PROGRAM ANNOUNCEMENT COVER PAGE

Date: 30 March 2021

Institution:	New Jersey Institute of Technology
New Program Title:	Materials Engineering
Degree Designation:	Bachelor of Science
Programmatic Mission Level for the Institution:	Public research university; doctoral
Degree Abbreviation:	B.S.
CIP Code and Nomenclature (*if possible*):	14.1801; Materials Engineering
Campus(es) where the program will be offered:	NJIT main campus, Newark, NJ
Date when program will begin (month and year):	September 2022
Institutions with which articulation agreements will be arranged:	N/A

Is licensure required of program graduates to gain employment? ☐Yes ☑No

Will the institution seek accreditation for this program? ☑Yes ☐No

If yes, list the accrediting organization:

Accreditation Board for Engineering and Technology (ABET)

PROGRAM ANNOUNCEMENT REVISED

The New Jersey Institute of Technology (NJIT) is proposing a Bachelor of Science degree in Materials Engineering. This degree will be offered by the O.H. York Department of Chemical and Materials Engineering (CME) that is within the Newark College of Engineering (NCE). The new Materials Engineering program will complement existing graduate programs in Materials Science and Engineering at NJIT. The anticipated start date for the Materials Engineering program is Fall 2022.

Materials Science and Engineering is an interdisciplinary field which combines elements of the physical sciences and engineering to solve technical problems relevant to nearly every aspect of modern society from safer, cleaner energy production and transport to smaller, faster microelectronics and telecommunications devices, to improved healthcare and biotechnology.

The proposed program will provide students with the necessary knowledge and skills in order to pursue a diverse array of careers in engineering and technology-based industries, government laboratories and regulatory agencies, as well as to pursue graduate degrees. Designed for students with a strong interest in engineering and the natural sciences, the B.S. in Materials Engineering program combines a strong knowledge in fundamental topics with extensive hands-on experiences in and out of the classroom. The proposed degree program builds heavily on existing strengths in the NCE, which has a large number of faculty who conduct research in areas of Materials Science and Engineering. In addition to the regular (non-cooperative education) version, the program will also offer a cooperative education (Co-Op) Option with two cycles. The Co-Op option will be a five-year program.

I. PROGRAM GOALS, OBJECTIVES, & OUTCOMES

Materials Science and Engineering is the study of the mechanical, physical, and chemical properties of engineering materials, such as metals, ceramics, polymers, and biomaterials. A materials engineer predicts and controls material properties through an understanding of atomic, molecular, crystalline, and microscopic structures of engineering materials. A materials engineer is an essential member of an engineering team responsible for synthesis and processing of advanced materials. The proposed B.S. in Materials Engineering program is designed to provide students with the necessary knowledge, skills, and professional training in order to pursue careers in the growing fields of Materials Science and Engineering with emphasis on careers in engineering and advanced technology. The program is based on 11 new courses and several existing courses (see sections VI and VII). The majority of these courses will be offered through the CME Department. The proposed B.S. degree in Materials Engineering program is designed to be ABET accredited.

IA. MATERIALS ENGINEERING PROGRAM GOALS

Materials engineers develop, process, and test materials used to create a wide range of products (Bureau of Labor Statistics, 2018). Students graduating with a baccalaureate degree in Materials Engineering should acquire the skills, knowledge, and professional training that enable them to pursue a career in technological companies that are based on, or related to, advanced materials development. Thus, programs in Materials Engineering must equip students with the requisite scientific knowledge and analytical skills in order to be successful in these endeavors (e.g., materials synthesis, characterization, and processing).

The proposed B.S. in Materials Engineering Program Announcement includes program goals, educational objectives, as well as student learning outcomes.

The program goals are to:

1. Equip students with skills, knowledge, and professional training to pursue a career in Materials Science and Engineering, with emphasis on engineering and advanced technology, and allow for continued professional growth. [PG1]
2. Support NJIT's strategic plan (see New Jersey Institute of Technology (2020)). The plan is titled *Building on a Strong Foundation – NJIT 2025 A Strategic Plan*. Specifically the Materials Engineering program supports the strategic plan's priorities related to student enrollment and retention (pp. 11-12); students' professional success (p. 13); and the creation of a diverse, global community (p. 18). [PG2]
3. Offer a Bachelor of Science in Materials Engineering program that satisfies the General Engineering Criteria and Materials Engineering Program Criteria of ABET. [PG3]

IB. PROPGRAM EDUCATIONALOBJECTIVES

The Materials Engineering program prepares students to apply their understanding of the structure, properties and processing of engineering materials essential to the realization of new ideas coming from engineers, scientists, enterprises, and society. The overarching objectives of the program are to equip graduates with the confidence that comes from a strong conceptual understanding of fundamentals, problem-solving skills and the tools needed to contribute meaningfully within any of the diverse professional career paths they may choose.

Since the discipline creates bridges between science and engineering, Materials Engineering majors must communicate effectively with people in many different specialties and work effectively in multi-disciplinary teams. Materials Engineering graduates must be aware of the economic, social, and environmental implications entailed in the processing and use of materials, and must have a solid grounding in professional engineering ethics.

The Program Educational Objectives (PEOs) of the Materials Engineering program are to:

1. Provide students a strong foundation in oral and written communication, teamwork experiences, and individual professionalism including ethics and environmental awareness. [PEO1]
2. Provide students with the skills for lifelong learning both within and outside the profession. [PEO2]
3. Provide students with the foundation necessary to succeed in materials-related industries or post graduate programs through a curriculum that includes in-depth instruction, the development of problem-solving skills, and exposure to open-ended real-world problems. [PEO3]

4. Provide students with the ability to think critically and to perform effectively within the profession. [PEO4]

IC. MATERIALS ENGINEERING STUDENT LEARNING OUTCOMES

In addition to goals and objectives, the proposed B.S. in Materials Engineering program includes two sets of student learning outcomes: (1) institutional (NJIT) and (2) those of the accrediting body (ABET).

Students earning a Bachelor of Science in Materials Engineering from NJIT will demonstrate proficiency in their abilities to:

1. **NJIT's General Education Requirement (GER) Learning Outcomes**
    a. Effectively communicate ideas orally and in writing, as informed by the tenets of a liberal arts education (Liberal Arts Literacy) [GER1]
    b. Use logical reasoning and a scientific approach to support conclusions based on empirical evidence (Scientific Literacy) [GER2]
    c. Form conclusions that are supported logically by the principles of qualitative and quantitative reasoning, probability, and statistics (Quantitative Literacy) [GER3]
    d. Demonstrate the ability to use computing systems in order to access, store, process and analyze information as an essential aspect of critical thinking and problem solving (Computing Literacy) [GER4]
    e. Identify and articulate the multifaceted relationships between the economic, social, and political forces that inform and structure society as well as an individual's place within it (Social Science Literacy) [GER5]

2. **ABET Student Outcomes**

    1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics [ABET1]
    2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors [ABET2]
    3. An ability to communicate effectively with a range of audiences [ABET3]
    4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts [ABET4]
    5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives [ABET5]
    6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions [ABET6]
    7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies [ABET7]

II. Program Evaluation & Student Outcomes Assessment Plans

All NJIT courses and degree programs are assessed regularly and systematically. The proposed B.S. in Materials Engineering program will be assessed in accordance with the institution's existing assessment standards and practices to ensure continual program improvement. Courses required in order to earn the B.S. in Materials Engineering will be evaluated in accordance with all applicable institutional and department-level academic assessment plan(s) and practices.

Formative and summative assessment will occur at multiple levels. The student learning outcomes represent dimensional operationalization of the program's objectives; thus, the assessment of one is inseparably linked to the evaluation of the other. The program objectives, in turn, are designed to meet the program goals, the evaluation of which will aid in confirming whether the program objectives and student learning outcomes are satisfactory and meaningful, and will also serve to identify areas for program improvement.

Both direct and indirect assessment methods will be used, including systematic analysis of coursework, course evaluations, student opinion reports, student surveys, student feedback sessions, exit interviews of graduating seniors, alumni surveys, internship reports, internship employer evaluations, advisory board surveys, and the results of the capstone experience.

At the institutional level, the Office of Institutional Effectiveness (OIE) is responsible for assessment oversight at NJIT. The OIE works with individual academic divisions and units in order to assess academic programs on an annual basis in an effective and reliable manner. Figure 1 displays a summary of the assessment and evaluation plans.

The proposed B.S. in Materials Engineering program is designed to be ABET accredited. All programs seeking accreditation from ABET must demonstrate that they satisfy all of the following General Criteria for Baccalaureate Level Programs (Criteria for Accrediting Engineering Programs, 2019-2020).

