


# Mohamed A. Mabrok, Ph.D.

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## Summary

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■ I am an associate professor of applied mathematics with the department of mathematics, statistics and physics, college of arts and sciences, Qatar University. I am also a multidisciplinary teacher and researcher with strong experience in the fields of applied mathematics, physics, dynamical systems, and game theoretic learning. I have strong technical knowledge of robotics, artificial intelligence, and machine learning techniques.

The following list summarizes my research interests:

- Mathematical modeling of dynamical systems.
- Robotics and intelligent systems.
- Human-in-the-loop and man-machine control systems.
- Game theory and evolutionary dynamics.
- Quantum control.

## Employment History

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- 2022 – Present     ■ **Associate Professor:** Department of Mathematics, Statistics and Physics, College of Arts and Sciences, Qatar University.
- 2021 – 2021     ■ **Associate Professor:** Department of Mathematics and Physics, Faculty of Engineering, Australian University, Kuwait.
- 2017 – 2021     ■ **Assistant Professor:** Department of Mathematics and Physics, Faculty of Engineering, Australian University, Kuwait.
- 2015 – 2017     ■ **Research Associate:** Robotics, Intelligent Systems and Control Lab at the King Abdullah University of Science and Technology (KAUST).
- 2013 – 2015     ■ **Research Associate:** Capability Systems Centre, University of New South Wales Canberra, Australia.
- 2004 – 2010     ■ **Lecturer:** Mathematics Department, Suez Canal University, Egypt.

## Education

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- 2010 – 2013     ■ **Ph.D., University of New South Wales, Australia.** In Applied Mathematics (Dynamical Systems and Control).  
Thesis title: *New Results on Negative Imaginary Systems Theory with Application to Flexible Structures and Nano-Positioning.*  
Advisor: *Professor Ian Petersen.*
- 2006 – 2009     ■ **M.Sc. Suez Canal University, Egypt and Queensland University, Australia.** In Applied Mathematics.  
Thesis title: *Studying the quantum properties for a system of atoms interacting with some field.*

## Education (continued)

- 1999 – 2004    **B.Sc. Suez Canal University, Egypt.** In Applied Mathematics.  
Graduation project : *Studying the quantum properties for a system of atoms interacting with some field.*

## Grants

- 2020    **Comprehensive Modeling and Prototyping of the Kuwaiti Water Distribution System**  
PI, 2020-2021 Value 50K USD, Funded by Kuwait Foundation for the Advancement of Science.
- 2019    **Structural retrofitting with post-tensioned cables using actively controlled mechanical devices.**    Co-PI, 2019-2020 Value 5K USD. Funded by the Australian University of Kuwait.

## Graduate Students

- Graduated    **Ahmed Gallab** PhD Co-supervisor with Professor Ian Petersen with UNSW, Canberra Australia .
- Graduated    **Mohamed Zahana.** Informal PhD Co-supervisor with Professor Jeff Shamma with KAUST, Saudi Arabia.
- Graduated    **Nour Eldeen.** Informal Masters Co-supervisor with Professor Jeff Shamma with KAUST, Saudi Arabia.

## Teaching Experience and Evaluation

### Teaching Experience

- I had the privilege to teach and work closely with both graduate and undergraduate students at an early stage of my academic career, as an instructor, senior instructor, and lecturer in the fields of mathematics, physics, and engineering.  
I have experienced in teaching different mathematics courses including:

- Applied Mathematics I & II.
- Engineering Mathematics I & II.
- Calculus I, II, & III .
- Real Analysis.
- Advanced Mathematical Methods.
- Differential equations I & II.
- Partial Differential Equation.
- Linear algebra.
- Advanced Linear Algebra.
- Matlab programming.
- Numerical analysis.
- Physics I.
- Analytical geometry.

### Students Evaluation

- Recipient of the 2021/2022 teaching excellence award from the Australian University.
- The following table summarizes the overall score of the students evaluation with is conducted each semester by the university:




Semester-year	Fall 2020	Spring 2019	Summer 2019	Fall 2019	Spring 2018
Out of 5	4.5/5	4.8/5	4.6/5	4.5/5	4.7/5

## Miscellaneous Experience

### Awards and Achievements



- 2022  **Teaching excellence award:** Recipient of the 2021/2022 teaching excellence award from the Australian University
- 2021  **Digital Transformation Hackathon** Two groups of ACK students that I was supervising achieved the first and second places in the 2021 "Digital Transformation Hackathon" competition organized by the Ministry of Oil, Kuwait.
- 2019  **The award of best graduation project** Co-supervising a group of students in graduation project.
- 2018  **The award of best graduation project** Co-supervising a group of students in graduation project.
- 2017  **Mohamed Bin Zayed International Robotics Challenge (MBZIRC)** Second runner-up position and bronze medal in Challenge-II.
- 2013  **Research Publication Fellowship** School of Engineering and Information Technology, UNSW Canberra, Australia.
- 2012  **PRSS Scholarship** School of Engineering and Information Technology, UNSW Canberra, Australia.
- 2010  **Full Ph.D. scholarship** School of Engineering and Information Technology, UNSW Canberra, Australia.
- 2008  **Partnership and Ownership Initiative** Ministry of Higher Education, Egypt. Visiting University of Queensland, Brisbane Australia.
- 1999–2004  **Outstanding Student Award** Suez Canal University for four years continuously in my undergraduate studies.

