

ISE 555, Digital Manufacturing Fall 2021, 3 credit hours

Prof. Binil Starly, Office: Room 4353 Fitts Woolard Hall; Tel: 919-515-1815; Email: bstarly@ncsu.edu
136 Monteith Research Center and Online, (T-Th, 11.45am – 1.00pm)

Course Purpose: Digital technologies influence every stage of product manufacturing, beginning from its conceptualization, to manufacturing on a shop floor, its use by consumers and final disposal. Advances in computing, artificial intelligence, automation and robotics and human-computer interaction have disrupted current manufacturing processes from the individual shop floor to the enterprise level. This digital connectivity between designers, production managers, supply chain vendors and the physical industrial machines that produce the product will undoubtedly improve productivity. This course is first in a series of Smart Manufacturing related courses, which aims to introduce students on the power of digital manufacturing and design technologies, particularly how product data can seamlessly transfer through the entire lifecycle of a manufactured product. This class will specifically focus on digitally enabled technologies that enhance product development through specific technology theory and practical training in Reverse Engineering, Machining Simulation, Design Automation via Programming. All hands-on simulation and virtual manufacturing will be in Autodesk Fusion 360, a cloud based design and manufacturing software.

Course Learning Objectives: By the end of this course, the student will be able to:

- Describe the underlying data structures behind 3D Engineering CAD Models (B-rep and CSG)
- Utilize foundational and advanced CAD/CAM tools to design and virtually simulate machining of products in Autodesk Fusion 360, a cloud-based CAD/CAE/CAM software.
- Practice the reverse engineering reconstruction process, building from 3D point cloud scans to 3D models.
- Describe Product Model Information (PMI) and Model Based Definition of Discrete Products.
- Create Fusion 360 Plugins/Apps to interact with 3D Models for Design and Manufacturing Workflows using the Python Programming language.
- Describe the Digital Twin Architecture and benefits to manufacturing

Prerequisites

Any graduate student in Engineering is eligible to take this course. Knowledge of any CAD or 3D Modeling software is preferred. Prior Programming logic experience (any one of VB, Python or C++) is preferred. Senior undergraduate students in Engineering are welcome provided they have had a previous undergraduate course related to design and manufacturing processes. Industrial Engineering students in particular should have completed ISE 316.

Textbook Downloads

No required textbook for the course. Since there is no single book available, the instructors will make available references to complement lecture content. Fusion API programming will be done in Python. References/online videos will be provided to students to obtain a crash course learning of Python fundamentals.

Laptop Requirements

Students are required to bring their OWN LAPTOPS to class. You are expected to install the freely available Autodesk FUSION product for completion of homework assignments. Instructions will be provided on how to obtain the software for your own desktop/laptop.

Grading Components:

Homework Assignments (30%), In-Class/Forum Participation (15%), Take-Home Examination (25%), End of Semester Project (30%);

Office Hours:

ON CAMPUS STUDENTS: By email appointment (for one-on-one discussion)

EOL Students: By email appointment (for one-on-one discussion)

Virtual Meeting Slots during the following times can enable multiple students to join at once.
Please notify instructor ahead of time.

Dr. Binil Starly's Personal Zoom Meeting Room: Link Available via Moodle Course Site

Day	Prof. Starly
Monday	4.30PM – 6.00PM
Tuesday	4.30PM – 6.00PM
Wednesday	X
Thursday	X
Friday	X
Saturday	10.00AM – 11.00AM
Sunday	X

* TIMESLOTS MAY BE UPDATED (Please Check Moodle for UPDATES)

* NCSU Login ID required

* ALL TIMES ARE USA EASTERN

TENTATIVE LECTURE AGENDA (subject to minor date changes)

Note: this syllabus is not a contract and can be altered at any point with advanced notice to accommodate the educational goals of the Course

