Degree Program:

**□** ECE-Electrical & Computer Engineering,

**▀ ME - Mechanical Engineering**

**□** General Courses for Both ECE & ME Degree Programs

Course Name: **Design and Manufacturing I**

Course Code: VM250

Course Credits: 4

Course Category: **▀** Required **□** Elective

Terms Offered:

**□** Fall \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**▀** Spring \_\_\_\_\_\_2021\_\_\_\_\_

**□** Summer\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Course Pre/Co-requisites: VV156 or VV186, VG100, VM010 or VM020

**Course Description**:

VM250 develops students' competence and self-confidence as engineers with design and manufacturing. Emphasis on the creative design process bolstered by the application of physical laws and mechanics. Instruction on how to complete projects on schedule and within budget. Robustness and manufacturability are emphasized. The subject relies on active learning via a major design-and-build project. Lecture topics include idea generation, estimation, concept selection, visual thinking, computer-aided design (CAD), mechanics of machine elements, manufacturing processes, selection of materials and manufacturing processes, basic electronics, and technical communication.

**Textbooks:**

* Richard G. Budynas, J. Keith Nisbett, **Shigley’s Mechanical Engineering Design**, Tenth Edition, McGraw-Hill, 2014, ISBN: 978-0-070-339820-4
* Mikell P. Groover, **Fundamentals of Modern Manufacturing-Materials, Processes, and Systems**, Wiley, 2010, ISBN:978-0470-467008
* J. Donnell, S. Jeter, C. MacDougall, J. Snedeker, **Writing Style, and Standards in Undergraduate Reports**, 3rd Edition, College Publishing, 2016, ISBN:978-1-932780-09-3

Other supplementary course materials may be available during the lecture and posted at the Canvas site.

**Instructors:**

Prof. Jaehyung “Joshua” Ju

Teaching Philosophy: Active Classroom Practice & Design Thinking

Email: Use the inbox tool of CANVAS

Phone: 021-34206765 (Ext. 5001)

Office: JI Bldg. 500

Office Hour: Monday 4:00 - 5:00 pm, Friday 3:00-4:00pm

**Teaching Assistants (TAs):**

|  |  |
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| **Yang Yang**  [yangyang\_helen@sjtu.edu.cn](mailto:yangyang_helen@sjtu.edu.cn)  Office hour: Monday 6:00–8:00 pm | * Leader of computational lab activities * The general communicator on CANVAS and Feishu * Organizer- Grouping * Leading grader of homework and exams |
| **Hang Jiang**  [makisejh@sjtu.edu.cn](mailto:makisejh@sjtu.edu.cn)  Office hour: Friday 2:00–4:00 pm | * Leader of mechatronics lab activities * Assistant of computational lab activities * Leading grader of projects (mini-projects of F-Lab and term projects) * Leading grader of class activities (CAD Sketch and MATLAB programming) |
| **Weihan Fan**  [fwh2017@sjtu.edu.cn](mailto:fwh2017@sjtu.edu.cn) | * Leader of fabrication lab activities * Supervisor of the term project * Supervisor of the lab facilities |

**Grading Policy:**

|  |  |
| --- | --- |
| Exam I | 20% |
| Exam II (final exam) | 20% |
| Homework assignments on the lectures | 10% |
| Class activities | 5% |
| Lab activities and assignments | 20% |
| Design review - Oral presentation of the term project | 5% |
| A final report with a prototype – Novel design, Manufacturing and Assembly of Parts, Demonstration, and Performance   * Final report (90%) * Gameday performance (10%) | 20% |

**Attendance Policy:**

* **Students must attend lectures and lab sessions**. If you have to miss a class or lab, you should inform the instructor ahead of time. The instructor may provide the lecture slides the student missed. However, we may not give recorded videos of the class.
* Students must behave professionally during lectures and lab sessions; the use of mobile devices is not allowed.
* According to the new SJTU's education policy, **three times** of absence without prior notification to the instructor results in “**automatic failure** (**F**)” in the course.
* If a student does not show up in the exam, he/she does not get any points on the exam.