### Visiting Scholar


- 2015  **Robotics, Intelligent Systems and Control Lab** King Abdullah University of Science and Technology (KAUST), Jeddah Saudi Arabia.
- 2012  **Los Alamos National Laboratory**, Los Alamos, New Mexico, USA.
- 2008  **Theoretical Physics Group, School of Physics**, University of Queensland, Brisbane, Australia.

## Research Publications

### Books and Chapters

- 1 Abdelkader, M., Fiaz, U. A., Toumi, N., **Mabrok, M. A.**, & Shamma, J. S. (2021). *Chapter 14 - rescuer: A reliable multi-uav search and rescue testbed* (A. Koubaa & A. T. Azar, Eds.).  
 doi:<https://doi.org/10.1016/B978-0-12-820276-0.00021-2>
- 2 Zahran, A. M. M., slam Hussain, **Mabrok, M. A.** et al. (2018). *Guide for scientific research and study abroad (in arabic)* (M. gamal, H. Henawy, E. Fadaly, K. Alasmorny et al., Eds.). EgyptScholars Inc. Retrieved from  <https://egyptscholars.org/study-abroad-guide/?fbclid=IwAR0FpTAi5i0eDlPalKhXHYsLsLZxMscnPNDaA-xwxb-PSX7xVGBQmbPKWwg>

### Journal papers

- 1 **Mabrok, M. A.** (2021). Controller synthesis for negative imaginary systems using nonlinear optimisation and  $H_\infty$  performance measure. *International Journal of Control*, 94(3), 579–587. Retrieved from  <https://doi.org/10.1080/00207179.2019.1601773>

- 2 **Mabrok, M. A.**, Alyami, M. A., & Mahmoud, E. E. (2021). On the dissipativity property of negative imaginary systems. *Alexandria Engineering Journal*, 60(1), 1403–1410. Retrieved from <https://doi.org/10.1016/j.aej.2020.10.060>
- 3 Saad, A. S., & **Mabrok, M. A.** (2021). Retrofitting of bridge superstructures using negative imaginary control theory. *International Journal of Control*, 1–16. Retrieved from <https://doi.org/10.1080/00207179.2021.1889032>
- 4 Tran, V. P., **Mabrok, M. A.**, Anavatti, S. G., Garratt, M. A., & R.Petersen, I. (2021a). Hybrid negative imaginary-adaptive neural-fuzzy control with model identification for a quad-rotor. *IFAC Journal of Systems and Control*. Retrieved from <https://doi.org/10.1016/j.ifacsc.2021.100156>
- 5 **Mabrok, M. A.** (2020). Passivity analysis of replicator dynamics and its variations. *IEEE Transactions on Automatic Control*. Retrieved from <https://doi.org/10.1109/TAC.2020.3027644>
- 6 **Mabrok, M. A.**, Mohamed, H. K., Abdel-Aty, A.-H., & Alzahrani, A. S. (2020). Human models in human-in-the-loop control systems. *Journal of Intelligent & Fuzzy Systems*, 38(3), 2611–2622. Retrieved from <https://content.iospress.com/articles/journal-of-intelligent-and-fuzzy-systems/ifs179548>
- 7 Güler, S., Algarni, M. A., Shaqura, M. Z., Jaleel, H., **Mabrok, M. A.**, Jiang, J., ... Shamma, J. S. (2019). Perception, navigation, and manipulation in the team kaust approach to the mbzirc ground robotics challenge. *Journal of Field Robotics*, 36(5), 973–1003. Retrieved from <https://doi.org/10.1002/rob.21865>
- 8 **Mabrok, M. A.**, & Abdel-Aty, A.-H. (2019). Pattern detection for time series trajectories in human in the loop applications. *Journal of Intelligent & Fuzzy Systems*, (Preprint), 1–9. Retrieved from <https://content.iospress.com/articles/journal-of-intelligent-and-fuzzy-systems/ifs179070>
- 9 Kuntz, K. B., Wheatley, T. A., Song, H., Webb, J. G., **Mabrok, M. A.**, Huntington, E. H., & Yonezawa, H. (2017). Ultra-wide frequency response measurement of an optical system with a dc photo-detector. *Optics express*, 25(2), 573–586.
- 10 **Mabrok, M. A.**, & Ryan, M. J. (2017). Category theory as a formal mathematical foundation for model-based systems engineering. *Appl. Math. Inf. Sci*, 11, 43–51.
- 11 **Mabrok, M. A.**, Elsayed, S., & Ryan, M. J. (2016). Mathematical framework for recursive model-based system design. *Nonlinear Dynamics*, 84(1), 223–236. Retrieved from <https://link.springer.com/article/10.1007/s11071-015-2418-1>
- 12 **Mabrok, M. A.**, & Petersen, I. R. (2016). Controller synthesis for negative imaginary systems: A data driven approach. *IET Control Theory & Applications*, 10(12), 1480–1486. Retrieved from <https://doi.org/10.1049/iet-cta.2015.0800>
- 13 Dong, D., **Mabrok, M. A.**, Petersen, I. R., Qi, B., Chen, C., & Rabitz, H. (2015). Sampling-based learning control for quantum systems with uncertainties. *IEEE Transactions on Control Systems Technology*, 23(6), 2155–2166. Retrieved from <https://doi.org/10.1109/TCST.2015.2404292>
- 14 **Mabrok, M. A.**, Efatmaneshnik, M., & Ryan, M. J. (2015). Integrating nonfunctional requirements into axiomatic design methodology. *IEEE Systems Journal*, 11(4), 2204–2214. Retrieved from <https://doi.org/10.1109/JSYST.2015.2462073>
- 15 **Mabrok, M. A.**, Haggag, M. A., & Petersen, I. R. (2015). System identification algorithm for negative imaginary systems. *Appl. Comput. Math*, 14(3), 336–348.
- 16 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., & Lanzon, A. (2015). A generalized negative imaginary lemma and riccati-based static state-feedback negative imaginary synthesis. *Systems & Control Letters*, 77, 63–68. Retrieved from <https://doi.org/10.1016/j.sysconle.2015.01.008>