Date		LECTURE TOPIC
Aug	Wk 1	Lecture: Digital Design & Manufacturing & Intro to Class
		Lecture: CAD Architecture (B-Rep, CSG, Curves, Surfaces in CAD) – 1
	Wk 2	Lab: Solid Design in Autodesk Fusion – 1 (Refresh CAD Skills)
		Lecture: CAD Architecture (B-Rep, CSG, Curves, Surfaces in CAD) – 2
	Wk 3	Lecture: CAD Architecture (B-Rep, CSG, Curves, Surfaces in CAD) – 3 Lecture: Digital File Standards & Formats for Digital Manufacturing
Sept	Wk 1	Lab: Machining Simulation in Autodesk Fusion (3 axis Milling) – 1
		Lab: Machining Simulation in Autodesk Fusion (3 axis Milling) – 2
	Wk 2	Lab: Machining Simulation in Autodesk Fusion (4+ axis Milling) – 3
		Lab: Machining Simulation in Autodesk Fusion (Turning) – 4
	Wk3	Lab: Machining Simulation in Autodesk Fusion (Mill-Turning) – 5
		Lecture: SCAN-to-CAD Digital Model Process
		Lab: SCAN-to-CAD Digital Model Process-1
Wk 4	Lab: SCAN-to-CAD Digital Model Process-2	
Oct	Wk 1	Python Programming Essentials
	Wk 2	Lab: Building Fusion 360 Apps to Interact with CAD Models – 2 Project Assignment (2 members each)
	Wk 3	Lab: Building Fusion 360 Apps to Interact with CAD Models – 3
		Lab: Building Fusion 360 Apps to Interact with CAD Models – 4
	Wk 4	TAKE-HOME EXAM (Due by Oct 27th) Lab: Building Fusion 360 Apps to Interact with CAD Models – 5
Nov	Wk 1	Lecture: Digital Thread in Manufacturing – Concept & Components
	Wk 2	Lecture: Machine Communication Protocols (MT-CONNECT)
		Lab: Machine Communication Protocols (MT-CONNECT)
	Wk 3	Digital Quality Control in Digital Manufacturing
		Conclusion and Look ahead
Dec	2 nd	Proj. Demo Videos DUE

COURSE DELIVERY and HOMEWORK SUBMISSION

All Lectures and Tutorials will be uploaded to Moodle. The instructor will provide reading references and web tutorials to enhance the learning in class. Homework submission will be entirely online through the Fusion Collaborate Platform. Any other assignment submission will be the through the Moodle submission. Grades will be periodically posted on Moodle.

ASSIGNMENT SUBMISSION by EOL Students

All homework assignment submission will take place through Moodle or through software collaborate features directly to the Instructors. Discussion boards will be opened up by the instructors to have suitable online discussions between instructors, on-campus students and online students.

ABET Outcomes

Outcome C: An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.

Outcome D: An ability to function in multidisciplinary teams.

This Course uses Standard NCSU Letter Grading:

97	≤	A+	≤	100
93	≤	A	<	97
90	≤	A-	<	93
87	≤	B+	<	90
83	≤	B	<	87
80	≤	B-	<	83
77	≤	C+	<	80
73	≤	C	<	77
70	≤	C-	<	73
67	≤	D+	<	70
63	≤	D	<	67
60	≤	D-	<	63
0	≤	F	<	60

Diversity, Equity and Inclusion (DEI) Initiative @NC State ISE

The Edward P. Fitts Department of Industrial & Systems Engineering seeks to create a learning environment that supports a diversity of thoughts, perspectives and experiences while honoring the identities (including but not limited to race, gender, class, sexuality, religion, ability, etc.) of our students. To do so, we must acknowledge the inherent dignity and value of every person and strive to maintain a climate for work and learning based on mutual respect and understanding.

While we fully support and encourage open expression as a part of the process of academic discourse, we should engage one another with civility, sensitivity and cordiality. In affirming our common humanity, we reject all forms of prejudice, discrimination and bias. The process of learning often requires difficult and uncomfortable conversations that challenge our beliefs or the status quo. These new perspectives deepen our understanding, strengthen our community and propel our innovation. Only through thoughtful engagement can we create an environment of inclusive excellence for all. As

faculty, staff and students we will navigate these challenges through dialogue, education, training, and development while adhering to our shared principles and community values.

Accommodations for Disabilities

Any student in this course, who has a disability which may prevent him/her from fully participating in class activities, should contact the instructor personally. Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, student must register with the Disability Services Office (<http://www.ncsu.edu/dso>), 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation at <http://policies.ncsu.edu/regulation/reg-02-20-01>.

