels Organization	Jan. 2022
Selected based on academic performance, character, and proficiency in a chosen field of study. (USD \$2,500)	
Dr. J. George H. Thompson Memorial Scholarship, Department of Mechanical Engineering, TAMU	Sep. 2021
Selected based on proven academic and research performance and demonstrated leadership. (USD \$2,000)	
Texas Public Education Grant, International Student & Scholar Services, TAMU	Sep. 2021
Awarded to international students at TAMU. (USD \$3,000)	
Graduate Summer Research Grant, Department of Mechanical Engineering, TAMU	May 2020
Only 15 outstanding graduate students in the department at TAMU are selected. (USD \$5,300)	
Honorable Mention Award, The 15th HIWIN Thesis Award, HIWIN Technologies Corp.	Jan. 2019
Honored with the excellent master's thesis in Taiwan. (USD \$3,200)	
Outstanding Master's Thesis, The Chinese Society of Mechanism and Machine Theory	Oct. 2018
Top 2 theses selected by the conference committee.	
Excellent Youth, College of Engineering, NTUST	Mar. 2016
Commended for excellent performance in the College of Engineering.	
Academic Excellence Award, Longshan Temple	Nov. 2015
1 recipient from the Department of Mechanical Engineering at NTUST.	
1st Prize, Creo Parametric Expert Modeling Competition, PTC Inc.	Jun. 2015
Selected from hundreds of participants from Taiwanese universities.	
Four Academic Excellence Awards, NTUST	Fall 2013 – Fall 2015
Top 10% of the department.	

PUBLICATIONS

Books

- [B1] Chen, W., Karkaria, V., Chen, Y.-P., & **Tsai, Y.-K.** (2027). *AI and Machine Learning for Digital Twins: Predictive Analytics and Systems Optimization*. (proposal accepted; under contract with Wiley)

Peer-Reviewed Journal Papers

- [J1] Lee, D. D., Wang, L., Chen, B., **Tsai, Y.-K.**, Sim, J., Zhao, R.R., Zhang, X. S., & Chen, W. (2026). Co-design of programmable material systems. *npj Metamaterials*, 2(1), 29.
- [J2] Chen, W., Karkaria, V., Chen, Y.-P., & **Tsai, Y.-K.** (2026). Physics-Based Predictive Control and Real-Time Decision-Making for Digital Twin-Enabled Autonomous Manufacturing. In *Roadmap on Artificial Intelligence and Machine Learning for Smart Manufacturing*, edited by Jay Lee. *Machine Learning: Engineering*.
- [J3] Chen, Y.-P., Suarez, D., **Tsai, Y.-K.**, Karkaria, V., Hu, G., Chen, Z., Guo, P., Cao, J., & Chen, W. (2026). Adaptive digital twin of sheet metal forming via proper orthogonal decomposition-based Koopman operator with model predictive control. *Journal of Manufacturing Systems*, 86, 762–773.
- [J4] **Tsai, Y.-K.**, Chen, Y.-P., Karkaria, V., & Chen, W. (2026). Reinforcement Learning-Based Control Co-Design of Digital Twin-Enabled Full-Vehicle Active Suspension Systems. *Structural and Multidisciplinary Optimization: Special Issue on Reduced Order Modeling, Generative AI, and SciML in Digital Twins*, 69(4), 108.
- [J5] **Tsai, Y.-K.**, Karkaria, V., Chen, Y.-P., & Chen, W. (2026). Digital Twin-Enabled Multi-Generation Control Co-Design with Deep Reinforcement Learning. *Journal of Mechanical Design*, 148(7), 071705.
- [J6] **Tsai, Y.-K.**, & Malak, R. J. (2026). Parametric Multi-Objective Optimization for Simultaneous and Nested Control Co-Design Formulations with Tube-Based Model Predictive Controllers. *Journal of Mechanical Design*, 148(11), 111701.
- [J7] Dewberry, N., AlHmoud, I., Benton, K., Suarez, D., Chen, Y.-P., Karkaria, V., **Tsai, Y.-K.**, Brock, M., Alazzawi, N., Chowdhury, S., Chen, W., Cao, J., & Gokaraju, B. (2025). A Real-Time VR-Enabled Digital Twin Framework for Multi-User Interaction in Industry 4.0. *Manufacturing Letters*, 44, 1486–1497.
- [J8] Chen, Y.-P., **Tsai, Y.-K.**, Karkaria, V., & Chen, W. (2025). Uncertainty-Aware Real-Time Decision-Making for Digital Twins: Multi-Step Robust Model Predictive Control using Time-Series Deep Quantile Learning. *Journal of Mechanical Design*, 148(2), 021702.
- [J9] Chen, Y.-P., Karkaria, V., **Tsai, Y.-K.**, Gao, R. X., & Chen, W. (2025). Real-Time Decision-Making for Digital Twin in Additive Manufacturing with Model Predictive Control using Time-Series Deep Neural Networks. *Journal of Manufacturing Systems*, 80, 412–424. (**Outstanding Paper, NAMRC53**)
- [J10] **Tsai, Y.-K.**, & Malak, R. J. (2025). Control Co-Design with Performance-Robustness Trade-Off using Tube-Based Stochastic Model Predictive Control. *ASME Letters in Dynamic Systems and Control: Special Issue on Control Co-Design*, 5(3), 031003.
- [J11] Karkaria, V., **Tsai, Y.-K.**, Chen, Y.-P., & Chen, W. (2024). An Optimization-Centric Review for Integrating Artificial Intelligence and Digital Twin Technologies in Manufacturing. *Engineering Optimization*, 57(1), 161–207.
- [J12] **Tsai, Y.-K.**, & Malak, R. J. (2024). Surrogate-Assisted Constraint-Handling Technique for Solving Constrained Multi-Objective Parametric Optimization. *Structural and Multidisciplinary Optimization*, 67(9), 167.
- [J13] **Tsai, Y.-K.**, & Malak, R. J. (2022). Design of Approximate Explicit Model Predictive Controller using Parametric Optimization. *Journal of Mechanical Design*, 144(12), 124501.