1. **Students** Student performance must be evaluated. Student progress must be monitored to foster success in attaining student outcomes, thereby enabling graduates to attain program educational objectives. Students must be advised regarding curriculum and career matters.
2. **Program Educational Objectives** The program must have published program educational objectives that are consistent with the mission of the institution, the needs of the program's various constituencies, and these criteria. There must be a documented, systematically utilized, and effective process, involving program constituencies, for the periodic review of these program educational objectives that ensures they remain consistent with the institutional mission, the program's constituents' needs, and these criteria.
3. **Student Outcomes** The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering.

4. **Continuous Improvement** The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the continuous improvement of the program.
5. **Curriculum** The curriculum requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The program curriculum must provide adequate content for each area, consistent with the student outcomes and program educational objectives, to ensure that students are prepared to enter the practice of engineering. The curriculum must include:
6. **Faculty** The program must demonstrate that the faculty members are of sufficient number and they have the competencies to cover all of the curricular areas of the program. There must be sufficient faculty to accommodate adequate levels of student-faculty interaction, student advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners, as well as employers of students.
7. **Facilities** Classrooms, offices, laboratories, and associated equipment must be adequate to support attainment of the student outcomes and to provide an atmosphere conducive to learning. Modern tools, equipment, computing resources, and laboratories appropriate to the program must be available, accessible, and systematically maintained and upgraded to enable students to attain the student outcomes and to support program needs. Students must be provided appropriate guidance regarding the use of the tools, equipment, computing resources, and laboratories available to the program.
8. **Institutional Support** Institutional support and leadership must be adequate to ensure the quality and continuity of the program. Resources including institutional services, financial support, and staff (both administrative and technical) provided to the program must be adequate to meet program needs. The resources available to the program must be sufficient to attract, retain, and provide for the continued professional development of a qualified faculty. The resources available to the program must be sufficient to acquire, maintain, and operate infrastructures, facilities, and equipment appropriate for the program, and to provide an environment in which student outcomes can be attained.

The curriculum must prepare graduates to apply the sciences, computational techniques and engineering principles to materials systems; to integrate the understanding of the scientific and engineering principles underlying the four major elements of the field: structure, properties, processing, and performance; to apply and integrate knowledge from each of the above four elements of the field using experimental, computational, and statistical methods to solve materials problems including selection and design. In addition, the faculty expertise must encompass the four major elements in the field.

ABET requires a plan for Continuous Improvement of accredited programs. Development of this plan will be overseen by the Materials Engineering Curriculum Committee (see section VI Faculty). The Continuous Improvement process for the new program will be adapted from that currently used by the Chemical Engineering Program. This process will entail having the Industrial Advisory Board (IAB) approve the Program Educational Objectives (PEOs) along with the Materials Engineering Curriculum Committee identifying performance indicators for each ABET student outcome listed in Section IC. Course coordinators will develop specific student learning objectives and an assessment rubric for each MTEN course that will allow instructors to measure performance indicators at the course level. Examples of assessment rubrics for two MTEN courses are given in Appendices A and B. Each year, approximately 10 core courses in the curriculum will be assessed by the course coordinators/instructors using the assessment rubrics and will include the collection of student work. The evaluation will be based on the performance indicators for each ABET student outcome. These evaluations will be performed by the course coordinator/instructor at the course level. The Materials Engineering Curriculum Committee will collect, organize, and analyze the assessment materials and evaluate the performance indicators for each ABET student outcome to make an overall determination as to whether each ABET student outcome is satisfactorily met at the program level. In this process, the Materials Engineering Curriculum Committee will also assess and evaluate data collected from both direct and indirect assessment methods, besides the aforementioned systematic analysis of coursework, such as course evaluations, student opinion reports, student surveys, student feedback sessions, exit interviews of graduating seniors, alumni surveys, internship reports, internship employer evaluations, advisory board surveys, and the results of the capstone experience. Based on the totality of these evaluations, continuous improvement in course content, delivery approaches, structure as well as other curricular changes (e.g., prerequisite/corequisite changes, and course description changes) will be implemented for future offerings both at the course level and at the program level. Finally, these improvements will be presented to the CME faculty and IAB for approval or revision. The curricular change requests will be brought to the Committee on Undergraduate Education (CUE) for approval, followed by Faculty Senate and Provost approvals for implementation in the subsequent academic year.

Programs requesting an initial ABET accreditation review must have at least one graduate prior to the academic year when the on-site review occurs.

Tables 1 and 2 present the assessment plans for the program goals, and program educational objectives and student outcomes, respectively, designed to achieve institution and accreditation requirements.

Figure 1. Program Evaluation and Outcomes Assessment Hierarchical Summary

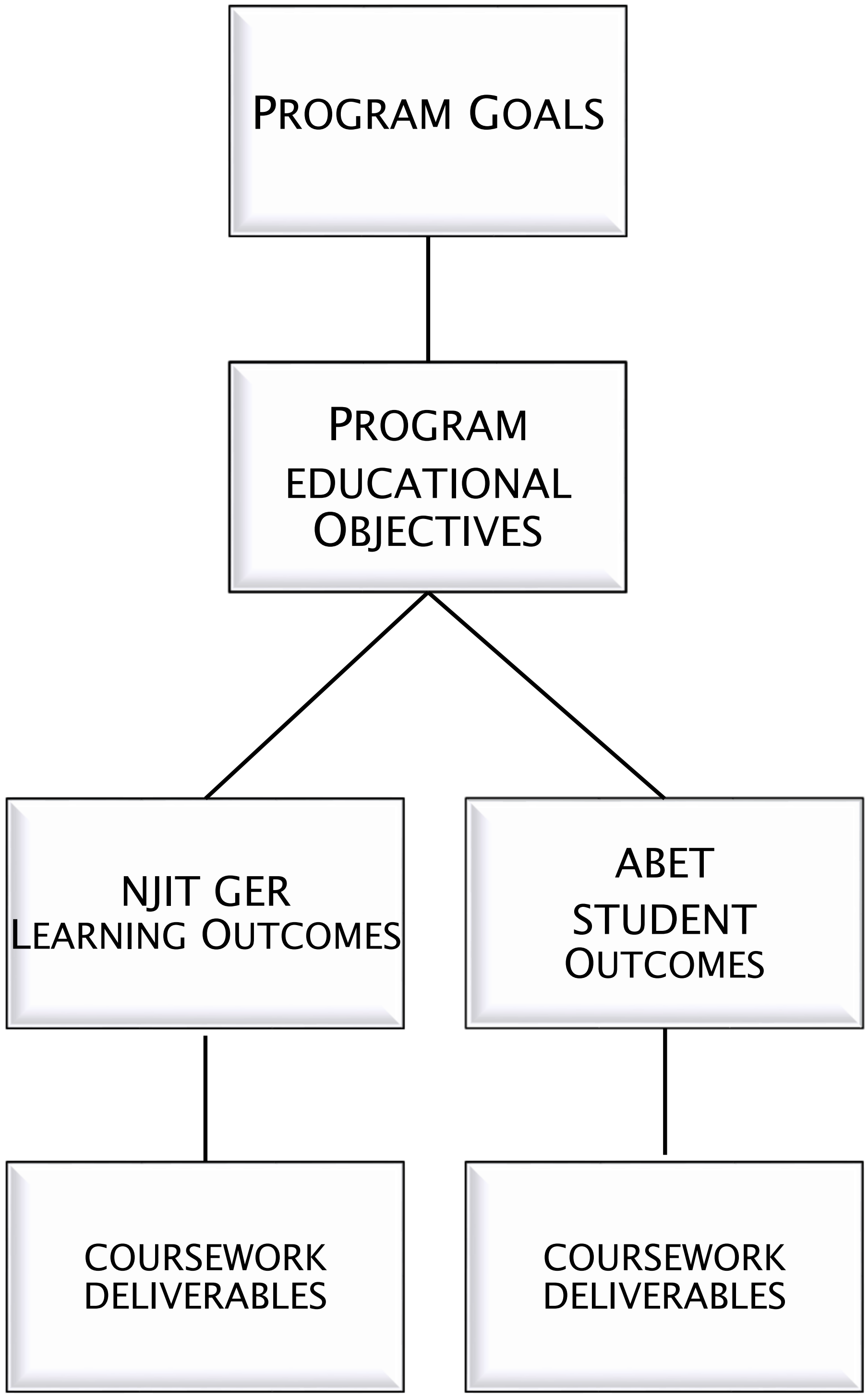

Table 1. Evaluation of Program Goals

	PROGRAM GOALS	MEASURES
1.	**PG1:** Equip students with the skills, knowledge and professional training to pursue a career in Materials Science and Engineering and allow for continued professional growth.	• Student satisfaction surveys, and student feedback sessions • Student, alumni, and employer surveys ascertaining employment, career placement, and career advancement • Exit interviews • Degree completion data
2.	**PG2:** To support *Building on a Strong Foundation – NJIT 2025 A Strategic Plan*. Specifically, the Materials Engineering program supports the strategic plan's priorities related to student enrollment and retention, students' professional success, and the creation of a diverse, global community.	• Appropriate institutional and state-level (i.e., AIC/NJPC) approvals • Enrollment and retention data • Successful recruitment and enrollment of gender and racially diverse students • Surveys ascertaining employment and salary 1, 5, and 10 years after graduating the program
3.	**PG3:** To offer a Bachelor of Science in Materials Engineering that satisfies the General Engineering Criteria and Materials Engineering Program Criteria of ABET.	• Accreditation by ABET