**Policy for Late Submission**

Students must submit the homework assignments to the instructor or TAs by the beginning of the class on the due date. Failure to submit homework on time will get a 25% deduction per day.

Review of the grading: If a student does not consent to the grading, he (or she) can appeal to TAs or the instructor for review. We will provide course materials and assignments on CANVAS. Students can communicate with TAs and the instructor via the communication tool of CANVAS. ***Students' responsibility is to check the posted information on Canvas and check the course-related announcements to their registered email addresses.***

**Academic Integrity:**

Assignments for Lecture and lab (computer) are to be completed on your own unless specified as group assignments. This means:

* Students are not allowed to sit together and work out the details of the problems with anyone.
* Students may not be authorized to discuss the problem set with previous class members or anyone else who has significant knowledge of the problem set's details.
* Nor should you compare your written solutions, whether in scrap paper form or your final work product, with other students (and vice versa).
* You are also not allowed to possess, look at, use, or in any way derive advantage from the existence of solutions prepared in previous years.

**Violation of this policy is considered a breach of the honor code. It is grounds for the instructor (s) to initiate an action that may lead to grade reduction, course withdrawal, University suspension, or expulsion.**

For your information, the UM-STJU JI has a nationally recognized Honor Code of Academic Integrity. This Code sets standards for academic integrity for all students. As a student, you are responsible for upholding these standards. For more information on the Honor Code at UM-SJTU Joint Institute, please visit http://umji.sjtu.edu.cn/academics/academic-integrity/honor-code/. After each examination, students must sign their names on the Honor Pledge on the test paper to further exhibit their academic integrity commitment. The Honor Pledge is as follows: "I have neither given nor received unauthorized aid on this examination, nor have I concealed any violations of the Honor Code." Instructors are not required to grade tests in which the signed Honor Pledge does not appear. The Honor Code remains enforced whether or not the student signs the Pledge.

**Lecture: (classroom: East Upper Hall 东上院)**

**Tuesday 4:00 – 5:40 pm (D407)**

**Thursday 4:00 – 5:40 AM (D106)**

**Friday 4:00 – 5:40 PM (D106)-Weeks 1, 3, 5, 7, and 9**

**Lab:**

**Notice: Anyone who is taking VM250 should pass VM010 or VM020 in the previous semester. Students who did not pass the course for any reason must communicate with the instructor before the semester.**

**There are three Lab parts.**

* **Engineering graphics (individual-based)**
  + **CAD drawing using SolidWorks and Unigraphics.**
  + **Place: JI computer room (3rd floor of JI building)**
  + **Time:** 
    - **Monday 4:00 – 5:40 pm (Weeks 1-8)**
* **Mechatronics (individual-based)**
  + **Programming of Arduino microcontroller**
  + **Place: Design and Manufacturing Lab (3rd floor of JI building)**
  + **Time:** 
    - **Friday 6:40 – 10:40 pm (Weeks 1, 3, 5, and 7)**
* **Fabrication (group-based)**
  + **Basic and Applied Manufacturing Activities**
  + **Place: Design and Manufacturing Lab (3rd floor of JI building)**
  + **Time:** 
    - **Friday 6:40 – 10:40 pm (Weeks 1 - 9)**

**Students are required to attend the lab sessions. TAs will collect the lab assignments with an attendance sheet during the lab sessions.**

**Course Topics:**

1. Engineering drawing
2. Computer-Aided Design (CAD)
3. Dimensions and tolerances, including GD&T and statistical tolerances
4. The engineering design process, including identifying functional requirements and specifications, conceptual design, embodiment design, engineering analysis, prototyping, and testing
5. Machine elements, including bearing, gears, springs, and DC electric motors
6. Engineering materials
7. Manufacturing processes
8. Rapid prototyping, including 3D printing and fabrication of soft robots
9. Basic machine shop techniques, including safety
10. The practice of technical report writing and making technical presentations.
11. Introduction to teamwork

