

# Amgad Abdrabou

## *Curriculum Vitae*



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Google Scholar

## RESEARCH PROGRAM

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My main research area is computational electromagnetics and photonics. Numerical solutions to either eigenvalue problems derived from Maxwell's equation or scattering of waves by obstacles are areas of great interest to both theory and applications. Using a variety of numerical and analytic techniques to analyze such problems helps to reveal new wave phenomena that may have potential applications. Examples include bound states in the continuum (BICs), exceptional points (EPs), and complex modes in lossless periodic structures. Recently, my research is centered around applying concepts from differential geometry to solutions of Maxwell's equations. When cast into differential forms, Maxwell's equations can be solved via concepts from discrete exterior calculus. Solutions obtained via this approach are stable and do not suffer from many problems that are found when using conventional techniques e.g., finite difference and finite element methods.

## EDUCATION

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- 2016 – 2019    **Doctor of Philosophy** in Mathematics (Research area: Computational Photonics)  
**City University of Hong Kong**, Hong Kong  
Advisor: Prof. Ya Yan Lu  
Thesis: Non-Hermitian spectral degeneracies for resonant states on dielectric structures, Oct. 2019.
- 2012 – 2015    **Master of Science** in Engineering Mathematics  
**Mansoura University**, Mansoura, Egypt  
Advisor: Prof. Mohammed El-Gamel, Co-advisor: Prof. Adel Mohsen.  
Thesis: Solution of biharmonic problems using Sinc bases, Jul. 2015.
- 2005 – 2010    **Bachelor of Science** in Electrical Power and Machines Engineering  
**Mansoura University**, Mansoura, Egypt  
Advisor: Prof. Akram Elmitwally  
Project report: Design of high-performance digital distance relay, July 2010.

## PROFESSIONAL EXPERIENCE

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JUNE. 2023 – NOW (FT)

Elmore Family School of Electrical and Computer Engineering, Purdue University

### Postdoctoral Research Associate

My research is about development of computational methods for real-world large-scale problems in the area of computational electromagnetics using Discrete Exterior Calculus (DEC).

NOV. 2020 – MAR. 2023 (FT)

School of Mathematical Sciences, Zhejiang University

### Postdoctoral fellow

I studied relevant symmetries for the robustness of BICs and associated topological properties. In addition, I investigate a systematic approach towards generation of off- $\Gamma$  BIC and their merging.

SEPT 2019 – FEB 2020 (FT)

Dept. of Mathematics, City University of Hong Kong

### Research Assistant

The research for this position involved studying an important class of eigensolutions known as complex modes. We studied their existence on open periodic dielectric structures and found new relations to bound states in the continuum (BICs), exceptional points, and special diffraction solutions.

APR 2014 – AUG 2016 (PT)

Center for Photonics and Smart Materials, Zewail City for Science and Technology

### Research Assistant

This position involved development of a novel treatment for unbounded domains in computational photonics. The technique developed was mainly based on multi-domain pseudo-spectral methods with Chebyshev or rational Chebyshev functions as bases.

## TEACHING EXPERIENCE

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SEPT 2017 – JUNE 2019 (PT)

Dept. of Mathematics, City University of Hong Kong

### Teaching Assistant

This position involved part-time teaching to undergraduate students as part of my postgraduate studentship duties. I taught courses in differential/integral Calculus, analytic geometry, complex analysis and linear algebra. It also involved participation at the Math Help Center of the department, during revision and examinations period.

SEPT 2010 – JAN 2014 (PT)

Department of Mathematics and Engineering Physics,

Mansoura University

### Teaching Assistant

This position involved teaching to undergraduate courses in differential/integral Calculus, analytic geometry, complex analysis and linear algebra. I also had the opportunity to teach a course in MATLAB programming to postgraduate students in the department.

## RESEARCH

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### *Interests*

- Application of differential geometry and forms concept to solutions of Maxwell's equations.
- Theoretical and numerical investigation of new wave phenomena in photonics.
- Non-Hermitian photonics: Exceptional points and complex modes.
- Bound states in the continuum.
- Topological nature of wave phenomena and relevant symmetries.

### *Experience*

- Computational photonics: Wave propagation and scattering problems.
- Computational electromagnetics using discrete exterior calculus.
- Pseudo-spectral methods: Modal analysis of optical waveguides.
- Perturbation analysis.
- Sinc methods: Numerical solutions of ordinary and partial differential equations.

