Matthew A. Taylor

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Education

Massachusetts Institute of Technology - M.S. in Music Technology and Computation *May '27 (expected)*

- **Research focus:** Design and optimization of FDTD schemes for the vibration of plates and shells

Massachusetts Institute of Technology - B.S. in Electrical Science and Engineering *May '26*

- **GPA:** 5.0/5.0
- **Relevant coursework:** EM Waves and Applications, Nanotechnology: Atoms to Systems, Lin. Alg., Diff. Eqs.

Research Experience

MIT Laboratory for Audio, Music, and Acoustics - Acoustics modeling *Jan '26–Present*

Supervisor: Mark Rau

- Extended an energy-conserving, non-iterative, and nonlinear FDTD scheme to model collision between a free Euler-Bernoulli beam and a clamped 2-D circular membrane. Derived stability conditions and numerical boundary conditions for the model and developed an explicit implementation in Python. Used the model to simulate the striking of a drum head and the rimshot percussion technique.
- Developed an implicit FDTD scheme for cylindrical shell vibration. Optimized free parameters in the model to minimize numerical dispersion over audible range, using analytical solutions as ground truth. Compared to an explicit scheme, the implicit scheme achieves a 5x-smaller maximum eigenfrequency error over the audible modes, using a 3x-larger time step.

National Renewable Energy Laboratory - CdTe photovoltaics modeling *May–Jul '25*

Supervisors: B. Edward Sartor and Matthew O. Reese

- Performed temperature-dependent time-resolved photoluminescence (TRPL) measurements of Cd(Se,Te) to characterize carrier trapping and recombination mechanisms with different dependence on temperature
- Incorporated shallow minority carrier traps into a COMSOL model of a Cd(Se,Te) solar cell to model carrier capture/emission dynamics that result from the traps
- Developed a novel Cd(Se,Te) solar cell parameter estimation procedure using COMSOL, which applies temperature-dependent TRPL measurements to decouple different recombination and trapping mechanisms

MIT Palacios Group - GaN transistor modeling *Jan–Dec '24*

Supervisors: John Niroula and Tomás Palacios

- Assembled and tested a high-temperature DC/RF probe station for transistor measurements up to 1000°C
- Developed a temperature-dependent compact model (Verilog-A) and parameter estimation scheme for gate leakage in GaN high-electron-mobility transistors. Fabricated a set of devices to validate the model.

Lincoln Laboratory - Photodiode evaluation *Jun–Aug '22*

Supervisor: Richard D. Younger

- Characterization of avalanche photodiodes and development of device evaluation software using MATLAB

Projects

FDTD Simulator for RF Microstrip Circuits with Experimental Validation

Class Project: Electromagnetic Waves and Applications

- Developed custom Python code implementing an FDTD solver for Maxwell's equations, including convolutional CFS-PML, conductors, lossy dielectrics, lumped elements (resistor, inductor, resistive voltage source), and conformal treatment of cells that are only partially filled by a perfect electric conductor
- Designed linearly and circularly polarized microstrip patch antennas with stub matching networks
- Modeled the patch antenna designs in HFSS and the FDTD simulator. Measured a transmission line test structure to calibrate series inductance due to the connector and the substrate's conductivity and real permittivity.
- Fabricated the patch antenna designs and compared simulated vs. measured input return loss. Demonstrated < 5% relative error in the resonant frequency between the simulations and measurements, with < 1% error between the FDTD and HFSS simulations.