**Course objective:**

1. Introduce students to the mechanical engineering design process and develop a product from its conception to the construction of a prototype.
2. Develop the technical skills necessary to generate an engineering drawing and an engineering assembly using a CAD system.
3. Provide a 'hands-on' experience through shop training and the construction of a physical artifact.
4. Introduce the elements of engineering communications, including a graphical representation of artifacts, communication within the design team, written reports, and oral presentations.
5. Introduce simple analysis and estimation of uncertainty in engineering design and manufacturing.
6. Obtain a basic understanding of various engineering materials and the manufacturing techniques used to process them into useful products.
7. Develop a basic understanding of various types of machine elements, including bearings, gears, springs, and DC electric motors, and apply these elements appropriately in the design and fabrication of a machine.

**Course outcomes:**

1. Students can understand engineering drawings with different views, including orthographic views, hidden lines, and cross-sectional views, and the representations of tolerances and surface finish on engineering drawings.
2. Students can create 3D models of engineering objects, engineering drawings with different views, and an assembly of the objects that make up engineered systems using a CAD system.
3. Students can use essential machine shop equipment and hand tools safely.
4. Students develop an awareness of CAM and rapid prototyping and the capabilities of these processes.
5. Students can design a moving machine based upon stated requirements and constraints using a systematic design process.
6. Students can recognize and apply various types of bearings, gears, springs, couplings, and DC electric motors in the design and fabrication of a moving machine.
7. Students can use the cumulative distribution of the normal distribution to predict probabilities in the context of dimensional tolerances.
8. Students can identify the main classes of engineering materials, namely metals, polymers, ceramics, and composites, and distinguish their main physical and mechanical properties. They also can name examples of artifacts made from these materials.
9. Students can name the most common processing techniques for metals, such as machining, casting, forging, extrusion, stamping, and forming. They can describe each process and give an example of an artifact made by the process.
10. Students can name the most common processing techniques for polymers, such as injection molding, blow molding, thermoforming, and rotational molding. They can describe each process and give an example of an artifact made by the process.

**Assignments:**

There are ~ 13homework assignments from the lecture and about 18 lab assignments from the lab activities.

**Final Project:**

Coursework also consists of a semester-long group project. The instructor and TAs will arrange groups based on some criteria. We expect 80% of your prototype is ready by the design-review on Friday, April 9. The term project competition is on **Friday**, **April 23**. The deadline for the term project report (~15 pages) is **Friday, April 30.**

**Exams:**

There are two exams in this course, each of which accounts for 20% of the final grade. The instructor will specify the content covered in each exam during the lecture. Exam I is scheduled for **Friday**, **March 26,** and Exam II **on Tuesday,** **April 27**.

**Peer evaluation:**

Since the collaborative activity is an essential part of this course, we may ask each member to submit a peer evaluation sheet at the end of the semester to evaluate each team member's effort (including yourself) to project activities. A peer evaluation form will be available on CANVAS under "Final Project."