- 17 **Mabrok, M. A.**, Dong, D., Petersen, I. R., & Chen, C. (2014). Entanglement generation in uncertain quantum systems using sampling-based learning control. *IFAC Proceedings Volumes*, 47(3), 5963–5968. Retrieved from <https://doi.org/10.3182/20140824-6-ZA-1003.02079>
- 18 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., & Lanzon, A. (2014a). Generalizing negative imaginary systems theory to include free body dynamics: Control of highly resonant structures with free body motion. *IEEE Transactions on Automatic Control*, 59(10), 2692–2707. Retrieved from <https://doi.org/10.1109/TAC.2014.2325692>
- 19 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., & Lanzon, A. (2014b). Locking a three-mirror optical cavity using negative imaginary systems approach. *Quantum Inf Rev*, 1, 1–8. Retrieved from <http://www.naturalspublishing.com/files/published/3pc9yuf33yj501.pdf>
- 20 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., & Lanzon, A. (2013). Spectral conditions for negative imaginary systems with applications to nanopositioning. *IEEE/ASME Transactions on Mechatronics*, 19(3), 895–903. Retrieved from <https://doi.org/10.1109/TMECH.2013.2263292>
- 21 **Mabrok, M. A.**, Lanzon, A., Kallapur, A. G., & Petersen, I. R. (2013). Enforcing negative imaginary dynamics on mathematical system models. *International Journal of Control*, 86(7), 1292–1303. Retrieved from <https://doi.org/10.1080/00207179.2013.804951>
- 22 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., & Lanzon, A. (2012b). Generalized negative imaginary lemma for descriptor systems. *Journal of Mechanics Engineering and Automation*, 2(1), 17–21.
- 23 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., & Lanzon, A. (2011d). Spectral conditions for the negative imaginary property of transfer function matrices. *IFAC proceedings volumes*, 44(1), 1302–1306. Retrieved from <https://doi.org/10.3182/20110828-6-IT-1002.00714>
- 24 El-Orany, F. A., Obada, A.-S., **Mabrok, M. A.**, & Wahiddin, M. (2008). Evolution of the pair-coherent state with the two-qubit: Entanglement and cat-state generation. *Journal of Modern Optics*, 55(10), 1649–1666. Retrieved from <https://doi.org/10.1080/09500340701762730>

