New Jersey Institute of Technology
University Heights
Newark, NJ 07102-1982

Newark College of Engineering
Fenster Hall Suite 280
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ENGR320
_Prototyping Essentials

NJIT
NEWARK COLLEGE OF ENGINEERING

1. Course Name (Number): Prototyping Essentials (ENGR 320)

2. Course Structure: 2hr lecture, 2hr lab, 3 credits

3. Course Coordinator: Mr. D. Brateris

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4. Instructional Materials: Other supplemental materials: Course materials provided by instructor on Learning Management System. Students may be required to purchase some materials for projects or assessments, as material usage is up to students in many assignments. The cost of completing the class is approximately comparable to that of a text book.

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5. Specific Course Information

a. Course Description: This course introduces students to the fundamental skills, equipment, safety procedures, theory, and mindset required to prototype and test basic mechanical and electrical systems as part of the engineering and product design process. Students learn basic prototyping skills starting with hand tools and moving to computer-controlled cutting, shaping, and measurement equipment such as 3D printers, water jets, lasers, mills, and lathes. Students learn to use software to design components, develop and interpret prints, and program fabrication and inspection machinery. Students learn resilience by definitely having to do things more than once. Entrepreneurial concepts, budget, and economic factors associated with prototyping are discussed and examined. Laboratory exercises require students to design, model, fabricate, and validate components and systems. The course concludes with a final project requiring students to design and produce a physical project in the NJIT Makerspace.

b. Prerequisites: Math 111 or Math 113 or Math 138 or (Math110 and ENGR 101) or (Math 107 and Arch 156)

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6. Educational Objectives for the Course

a. Course Outcomes: By the end of the course students are able to:

1. Follow all shop safety procedures and participate in continuous safety improvement processes.
2. Approach unfamiliar techniques and equipment with the goal of understanding how they can be used to accomplish specific outcomes. Practice using these tools and techniques critically, with the intention of improving outcomes.
3. Read project briefs for comprehension, then formulate a plan for achieving stated goals using tools and techniques covered in class.
4. Cope with undesirable outcomes in a timely manner, using thoughtful analysis to identify and improve/replace under-performing elements of the design. Iteration is mandatory for good outcomes on most projects.
5. Use hand tools safely to perform prototyping tasks.
6. Design and model components in CAD software.
7. Generate and interpret engineering prints and drawings.
8. Select appropriate hand measurement instruments for evaluating physical features and perform measurements and validation.
9. Select appropriate prototyping materials and parts.
10. Describe and understand the capabilities and limitations of common prototyping equipment and processes.
11. Program and operate prototyping equipment such as wood working equipment, metal working equipment, 3D printers, laser cutters, water jets, milling and turning machines, CNC machines, and others.
12. Produce a prototype part or system which includes planning, cost and time estimation, selection of appropriate processes and equipment, fabrication of parts, and validation.

b. Student Outcomes: The Course Learning Outcomes support achievement of the following Student Outcomes from the EAC of ABET Criterion 3 requirements:
Student Outcome 6: an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. (Course Outcome 2, 4)
Student Outcome 7: an ability to acquire and apply new knowledge as needed, using appropriate learning strategies (Course Outcomes 2, 3)

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7. Course Topics:

- Safety Procedures & PPE
- Calipers, Micrometers, Pins, Gauges
- Inspection & Validation
- Engineering Prints
- 3D Printing
- Engineering Materials
- CNC Basics
- Entrepreneurial Prototypes
- Hand Tools
- CAD Software
- Precision and Tolerance
- CAM Software
- Laser Cutting
- Fasteners
- Milling & Turning
- Project Budgets

Grading:

Attendance and Professionalism:	**5%**
Assignments:	**40%**
Midterm:	**25%**
Final Exam/Project:	**30%**

A :	**100% - 92%**
B+:	**91% - 88%**
B :	**87% - 82%**
C+:	**81% - 77%**
C :	**76% - 70%**
D :	**69% - 60%**
F :	**59% - 0%**

Withdrawal Policy:

Carefully monitor dates if you plan to exercise your option to withdraw from the course. Withdraw dates are listed in the academic calendar located at: http://www.njit.edu/registrar/calendars/

Attendance Policy:

Attendance is necessary for success in this class and is required. Required machine training will be conducted during class and lab time. If you are absent during class or lab it is the students responsibility to schedule makeup training outside of class time. Makeup training may not be immediately available and could lead to an inability to operate machinery required for assignments. If more than three classes are missed without excused absences, a failing grade will be issued.

If you expect to be absent contact the instructor ahead of time, preferably more than 48 hours prior to class time. If you are absent unexpectedly or due to planned medical or substantial family or personal matters, please contact the NJIT Dean of Students Office (doss@njit.edu) to determine if the absence can be considered excused. Documentation will be required.

Late Assignment Policy:

Late assignments will be penalized according to the scale:

- 0 to 24 hours late –80% maximum credit
- 24 to 48 hours late – 75% maximum credit
- More than 48 hours late – 50% maximum credit
- More than 1 week late - not graded

Academic Integrity:

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf

Please note that it is the instructor's professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

Generative AI:

We welcome the use of generative AI tools, so long as they are relegated to the roles of research and inspiration. Students are required to disclose all sources of inspiration in each assignment's Project Roadmap documentation.
The instructor's policy for ENGR320 is that all student work be authored by the student. This goes for all physical, digital, written, and presented materials that constitute a student's "coursework".

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Modification to Course:

The Course Outline may be modified at the discretion of the instructor or in the event of extenuating circumstances. Students will be notified in class of any changes to the Course Outline.

Course Calendar:
(Subject to Update)

Class #	Topic	Homework Assignment
Week 1	Introduction, Makerspace Walkthrough, Make101, Foam Core Excercise	Foamcore mechanism design & fab
Week 2	Parametric Drawing in Fusion360, Introduction to basic 3D CAD operations & reading technical drawings	Desktop organizer
Week 3	Make102, CO2 laser cutters, design considerations for making close-tolerance parts, basic metrology	Laser-cut assembly
Week 4	Make202, fiber laser cutter, vector drawing software	Wallet multi-tool
Week 5	Make261, vacuum thermo-former, design considerations and CAD modeling techniques for 3-axis mold making	Vacuum thermo-forming tool model
Week 6	CNC, introduction to Fusion CAM, machine setup and operation	CNC milled mold and thermo-formed part
Week 7	Threading, drill press, acrylic cement, gaskets	Liquid-tight container
Week 8	Midterm	
Week 9	Microcontrollers	Arduino-controlled electronic device
Week 10	Make103, FDM printing, modeling for additive manufacturing	Functional 3D-printed part for in-class competition
Week 11	Design considerations and techniques for modeling functional joints in 3D printed components	"The Gizmo"
Week 12	Woodshop fundamentals, reading a tape measure	Laptop stand
Week 13	Soldering, basic electronic tools	Electronic assembly and soldering project
Week 14	Addressing model appearance	Final project assigned
Week 15		