### *Skills*

- MATLAB (Experienced)
- C++ and Python (Intermediate)
- $\LaTeX$  (Experienced)
- Inkscape: Graphics and vector design (Intermediate)

## AWARDS

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- 2019 **Best student paper award (third prize)**  
2019 IEEE International Conference on Computational Electromagnetics (ICCEM 2019), Shanghai, China
- 2018/2019 **Outstanding teaching award for teaching assistants**  
*City University of Hong Kong*
- 2018 **Outstanding academic performance award for research degree students**  
*City University of Hong Kong*
- 2016-2019 **Postgraduate Studentship**  
*City University of Hong Kong*

## ATTENDED CONFERENCES

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- 2019 Poster Presentation at the IEEE International Conference on Computational Electromagnetics (ICCEM) Shanghai, China.
- 2018 Oral Presentation at the 40th Progress in Electromagnetics Research Symposium (PIERS) Toyama, Japan.
- 2018 Oral Presentation at the International Conference on Applied Mathematics (ICAM 2018) City University of Hong Kong, Hong Kong.
- 2015 Oral Presentation at the 36th Progress in Electromagnetics Research Symposium (PIERS), Prague, Czech Republic.

## PUBLICATIONS

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### Journal papers:

1. **Amgad Abdrabou**, L. Yuan, W. Lu and Y. Y. Lu (2023). Parametric dependence of bound states in the continuum: a general theory. *Physical Review A*, **107** (3), 033511.
2. **Amgad Abdrabou** and Y. Y. Lu (2022). Frequency perturbation theory of bound states in the continuum in a periodic waveguide. *Physical Review A*, **106** (4), 013523.
3. **Amgad Abdrabou** and Y. Y. Lu (2021). Circularly polarized states and propagating bound states in the continuum in a periodic array of cylinders. *Physical Review A*, **103** (4), 043512.
4. **Amgad Abdrabou** and Y. Y. Lu (2020). Complex modes in an open lossless periodic waveguide. *Optics Letters*, **45** (20), 5632-5635.
5. **Amgad Abdrabou** and Y. Y. Lu (2020). Exceptional points of Bloch eigenmodes on a dielectric slab with a periodic array of cylinders. *Physica Scripta*, **95** (9), 095507.
6. **Amgad Abdrabou** and Y. Y. Lu (2019). Indirect link between resonant and guided modes on uniform and periodic slabs. *Physical Review A*, **99** (6), 063818.
7. **Amgad Abdrabou** and Y. Y. Lu (2019). Exceptional points for resonant states on parallel circular dielectric cylinders. *J. Opt. Soc. Am. B*, **36** (6), 1659-1667.
8. M. El-Gamel and **Amgad Abdrabou** (2019). Sinc-Galerkin method for solving eighth-order boundary-value problems. *SeMA Journal*, **76** (2), 249-270.

9. **Amgad Abdrabou** and Y. Y. Lu (2018). Exceptional points of resonant states on a periodic slab. *Physical Review A*, **97** (6), 063822.
10. **Amgad Abdrabou** and M. El-Gamel (2018). On the sinc-Galerkin method for triharmonic boundary-value problems. *Computers & Mathematics with Applications*, **76** (3), 520-533.
11. M. El-Gamel, A. Mohsen, and **Amgad Abdrabou** (2017). Sinc-Galerkin solution to the clamped plate eigenvalue problem. *SeMA Journal*, **74** (2), 165-180.
12. **Amgad Abdrabou**, A. M. Heikal, and S. S. A. Obayya (2016). Efficient Rational Chebyshev Pseudospectral Method with Domain Decomposition for Optical Waveguides Modal Analysis. *Optics Express*, **24** (10), 10495-10511.
13. M. El-Gamel, A. Mohsen, A. and **Amgad Abd El-Mohsen** (2014). Sinc-Galerkin method for solving biharmonic problems. *Appl. Math. Comp.*, **247** (2), 386-396.

### Conference papers:

1. **Amgad Abdrabou** and Y. Y. Lu (2019). Formation of Resonance State Exceptional Points in Two-Dimensional Periodic Structures. *2019 IEEE International Conference on Computational Electromagnetics (ICCEM)*, Shanghai, China.
2. **Amgad Abdrabou** and Y. Y. Lu (2018). Families of Exceptional Points in Period Slabs. *XXVI International Workshop on Optical Wave & Waveguide Theory and Numerical Modelling (OWTNM 2018)*, Bad Sassendorf, Germany.
3. **Amgad Abdrabou** and Y. Y. Lu. Exceptional Points on a Periodic Dielectric Slab. *Progress in Electromagnetics Research Symposium (PIERS)*, Toyama, Japan.
4. **Amgad Abd El-Mohsen**, A. M. Heikal, and S. S. A. Obayya (2015). An Efficient Sinc-Collocation Domain Decomposition Method for Optical Waveguides Analysis. *Progress in Electromagnetics Research Symposium (PIERS)*, Prague, Czech Republic.
5. **Amgad Abd El-Mohsen**, A. M. Heikal, and S. S. A. Obayya (2015). Semi-vectorial sinc-Galerkin method with domain decomposition for optical waveguides analysis. *XXIII International Workshop on Optical Wave & Waveguide Theory and Numerical Modelling (OWTNM 2015)*, City University London.
6. **Amgad Abd El-Mohsen**, A. M. Heikal, and S. S. A. Obayya (2015). Full-Vectorial Cardinal-type Approximation Method for Optical Waveguide Analysis. *The International Applied Computational Electromagnetics Society (ACES)*, Virginia, USA.