Islam I. Abdulaal

Postgraduate Researcher in Integrated Photonics

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Research Interests

Integrated photonics research interests include nanophotonics, nonlinear optics, and photonic-electronic co-design for all-optical neural networks, programmable photonics, quantum systems, and high-capacity optical communications. Current focus also includes physics-informed machine learning as a digital twin for inverse design, optimization, and device reliability.

Education

B.Sc in Electronics and Communications Engineering Aug 2021 – Aug 2026
Alexandria University, Faculty of Engineering *Alexandria, Egypt*

- **CGPA:** 3.39/4.0 (Distinct with Honors)
- **Bachelor Thesis:** "Intra-DC IEEE 802.3 Ethernet MDM-based 400 Gb/s Integrated Si Transceiver"
- **Thesis Advisor:** Dr. Eslam Elfiky
- **Thesis Focus:** Modeling and Design of waveguide-based Ge/Si PIN photodetector; collaborated on mode division multiplexing, electro-optic modulator design, and optical digital signal processing
- **Relevant Coursework:** Electromagnetic Fields, Electromagnetic Waves, Optical Devices, Optical Communications, Digital Signal Processing

Skills: Lumerical, MATLAB, VHDL, LabVIEW, PSpice

Research Experience

Research Intern Sep 2025 – Present
*NanoPhoto Lab, IMRE, A*STAR* *Remote*

- Extended collaboration from Egypt Scholars program to work with Dr. Abdelraouf at nanophoto.org
- Contributing to comprehensive review paper on metamaterial bound states in the continuum (BIC)
- Investigating quantum photonics including applications of 2D MoS_2 and Liquid crystals
- Conducting device-level simulations using Lumerical FDTD and post-processing in MATLAB

Skills: Lumerical FDTD, MATLAB, Python, EndNote

Research Intern Jul 2025 – Sep 2025
Advanced Labs Program, Egypt Scholars Inc. *Remote*

- Completed intensive 10-week training program focused on developing independent research capabilities
- Collaborated with Dr. Omar Abdelraouf in Group 4 on MPM SPDC inverse design using PINNs
- Generated 12 million training data points for $NbOCl_{2x}$, benchmarking PINN against conventional
- Contributing to technical manuscript and review paper on multiphysics simulations using PINN

Skills: Lumerical FDTD, MATLAB, Python, PyTorch, EndNote

Undergraduate Researcher Jul 2023 – Aug 2025
OPST Group, CSMNP, SmartCI, Alexandria University *Hybrid*

- Supervised by Dr. Ishac Kandas and Dr. Eman Elzahaby
- Completed comprehensive 3-month lecture-based training program covering fundamentals of photonics
- Completed following 3-month hands-on training in Lumerical simulation and MATLAB modeling
- Developed FBG for multi-parameter vital monitoring with emphasis on asthma and COPD detection
- Co-authored research proposal securing USD 15k in funding from Alexandria University Technology Park

- Implemented models for fiber core and cladding mode coupling in MATLAB, validated using Lumerical
- Designed low-cost edge-filter detection system using Lumerical INTERCONNECT for sensor

Skills: Lumerical (FDTD, MODE, INTERCONNECT), MATLAB

Research Projects

Multi-Parameter Vital Monitoring Sensor for Respiratory Disease Detection via FBG
Type: Funded Research Project — Aug 2025 – Ongoing (12 months)

- Developing compact photonic sensor system for early detection of asthma and COPD exacerbations
- Used fiber Bragg grating (FBG) technology and edge AI signal processing
- Led conceptualization, theoretical framework development, and implementation methodology design
- Implemented analytical MATLAB models for fiber mode coupling and FBG spectral response
- Validated theoretical approach using Lumerical FDTD and MODE solvers with excellent agreement
- Designed low-cost edge-filter interrogation system using Lumerical INTERCONNECT for monitoring
- Secured USD 15k research grant from AUTP based on feasibility and potential to commercialize IP

Skills: Lumerical (FDTD, MODE, INTERCONNECT), MATLAB, Python

Physics-Informed Neural Network Inverse Design for Photonic Quantum Systems
Type: Collaborative Research Project — Jul 2025 – Ongoing (6 months)

- Developed PINN-architecture for inverse design on multi-parameter optimization of integrated source
- Developed spontaneous parametric down-conversion (SPDC) source in $NbOCl_{2x}$ nonlinear waveguides
- Generated 12 million training samples through systematic FDTD simulation sweeps of waveguide
- Implemented and benchmarked multiple PINN architectures in PyTorch achieving superior convergence
- Contributing to technical manuscript compared to traditional design methods

