

## Integrative STEM Education

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We live in a highly technological age and the impacts of technology and engineering on the individual, society, and environment are great. Design, a fundamental aspect of technology and engineering, is central to our department's teacher preparation methods. The K–12 educational system, as well as society in general, can benefit from professionals who understand the impacts and value of developing the habits of mind of designers. Our department coordinates two undergraduate teacher preparation programs — Technology & Engineering Education, with a focus on preparing educators for the middle school and high school grade levels, and iSTEM (integrative Science, Technology, Engineering, and Mathematics), with a focus on preparing educators for the PreK–8 grades.

Both undergraduate teacher preparation programs are integrative STEM-based programs, studying a variety of STEM content areas and problem-based learning educational methods. STEM content areas include science and math applied in design processes (for K–12 environment), historical and contemporary influence of designed objects, creativity, product development, human factors engineering, product modeling, problem-solving techniques, environmental and biotechnical systems, communications, electronics and computers, structures, mechanisms and robotics. Emphasis is placed on understanding and applying core STEM principles and applying design-centric problem-based pedagogies. Courses are conducted in modern classrooms and laboratories housed in the School of Engineering.

Many reports have explicitly outlined the value that technology and engineering (design-based fields) have on the educational quality in the K–12 system. These include, (i) *Rise Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (NAS and NAE, 2007), (ii) *Rise above the Gathering Storm, revisited: Rapidly approaching Category 5* (NAE and NRC, 2010), (iii) *Engineering in K–12 Education: Understanding the Status and Improving the Prospects* (NAE and NRC, 2009), (iv) *STEM Integration in K–12 Education, Status, Prospects, and an Agenda for Research* (NAE and NRC, 2014), and (v) the Next Generation Science Standards (NGSS), which require engineering content in science courses.

New Jersey also recognizes the importance of technology and engineering through the establishment of standards for K–12 students (NJ Core Content Standard 8.2 for “Technology Education, Engineering, Design, and Computational Thinking-Programming”). Graduates of our programs receive provisional certification to teach in New Jersey schools, and most states recognize teacher candidates from CAEP nationally accredited programs, such as TCNJ. Graduates from both the Technology & Engineering Education and iSTEM programs are in high demand.

### **Program Entrance, Retention and Exit Standards for the Integrative STEM Education Programs**

#### **1. Technology & Engineering Education (Undergraduate)**

Retention in this program is based on the following performance standards in these “critical content courses: MAT 127 (C–), PHY 201 (C–), ETE 131 (C), ETE 271 (C), TED 280

(C+). A student who does not achieve these minimum performance standards and/or earns a grade of F in any other in-major course will be placed on the School of Engineering Academic Warning List.

The State of New Jersey currently requires a cumulative GPA of at least 3.00 for students to be recommended for certification, and a department requirement is that students in this major must maintain a GPA of at least 2.33 for any single academic semester. Students who do not achieve these minimum GPA milestones will be placed on the School of Engineering Academic Warning List. Placement on the Academic Warning List for two consecutive semesters or any three non-consecutive semesters will result in dismissal from the major.

Students dismissed from the major may appeal for re-entry into the major. Students dismissed from the major may not enroll in School of Engineering offerings with the exception of offerings that meet College Core program requirements.

Entrance (internal transfer) into this program from another program within the College is based upon meeting or exceeding the following performance standards: TED 280 (C+) and overall cumulative GPA  $\geq 2.75$ . Internal transfer within engineering programs will be permitted as long as enrollment limits are not exceeded.

## 2. iSTEM (Undergraduate)

Retention in this program is based on the following performance standards in these critical content courses: MAT 127 (C-) and ETE 271 (C). A student who does not achieve these minimum performance standards and/or earns a grade of F in any other in-major course will be placed on the School of Engineering Academic Warning List. In-major courses for this major are any professional (education/methods) or content (STEM) course required for the iSTEM major, including Specialization courses.

A cumulative GPA of 3.00 is required for TCNJ to recommend the student for certification to the New Jersey Department of Education. The department's requirement is that students in this major must maintain a GPA of at least 2.33 for any single academic semester. Students who do not achieve this minimum GPA milestone will be placed on the School of Engineering Academic Warning List. Placement on the Academic Warning List for two consecutive semesters or three non-consecutive semesters will result in dismissal from the major. Students dismissed from the major may appeal for re-entry into the major.

