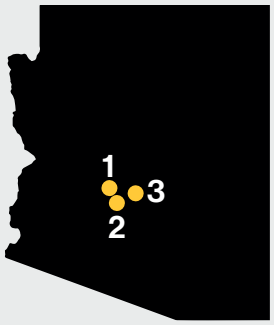
Engineering a microelectronics and semiconductors workforce

New U.S. semiconductor builds have the largest investments in Arizona



- **$40 billion,** December 2022: Two leading-edge foundries focused on 3-nanometer (nm) and 5-nm logic circuits.
- **$20 billion,** March 2021: Two leading-edge fabrication plants producing 5-nm logic circuits.
- **$2 billion,** November 2023: Advanced packaging and test facility.

As the need for workers with microelectronics skills rapidly grows, ASU is answering the call to train a new generation of workers, ensuring a robust U.S. microelectronics and semiconductors industry.

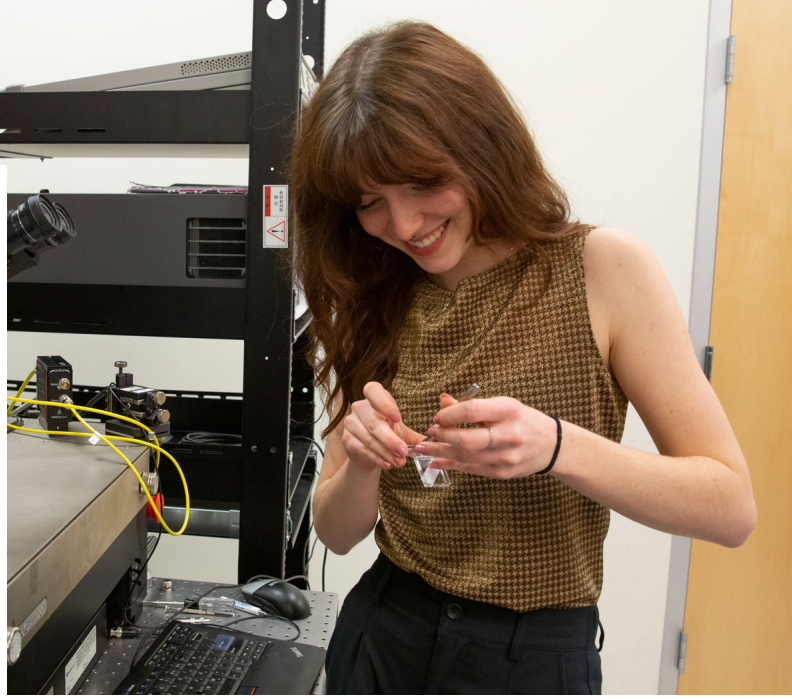
As the largest and most comprehensive engineering program in the country, the Fulton Schools is working with local industry, governmental partners and economic development agencies to equip members of the workforce with the knowledge and skills to support industry needs. The intersection of scale, innovative learner pathways, unique infrastructure and collaborative partnerships position the Fulton Schools as a leader in workforce development.

Consulting firm McKinsey Company has released a report earlier this year outlining future job opportunities in semiconductor manufacturing and semiconductor fab operations:

- Process engineers oversee process stability and recipe development and optimization.
- Equipment engineers work with tool functionality and reliability as well as strategic improvement.
- Production control engineers manage and coordinate activities across modules.
- Integration engineers develop, optimize and stabilize process integration across modules.
- Yield engineers improve yield and run contaminant-free manufacturing (CFM) and testing.
- Integration and yield managers supervise integration and yield teams.

Ira A. Fulton Schools of Engineering
Arizona State University

Technical electives



If students are interested in pursuing a career in these fields, they might not find courses in their program that cover the content necessary to prepare them for the tasks they will be taking on in one of these roles. However, they can use courses from other disciplines as technical electives in their junior and senior years that cover the "missing" content. While most of the courses have already been listed as approved electives in the respective programs, students can also ask for permission to enroll in any of the classes in other programs. They can also petition prerequisite overrides if they have taken a course in their program that covers similar content.

The following list contains suggestions for technical electives in the different Fulton Schools majors, which align with the job descriptions mentioned in the McKinsey report.