- [J14] Tsai, Y.-K., & Chan, K.-Y. (2019). Investigation on the Impact of Nongeometric Uncertainty in Dynamic Performance of Serial and Parallel Robot Manipulators. *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, 233(10), 3487–3511.
- [J15] Li, K.-L., Tsai, Y.-K., & Chan, K.-Y. (2018). Identifying Joint Clearance via Robot Manipulation. *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, 233(15), 2549–2574.

Peer-Reviewed Conference Papers (* Presenter, † Equal Contribution)

- [C1] Tsai, Y.-K.†, Fernandez, C. A.*†, Brahan, R. D., Deshpande, A. A., Smith, C. I., Pan, Y., & Chen, W. (2026). Adaptive Uncertainty-Aware Material-Process Co-Design for Sustainable In-Space Manufacturing of Recycled Composites. *International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (IDETC-CIE)*. Houston, TX, Aug. 23–26, 2026. (accepted)
- [C2] Karkaria, V.*, Lee, D., Chen, Y.-P., Tsai, Y.-K., Yu, Y., & Chen, W. (2026). Towards Intelligent Manufacturing: Spatio-Temporal Learning of Process–Material Dynamics with Attention-Driven Neural Operators. *The AI for Accelerated Materials Discovery (AI4Mat) Workshop at ICLR 2026*. (accepted)
- [C3] Karkaria, V., Tsai, Y.-K.*, Chen, Y.-P., Lee, D., Cao, J., & Chen, W. (2026). UNiCO-AM: Uncertainty-Aware Neural Co-Design for Additive Manufacturing via an Attention-Based Spatio-Temporal Neural Operator and Bayesian Optimization. *North American Manufacturing Research Conference (NAMRC) 54*. University Park, PA, Jun. 14–18, 2026. (accepted)
- [C4] Tsai, Y.-K.*, Karkaria, V., Chen, Y.-P., & Chen, W. (2025). Multi-Generational Control Co-Design for Digital Twin-Enabled Systems with Deep Reinforcement Learning. *IDETC-CIE*. Anaheim, CA, Aug. 17–20, 2025. (Paper of Distinction, 51st ASME Design Automation Conference)
- [C5] Chen, Y.-P.*, Tsai, Y.-K., Karkaria, V., & Chen, W. (2025). Real-Time Decision-Making Under Uncertainty in Digital Twins: Robust Model Predictive Control Using Time-Series Deep Quantile Learning. *IDETC-CIE*. Anaheim, CA, Aug. 17–20, 2025.
- [C6] Karkaria, V.*, Chen, Y.-P., Tsai, Y.-K., Erdogan, G., Radulescu, R., & Chen, W. (2025). AI-Driven Digital Twin Framework for Predictive Maintenance: Dynamic Decision Making and Adaptive Model Updates. *IDETC-CIE*. Anaheim, CA, Aug. 17–20, 2025.
- [C7] Tsai, Y.-K.*, & Malak, R. J. (2023). Control Co-Design with Approximate Explicit Optimal Controller. *IDETC-CIE*. Boston, MA, Aug. 20–23, 2023.
- [C8] Tsai, Y.-K.*, & Malak, R. J. (2023). Robust Control Co-Design using Tube-Based Model Predictive Control. *2023 American Control Conference (ACC)*, pp. 769–775. San Diego, CA, May 31 – Jun. 2, 2023.