Non-Discrimination Policy

NC State University provides equality of opportunity in education and employment for all students and employees. Accordingly, NC State affirms its commitment to maintain a work environment for all employees and an academic environment for all students that is free from all forms of discrimination. Discrimination based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation is a violation of state and federal law and/or NC State University policy and will not be tolerated. Harassment of any person (either in the form of quid pro quo or creation of a hostile environment) based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation also is a violation of state and federal law and/or NC State University policy and will not be tolerated. Retaliation against any person who complains about discrimination is also prohibited. NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at <http://policies.ncsu.edu/policy/pol-04-25-05> or http://www.ncsu.edu/equal_op/. Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Equal Opportunity (OEO) at 919-515-3148.

Students in Stress/Distress

As members of the NC State Wolfpack community, we each share a personal responsibility to express concern for one another and to ensure that this classroom and the campus as a whole remains a safe environment for learning. Occasionally, you may come across a fellow classmate whose personal behavior concerns or worries you. When this is the case, I would encourage you to report this behavior to the NC State Students of Concern website: <http://studentsofconcern.ncsu.edu/>. Although you can report anonymously, it is preferred that you share your contact information so they can follow-up with you personally.

Requirements for Credit-Only (S/U) Grading

In order to receive a grade of S, students are required to take all exams and quizzes, complete all assignments, and earn a grade of C- or better. Conversion from letter grading to credit only (S/U) grading is subject to university deadlines. Refer to the Registration and Records calendar for deadlines related to grading. For more details, refer to <http://policies.ncsu.edu/regulation/reg-02-20-15>.

Requirements for Auditors (AU)

Information about and requirements for auditing a course can be found at <http://policies.ncsu.edu/regulation/reg-02-20-04>.

Policies on Incomplete Grades

If an extended deadline is not authorized by the instructor or department, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as an attempted course on

transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The university policy on incomplete grades is located at <http://policies.ncsu.edu/regulation/reg-02-50-3>.

Academic Integrity

Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct found at <http://policies.ncsu.edu/policy/pol-11-35-01>. See Page 5 for Department of Industrial and Systems Engineering policies.

Academic Honesty

See <http://policies.ncsu.edu/policy/pol-11-35-01> for a detailed explanation of academic honesty.

Honor Pledge

Your signature on any test or assignment indicates "I have neither given nor received unauthorized aid on this test or assignment."

COVID-19 CONSIDERATIONS

Due to the Coronavirus pandemic, public health measures have been implemented across campus. Students should stay current with these practices and expectations through the Protect the Pack website (<https://www.ncsu.edu/coronavirus/>). The sections below provide expectations and conduct related to COVID-19 issues.

Health and Participation in Class

We are most concerned about your health and the health of your classmates and instructors/TAs.

- If you test positive for COVID-19, or are told by a healthcare provider that you are presumed positive for the virus, please work with your instructor on health accommodations and follow other university guidelines, including self-reporting: <https://healthypack.dasa.ncsu.edu/coronavirus/>. Self-reporting is not only to help provide support to you, but also to assist in contact tracing for containing the spread of the virus.
- If you feel unwell, even if you have not been knowingly exposed to COVID-19, please do not come to class.
- If you are in quarantine, have been notified that you may have been exposed to COVID-19, or have a personal or family situation related to COVID-19 that prevents you from attending this course in person (or synchronously), please connect with your instructor to discuss the situation and make alternative plans, as necessary.
- If you need to make a request for an academic consideration related to COVID-19, such as a discussion about possible options for remote learning, please talk with your instructor for the appropriate process to make a COVID-19 request.

Health and Well-Being Resources

These are difficult times, and academic and personal stress is a natural result. Everyone is encouraged to take care of themselves and their peers. If you need additional support, there are many resources on campus to help you:

- Counseling Center (<https://counseling.dasa.ncsu.edu/>)
- Health Center (<https://healthypack.dasa.ncsu.edu/>)
- If the personal behavior of a classmate concerns or worries you, either for the classmate's well-being or yours, we encourage you to report this behavior to the NC State CARES team: (<https://advising.dasa.ncsu.edu/resources-for-advisors/advisors-toolkit/cares/>)
- If you or someone you know are experiencing food, housing or financial insecurity, please see the Pack Essentials Program (<https://dasa.ncsu.edu/pack-essentials/>).