Skills: Lumerical FDTD, Python, PyTorch, MATLAB

Publications

Preprints

[1] **Abdulaal, I. I.**, Elsayed, A. W. A., Abdelraouf, O. A. M., "Terahertz quasi-bic metasurfaces for ultra-sensitive biosensing and high-speed wireless communications," Preprint submitted to *Journal of Optics* (IOP), 2025. arXiv: 2510.00357 [physics.optics]. [Online]. Available: https://arxiv.org/abs/2510.00357

In Preparation

[2] **Abdulaal, I. I.**, Abdelraouf, O. A. M., "Nbocl$_{2x}$-based spdc inverse design using a physics-informed neural network model," Manuscript in preparation, 2026.

[3] **Abdulaal, I. I.**, Elsayed, A. W. A., Abdelraouf, O. A. M., Sallam, B., Mahmoud, A., Hazem, A., "Physics-informed machine learning multiphysics for forward modelling, inverse design, and equation discovery," Manuscript in preparation, 2026.

Professional Training and Internships

Analog and Mixed-Signal Simulation & Modeling Trainee — Jul 2025 – Sep 2025
Siemens EDA – EMEA — *Hybrid*

- Completed comprehensive 90+ hours training program in AMS behavioral modeling and verification
- Designed 8× PLL using behavioral Verilog-A modeling, achieving V_{ctrl} = 377.6 mV and f_{out} = 960 MHz
- Achieved 92% overall grade across simulation modules, concept quizzes, and hands-on laboratories
- Developed proficiency in SPICE simulation (LTspice) and MATLAB for parsing and solving

Skills: LTspice, MATLAB, Mentor Graphics S-Edit, Analog Design Tools (ADT), Verilog-A

Analog-to-Digital Converter Design & Verification Trainee — Feb 2025
Siemens EDA – EMEA — *Remote*

- Completed intensive 2-week training on ADC architectures, quantization theory, and performance metrics

- Designed and verified 8-bit SAR ADC in both single-ended and fully differential configurations
- Achieved 7.8-bit ENOB, 49.3 dB SNR, -56.3 dB THD, and 60.5 dB SFDR with 256-point FFT analysis
- Scored 101% overall across evaluation modules demonstrating mastery of ADC design principles

Skills: Xschem, NGspice, Octave

CMOS Analog Integrated Circuit Design Trainee Jun 2024 – Sep 2024
Information Technology Institute (ITI) *Remote*

- Completed rigorous 180+ hours program covering CMOS design fundamentals and advanced concepts
- Designed fully differential folded cascode OTA achieving 60 dB DC gain, 80° phase margin, 62.9 MHz GBW, 80 ns rise time, and 3k open-loop gain using GF180 PDK
- Designed two-stage Miller-compensated OTA achieving 66.8 dB DC gain, 77.18 dB CMRR, 75.68° phase margin, 5.1 MHz GBW, and 52.95 ns rise time using GF180 PDK
- Completed comprehensive design labs including bias circuits, current mirrors, and stability analysis
- Achieved 82% final grade across design projects, quizzes, and simulation laboratories

Skills: Cadence Virtuoso, Cadence Spectre, Xschem, NGspice, Analog Design Tools (ADT)

Selected Technical Projects

Behavioral Phase-Locked Loop Design
Type: Training Project Sep 2025

- Designed 8× frequency multiplication PLL using Verilog-A behavioral modeling
- Achieved 960 MHz output frequency with 377.6 mV control voltage
- Collaborated in team of 3 to develop transistor-level frequency divider and compare with Verilog-A

Skills: Mentor Graphics S-Edit, Verilog-A

Two-Stage Miller Operational Transconductance Amplifier
Type: Training Project Sep 2024

- Designed Miller-compensated two-stage OTA achieving 66.8 dB DC gain, 77.18 dB CMRR, 75.68° phase margin, 5.1 MHz GBW, 4.35 V/μs slew rate, and 56.09 μA current consumption
- Performed design including bias circuit sizing, frequency compensation, and stability analysis
- Validated design through extensive AC, transient, and corner analysis using GF180 180nm technology

Skills: Cadence Virtuoso, Analog Design Tools (ADT)

8×8-Bit Sequential Multiplier with FSM Control
Type: Self-Learning Project Aug 2023

- Designed sequential multiplier in Verilog achieving 16-bit product through 4-cycle shift-and-add
- Developed complete system architecture including datapath partitioning and multi-state FSM controller
- Performed modular verification with comprehensive testbenches for all components