Entrance (internal transfer) into this program from another program within the College is based upon meeting or exceeding the following performance standards: MAT 105 or MAT 106 (C) and overall cumulative GPA  $\geq 3.00$ . Internal transfer within engineering programs will be permitted as long as enrollment limits are not exceeded.

## **Program Course Sequences**

### **1. Technology & Engineering Education (undergraduate degree program)**

Candidates for a teacher-education certificate must have a cumulative grade point average of at least 3.00 to complete the teaching preparation program, and should have a 3.00

cumulative GPA to enter their junior professional experience. They also must meet the state hygiene/physiology requirement; the state Harassment, Intimidation, and Bullying Prevention (HIB) training certificate requirement, and pass the appropriate PRAXIS examination before the New Jersey State Department of Education will issue the appropriate certificate. Teacher-education candidates will receive a “certificate of eligibility with advanced standing” which requires a candidate to be provisionally certified for his or her first year of teaching. After one year of successful teaching, the candidate is eligible for a permanent certificate.

Students should consult with their departmental advisers in planning their academic program. These plans should take into account requirements for the major, general education, professional courses, and state certification. All teacher candidates are officially accepted into the teacher education program as rising juniors. Entrance requirements include a cumulative 3.00 GPA, demonstration of basic skills competency (qualifying SAT, ACT, or Praxis Core scores), and satisfaction of departmental requirements. In order to be eligible for *institutional recommendation* for teacher certification, all candidates must successfully complete program requirements, attain a 3.00 cumulative GPA, and earn a minimum student teaching grade of B-. The department also requires a minimum grade of a B- in TED 380 and TED 480, as well as a minimum grade of a C+ in TED 280.

#### **Required Major Courses (College Core)**

TST 161/Creative Design (1 unit)  
 SPE 103/ Social & Legal Foundations of Special Education (1 unit)  
 MAT 127/Calculus A (1 unit)  
 PHY 201/General Physics I (1 unit)  
 SED 224/Adolescent Learning and Development (1 unit)  
 FYS First Year Seminar (1 unit)  
 FYW Academic Writing (0 units)  
 Quantitative Reasoning or Natural Science Elective (1 unit)  
 World Views and Ways of Knowing elective (1 unit)  
 Social Change in Historical Perspectives elective (1 unit)  
 Behavioral, Social, and Cultural Perspectives elective, or Social Change in Historical Perspective elective (1 unit)

#### **Required Major Courses (Technology & Engineering Education Core)**

ENG 144/Fundamentals of Engineering Design (0.5 unit)  
 ETE 145/Introduction to Engineering Design for Educators (0.5 unit)  
 ETE 131/Engineering Math for Educators (1 unit)  
 ETE 261/Multimedia Design (1 unit)  
 ETE 271/Structures and Mechanisms (1 unit)  
 ETE 275/Mechanics and Materials (1 unit)  
 ETE 281/Analog Circuits and Devices (1 unit)  
 ETE 341/Environmental and Biotechnology Systems (1 unit)  
 ETE 361/Architectural and Civil Engineering Design (1 unit)  
 ETE 365/Prototyping Lab (0.5 unit)  
 ETE 371/Mechanical Systems Design (1 unit)

- ETE 381/Digital Electronics (1 unit)  
 ETE 385/Controls and Robotics (0.5 unit)  
 ETE 395/Senior Design Proposal (0.5 unit)  
 ETE 461/Manufacturing Systems (1 unit)  
 ETE 492/Facilities Design and Management (1 unit)  
 ETE 495/Senior Design (1 unit)

### Required Major Courses (Professional Education)

- TED 280/Introduction to Teaching Technology & Engineering Education (1 unit)  
 TED 380/Junior Professional Experience in Technology & Engineering Education (1 unit)  
 TED 460/Integrated STEM for the Child/Adolescent Learner (1 unit)  
 TED 480 Content & Methods in Technology & Engineering Education (1 unit)  
 TED 481/Seminar in Technology & Engineering Education (1 unit)  
 TED 490/Student Teaching in Technology & Engineering (2 units)  
 RAL 328/Reading in Secondary Education (0.5 unit)