## Conference Proceedings

- 1 Owyed, S., Abdel-Aty, A., **Mabrok, M. A.**, & Zakaria, N. (2019). Mathematical modeling and simulation of 3-qubits quantum annealing processor. In *Proceedings of the 2019 2nd international conference on mathematics and statistics* (pp. 14–18).
- 2 Ghallab, A. G., **Mabrok, M. A.**, & Petersen, I. R. (2018). Extending negative imaginary systems theory to nonlinear systems. In *2018 IEEE conference on decision and control (cdc)* (pp. 2348–2353). IEEE.
- 3 Kuntz, K. B., Wheatley, T. A., Webb, J. G., Song, H., **Mabrok, M. A.**, & Huntington, E. H. (2018). Frequency response measurement of optical cavities using an intensity modulated laser beam and direct power measurement.
- 4 **Mabrok, M. A.**, & Petersen, I. R. (2018). Negative imaginary  $h_{-2}$  controller synthesis using nonlinear optimization. In *2018 IEEE conference on decision and control (cdc)* (pp. 6526–6531). IEEE.
- 5 Ghallab, A. G., **Mabrok, M. A.**, & Petersen, I. R. (2017). Lyapunov-based stability of feedback interconnections of negative imaginary systems. (Vol. 50, pp. 3424–3428). Elsevier.
- 6 **Mabrok, M. A.**, & Shamma, J. S. (2016). Passivity analysis of higher order evolutionary dynamics and population games. In *2016 IEEE 55th conference on decision and control (cdc)* (pp. 6129–6134). IEEE.
- 7 **Mabrok, M. A.**, Efatmaneshnik, M., & Ryan, M. (2015). Including non-functional requirements in the axiomatic design process. In *2015 annual IEEE systems conference (syscon) proceedings* (pp. 54–60). IEEE.
- 8 **Mabrok, M. A.**, & Petersen, I. R. (2015). Data driven controller synthesis for negative imaginary systems. In *2015 10th asian control conference (ascc)* (pp. 1–5). IEEE.

- 9 Abdel-Aty, A.-H., Zakaria, N., & **Mabrok, M. A.** (2014). Dynamics of the entanglement over noisy quantum networks. In *2014 international conference on computer and information sciences (iccoins)* (pp. 1–6). IEEE.
- 10 **Mabrok, M. A.**, Dong, D., Chen, C., & Petersen, I. R. (2014). Robust entanglement control between two atoms in a cavity using sampling-based learning control. In *53rd IEEE conference on decision and control* (pp. 5802–5807). IEEE.
- 11 **Mabrok, M. A.**, Haggag, M., Petersen, I. R., & Lanzon, A. (2014). A subspace system identification algorithm guaranteeing the negative imaginary property. In *53rd IEEE conference on decision and control* (pp. 3180–3185). IEEE.
- 12 **Mabrok, M. A.**, & Petersen, I. R. (2014). Negative imaginary feedback systems. In *2014 4th Australian control conference (aucc)* (pp. 130–133). IEEE.
- 13 Kallapur, A. G., **Mabrok, M. A.**, & Petersen, I. R. (2013). An integral resonant controller approach to frequency locking an optical cavity. In *2013 IEEE international conference on control applications (cca)* (pp. 407–411). IEEE.
- 14 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., & Lanzon, A. (2012a). A stability result on the feedback interconnection of negative imaginary systems with poles at the origin. In *2012 2nd Australian control conference* (pp. 98–103). IEEE.
- 15 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., Schütte, D., Boyson, T. K., & Lanzon, A. (2012). Locking a three-mirror optical cavity: A negative imaginary systems approach. In *2012 2nd Australian control conference* (pp. 476–480). IEEE.
- 16 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I., & Lanzon, A. (2012). Stabilization of conditional uncertain negative-imaginary systems using riccati equation approach. In *Proceedings of the 20th international symposium on mathematical theory of networks and systems (mnts)* (pp. 9–13).
- 17 Kuffner, P. C., Conroy, K. J., Boyson, T. K., Milford, G., **Mabrok, M. A.**, Kallapur, A. G., ... Kirkbride, K. P. et al. (2011). Quantum cascade laser-based substance detection: Approaching the quantum noise limit. In *Next-generation spectroscopic technologies iv* (Vol. 8032, p. 80320C). International Society for Optics and Photonics.
- 18 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., & Lanzon, A. (2011a). A negative imaginary lemma for descriptor systems. In *2011 Australian control conference* (pp. 543–546). IEEE.
- 19 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., & Lanzon, A. (2011b). A new stability result for the feedback interconnection of negative imaginary systems with a pole at the origin. In *2011 50th IEEE conference on decision and control and European control conference* (pp. 3753–3757). IEEE.
- 20 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., & Lanzon, A. (2011c). Enforcing a system model to be negative imaginary via perturbation of hamiltonian matrices. In *2011 50th IEEE conference on decision and control and European control conference* (pp. 3748–3752). IEEE.
- 21 **Mabrok, M. A.**, Kallapur, A. G., Petersen, I. R., & Lanzon, A. (2011e). Stability analysis for a class of negative imaginary feedback systems including an integrator. In *2011 8th Asian control conference (ascc)* (pp. 1481–1486). IEEE.

## References

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Relationship: Head of the department of my current position.