Table 2. Curriculum Map & Assessment of Student Outcomes

PROGRAM EDUCATIONAL OBJECTIVE	STUDENT OUTCOMES	COURSE(S)	ASSESSMENT
1. **PEO1:** Provide students an introduction to communication techniques, teamwork and individual professionalism including ethics and environmental awareness.	• **GER1**: Effectively communicate ideas orally and in writing, as informed by the tenets of a liberal arts education. • **GER5**: Identify and articulate the multifaceted relationships between economic, social, and political forces that inform and structure society as well as an individual's place within it. • **ABET2**: An ability to apply engineering design to produce solutions that meet the specified needs with consideration of public health, safety, and welfare as well as global, cultural, social environmental, economic factors. • **ABET3**: An ability to communicate effectively with a wide range of audiences • **ABET4**: An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements , which must consider the impact of engineering solutions in global, economic, and societal contexts. • **ABET5**: An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	HUM 101 & 102 FED 101 200-level HIST *or* HUM course 300-level HIST *or* HUM courses 400-level HIST *or* HUM courses PHIL 334 ENG 352 MTEN 395 MTEN 450 MTEN 496	• Capstone experience report • Case studies with rubrics • Final projects with rubrics • Objective exam results • Oral & written assignments with rubrics • Lab reports with rubrics
2. **PEO2:** Provide students with the skills for lifelong learning both within and outside the profession.	• **GER2**: Use logical reasoning and a scientific approach to support conclusions based on empirical evidence. • **GER3**: Form conclusions that are supported logically by the principles of qualitative and quantitative reasoning, probability, and statistics. • **ABET1**: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science and mathematics. • **ABET6**: An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement	CS 105 CHEM 124, 125, 126 & 243 PHYS 111, 111A, 121, 121A & 234 MATH 111, 112, 211, 222 & 333 ENGR 301 MTEN 395 MTEN 496	• Case studies with rubrics • Final projects with rubrics • Lab reports with rubrics • Objective exam results • Oral & written assignments with rubrics

	to draw conclusions. • **ABET7**: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.		
3. PEO3: Provide students with the foundation necessary to succeed in materials-related industries or post graduate programs through a curriculum that includes in-depth instruction, the development of problem-solving skills, and exposure to open-ended real-world problems.	• **GER4**: Demonstrate the ability to use computing systems in order access, store, process, and analyze information as an essential aspect of critical thinking and problem solving. • **ABET1**: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science and mathematics. • **ABET6**: An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	BME 304 ENGR 301 IE 492 ME 438 MTEN 201 MTEN 205 MTEN 301 MTEN 305 MTEN 310 MTEN 311 MTEN 395 MTEN 410 MTEN 450 MTEN 460 MTEN 496	• Capstone experience report • Case studies with rubrics • Final projects with rubrics • Lab reports with rubrics • Objective exam results • Oral & written assignments with rubrics • Research papers with rubrics
4. PEO4: Provide students with the ability to think critically and to perform effectively within the profession.	• **ABET1**: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science and mathematics. • **ABET6**: An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. • **ABET7**: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	ENGR 301 MTEN 310 MTEN 311 MTEN 395 MTEN 410 MTEN 450 MTEN 460 MTEN 496	• Case studies with rubrics • Final projects with rubrics • Lab reports with rubrics • Objective exam results • Oral & written assignments with rubrics

III. RELATIONSHIP TO INSTITUTIONAL STRATEGIC PLAN & INSTITUTIONAL IMPACT

The proposed B.S. in Materials Engineering program has the appropriate university approvals and the institutional support necessary for its implementation. The program is strongly aligned with NJIT's strategic priorities, as identified in *Building on a Strong Foundation – NJIT 2025 A Strategic Plan*:

1. Students: Increase enrollment and retention (pp. 11-12)
2. Learning: Focus on professional outcomes of degree programs (p. 13)
3. Community: Foster a global, inclusive, and diverse student community (pp. 11-12,18)

Nationally, the number of students interested in engineering degrees has increased since 2010 and represents approximately 10% of the total number of students pursuing college degrees; the state of New Jersey represents about 9% of the total number of students pursuing college degrees (College Board, 2015, 2107). Significant growth in materials engineering programs has occurred in terms of the number of enrolled students as well as the number of degrees awarded in the past decade. In the period 2011-16, the increase in undergraduate enrollment across the US is approximately 30%, with larger increases in R1 universities compared to non-R1 universities (Kimel and Sinnott, 2018). From the same study, the number of degrees awarded from 2008-2016 in Materials Science and Engineering increased by 80% compared to an increase in 50% for all engineering degrees (Kimel and Sinnott, 2018). This rapid growth is due in part to the attractiveness of materials engineering to undecided and transfer students. It stands to reason that the introduction of a materials engineering degree program at NJIT would help the university meet its goal to increase enrollment and retain students in the State of New Jersey, as there is currently only one B.S. in Materials Engineering program offered in the state (see section IV).

The market need and high earning potential for materials engineers are discussed in the next section. However, it is important to note that students graduating from ABET-accredited programs are well prepared for careers in numerous fields, including government laboratories and regulatory agencies, and to pursue graduate degrees in STEM, medicine, or law. Thus, a degree program in materials engineering will undoubtedly serve to bolster NJIT's reputation for conferring high-(Return on Investment) ROI degrees.

Finally, a degree program in materials engineering will aid in the university's mission to foster a global, inclusive, and diverse student community, especially with respect to women in STEM. According to a report by the ASEE, the percentage of women earning a B.S. in Materials Science and Engineering was 32% compared to 22% for all engineering disciplines in 2018 (Roy, 2018), which represents an increase from 30% in 2013 (Roy, 2013). Coupled with the above-average wages earned by practitioners in this field, Materials Science and Engineering has the potential to make a positive impact on the traditional narrative about science, gender, and wage equity.

Impact on Existing Programs

There is currently no program at NJIT that parallels the proposed B.S. degree in Materials Engineering. Existing programs in Biomedical, Chemical, Civil, Electrical, and Mechanical Engineering will benefit from the availability of new elective courses. Also, with the existence of a M.S. degree program in Materials Science and Engineering, it is anticipated that students from the new B.S. may participate in a 4+1 program available at NJIT (known as BS/MS program).

In 2018, a graduate program in *Materials Science and Engineering – Engineering Option* was initiated within the NCE with M.S. and Ph.D. degrees offered by the CME Department. This program parallels a previously existing graduate program offered by the Physics Department in the College of Science and Liberal Arts. It is noteworthy that highly ranked graduate programs in Materials Science and Engineering in the U.S. are in departments that also have strong, accredited undergraduate programs. In light of this, it is not surprising that Materials Science and Engineering departments at the University of Virginia and University of Delaware, where graduate programs have existed for many years, are now starting B.S. degree programs. It is anticipated that the new B.S. degree program in Materials Engineering at NJIT will enhance the existing graduate program.

IV. NEED

As discussed in the recent National Academies of Sciences, Engineering, and Medicine report (2019) entitled *Frontiers of Materials Research: A Decadal Survey*, Materials Science and Engineering impacts national security, health, and renewable energy technology. The broad field of materials research is fundamentally connected to the needs and interests of the industrial sector, and it is essential for the U.S. to maintain leadership among developed and developing countries in key economic drivers such as smart manufacturing and materials science. Clearly, there will be a great demand for professionals with training in Materials Science and Engineering in the foreseeable future.

The economy of the state of New Jersey has significant components related to the field of Materials Science and Engineering. In 2017, roughly two-thirds of the state's economy was in manufacturing and in professional, scientific and technical services. These broad areas employ a significant number of professionals with expertise in Materials Science and Engineering. In particular, the advanced manufacturing industry, which makes up approximately 6% of the state's economy (New Jersey Department of Labor & Workforce Development), is heavily dependent on Materials Science and Engineering.