### Suggested Course Sequence Technology & Engineering Education

#### First Year (by advisement)

- |     |   |                 |
|-----|---|-----------------|
| FYS | First Year Seminar                                    | 1 course unit   |
| ENG | 144/Fundamentals of Engineering Design                | 0.5 course unit |
| ETE | 99/Orientation to Technology & Engineering Education  | 0 course units  |
| TST | 161/Creative Design                                   | 1 course unit   |
| ETE | 131/Engineering Math for Educators                    | 1 course unit   |
|     | MAT 120/Pre-calculus (if not exempt)*                 | 1 course unit   |
|     | MAT 95/Intermediate Algebra (if not exempt)*          | 0.5 course unit |
|     | College Core elective                                 | 1 course unit   |
| ETE | 261/Multimedia Design                                 | 1 course unit   |
| MAT | 127/Calculus A  | 1 course unit   |
| PHY | 201/General Physics I                                 | 1 course unit   |
| FYW | Academic Writing (if not exempt)*                     | 1 course unit   |
| ETE | 145: Introduction to Engineering Design for Educators | 0.5 course unit |

**Total for year** **8 course units**

*\*Students exempted from the FYW course should enroll in a College Core course.*

### Technology Minor

The minor consists of five units:

Required: TST 161/Creative Design

And select four of the following courses (with at least one 300-level course):

- ETE 131/Engineering Math for Educators
- ETE 261/Multimedia Design
- ETE 271/Structures and Mechanisms
- ETE 275/Mechanics and Materials
- ETE 281/Analog Circuits and Devices

- ETE 341/Environmental and Biotechnology Systems
- ETE 361/Architectural and Civil Engineering Design
- ETE 381/Digital Electronics
- ETE 461/Manufacturing Systems

## **2. iSTEM (undergraduate degree program)**

This disciplinary content major is open to students in the following education majors: Elementary Education, Early Childhood, Special Education, Deaf and Hard of Hearing, or Urban Education. The iSTEM disciplinary content major cannot be taken as a stand-alone major, and must be coupled with one of the above listed School of Education majors.

### **Required Major Courses (Content)**

- TST 161/Creative Design
- MAT 127/Calculus A
- ETE 261/Multimedia Design
- ETE 271/Structures and Mechanisms
- TED 460/Integrated STEM for the Child/Adolescent Learner

Note 1: There are other required courses in Math, Science and/or Technology & Engineering Education but depend on which Specialization a student chooses.

Note 2: A student is required to choose an area of (STEM) Specialization.

Note 3: There are 5 choices for a specialization: Technology, Mathematics, Biology, Chemistry, or Physics.

Note 4: Graduates of the iSTEM program are eligible for K–6 initial certification (Early Childhood majors receive PreK–3 certification but are also eligible for K–6 certification). Students in the major receive careful course advisement so that they qualify to add endorsements to teach middle school math and/or middle school science. Students seeking either or both of these endorsements must complete at least 15 credits of coursework in math and/or science, and must also pass the pertinent PRAXIS exam(s). Students who choose the Technology Specialization can also become eligible for K–12 certification in Technology & Engineering Education, in addition to K–6 certification with endorsements for middle school math and middle school science.

### **Suggested Course Sequence integrative STEM Education**

#### **Freshman Year (by advisement)**

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|-----|--|-----------------|
| FYS | First Year Seminar   | 1 course unit   |
| SPE | 099/Orientation to Education   | 0 course units  |
| TST | 161/Creative Design  | 1 course unit   |
| MAT | 105/Mathematical Structures & Algorithms for Education I<br>(or MAT 106/Mathematical Structures & Algorithms for Education II) | 1 course unit   |
| MAT | 120/Pre-calculus (if not exempt)*  | 1 course unit   |
| MAT | 095 Intermediate Algebra (if not exempt)*  | 0.5 course unit |
| MAT | 127/Calculus A   | 1 course unit   |
|     | Science Option #1 (by advisement)  | 1 course unit   |
| ETE | 261/Multimedia Design  | 1 course unit   |
| FYW | Academic Writing (if not exempt)*  | 1 course unit   |

\* Students exempted from these courses should enroll in other College Core courses.