- [C9] Tsai, Y.-K.*, & Malak, R. J. (2022). A Constraint-Handling Technique for Parametric Optimization and Control Co-Design. *IDETC-CIE*. St. Louis, MO, Aug. 14–17, 2022.
- [C10] Weaver-Rosen, J. M.*, Tsai, Y.-K., Schoppe, J., Terada, Y., Malak, R. J., Cizmas, P. G., & Lazzara, D. (2022). Surrogate Modeling and Parametric Optimization Strategy for Minimizing Sonic Boom in a Morphing Aircraft. In *AIAA Scitech 2022 Forum* (p. 0097). San Diego, CA, Jan. 3–7, 2022.
- [C11] Tsai, Y.-K.*, & Malak, R. J. (2021). A Methodology for Designing a Feedback Controller via Parametric Optimization: State-Parameterized Nonlinear Programming Control. *IDETC-CIE*. Virtual, Aug. 17–19, 2021.
- [C12] Tsai, Y.-K.*, & Chan, K.-Y. (2018). Parameter Identification and Performance Optimal Design for Vertical Articulated Robot Manipulators. *The 21st National Conference on Mechanism and Machine Design*, National Taiwan Ocean University, Keelung, Taiwan, Oct. 26–27, 2018.

Conference Presentations (* Presenter)

- [P1] Lee, D.*, Wang, L., Chen, B., **Tsai, Y.-K.**, Sim, J., Zhao, R. R., Zhang, X. S., & Chen, W. (2025). Co-Design of Programmable Material Systems: A Perspective. *Multifunctional Materials and Structures Gordon Research Conference*, Ventura, CA, USA, Jan. 25–30.
- [P2] **Tsai, Y.-K.***, Karkaria, V., Chen, Y.-P., & Chen, W. (2025). Digital Twin-Enabled Multi-Generation Control Co-Design with Deep Reinforcement Learning. *NSF Workshop on Artificial Intelligence in Engineering Design and Systems Engineering (AI-EDSE)*, Purdue University, West Lafayette, IN, USA, Oct. 16–17.
- [P3] Chen, Y.-P.*, Karkaria, V., **Tsai, Y.-K.**, Gao, R. X., & Chen, W. (2025). Real-Time Decision-Making for Digital Twin in Additive Manufacturing with Model Predictive Control using Time-Series Deep Neural Networks. *NAMRC53*, Greenville, SC, USA, Jun. 23–27.
- [P4] **Tsai, Y.-K.**, Wang, L., & Chen, W.* (2025). Control Co-Design of Geometrically Nonlinear Piezoelectric Actuators using Topology Optimization. *16th World Congress on Structural and Multidisciplinary Optimization (WCSMO-16)*, Kobe, Japan, May 18–23.
- [P5] Chen, Y.-P., **Tsai, Y.-K.***, Karkaria, V., & Chen, W. (2024). Multi-Step Robust Model Predictive Control with Time-Series Learning and Quantile Regression. *IDETC-CIE*, Washington, DC, Aug. 25–28.
- [P6] **Tsai, Y.-K.***, & Malak, R. J. (2022). Parametric Optimization for Control Design of Adaptive Aeroelastic Structures. *Society of Engineering Science (SES) Annual Technical Meeting*, College Station, TX, Oct. 16–19.