IVA. OCCUPATIONAL GROWTH

Employment numbers for materials engineers have steadily increased in the past decade. Projections for the first half of this decade indicate increases ranging from 1.3% (Bureau of Labor Statistics, 2018) to 1.9% (Projection Central). These estimates are below trends for all engineering (4-5%) and all occupations (5%). The projected growth rate for employment of Materials Engineers in the state of New Jersey is somewhat higher at 6% (Projection Central). In addition, given the highly interdisciplinary nature of Materials Science and Engineering, it may be difficult to identify the number of employees and jobs in this field within different industries. The median annual wage for materials engineers was $92,930 for the U.S. and $87,750 for New Jersey in 2018 (see Table 3). This compares well to the average annual wage for all engineering disciplines $80,170 in 2018. The median wage for all occupations in 2018 was $38,640.

Table 3. Federal, State, and Local Wages for Materials Scientists and Engineers (BLS, 2018)

LOCATION	PAY PERIOD	10%	25%	MEDIAN	75%	90%
United States	Hourly	$27.46	$34.60	$44.42	$57.39	$71.21
	Yearly	$57,110	$71,960	$92,930	$119,360	$148,110
New Jersey	Hourly	$28.45	$34.07	$42.19	$53.11	$61.79
	Yearly	$59,180	$70,870	$87,750	$110,460	$128,520
New York	Hourly	$30.53	$37.15	$47.19	$59.99	$72.34
	Yearly	$63,490	$77,270	$98,160	$124,780	$150,460
Pennsylvania	Hourly	$26.27	$33.28	$42.23	$49.69	$62.10
	Yearly	$54,640	$69,220	$87,830	$103,360	$129,160

IVB. Relationship to Other Programs in the State & Region

There are approximately 115 undergraduate degree programs in materials science (and engineering) within the U.S. At present, there is one accredited Materials Science and Engineering program in the State of New Jersey that is offered by Rutgers University. The nearest ABET-accredited institutions offering a B.S. degree in Materials Science and Engineering are displayed in Table 4b. It should be noted that the program offered by the University of Delaware began in the Fall of 2020. Also note that Stevens Institute of Technology, Stony Brook University, and Binghamton University only have graduate (MS & PhD) programs in Materials Science and Engineering.

Table 4a. State ABET Accredited B.S. Programs in Materials Science & Engineering

Institution	Program
Rutgers University (New Brunswick, NJ)	B.S. in Materials Science & Engineering

Table 4b. Regional ABET Accredited B.S. Programs in Materials Science & Engineering

Institution	Program
Drexel University (Philadelphia, PA)	B.S. in Materials Science & Engineering
University of Pennsylvania (Philadelphia, PA)	B.S. in Materials Science & Engineering
Lehigh University (Lehigh, PA)	B.S. in Materials Science & Engineering
University of Delaware (Newark, DE)	B.S. in Materials Science & Engineering
University of Connecticut (Storrs, CT)	B.S. in Materials Science & Engineering
Alfred University (Alfred, NY)	B.S. in Materials Science & Engineering
Rensselaer Polytechnic Institute (Rensselaer, NY)	B.S. in Materials Science & Engineering
Cornell University (Cornell, NY)	B.S. in Materials Science & Engineering

V. Student Enrollment

As discussed in section III, undergraduate programs in materials engineering have seen significant growth in terms of the number of enrolled students as well as the number of degrees awarded in the past decade. In the period 2011-16, the increase in undergraduate enrollment across the U.S. is approximately 30% (Kimel and Sinnott, 2018). Also, the number of degrees awarded from 2008-2016 in Materials Science and Engineering increased by 80% compared to an increase in 50% for all engineering degrees (Kimel and Sinnott, 2018).

Across the US, enrollment in B.S. degree programs in Materials Science and Engineering is roughly 2% of the total enrollment in engineering. For NJIT, this corresponds to an enrollment of approximately 85 students. Projections for the proposed B.S. in Materials Engineering program are based both on this statistic and the anticipated demand. Also included in these projections are a retention rate of 80%, which is a conservative estimate based on recent data from NCE. With program marketing to capitalize on innate interest in the degree program, we estimate that the program will have at least 30 students by the end of the second academic year that it is offered. Building on this momentum, we project an increase of approximately 20 majors per year in Years 3, 4, and 5.

Given the discipline of Materials Science and Engineering may be less familiar to the target audience compared to other engineering disciplines, the successful recruitment of students will require close collaboration with NJIT's Office of University Admissions. A recruitment effort is planned which includes outreach to school counselors in high schools with large NJIT-bound students, targeted on-line ads, fliers, a separate booth (or virtual room) in NCE Open Houses, and wide distribution of promotion literature.

Table 5. B.S. in Materials Engineering Enrollment Projections, AYs 2022-2027

Academic Year	New Freshmen Enrollment	Transfer Student Enrollment	Total Enrollment
2022-2023	10	0	10
2023-2024	17	5	30
2024-2025	18	5	50
2025-2026	17	5	70
2026-2027	18	5	90

Admission Requirements

The requirements for admission to the B.S. in Materials Engineering program for new students and for transfer students are those of NCE, which include the general admission and academic policies of NJIT (https://catalog.njit.edu/undergraduate/academic-policies-procedures/). Matriculated NJIT students may transfer to the Materials Engineering Program if they have a minimum GPA of 2.0.

VI. PROGRAM RESOURCES

Course Development

NJIT is in a strategic position to launch a degree-granting program in Materials Engineering. This new program will benefit from the existence of established engineering programs within NCE and from the extensive of natural science and mathematics courses offered by various departments in the CSLA.

NJIT currently offers courses to satisfy all the ABET-mandated natural science and mathematics course criteria. In several cases, existing courses offered by various NCE departments have been identified for inclusion in the new program. The bulk of the program is based on 11 new courses that have been developed by a committee comprised of NCE faculty that have been approved by the relevant NJIT shared governance bodies. This development has also had input from the CME department's Undergraduate Curriculum & Accreditation Committee (UCAC) and Industrial Advisory Board (see Table 6).

The proposed B.S in Materials Engineering program includes new courses serving as core courses in the Materials Engineering program:

MTEN 201: Introductory Principles of Materials Engineering

This course provides a broad introduction to materials engineering topics, including atomic structure and bonding, structure and properties of metals, polymers, ceramics and composites, phase diagrams and phase transformations, and applications of materials. Pre-requisites: FED 101, CHEM 126, PHYS 121 or PHYS 122, MATH 112.

MTEN 205 Mechanical Behavior of Materials

Basic concepts of stress, strain, structure of materials, the microstructure connection to mechanical properties, and ultimately failure mechanisms; Specific interest will be defects within materials, defect formation/evolution, and their role in strengthening mechanisms; Material anisotropy, micromechanisms, and elasto-plastic properties at the atomic, single crystal/constituent, and polycrystal/material levels and their use in explaining the deformation and failure characteristics in metals, polymers, and ceramics; Failure mechanisms and toughening in composites; Structure and behavior of engineering materials: metal alloys, ceramic-matrix composites, and fiber-reinforced polymer composites. Particular topics: elastic deformation, dislocation mechanics, plastic deformation and strengthening mechanisms, creep, and fracture mechanics. Pre-requisites: MATH 211 or MATH 213, MTEN 201, MECH 234.

MTEN 301 Thermodynamics of materials

Laws of thermodynamics and their correlation with molecular phenomena describing materials systems in equilibrium. Applications to properties, reactions and phase equilibria in materials. Thermodynamic foundation, interpretation and utilization of binary phase diagrams. Contemporary software for phase diagram calculation. Thermodynamic principles describing liquid and solid solutions, chemical reactions, and order-disorder phase transitions. Pre-requisites: MATH 211 or MATH 213, PHYS 234, MTEN 205.

MTEN 305 Materials characterization methods

This course will introduce methods of characterization for a diverse range of material properties, including mechanical, electrical, and optical as well as characterization of material structures and compositions. Characterization of hardness, strength, electrical conductivity, emissivity and absorptivity will be discussed. Principles of optical, electron, and atomic force microscopy will be discussed. Principles of x-ray diffraction and x-ray, IR, UV, electron and ion spectroscopies will be introduced considering interaction of materials with electromagnetic radiation, electrons, and ions. Finally, principles of thermal analysis will be introduced. The lecture component will be supplemented by experiments involving measurements of mechanical strength and electrical conductivity of test material samples. Hands on exposure to optical and electron microscopy and x-ray diffraction will also be available. Pre-requisites: MATH 211 or MATH 213, PHYS 234, CHEM 243, MTEN 205.