Community Standards related to COVID-19

We are all responsible for protecting ourselves and our community. Please see the community expectations (link TBD) and Rule 04.21.01 regarding Personal Safety Requirements Related to COVID-19 <https://policies.ncsu.edu/rule/rul-04-21-01/>

Course Expectations Related to COVID-19:

- **Personal Protective Equipment:** As a member of the NC State academic community you are required to follow all university guidelines for personal safety with face coverings, physical distancing, and sanitation. **Face coverings are required in this class and in all NC State buildings.** Face coverings should be worn to cover the nose and mouth and be close fitting to the face with minimal gaps on the sides. In addition, students are responsible for keeping their course/work area clean.

- Course Attendance: NC State attendance policies can be found at: <https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/> . Please refer to this course's attendance, absence, and deadline policies for additional details. If you are quarantined or otherwise need to miss class because you have been advised that you may have been exposed to COVID-19, you should not be penalized regarding attendance or class participation. However, you will be expected to develop a plan to keep up with your coursework during any such absences. If you become ill with COVID-19, you should follow the steps outlined in the health and participating section above. COVID 19-related absences will be considered excused; documentation need only involve communication with your instructor.
- Course Meeting Schedule: Be sure to pay attention to any updates to the course schedule as the information in this syllabus may have changed. Please discuss any questions you have with the instructor.
- Classroom Seating: To support efficient, effective contact tracing, please sit in the same seat when possible and take note of who is sitting around you; instructors may also assign seats for this purpose..
- Technology Requirements: This course may require particular technologies to complete coursework. Be sure to review the syllabus for these expectations, and see go.ncsu.edu/syllabus-tech-requirements to find out more about technical requirements for your course. If you need access to additional technological support, please contact the Libraries' Technology Lending Service: <https://www.lib.ncsu.edu/devices>.

Course Delivery Changes Related to COVID-19

Please be aware that the situation regarding COVID-19 is frequently changing, and the delivery mode of this course may need to change accordingly, including from in-person to online. Regardless of the delivery method, we will strive to provide a high-quality learning experience.

Grading/Scheduling Changing Options Related to COVID-19

If the delivery mode has a negative impact on your academic performance in this course, the university has provided tools to potentially reduce the impact:

- Enhanced S/U Grading Option: <https://studentservices.ncsu.edu/your-resources/covid-19/spring2020-sat-grading/>
- Late Drop: <https://studentservices.ncsu.edu/your-resources/covid-19/spring2020-latedrop/>

In some cases, another option may be to request an incomplete in the course. Before using any of these tools, discuss the options with your instructor and your academic advisor. Be aware that if you use the enhanced S/U, you will still need to complete the course and receive at least a C- to pass the course.

Other Important Resources

- Keep Learning: <https://dasa.ncsu.edu/students/keep-learning/>
- Protect the Pack FAQs: <https://www.ncsu.edu/coronavirus/frequently-asked-questions/>
- NC State Protect the Pack Resources for Students: <https://www.ncsu.edu/coronavirus/reactivating-campus/resources-for-students/>
- NC State Keep Learning, tips for students opting to take courses remotely: <https://dasa.ncsu.edu/students/keep-learning/>

- Introduction to Zoom for students:
<https://youtu.be/5LbPzzPbYEw>
- Learning with Moodle, a student's guide to using Moodle:
<https://moodle-projects.wolfware.ncsu.edu/course/view.php?id=226>

Edward P. Fitts Department of Industrial and Systems Engineering
North Carolina State University

The Department strives to provide an environment conducive to learning and believes strongly in the Code of Student Conduct (POL 11.35.01). The portion below, extracted from POL 11.35.01, is specific to academic misconduct:

8 ACADEMIC MISCONDUCT

All members of the University community, students, faculty and other employees, have the responsibility to report academic misconduct to the appropriate authority.