**Lecture Schedule: (tentative)[[1]](#footnote-1)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Week #** | **Date** | **Lec.**  **#** | **Topic** | **Chapters** | **HW** |
| 1 | Tu 2/23 | 1 | Course Introduction, Theory of projection - Orthographic view, Line types | Coursepack | HW 0 |
| Th 2/25 | 2 | Pictorials | Coursepack | HW 1 |
| Fr 2/26 | 3 | Theory of projection - Sectional view | Coursepack | HW 2 |
| 2 | Tu 3/2 | 4 | Auxiliary view, Dimensioning (1) | Coursepack |  |
| Th 3/4 | 5 | Dimensioning (2) | Coursepack | HW 3 |
| 3 | Tu 3/9 | 6 | Tolerance (dimensional) | Coursepack | HW 4 |
| Th 3/11 | 7 | Tolerance (geometric), GD&T | Shigley 20 | HW 5 |
| Fr 3/12 | 8 | Design Process, QFD; Gantt Charts (Project) | Ashby 2 | HW 6 |
| 4 | Tu 3/16 | 9 | Uncertainty and Reliability, (Mechanism and Statics) | Shigley 1 | HW 7 |
| Th 3/18 | 10 | Power transmission (gears, belts, and chains) | Shigley 13, 17 |  |
| 5 | Tu 3/23 | 11 | Bearings, DC motors | Shigley 11, 12 |  |
| Th 3/25 | 12 | Springs, Screws | Shigley 10 | HW 8 |
| Fr 3/26 |  | Exam I |  |  |
| 6 | Tu 3/30 | 13 | Engineering materials, Testing | Groover 2 | HW 9 |
| Th 4/1 | 14 | Materials selection for mechanical design | Shigley 2, |  |
| 7 | Tu 4/6 | 15 | Design problems with mechanics | Hibbeler 1 | HW 10 |
| Th 4/8 | 16 | Materials removal processes | Groover 22 |  |
| Fr 4/9 |  | Design review presentation of the term project |  | HW 11 |
| 8 | Tu 4/13 | 17 | Solidification processes – metal casting | Groover 11 |  |
| Th 4/15 | 18 | Sheet metalworking | Groover 20 | HW 12 |
| Sat 4/17 | 19 | Field trip (8:00 am - 11:40 am) Adhesion | Hankel, Ltd. |  |
| 9 | Tu 4/20 | 20 | Bulk metalworking (rolling, forging, extrusion) | Groover19 | HW 13 |
| Th 4/22 | 21 | Polymer shaping processes | Groover 13 |  |
| Fr 4/23 |  | Design competition – game day |  | Final report |
| 10 | Tu 4/27 |  | Exam II (10:00 am) |  |  |

**Lab Schedule: (tentative)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Week** | **Engineering graphics:**  Computational Lab (3F) | **Fabrication:**  Design and Manufacturing Lab (3F) | **Mechatronics**  Design and Manufacturing Lab (3F) |
| 1 | **C-Lab #1**  Introduction – SolidWorks (with simple geometric examples), 2D and simple 3D bearing parts | Introduction to the term project (distribution of materials) | Controlling LED with “while” loop / Writing analog voltage |
| 2 | **C-Lab #2**  Assembly of bearing parts | DIY 1- Construction of a DC motor (and solenoid) with a mechanical switch |  |
| 3 | **C-Lab #3**  Mold design for soft robotics | 3D printing & elastomer plastic molding for soft robotics (integrated with C-Lab 3) | Controlling RGB LED with “if” statement |
| 4 | **C-Lab #4**  Assembly of shaft, bearing & fixture drawing / FEA with SolidWorks – structural mechanics | DIY 2 – Origami gripper |  |
| 5 | **C-Lab #5**  (1) Gears - spur and helical  (2)Curves and surfaces – preparation for reverse engineering | Injection molding for polymer shaping | Controlling a Servo Motor |
| 6 | **C-Lab #6**  Mold of nonpneumatic wheels | Injection molding of nonpneumatic wheels | Bluetooth based communication with Arduino – iOS & Android |
| 7 | Holiday - Tomb sweeping day  (no class) | DIY 3- Design and manufacturing of springs / 3D printing of parts for shock absorber/assembly  (integrated with C-Lab 7) |  |
| 8 | **C-Lab #7**  Shock absorber with a coil spring (animation) | Field trip (DIY 4) |  |
| 9 | Design competition – game day (extra work for project report) | | |

1. green – engineering drawing, red – machine components, orange – materials, blue- manufacturing [↑](#footnote-ref-1)