INVITED TALKS

- “Academic and Scientific Writing with AI,” Lab Meeting, IDEAL, Northwestern University, May 19, 2026.
- “AI-Enabled Digital Twins as Adaptive Co-Design Engines for Autonomous Systems,” Seminar, Department of Mechanical and Aerospace Engineering, North Carolina State University, February 26, 2026.
- “Empowering Autonomous Systems: Co-Design for Digital Twins with Uncertainty-Aware Optimization,” Seminar, Department of Mechanical and Industrial Engineering, University of Massachusetts Amherst, February 27, 2026
- “Multidisciplinary Design Optimization in Engineering Applications,” Academic Presentation Review, Taiwanese Student Association at TAMU, Virtual, May 9, 2020.

FUNDED RESEARCH PROJECTS

Northwestern University – NSF Division of Engineering Education and Centers **Feb. 2024 – Jul. 2026**

Project: Hybrid Autonomous Manufacturing: Moving from Evolution to Revolution (NSF ERC Award, \$26,000,000)

Developing new manufacturing technologies and intelligent autonomous manufacturing systems to allow rapid customization and high assured performance.

UIC – NASA Minority University Research and Education Project Institutional Research Opportunity (MIRO)

Oct. 2024 – Jul. 2026

Project: Center for In-Space Manufacturing: Recycling and Regolith Processing (NASA MSFC Award, \$4,650,000)

Developing recycling and regolith-based materials and in-space additive/hybrid manufacturing, using AI-guided co-design and data-driven optimization for sustainable, on-demand production in deep-space missions.

Northwestern University – NSF Division of Civil, Mechanical and Manufacturing Innovation Collaboration

Feb. 2024 – Jan. 2025

Project: AI-Enabled Discovery and Design of Programmable Material Systems (NSF BRITE Award, \$999,809)

Developing methods to design the materials, architectures, and stimuli of programmable material systems simultaneously and predictably.

Texas A&M University – NASA University Leadership Initiative

Jul. 2021 – Jan. 2023

Project: Adaptive Aerostructures for Revolutionary Civil Supersonic Transportation (NASA ARMD Award, \$9,972,212)

Developed computational methods and hardware for small real-time geometric outer mold line reconfigurations to minimize sonic boom signatures and aircraft drag in response to changing ambient conditions.

National Taiwan University – Ministry of Science and Technology (MOST)

Sep. – Dec. 2016

Project: Uncertainty Identification and Accuracy Validation of Robot Manipulators

Developed computational methods for identifying uncertainty, calibration, and optimization of industrial robots with hardware integration.

TEACHING INTERESTS

- **Design:** design optimization, design under uncertainty, design of experiments, computer-aided design/manufacturing (CAD/CAM), design for manufacturing, senior design
- **Dynamics and Control:** system dynamics, control systems, optimal control, reinforcement learning
- **Probability and Data Analytics:** engineering probability and statistics, stochastic processes, decision analysis
- **Computation:** computer programming using MATLAB/Python, computer-aided engineering (CAE), numerical methods for engineers, applied ML/AI

TEACHING EXPERIENCE

ME 4531: Control Systems <i>Main Instructor · Ingram School of Engineering, Texas State University</i>	Aug. 2026 – present <i>San Marcos, TX, USA</i>
CS 338: The Practicum in Intelligent Systems <i>Project Mentor · Department of Computer Science, Northwestern University</i>	Sep. – Dec. 2025 <i>Evanston, IL, USA</i>
ME 341: Computational Methods for Engineering Design <i>Instructional Assistant · Department of Mechanical Engineering, Northwestern University</i>	Jan. – Mar. 2025 <i>Evanston, IL, USA</i>
Gaussian Processes and Bayesian Optimization <i>Postdoctoral Lecturer · IDEAL, Northwestern University</i>	Oct. – Dec. 2024 <i>Evanston, IL, USA</i>
MEEN 357: Engineering Analysis for Mechanical Engineers <i>Graduate Instructor · Department of Mechanical Engineering, Texas A&M University</i>	Aug. – Dec. 2023 <i>College Station, TX, USA</i>
MEEN 357: Engineering Analysis for Mechanical Engineers <i>Graduate Instructor · Department of Mechanical Engineering, Texas A&M University</i>	Jan. – May 2023 <i>College Station, TX, USA</i>
MEEN 357: Engineering Analysis for Mechanical Engineers <i>Graduate Teaching Assistant · Texas A&M University</i>	Jan. – May 2020 <i>College Station, TX, USA</i>
South-Pointing Chariot Workshop <i>Graduate Teaching Assistant · Stanley Wang D-School, National Taiwan University</i>	Nov. 2018 <i>Taipei, Taiwan</i>
Participatory Design <i>Graduate Teaching Assistant · Stanley Wang D-School, National Taiwan University</i>	Sep. 2017 – Feb. 2018 <i>Taipei, Taiwan</i>
Innovative Vehicle Design <i>Graduate Teaching Assistant · Stanley Wang D-School, National Taiwan University</i>	Sep. 2016 – Feb. 2017 <i>Taipei, Taiwan</i>