MTEN 310 Transport Phenomena in Materials I

This course introduces the concepts of transport phenomena and develops the balance equations for the transport of mass, momentum, and energy. Classical force-flux relations that include Newton's law of viscosity and Fourier's law are considered. These equations, along with suitable boundary conditions, are applied to fluid mechanics and heat transfer problems relevant to materials characterization and processing. This includes laminar flows of both Newtonian and non-Newtonian fluids, conduction in solids, convective heat transfer, and phase change in single-component materials. Pre-requisites: MATH 222, PHYS 234, CHEM 243, MTEN 205.

MTEN 311 Transport Phenomena in Materials II

This course continues the development and application of the equations of transport phenomena and includes balance equations for transport at interfaces. Classical constitutive equations that include Fick's law and the Nernst-Planck equation as well as expressions for both homogeneous and heterogeneous chemical reaction are considered. These equations, along with suitable boundary conditions, are applied to multi-component and charged systems that are relevant to materials characterization and processing. This includes diffusion, chemical reaction, charge and coupled transport, and phase change in multi-component materials. Pre-requisites: MTEN 301, MTEN 310.

MTEN 395 Materials Engineering Lab I

Characterization of the structure and properties of materials through hands-on experiments that include microscopy, optical spectroscopy, thermal and mechanical testing. Instruction on basic laboratory skills, safety, statistical analysis of data, use of laboratory notebooks and technical report writing. Pre-requisites: MATH 333, MTEN 301, MTEN 305, MTEN 310.

MTEN 410 Soft Materials

This course is an introduction to soft materials such as polymers, colloids, liquid crystals, gels, and biomaterials. The course will cover the structure, properties, and applications of soft materials. Specific topics will include kinetics in material synthesis/growth, assembly, phase behavior, phase transitions, dynamics, characterization techniques, and applications. Pre-requisites: CHEM 126, PHYS 121, MTEN 205.

MTEN 450 Materials Engineering Design

This course will cover the processing/structure/property/performance relations of a wide range of materials, including metals, ceramics, polymers and composite materials. Case studies in material selection, rational design, and applications will be presented and discussed. The challenges associated with environmental protection, material degradation and health/safety concerns will also be discussed. Pre-requisites: MATH 333, MTEN 301, MTEN 305, MTEN 311.

MTEN 460 Materials Processing

This course gives an introduction to fundamental concepts and principles in materials processing, including processing of metals, polymers, and ceramics. This course summarizes the processing fundamentals to manufacture and shape materials from melt, solid, power, solution and dispersion, and vapor. In addition, the effects of processing and processing parameters on structure and properties of the final product are explained. Conventional and advanced manufacturing approaches are discussed. Pre-requisites: MTEN 301, MTEN 305, MTEN 310.

MTEN 496 Materials Engineering Lab II

Processing, structure, properties relationships are explored through a series of hands-on experiments that involves ceramics, semiconductor, polymeric and composite materials. Instruction on basic laboratory skills, safety, statistical analysis of data, use of laboratory notebooks and technical report writing. Pre-requisites: FED 101, MTEN 301, MTEN 305, MTEN 310.

Course proposal forms including detailed syllabi for all of these courses are complete and have been voted on and approved by NJIT’s Committee on Undergraduate Education (CUE) per university new course proposal and development protocol.

Faculty

Within the CME Department, there are currently faculty with expertise in the area of Materials Science and Engineering. These faculty would be able to teach several of the new MTEN courses that constitute the new degree program in Materials Engineering. Several of the new courses ideally would be taught by new faculty with specialized knowledge and skills. Furthermore, the addition of 11 new required courses will necessitate the hiring of additional faculty. To that end, faculty searches were carried out in the 2018-19 and 2019-20 Academic Years during which three faculty (Venerus, Young & Zhao) were hired. Furthermore, during the 2020-2021 Academic Year, a faculty search has resulted in the hire of a Dr. Kerri-lee Chintersingh, who will begin her tenure-track position in Fall 2021. It is anticipated that 5-6 new faculty will be required by 2022 to teach the courses required to offer the new degree.

An NCE-wide Materials Engineering Curriculum Committee has been charged with overseeing the program development and is chaired by the Program Director Professor David Venerus:

1. David Venerus (Chemical and Materials Engineering)
2. Ed Dreizin (Chemical and Materials Engineering)
3. Murat Guvendiren (Chemical and Materials Engineering)

4. Boris Khusid (Chemical and Materials Engineering)
5. Josh Young (Chemical and Materials Engineering)
6. Matthew Adams (Civil and Environmental Engineering)
7. Dibakar Datta (Mechanical and Industrial Engineering)
8. Haim Grebel (Electrical and Computer Engineering)
9. Vivek Kumar (Biomedical Engineering)
10. Sam Lieber (School of Applied Engineering Technology)

The director of the program, a faculty member, will serve as the Program's academic and career advisor as well as the cooperative education (co-op) coordinator. As the program grows, the need for additional academic support staff in areas of academic advising and co-op coordination will be assessed with the expectation that a dedicated advisor will be brought on for the program.

Research & Synergistic Activities

A significant number of faculty within NCE conduct research in the field of Materials Science and Engineering, providing opportunities for student research and additional experiential learning. The faculty are listed in Table 6 and include faculty from the departments of Biomedical Engineering (BME), Chemical and Materials Engineering (CME), Civil and Environmental Engineering (CEE), Electrical and Computer Engineering (ECE), Mechanical and Industrial Engineering (MIE), and the School of Applied Engineering Technology (SAET). The faculty are working in forefront areas of Materials research including biomaterials, computational, energy and storage, nanotechnology, particulate and composites, and polymeric and soft materials.

Table 6. NCE Materials Faculty

1	Matthew Adams	CEE	Cement based materials
2	Fatemah Ahmadpoor	MIE	2D materials
3	Treena Arinzeh	BME	Tissue Engineering, Biomaterials Processing, Materials Testing
4	Lisa Axe	CME	Nanomaterials in Natural and Engineered Environmental Systems
5	Matthew Bandelt	CEE	Cement based materials
6	Sagnik Basuray	CME	Micro/Nano Systems and Nanotechnology
7	Ecevit Bilgili	CME	Particle Engineering and Pharmaceutical Nanotechnology
8	Namas Chandra	BME	Mechanics of biomaterials, material interface interaction, blast mechanics
9	Shawn Chester	MIE	Multi-physics behavior of polymeric materials
10	Dibakar Datta	MIE	Modeling of Energy Storage, Nanomaterials for Biological Problems
11	Rajesh Dave	CME	Particle Engineering and Pharmaceutical Nanotechnology
12	Edward Dreyzin	CME	Synthesizing new materials mechanochemically
13	Samaneh Faokhirad	MIE	CFD, Lattice Boltzmann Method, Collloidal & Interface Science
14	Gennady Gor	CME	Modeling materials on atomistic or molecular level
15	Jonathan Grasman	BME	Biomaterial development and Regenerative Medicine
16	Haim Grebel	ECE	Carbon based nanoscale devices and systems
17	Murat Guvendiren	CME	Polymeric biomaterials for tissue engineering
18	Boris Khusid	CME	Microfluidics, colloids, micro-organisms
19	Dong Kyun Ko	ECE	Quantum dot based materials and devices
20	Vivek Kumar	BME	Tissue Engineering, Self-assembling peptides, synthetic biochemistry, drug delivery
21	Alice Eun Jung Lee	BME	Cardiovascular Tissue Engineering & Applied Mechanics, Stem Cells
22	Samuel Lieber	SAET	Additive Manufacturing
23	Kathleen McEnnis	CME	Designing better particles for drug delivery
24	Durga Misra	ECE	Nanoscale devices
25	Hieu Pham Trung Nguyen	ECE	Nitride-based semiconductor nanostructures for optoelectronics and energy applications
26	Bryan Pfister	BME	Applied Biomaterials and Behavior, Tissue Engineering, Tissue Mechanics
27	Bipin Rajendran	ECE	Novel materials & devices for next-generation computing
28	Kam Sirkar	CME	Membranes
29	Leonid Tsybeskov	ECE	Group IV semiconductor nanostructures and nano-devices
30	David Venerus	CME	Transport phenomena in soft matter, polymer science
31	Xianqin Wang	CME	Nanomaterials for Energy and Environmental applications
32	Xiaoyang Xu	CME	Biomaterials and nanotechnologies for medical applications
33	Joshua Young	CME	Materials design, energy materials, electronic materials
34	Meng-Qiang (Mark) Zhao	CME	2D & nanomaterials for electronics and energy applications
35	Wen Zhang	CEE	Sustainable nanomaterials for water treatment

Industrial Advisory Board

In order to address the program's long-term goals and objectives, the Department of Chemical & Materials Engineering and the Office of the Dean in the Newark College of Engineering have assembled an Industrial Advisory Board of engineering practitioners to provide feedback and guide the development of the program. The Industrial Advisory Board is comprised of professionals from the chemical and materials industry (Table 7), but future members will be recruited from materials-related corporations and from academia. Examples of board functions include providing feedback and guidance on curriculum, assisting with internships and placement, assisting with project-identification, and mentoring students.