Skills: Verilog, Xilinx Vivado, QuestaSim

Technical Skills and Competencies

Photonic Simulation and Design

FDTD/FEM Solvers: Lumerical, COMSOL
Semiconductor Modeling: Silvaco TCAD
General Modeling: MATLAB

Programming and Computational Methods

Scientific Computing: Python, Octave
Machine Learning: PyTorch, TensorFlow
General Programming: C/C++, Assembly, Bash
Development Tools: Git, Linux, LaTeX, Jupyter

Electronic Simulation and Design

Analog IC Design: Cadence, Mentor, Xschem, ADT

Mixed-Signal Design: Verilog-A/AMS, SPICE
Digital Design: Verilog, VHDL, Vivado, Quartus, QuestaSim
System Simulation: Simulink, LabVIEW

Hardware Development

Embedded Systems: Altium, Proteus, Arduino, ESP32, ATmega, FPGA/CPLD
Laboratory Equipment: Network analyzer, oscilloscope, photometer, spectroscopy

Professional Certifications

Machine Learning Specialization Dec 2024
Issuer: DeepLearning.AI via Coursera

Languages

Arabic: Native proficiency
English: Professional working proficiency (Fluent)

Honors, Awards, and Research Funding

Research Funding

Alexandria University Technology Park (AUTP) Research Grant 2025
Issuer: Alexandria University

- Awarded USD 15k for multi-parameter vital monitoring sensor for asthma and COPD detection
- Selected based on technical feasibility, market potential, and innovation
- Project focused on translating FBG sensing technology to clinical applications

Academic Honors

Distinction Grade - Dean's Honors for Academic Excellence 2021 – 2025
Issuer: Alexandria University, Faculty of Engineering

- Maintained distinction grade status throughout undergraduate studies
- Recognized annually for academic excellence, qualifies for honors designation at graduation
- Earned GSEC top achiever scholarship through the Ministry of Higher Education

Competition Awards

ICMTC Artificial Intelligence Contest (AIC-2) – 4th Place 2024
Issuer: Military Technical College

- Achieved 4th place among 500 competing teams in national AI competition
- Developed SphinxSpeech Egyptian dialect ASR system using NVIDIA NeMo framework
- Integrated PyAnnote diarization with agglomerative clustering and embedding-based identification

Huawei ICT Skills Competition – National Finalist (AI Track) 2023
Issuer: Huawei Technologies – MENA

- Qualified among top national individuals representing Egypt in artificial intelligence track
- Demonstrated technical proficiency through HCIA certification examination

NASA Space Apps Challenge – Global Nominee 2021
Issuer: National Aeronautics and Space Administration (NASA)

- Selected as global nominee for project submission in international hackathon
- Developed Unity-based C# educational video game for lunar mission awareness and space exploration

International Youth Math Challenge (IYMC) – Finalist 2021
Issuer: IYMC Foundation

- Selected as finalist in international mathematics competition
- Solved advanced mathematical problems with rigorous step-by-step proofs

Leadership Experience and Academic Service

Chairman Feb 2025 – Oct 2025
IEEE SSCS Alexandria University Student Branch Chapter *Hybrid*

- Led chapter restructuring effort establishing clear program portfolio and governance bylaws
- Established 50+ partnerships with IEEE branches, government entities, and semiconductor companies
- Developed and launched 4 major programs (Si-Cast, Si-Clash, AlexDuino, SPARK Meetup)
- Managed 200+ volunteers serving 500+ students across 30 universities and 5 pre-university schools
- Organized 80+ technical events featuring 35+ industry and academic experts from semiconductor fields

Skills: Leadership, Management, Communications

General Coordinator Aug 2021 – Sep 2023
Education Clinic (USA-Registered NGO) *Remote*

- Led volunteer organization of 80+ members serving 250,000+ students across MENA region
- Developed and launched 3 major programs spanning academic support and technical skill development
- Organized webinars featuring faculty from top-100 universities including Nobel and Fields recipients

Skills: Leadership, Management, Communications

Teaching and Mentoring Experience

Peer Tutor/Mentor 2025 – Present

- Optical subteam lead/technical committee co-head for IEEE SSCS season 2026
- Responsible for intensive training for students on photonics with concentration on computational aspects
- Developed curriculum covering fundamental concepts and practical applications in integrated photonics

Professional Memberships

- **Institute of Electrical and Electronics Engineers (IEEE)** 2025 – Present
  Student Member, Member ID: 101099759
  - **IEEE Solid-State Circuits Society (SSCS)** 2025 – Present
  - **IEEE Photonics Society** 2025 – Present

References

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Dr. Omar Abdelraouf
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Additional letters of recommendation available upon request from research supervisors and academic advisors.