MENTORSHIP EXPERIENCE

Md Muhtasim Fuad — <i>Ph.D., Mechanical Engineering, Texas State University</i>	2030
Tanvir Ahmed — <i>Ph.D., Mechanical Engineering, Texas State University</i>	2030
Christian Fernandez Soria — <i>Ph.D., Mechanical Engineering, Northwestern University</i>	2030
Seul Lee — <i>Ph.D., Mechanical Engineering, Northwestern University</i>	2029
Yi-Ping Chen — <i>Ph.D., Mechanical Engineering, Northwestern University</i>	2026
Vispi Karkaria — <i>Ph.D., Mechanical Engineering, Northwestern University</i>	2026
Ryan Daniel Brahan — <i>Undergraduate, Mechanical Engineering, Northwestern University</i>	2026
Christopher Luey — <i>Undergraduate, Mechanical Engineering, Northwestern University</i>	2025
Prarthana Chakrabarti — <i>M.S., Mechanical Engineering, Northwestern University</i>	2024
Pradeep Bharathi — <i>M.S., Mechanical Engineering, Texas A&M University</i>	2024
Yutaka Terada — <i>Undergraduate, Mechanical Engineering, Texas A&M University</i>	2022
Po-Yu Chen — <i>M.S., Mechanical Engineering, National Taiwan University</i>	2019

PROFESSIONAL SERVICE

Journal & Conference Reviewer

- IEEE International Conference on Robotics and Automation (ICRA)
- IEEE Transactions on Automatic Control
- American Control Conference (ACC)
- Control Engineering Practice
- IEEE Transactions on Control Systems Technology
- ASME Letters in Dynamic Systems and Control
- An International Journal of Optimization and Control: Theories & Applications
- Engineering Applications of Artificial Intelligence
- Structural and Multidisciplinary Optimization
- Artificial Intelligence for Engineering Design, Analysis and Manufacturing
- Applied Soft Computing
- ASME Journal of Mechanical Design
- ASME Journal of Computing and Information Science in Engineering
- ASME International Design Engineering Technical Conferences (IDETC)
- Journal of Manufacturing Processes

Membership: American Society of Mechanical Engineers (ASME)

RELATED SKILLS

- **Technical Skills:** dynamic modeling, optimization, model predictive control, dynamic programming, reinforcement learning, Koopman operator, time-series analysis, Bayesian statistics, supervised and unsupervised machine learning, deep learning, uncertainty quantification
- **Programming Languages:** MATLAB (expert), Python (expert), C/C++ (proficient), R (proficient)
- **Professional Software:** AutoCAD, PTC Creo, SolidWorks, ANSYS, Abaqus, XFOIL, MSC Adams, MS Excel
- **Other:** Mathematica, LaTeX

COMMUNITY SERVICE, LEADERSHIP & DEVELOPMENT

Mentor, Northwestern University Research Program for High Schoolers (NURPH)	Jun. – Aug. 2025
– Student: Oprah Momoh (junior-level), Chicago Math and Science Academy (CMSA). – Topic: Design Exploration and Optimization for Pipes.	
Grad Camp Counselor, Graduate & Professional Student Government at TAMU	Jul. – Aug. 2021
Mentor, Designing Your Life Workshop, D-School@NTU × d.life@Stanford	Jul. – Aug. 2018
Team Leader, Hackathon, HackNTU	Aug. 2016