Table 7. NJIT Department of Chemical & Materials Engineering Industrial Advisory Board

MEMBER	POSITION TITLE	POSITION AFFILIATION
Mr. Ilgaz Akseli	Director	Pharmaceutical Sci & Tech, Celgene Corporation, Summit, NJ
Mr. Michael Bober Jr.	Consultant	MB Consulting
Mr. Greg Czerwienski	Field Service Engineer	OSIsoft LLC, Bayonne, NJ
Dr. Lucas Dorazio	Team Leader	Gasoline Technologies, BASF Corporation, Iselin, NJ
Mr. Karthik Eticala	Head of Supply Chain Management	3M, Health Care Business Group, Medical Solutions Division, Flemington, NJ
Ms. Christine Farner	Technical Executive	Life Sciences Exyte Inc.
Dr. Ronald Gabbard	Director, Delivery Systems	International Flavors & Fragrances Inc., Union Beach, NJ
Ms. Elizabeth Garcia	retired	Infineum
Mr. Steve Misner	retired	Colgate-Palmolive
Mr. Vince Patram	Global Distribution Director	Industrial and Specialty Products, U.S. Silica, Frederick, MD
Dr. Andrei Potanin	Manager, Associate Director	Colgate-Palmolive, Piscataway, NJ
Dr. Patrick Robinson	Team Leader	Process Controls & Modeling, Phillips 66-Bayway Refinery, Linden, NJ
Mr. Robert Rossi	Consultant	North Bergen NJ
Mr. Joseph Shatynski	Senior Director	Daiichi Sankyo Inc. Basking Ridge, NJ
Mr. Jack Shea	Director, Corporate Development	Merck & Co., Inc., Doylestown, PA
Mr. Peter Sibilski	Plant Manager	Pharmetic Manufacturing Co., Sayreville, NJ
Mr. Vikram Singh	Lead Fractionation Specialist	ExxonMobil, Baytown, TX
Ms. Monique Sprueill	Senior Manager	Strategy, Insights & Innovation Johnson & Johnson

Facilities and Resources

Education in Materials Science and Engineering is heavily based on hands-on laboratory experiences. NJIT's proposed B.S. in Materials Engineering program involves exposure to and participation in laboratory activities in nearly every semester. Plans are underway to develop a state-of-the-art undergraduate teaching laboratory to support this program.

This new laboratory will be used throughout the undergraduate program beginning with the FED 101 Fundamentals of Engineering Design course in the first year and continuing with second- and third-year lab experiences in MTEN 205 Mechanical Behavior of Materials and MTEN 305 Characterization of Materials. Two dedicated laboratory courses MTEN 395 Materials Engineering Lab I and MTEN 496 Materials Engineering Lab II will be taught exclusively in the new laboratory. Both of these courses will consist of seven distinct laboratory modules that will cover property measurement and structural characterization for material classes that include biomaterials, ceramics, composites, energetic and energy generation materials, metallics and alloys nanomaterials and polymeric/soft materials.

Laboratory Space and Instrumentation

A list of instruments and devices required for the laboratory is given below. The total cost of the equipment is estimated to be $1.3 M. The laboratory will include adequate counter space as most of the equipment will be of the table-top configuration. For some of the equipment, vibration isolation tables are required. The counter space will also have adequate storage space and access to electrical service (both 120 V and 208 V), compressed air and vacuum connections, and several sinks (with the tap meeting the U.S. EPA National Primary Drinking Water Regulations). The laboratory will also have two standard-size fume hoods. The total space required for the laboratory is 2500 sqft. Ideally, the main laboratory (1000 sqft) will be connected to two smaller laboratories (500 sqft each). One of the smaller laboratories will house Sample Preparation equipment, and the second will house some of the more sensitive Imaging and Structural Characterization instruments. The main laboratory will house the remainder of the equipment. An additional lecture and meeting space (500 sqft) will include a projection area, white boards, and seating for students.

1. Mechanical Property Measurement
    a. Modulus, Yield Strength
    b. Hardness
    c. Impact
    d. Rheology

2. Thermal Property Measurement
    a. Thermal Gravimetric Analysis (TGA)
    b. Differential Scanning Calorimetry (DSC)
    c. Dynamic Mechanical Analysis (DMA)

3. Transport Property Measurement
    a. Electrical Conductivity
    b. Rheology

c. Thermal Conductivity
d. Thermoelectric Coefficient
e. Dynamic Light Scattering

4. Imaging and Structural Characterization
    a. Microscope (stage, x-polarized)
    b. Atomic Force Microscope (AFM)
    c. Scanning Electron Microscope (SEM)
    d. X-ray Diffraction (XRD)
    e. Gel Permeation Chromatography (GPC)
    f. UV/VIS Spectrophotometer
    g. Fourier Transform Infrared (FTIR) Spectrophotometer

5. Sample Preparation (2 hoods)
    a. Oven/Furnace
    b. Ball Mill
    c. Mounting
    d. Slicing/cutting
    e. Polishing
    f. Press
    g. Balances
    h. Sputter Coater

Operating Budget

A budget of $65,000/year will be required to maintain equipment and carry service agreements (where appropriate). A budget of $35,000 will be required for consumable items in the operation of some equipment. An annual budget of $80,000 for capital renewal costs will also be required to offset equipment depreciation.

Staff

A Laboratory Director, Dr. Rees Rankin, has been hired for the installation and maintenance of equipment. This individual will also be responsible to train students on the use of all laboratory equipment and assist in teaching laboratory courses.

VII. Degree Requirements

The accreditation of engineering programs by ABET requires students pursuing a B.S. in an engineering to complete the following coursework:

- Natural Sciences & Mathematics (at least 30 credit hours)
- Broad Education
- Engineering Coursework (40-45 credit hours)
- Capstone Design Course

Individual institutions may make decisions about which classes comprise each of the above concentrations, but must do so within the parameters as articulated by ABET in order to qualify for accreditation.

In addition to the above areas, all undergraduate degree-seeking NJIT students must satisfy the university's General Education Requirements (GER). The GER is comprised of five thematic areas of knowledge and skills that the university has deemed essential to broadening students' critical thinking and increasing their exposure to subjects beyond the scope of their selected degree programs. The thematic areas and corresponding requisite credit hours are as follows:

- Liberal Arts Literacy (18 credit hours)
- Computing Literacy (3 credit hours)
- Social Science Literacy (3 credit hours)
- Scientific Literacy (7 credit hours)
- Quantitative Reasoning/Mathematics (6 credit hours)

The core requirements of the proposed curriculum for the Materials Engineering program will satisfy the Scientific Literacy and Quantitative Reasoning/Mathematics components of the GER. The required course CS 115 satisfies the Computational Literacy component of the GER. Furthermore, elective courses in humanities and social sciences along with PHIL 334 will satisfy the Liberal Arts Literacy and IE 492 will satisfy the Social Science Literacy requirements of the GER. NJIT's GER satisfy the Broad Education requirement mandated by ABET.

A summary of the curriculum for the proposed program is given in Table 8. A course grid for the proposed program is displayed in Tables 9-11, where red text indicates new courses that have been developed. In the proposed Materials Engineering degree, students will have the option to complete the curriculum through a five-year Co-op program following the Cycle A or Cycle B schedules (Tables 10 and 11) developed and used for existing programs in NCE.