Talk to your advisor if you want to learn more about technical electives and schedule availability.

students.engineering.asu.edu/advising

Chemical engineering (BS)

OPTION 1	**Fab factory operations**
CHM 471	Solid-State Chemistry (advanced chemistry elective)
CHE 477	Inorganic Membranes and Thin Films (CHE elective)
CHE 461	Process Dynamic Control (CHE elective)
IEE 380	Probability and Statistics for Engineering Problem Solving (engineering elective)
OPTION 2	**Semiconductor materials processing focus**
CHM 471	Solid-State Chemistry (advanced chemistry elective)
CHE 477	Inorganic Membranes and Thin Films (CHE elective)
EGR 394	Heterogeneous Integration and Electronic Packaging (engineering elective)
IEE 381	Lean Six Sigma Methodology (engineering elective)

Electrical engineering (BS)

OPTION 1	**Semiconductor materials processing focus**
EEE 352	Properties of Electronic Materials (pathway)
EEE 435	Fundamentals of CMOS and MEMS (elective)
IEE 380	Probability and Statistics for Engineering Problem Solving (elective)
OPTION 2	**Semiconductor materials characterization focus**
EEE 352	Properties of Electronic Materials (pathway)
EEE 436	Fundamentals of Solid-State Devices (elective)
MSE 355	Structure and Defects (elective, prerequisite for MSE 450)
MSE 450	Introduction to Materials Characterization (elective)
OPTION 3	**Fab factory operations**
EEE 352	Properties of Electronic Materials (pathway)
EEE 439	Semiconductor Facilities and Cleanroom Practices (elective)
EGR 494	Manufacturing Systems Management (elective)

Industrial engineering (BS)

OPTION 1	**Semiconductor materials processing focus**
EEE 352	Properties of Electronic Materials (prerequisite for EEE 435)
EEE 435	Fundamentals of CMOS and MEMS (elective)
IEE 458	Project Management (IEE elective)
IEE 461	Production Control (IEE elective)
OPTION 2	**Fab factory operations**
EEE 352	Properties of Electronic Materials (prerequisite for EEE 435)
EEE 439	Semiconductor Facilities and Cleanroom Practices (elective)
IEE 458	Project Management (IEE elective)
IEE 461	Production Control (IEE elective)
OPTION 3	**Statistical analysis focus**
IEE 461	Production Control (IEE elective)
IEE 470	Stochastic Operations Research (IEE elective)
IEE 474	Quality Control (IEE elective)
IEE 475	Simulating Stochastic Systems (IEE elective)

Manufacturing engineering (BS)

OPTION 1	**Semiconductor materials processing focus**
EEE 352	Properties of Electronic Materials (prerequisite for EEE 435)
EEE 435	Fundamentals of CMOS and MEMS (elective)
EGR 394	Heterogeneous Integration and Electronic Packaging (engineering elective)
OPTION 2	**Fab factory operations**
EEE 352	Properties of Electronic Materials (prerequisite for EEE 435)
EEE 439	Semiconductor Facilities and Cleanroom Practices (elective)
EGR 494	Manufacturing Systems Management (elective)
MFG 524	Engineering Computing with Python & SQL

Materials science (BS)

OPTION 1	**Semiconductor materials processing Focus**
EEE 352	Properties of Electronic Materials (prerequisite for EEE 435, override possible)
EEE 435	Fundamentals of CMOS and MEMS (elective)
IEE 380	Probability and Statistics for Engineering Problem Solving (elective)
MSE 476	Growth and Processing of Semiconductors (MSE elective)
OPTION 2	**Semiconductor materials characterization Focus**
EEE 352	Properties of Electronic Materials (prerequisite for EEE 436, override possible)
EEE 436	Fundamentals of Solid-State Devices (elective)
MSE 450	Introduction to Materials Characterization (elective)
OPTION 3	**Fab factory operations**
EEE 352	Properties of Electronic Materials (pathway)
EEE 439	Semiconductor Facilities and Cleanroom Practices (elective)
EGR 494	Manufacturing Systems Management (elective)

Mechanical engineering (BS)

OPTION	**Semiconductor materials processing focus**
IEE 380	Probability and Statistics for Engineering Problem Solving (elective)
MSE 476	Growth and Processing of Semiconductors (elective)
MSE 450	Introduction to Materials Characterization (elective)