Modular Synthesizer
Personal Project

- Designed various analog audio circuits: spring reverb, envelope generators, oscillators, amplifiers, filters
- Verified circuit designs in LTspice and designed printed circuit boards (PCBs) in KiCad for 13 synthesizer modules
- Optimized PCB designs, circuit designs, and power distribution to minimize noise and crosstalk between modules

FPGA Drum Processor
Class Project: Digital Systems Laboratory I

- Designed six real-time audio effects in fixed point with < 1 ms total latency, including:
  - Resampling pitch shift using a Farrow structure variable-rate upsampler and polyphase FIR downsampler
  - Virtual analog model of a 4-pole ladder filter, including tanh feedback nonlinearity and oversampling
- Designed a 16-channel Ethernet audio interface with < 7 ms latency and adaptive resampling to combat clock drift

Conferences

M. A. Taylor and M. Rau. FPGA-enabled real-time audio sampling, processing, and recording for an electronic drum set. Demo presenter at the 2026 International Conference on Digital Audio Effects.

M. A. Taylor, J. Niroula, Q. Xie, S. Luo, Y. Zhao, and T. Palacios. High temperature gate leakage modeling from 25°C to 500°C in high performance, scaled AlGaN/GaN HEMTs. Contributor to an oral presentation at the 2024 International Workshop on Nitride Semiconductors.

J. Niroula, **M. A. Taylor**, Q. Xie, P. Yadav, S. Luo, Y. Zhao, and T. Palacios. Record high temperature performance in scaled AlGaN/GaN-on-Si HEMTs up to 500°C. Contributor to an oral presentation at the 2024 Device Research Conference.

Publications

Manuscript in Progress: **M. A. Taylor**, P. Roy, M. O. Reese, B. E. Sartor. Shallow traps in Cd(Se,Te) photovoltaic absorbers observed by temperature-dependent time-resolved photoluminescence.

J. Niroula, Q. Xie, E. R. Borujeny, S. Luo, M. Oh, **M. A. Taylor**, Y. Zhao, and T. Palacios. High temperature AlGaN/GaN MISHEMT with W/AlON gate stack and I_{max} > 1 A/mm at 500°C. *IEEE Electron Device Letters*. Jul. 2025.

Industry Experience

Bazoomq Space Research Laboratory - Intern **-** Stratospheric balloon electronics design *Jun–Aug '26*
Supervisor: Avetik Grigoryan

- Selected electrical components and designed electrical schematics for a stratospheric balloon experiment
- Evaluated the radio link budget to select radios and antennas for the ground station and balloon payload
- Developed C code for an ESP32, including Wi-Fi networking code and sensor drivers (e.g., GNSS, IMU)
- Implemented a model of the weather balloon's ascent/descent in Python. Integrated the model into the ESP32 software testing methodology to evaluate the software behavior in different stages of the mission.

Active Surfaces - Intern **-** Solar cell evaluation *Jan–May '25*
Supervisor: Richard Swartwout

- Developed a software interface for performing stability tests on perovskite solar cells, analyzing measurement data, and uploading measurement data to a MySQL database

Analog Devices - Intern **-** FPGA design *Jun–Aug '23*
Supervisors: Jason Ziomek and Steven Tanghe

- Implemented and evaluated an ASIC ADC design on an FPGA "digital twin" using SystemVerilog
- Developed testbenches to verify state machines and signal processing logic matched specifications
- Collaborated with an overseas team to develop an ADC evaluation setup on new measurement equipment

Awards

2026 Northern Telecom/BNR Laboratory Prize: For the "FPGA Drum Processor" class project

Teaching Experience

Teaching Assistant - Electrical Circuits: Modeling and Design of Physical Systems *Sep '26–Present*
Laboratory Assistant *Sep–Dec '23*

Instructor - High school class on audio electronics (via ESP HSSP at MIT) *Jan–Apr '26*

- Developed a curriculum which introduces high school students to some key ideas in electrical engineering (analog circuits, frequency-domain analysis, oscillators, amplifiers, filters) in the context of audio electronics

Skills

Numerical Methods: FDTD method, iterative methods (Jacobi, Gauss-Seidel, conjugate gradient)

Simulation Tools: COMSOL (Semiconductor Module), Ansys HFSS

Software Programming: Python, C, C++

Register-Transfer Level Programming: SystemVerilog, Verilog, cocotb, AMD Vivado

Circuit Design: LTspice, KiCad