Please note that all course grids make use of the following shorthand: "GER" = *General Education Requirement;* "HIST/HUM Course" = *a course in either the Departments of History or Humanities that has been designated as satisfying the Liberal Arts Literacy component of the GER*; "CS or SS Course" = *Computer Science or Social Science course to fulfill the corresponding component of the GER*; and "ULE" = *upper-level elective*

Table 8. Degree Requirements Overview

CHEMISTRY CORE (10 hrs)
CHEM 125: General Chemistry I (3)
& CHEM 125A: General Chemistry Lab I (1)
CHEM 126: General Chemistry II (3)
CHEM 243: Organic Chemistry I (3)

PHYSICS CORE (11 hrs)
PHYS 111: Physics I (3)
& PHYS 111A: Physics I Lab (1)
PHYS 121: Physics II (3)
& PHYS 121A: Physics II Lab (1)
PHYS 234: Physics III (3)

MATHEMATICS CORE (18 hrs)
MATH 111: Calculus I (4)
MATH 112: Calculus II (4)
MATH 211: Calculus III (3)
MATH 222: Differential Equations (4)
MATH 333: Probability & Statistics (3)

GENERAL EDUCATION REQUIREMENTS (37 hrs)
Liberal Arts Literacy (18) HUM 101: English Comp. I, HUM 102 English Comp. II, ENG 352: Tech. Writing, PHIL 334: Eng. Ethics, and two HIST/HUM electives
Computing Literacy (3) CS 115: Intro to CS I in C++
Social Science Literacy (3) IE 492: Eng. Management
Scientific Literacy (7) – satisfied by science core
Quantitative Reasoning/Math (6) – satisfied by math core

MISCELLANEOUS COURSES (7 hrs)
ENGR 210: Career Planning Seminar for Eng (1)
ENGR 301: Eng. Applications of Data Science (3)
MECH 234: Engineering Mechanics: Statics (3)

MATERIALS ENGINEERING CORE (41 hrs)
Complete all of the following:
FED 101: Fundamentals of Engineering Design (1)
MTEN 201: Principles of Materials Engineering (3)
MTEN 205: Mechanical Behavior of Materials (3)
MTEN 301: Thermodynamics of Materials (3)
MTEN 305: Materials Characterization Methods (4)
MTEN 310: Transport in Materials I (3)
MTEN 311: Transport in Materials II (3)
MTEN 395: Materials Engineering Lab I (3)
MTEN 410: Soft Materials (3)
MTEN 450: Materials Engineering Design (3)
MTEN 460: Materials Processing (3)
MTEN 496: Materials Engineering Lab II (3)
BME 304: Material Fundamentals of Biomedical Eng (3)
ME 438: Physical Metallurgy (3)

TECHNICAL ELECTIVES (9 hrs)
At least two 300-level or above courses from BME, CE CHE, ECE or ME programs, which may include Independent Study Courses MTEN 491 and MTEN 492

Table 9. B.S. in Materials Engineering Program

	First Year	
	1st Semester	
CHEM 125	General Chemistry I	3
CHEM125A	General Chemistry Laboratory	1
FED 101	Fundamentals of Engineering Design	2
HUM 101	English Composition: Writing, Speaking, Thinking I	3
MATH 111	Calculus I	4
FRSH SEM	Freshman Seminar	0
PHYS 111	Physics I	3
PHYS 111A	Physics I Laboratory	1
	Term Credits	17
	2nd Semester	
CHEM 126	General Chemistry II	3
HUM 102	English Composition: Writing, Speaking, Thinking II	3
MATH 112	Calculus II	4
PHYS 121	Physics II	3
PHYS 121A	Physics II Laboratory	1
	Term Credits	14
	Second Year	
	1st Semester	
MTEN 201	Principles of Materials Engineering	3
MECH 234	Engineering Mechanics: Statics	2
CHEM 243	Organic Chemistry I	3
PHYS 234	Physics III	3
MATH 211	Calculus III A	3
	Term Credits	14
	2nd Semester	
MTEN 205	Mechanical Behavior of Materials	3
CS 115	Intro. to CS I in C++	3
Elective	Humanities and History GER (200 level)[2]	3
ENGR 210	Career Planning Seminar for Eng.	1
MATH 222	Differential Equations	4
	Term Credits	14

Table 9. B.S. in Materials Engineering Program

Third Year

	1st Semester	
MTEN 301	Thermodynamics of Materials	3
MTEN 310	Transport in Materials I	3
MTEN 305	Materials Characterization Methods	4
ENG 352	Technical Writing	3
MATH 333	Probability and Statistics	3
	Term Credits	16
	2nd Semester	
MTEN 311	Transport in Materials II	3
MTEN 395	Materials Engineering Lab I	3
BME 304	Material Fundamentals of Biomedical Eng.	3
ME 438	Physical Metallurgy	3
ENGR 301	Eng. Applications of Data Science	3
	Term Credits	15

Fourth Year

	1st Semester	
MTEN 410	Soft Materials	3
MTEN 496	Materials Engineering Lab II	3
PHIL 334	Engineering Ethics and Technology Practice	3
Technical Elective[1]		3
Technical Elective[1]		3
	Term Credits	15
	2nd Semester	
MTEN 450	Materials Engineering Design	3
MTEN 460	Materials Processing	3
IE 492	Engineering Management	3
Technical Elective[1]		3
Humanities and Social Sciences (upper-level) Capstone GER[3]		3
	Term Credits	15
	Total Credits	120

Table 10. CoOp Option A Track B.S. in Materials Engineering Program

	First Year	
	1st Semester	
CHEM 125	General Chemistry I	3
CHEM125A	General Chemistry Laboratory	1
FED 101	Fundamentals of Engineering Design	2
HUM 101	English Composition: Writing, Speaking, Thinking I	3
MATH 111	Calculus I	4
FRSH SEM	Freshman Seminar	0
PHYS 111	Physics I	3
PHYS 111A	Physics I Laboratory	1
	Term Credits	17
	2nd Semester	
CHEM 126	General Chemistry II	3
HUM 102	English Composition: Writing, Speaking, Thinking II	3
MATH 112	Calculus II	4
PHYS 121	Physics II	3
PHYS 121A	Physics II Laboratory	1
	Term Credits	14
	Second Year	
	1st Semester	
MTEN 201	Principles of Materials Engineering	3
MECH 234	Engineering Mechanics: Statics	2
CHEM 243	Organic Chemistry I	3
PHYS 234	Physics III	3
MATH 211	Calculus III A	3
	Term Credits	14
	2nd Semester	
MTEN 205	Mechanical Behavior of Materials	3
CS 115	Intro. to CS I in C++	3
Elective	Humanities and History GER (200 level)[2]	3
ENGR 210	Career Planning Seminar for Eng.	1
MATH 222	Differential Equations	4
	Term Credits	14

Table 10. CoOp Option A Track B.S. in Materials Engineering Program

	Third Year	
	1st Semester	
ENGR 310	Co-op Work Experience	12
	Term Credits	**12**
	2nd Semester	
MTEN 301	Thermodynamics of Materials	3
MTEN 310	Transport in Materials I	3
MTEN 305	Materials Characterization Methods	4
ENG 352	Technical Writing	3
MATH 333	Probability and Statistics	3
	Term Credits	16
	Fourth Year	
	1st Semester	
ENGR 410	Co-op Work Experience	12
	Term Credits	12
	2nd Semester	
MTEN 311	Transport in Materials II	3
MTEN 395	Materials Engineering Lab I	3
BME 304	Material Fundamentals of Biomedical Eng.	3
ME 438	Physical Metallurgy	3
ENGR 301	Eng. Applications of Data Science	3
	Term Credits	15
	Fifth Year	
	1st Semester	
MTEN 410	Soft Materials	3
MTEN 496	Materials Engineering Lab II	3
PHIL 334	Engineering Ethics and Technology Practice	3
Technical Elective[1]		3
Technical Elective[1]		3
	Term Credits	15

2nd Semester

MTEN 450	Materials Engineering Design	3
MTEN 460	Materials Processing	3
IE 492	Engineering Management	3
Technical Elective[1]		3
Humanities and Social Sciences (upper-level) Capstone GER[3]		3
	Term Credits	15
	Total Credits	144

Table 11. CoOp Option B Track B.S. in Materials Engineering Program

	First Year	
	1st Semester	
CHEM 125	General Chemistry I	3
CHEM125A	General Chemistry Laboratory	1
FED 101	Fundamentals of Engineering Design	2
HUM 101	English Composition: Writing, Speaking, Thinking I	3
MATH 111	Calculus I	4
FRSH SEM	Freshman Seminar	0
PHYS 111	Physics I	3
PHYS 111A	Physics I Laboratory	1
	Term Credits	17
	2nd Semester	
CHEM 126	General Chemistry II	3
HUM 102	English Composition: Writing, Speaking, Thinking II	3
MATH 112	Calculus II	4
PHYS 121	Physics II	3
PHYS 121A	Physics II Laboratory	1
	Term Credits	14
	Second Year	
	1st Semester	
MTEN 201	Principles of Materials Engineering	3
MECH 234	Engineering Mechanics: Statics	2
CHEM 243	Organic Chemistry I	3
PHYS 234	Physics III	3
MATH 211	Calculus III A	3
	Term Credits	14
	2nd Semester	
MTEN 205	Mechanical Behavior of Materials	3
CS 115	Intro. to CS I in C++	3
Elective	Humanities and History GER (200 level)[2]	3
ENGR 210	Career Planning Seminar for Eng.	1
MATH 222	Differential Equations	4
	Term Credits	14