Faculty members must undertake a threshold responsibility for such traditional safeguards as examination security and proctoring and should clearly communicate their academic expectations in the course syllabus. The use of the Pack Pledge, "I have neither given nor received unauthorized aid on this test or assignment," on all syllabi, assignments, examinations, or other academic evaluations is encouraged. Similarly, faculty members should familiarize themselves with the procedures for addressing academic misconduct. The procedures for reporting academic misconduct can be found in [**NCSU REG11.35.02 - Student Discipline Procedures.**](#)

Definitions regarding academic misconduct are set forth in writing in order to give students general notice of prohibited conduct. They should be read broadly and are not designed to define academic misconduct in exhaustive terms. If a student is in doubt regarding any matter relating to the standards of academic integrity in a given course or on a given assignment, that student must consult with the faculty member responsible for the course before presenting the work.

8.1 Aiding and Abetting

Aiding and abetting others to cheat or plagiarize is as detrimental to the scholarly community as engaging in the acts themselves. Aiding and abetting others to cheat or plagiarize includes, but is not limited to, the following:

- (a) Giving unauthorized assistance to another or others during a test or evaluation;
- (b) Posing as another student in order to meet a course or graduation requirement;
- (c) Providing specific information about a recently given test, examination, or assignment to a student who thereby gains an unfair advantage in an academic evaluation;
- (d) Providing aid to another person, knowing such aid is expressly prohibited by the faculty member, in the research, preparation, creation, writing, performing, or publication of work to be submitted for academic evaluation;
- (e) Permitting one's academic work to be represented as the work of another; or
- (f) Sharing or distributing academic materials, including class notes, in violation of the [**UNC Policy Manual 500.2 – Patent and Copyright Policies**](#) or [**NCSU REG01.25.02 – Copyright Infringement – Policy Statement.**](#)

8.2 Cheating

Cheating is the giving, taking, or presenting of information or material by a student that unethically or fraudulently aids oneself or another person on any work which is to be considered in the determination of a grade or the completion of academic requirements or the enhancement of that student's record or academic career. Cheating includes, but is not limited, to the following actions:

- (a) Copying from someone else's assignment, examination, or other academic exercise;
- (b) Possessing, buying, selling, removing, receiving, or using, at any time or in any manner not prescribed by the faculty member, any information related to an instrument of academic evaluation;

- (c) Using materials, equipment, or assistance in connection with an assignment, examination, or other academic exercise which have not been authorized by the faculty member, including but not limited to, notes, calculator, or other technology;
- (d) Obtaining or attempting to obtain, in a dishonest manner, any material relating to a student's academic work;
- (e) Working with another or others in completing an assignment, examination, or other academic exercise when the faculty member has required independent and unaided action;
- (f) Attempting to influence or change an academic evaluation, grade, or record by unfair means;
- (g) Permitting another individual to substitute for one's self in an academic evaluation;
- (h) Marking or submitting an examination or evaluation material in a manner designed to deceive the grading system;
- (i) Failing to comply with a specific condition of academic integrity which has been clearly announced in a particular course;
- (j) Submitting, without prior permission of the faculty member, any work by a student which has at any time been submitted in identical or similar form by that student in fulfillment of any other academic requirement at any institution;
- (k) Submitting of material in whole or part for academic evaluation that has been prepared by another individual(s);
- (l) Submitting data which have been altered or contrived in such a way as to be deliberately misleading; or
- (m) Providing false information to the University in any manner to achieve an unfair advantage, enhance one's record, or complete a requirement.

8.3 Destruction or Removal of Academic Materials

The destruction or removal of academic materials denies access to, and prevents the ability to develop the full potential of, scholarly resources. Prohibited acts under this section include, but are not limited to, the following:

- (a) Removing or attempting to remove, destroy, steal, or make inaccessible library or other academic material without authorization; or
- (b) Willfully damaging the academic work or efforts of another.

8.4 Plagiarism

Plagiarism is the use or close imitation of the language and thoughts of another and the representation of the other's work as their own. The act of submitting work for evaluation or to meet a requirement is regarded as assurance that the work is the result of the student's own thought and study, produced without assistance, and stated in that student's own words, except as quotation marks, references, or footnotes acknowledge the use of other sources. Any ideas or materials taken from another source for either written or oral use must be fully and correctly acknowledged. Submission of work used previously must first be approved by the faculty member. Plagiarism includes, but is not limited, to the following actions:

- (a) Representing the work of others as his or her own; or
- (b) Submitting written materials without proper attribution or acknowledgment of the source.

I have read, understand, and agree to abide by the Code of Student Conduct.

Name (Printed)

Signature

Date