Ying-Kuan (Rick) Tsai

Assistant Professor of Mechanical Engineering

Ingram School of Engineering · Texas State University

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PROFESSIONAL APPOINTMENTS

Assistant Professor **Aug. 2026 – present**

Texas State University, Ingram School of Engineering *San Marcos, TX, USA*

Design Integration and Systems Optimization Laboratory (DISO Lab)

Postdoctoral Scholar **Feb. 2024 – Jul. 2026**

Northwestern University, Department of Mechanical Engineering *Evanston, IL, USA*

Integrated Design Automation Laboratory (IDEAL)

- Advisor: Prof. Wei Chen
- Direction: Building and optimizing uncertainty-aware AI-driven digital twins that leverage control co-design and learning-based control for autonomous manufacturing and dynamical systems.

EDUCATION

Ph.D. in Mechanical Engineering **Aug. 2019 – Dec. 2023**

Texas A&M University (TAMU) *College Station, TX, USA*

- Dissertation: *Control Co-Design using Parametric Optimization* (advised by Prof. Richard Malak)
- Academy for Future Faculty Certificate, The Center for the Integration of Research, Teaching, and Learning (CIRTL)
- Received 2 Graduate Teaching Fellowships
- GPA: 4.0 / 4.0

M.S. in Mechanical Engineering **Sep. 2016 – Jun. 2018**

National Taiwan University (NTU) *Taipei, Taiwan*

- Thesis: *Uncertainty Estimation and Performance Optimization for Vertical Articulated and Parallel Robot Manipulators* (advised by Prof. 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
- GPA: 3.93 / 4.3

B.S. in Mechanical Engineering **Sep. 2012 – Jun. 2016**

National Taiwan University of Science and Technology (NTUST) *Taipei, Taiwan*

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

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] 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.*

[J2] Chen, Y.-P., Suarez, D., **Tsai, Y.-K.**, Karkaria, V., Hu, G., Chen, Z., Guo, P., Cao, J., & Chen, W. (2026). Digital Twin-Enabled Sheet Metal Forming through Robotic English Wheel via Proper Orthogonal Decomposition-Based Deep Koopman Operator. *Journal of Manufacturing Systems*, 86, 762–773.

[J3] **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.

[J4] **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.* (accepted)

[J5] **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.

[J6] 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.

[J7] 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.

[J8] 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)**

[J9] **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.

[J10] 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.

[J11] **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.

[J12] **Tsai, Y.-K.**, & Malak, R. J. (2022). Design of Approximate Explicit Model Predictive Controller using Parametric Optimization. *Journal of Mechanical Design*, 144(12), 124501.

[J13] **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.

[J14] 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 **Aug. 2026 – present**
Main Instructor · Ingram School of Engineering, Texas State University *San Marcos, TX, USA*

CS 338: The Practicum in Intelligent Systems **Sep. – Dec. 2025**
Project Mentor · Department of Computer Science, Northwestern University *Evanston, IL, USA*

ME 341: Computational Methods for Engineering Design **Jan. – Mar. 2025**
Instructional Assistant · Department of Mechanical Engineering, Northwestern University *Evanston, IL, USA*

Gaussian Processes and Bayesian Optimization **Oct. – Dec. 2024**
Postdoctoral Lecturer · IDEAL, Northwestern University *Evanston, IL, USA*

MEEN 357: Engineering Analysis for Mechanical Engineers **Aug. – Dec. 2023**
Graduate Instructor · Department of Mechanical Engineering, Texas A&M University *College Station, TX, USA*

MEEN 357: Engineering Analysis for Mechanical Engineers **Jan. – May 2023**
Graduate Instructor · Department of Mechanical Engineering, Texas A&M University *College Station, TX, USA*

MEEN 357: Engineering Analysis for Mechanical Engineers **Jan. – May 2020**
Graduate Teaching Assistant · Texas A&M University *College Station, TX, USA*

South-Pointing Chariot Workshop **Nov. 2018**
Graduate Teaching Assistant · Stanley Wang D-School, National Taiwan University *Taipei, Taiwan*

Participatory Design **Sep. 2017 – Feb. 2018**
Graduate Teaching Assistant · Stanley Wang D-School, National Taiwan University *Taipei, Taiwan*

Innovative Vehicle Design **Sep. 2016 – Feb. 2017**
Graduate Teaching Assistant · Stanley Wang D-School, National Taiwan University *Taipei, Taiwan*

MENTORSHIP EXPERIENCE

Tanvir Ahmed — *Ph.D., Mechanical Engineering, Texas State University* **2030**

Christian Fernandez Soria — *Ph.D., Mechanical Engineering, Northwestern University* **2030**

Seul Lee — *Ph.D., Mechanical Engineering, Northwestern University* **2029**

Yi-Ping Chen — *Ph.D., Mechanical Engineering, Northwestern University* **2026**

Vispi Karkaria — *Ph.D., Mechanical Engineering, Northwestern University* **2026**

Ryan Daniel Brahan — *Undergraduate, Mechanical Engineering, Northwestern University* **2026**

Christopher Luey — *Undergraduate, Mechanical Engineering, Northwestern University* **2025**

Prarthana Chakrabarti — *M.S., Mechanical Engineering, Northwestern University* **2024**

Pradeep Bharathi — *M.S., Mechanical Engineering, Texas A&M University* **2024**

Yutaka Terada — *Undergraduate, Mechanical Engineering, Texas A&M University* **2022**

Po-Yu Chen — *M.S., Mechanical Engineering, National Taiwan University* **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**