Table 11. CoOp Option B Track B.S. in Materials Engineering Program

	Third Year	
	1st Semester	
MTEN 301	Thermodynamics of Materials	3
MTEN 310	Transport in Materials I	3
MTEN 305	Materials Characterization Methods	4
ENG 352	Technical Writing	3
MATH 333	Probability and Statistics	3
	Term Credits	16
	2nd Semester	
ENGR 310	Co-op Work Experience	12
	Term Credits	12
	Fourth Year	
	1st Semester	
MTEN 311	Transport in Materials II	3
MTEN 395	Materials Engineering Lab I	3
BME 304	Material Fundamentals of Biomedical Eng.	3
ME 438	Physical Metallurgy	3
ENGR 301	Eng. Applications of Data Science	3
	2nd Semester	
ENGR 410	Co-op Work Experience	12
	Term Credits	12
	Fifth Year	
	1st Semester	
MTEN 410	Soft Materials	3
MTEN 496	Materials Engineering Lab II	3
PHIL 334	Engineering Ethics and Technology Practice	3
Technical Elective[1]		3
Technical Elective[1]		3
	Term Credits	15

2nd Semester

MTEN 450	Materials Engineering Design	3
MTEN 460	Materials Processing	3
IE 492	Engineering Management	3
Technical Elective[1]		3
Humanities and Social Sciences (upper-level) Capstone GER[3]		3
	Term Credits	15
	Total Credits	144

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Appendix

Course Assessment Rubrics for

MTEN 201 Principles of Materials Engineering

MTEN 310 Transport Phenomena in Materials I

Assessment Rubric for MTEN 201 – *semester*
By *Instructor Name*

Course Learning Outcome/Attribute	No Proficiency 1	Some Proficiency 2	Proficient 3	Superior Proficiency 4	Avg. Score	ABET Student Outcomes	Assessment Tools
Students will be able to identify, formulate, and solve complex materials engineering problems related to metals, ceramics, and polymers by applying principles of engineering, science, and mathematics.	No ability to identify, formulate, and solve materials engineering problems	Some ability to identify, formulate, and solve materials engineering problems	Fully able to identify, formulate, and solve complex materials engineering problems	Superior ability to identify, formulate, and solve complex materials engineering problems		**1**	HWK, Quiz, Exam
Students will develop ability to apply materials engineering design (structure-property relationships) to engineer materials that meet specified needs.	No ability to apply materials engineering design to engineer materials that meet specified needs.	Some ability to apply materials engineering design to engineer materials that meet specified needs.	Fully able to apply materials engineering design to engineer materials that meet specified needs.	Superior ability to apply materials engineering design to engineer materials that meet specified needs.		**2**	HWK, Quiz, Exam
Students will identify impact of materials engineering advances in global, cultural, social, environmental, and economic context.	No ability to identify impact of materials engineering advances in global, cultural, social, environmental, and economic context.	Some ability to identify impact of materials engineering advances in global, cultural, social, environmental, and economic context.	Fully able to identify impact of materials engineering advances in global, cultural, social, environmental, and economic context.	Superior ability to identify impact of materials engineering advances in global, cultural, social, environmental, and economic context.		**4**	HWK, Quiz, Exam

Students will be able to analyze and interpret materials related data (such as structure, processing, etc.) and use engineering judgment to draw conclusions on end use properties (including mechanical, optical, thermal, and electrical properties)	No ability to analyze and interpret materials related data and use engineering judgment to draw conclusions on end use properties.	Some ability to analyze and interpret materials related data and use engineering judgment to draw conclusions on end use properties.	Fully able to analyze and interpret materials related data and use engineering judgment to draw conclusions on end use properties.	Superior ability to analyze and interpret materials related data and use engineering judgment to draw conclusions on end use properties.		**6**	HWK, Quiz, Exam
Overall Average							

Assessment of MTEN 201 Principles of Materials Engineering

semester

Instructor Name

Course Description

This course introduces the basic concepts of Materials Engineering, and covers introductory topics including structure, property, performance, and processing of materials. This course focuses on conventional materials including metallic materials and their alloys, ceramics, polymers, and composites. Relationship between structure and material properties, such as mechanical, electronic, thermal, optical, magnetic, and electrochemical, are investigated with a particular interest on ways to engineer material structures to produce desired set of properties. Broader themes associated with the property, processing and performance of materials that influence the economy, environment, and society are discussed.

Overall Assessement

Report average scores for each Student Learning Outcome, overall average for course, and final grades distribution. Brief discussion of overall instructor experience for the course.

Teaching philosophy

Brief discussion of teaching philosophy and approaches used for the course

What worked the Best

Brief discussion of teaching approaches and activities that were succesful for the course.

Area of Improvements

Brief discussion of changes in teaching approaches and activities that are reccommended for future offerings of the course

Assessment Rubric for MTEN 310 – *semester*
By *Instructor Name*

Student Learning Outcome/Attribute	**No Proficiency 1**	**Some Proficiency 2**	**Proficient 3**	**Superior Proficiency 4**	**Avg. Score**	**ABET Student Outcomes**	**Assessment Tools**
Students are able to formulate conservation laws for mass, momentum and energy as differential transport equations.	No ability to formulate conservation laws for mass, momentum and energy as differential transport equations.	Some ability to formulate conservation laws for mass, momentum and energy as differential transport equations.	Fully able to formulate conservation laws for mass, momentum and energy as differential transport equations.	Superior ability to formulate conservation laws for mass, momentum and energy as differential transport equations.		**1,7**	HWK, Quiz, Exam
Students are able to formulate classical constitutive laws for momentum and energy transport and identify transport coefficients such as viscosity and thermal conductivity.	No ability to formulate classical constitutive laws for momentum and energy transport and identify transport coefficients such as viscosity and thermal conductivity.	Some ability to formulate classical constitutive laws for momentum and energy transport and identify transport coefficients such as viscosity and thermal conductivity.	Fully able to formulate classical constitutive laws for momentum and energy transport and identify transport coefficients such as viscosity and thermal conductivity.	Superior ability to formulate classical constitutive laws for momentum and energy transport and identify transport coefficients such as viscosity and thermal conductivity.		**1,7**	HWK, Quiz, Exam
Students are able to formulate boundary conditions for fluid flow and heat transfer problems.	No ability to formulate boundary conditions for fluid flow and heat transfer problems.	Some ability to formulate boundary conditions for fluid flow and heat transfer problems.	Fully able to formulate boundary conditions for fluid flow and heat transfer problems.	Superior ability to formulate boundary conditions for fluid flow and heat transfer problems.		**1,7**	HWK, Quiz, Exam

Students are able to apply dimensional analysis to find limiting forms of the transport equations.	No ability to apply dimensional analysis to find limiting forms of the transport equations.	Some ability to apply dimensional analysis to find limiting forms of the transport equations.	Fully able to apply dimensional analysis to find limiting forms of the transport equations.	Superior ability to apply dimensional analysis to find limiting forms of the transport equations.		**1,7**	HWK, Quiz, Exam
Students are able to solve and interpret solutions of transport problems for fluid flow and heat transfer relevant to materials processing applications.	No ability to solve and interpret solutions of transport problems for fluid flow and heat transfer relevant to materials processing applications.	Some ability to solve and interpret solutions of transport problems for fluid flow and heat transfer relevant to materials processing applications.	Fully able to solve and interpret solutions of transport problems for fluid flow and heat transfer relevant to materials processing applications.	Superior ability to solve and interpret solutions of transport problems for fluid flow and heat transfer relevant to materials processing applications.		**1,7**	HWK, Quiz, Exam
Overall Average							

Assessment of MTEN 310 Transport Phenomena in Materials I
semester
Instructor Name

Course Description
This course introduces the concepts of transport phenomena and develops the balance equations for the transport of mass, momentum, and energy. Classical force-flux relations that include Newton's law of viscosity and Fourier's law are considered. These equations, along with suitable boundary conditions, are applied to fluid mechanics and heat transfer problems relevant to materials characterization and processing. This includes laminar flows of both Newtonian and non-Newtonian fluids, conduction in solids, convective heat transfer, and phase change in single-component materials.

Overall Assessement
Report average scores for each Student Learning Outcome, overall average for course, and final grades distribution. Brief discussion of overall instructor experience for the course.

Teaching philosophy
Brief discussion of teaching philosophy and approaches used for the course

What worked the Best
Brief discussion of teaching approaches and activities that were succesful for the course.

Area of Improvements
Brief discussion of changes in teaching approaches and activities that are reccommended for future offerings of the course