



Capstone Design Projects
VE 450 Major Design Experience & VM 450 Design and Manufacturing III
UM-SJTU Joint Institute, Fall 2019

Course Mission

The educational goal of Capstone Design Projects is to give each student a deep understanding of how to approach open ended challenges *by process*, and to learn how to innovate and apply the seemingly fragmented engineering knowledge acquired at JI to the design and manufacturing of real mechanical, electrical/computer, mechatronic, or multidisciplinary engineering systems.

Course Schedules and Locations

Class Schedule: Monday 2:00pm-3:40pm
Wednesday 4:00pm-5:40pm
Friday 2:00pm-3:40pm (Only the first five weeks)

Classroom: D311

Open Lab: VM395&VM495 labs in 310 Longbin Bldg.

Open Lab time: Week 5~14 Monday 9:00 - 11:40 am
Week 5~14 Tuesday 9:00 – 11:40 am
Week 5~14 Thursday 9:00 – 11:40 am

Discussion/Meeting Section: To be scheduled by Section Instructors

Course Instructors

| Name | Course Role | Room | Phone | E-mail |
|-----------------|--------------------|------|---------------|-------------------------|
| Dr. Mian Li | Course Coordinator | 520 | 34206765-5201 | mianli@sjtu.edu.cn |
| Dr. Chengbin Ma | Course Coordinator | 420 | 34206765-4201 | chbma@sjtu.edu.cn |
| Dr. Yunlong Guo | Section Instructor | 510 | 34206765-5101 | yunlong.guo@sjtu.edu.cn |
| Dr. Yong Long | Section Instructor | 402 | 34206765-4021 | yong.long@sjtu.edu.cn |

Staff and Teaching Assistants

| Name | Phone | E-mail | Responsibilities |
|-----------------------------|-----------------------------------|--|--|
| Mr. Siwei YE | 15618348620 | swayye@sjtu.edu.cn | 1. Grading 2. Design Review 3. Design Expo 4. Corporate projects |
| Mr. Jiawen XU | 15821285629 | xujiawen@sjtu.edu.cn | 1. Grading 2. Design Review 3. Design Expo 4. Corporate projects |
| Ms. Jin HUANGFU | 13868043427 | jinhf2017@sjtu.edu.cn | 1. Grading 2. Design Review 3. Design Expo 4. Corporate projects |
| Mr. Jibin SONG | 18217357182 | jibinsong@sjtu.edu.cn | 1. Design Expo 2. Corporate projects agreement/payment/kick-off/final delivery 3. Final prototype handover |
| Staff: Mr. Allen ZHU | 34206045 ext. 4532 18964022048 | bingru.zhu@sjtu.edu.cn | 1. Corporate projects agreement/payment/kick-off/final delivery 2. Design Expo 3. Reimbursement 4. Final prototype handover |

Course Objectives

The educational goal of the courses is to give each student an understanding of design principles and to teach the integration and application of engineering knowledge obtained at JI toward the design and manufacturing of mechanical, mechatronic, or electrical/computer systems. At the end of the course, students are expected to:

1. Solve an open-ended mechanical, mechatronic or electrical/computer engineering design problem including considerations of performance, cost, and many other aspects. The problem must provide opportunities for creative design, fundamental analysis, and proof-of-concept prototyping (mechanical electrical systems or standalone software packages). Each student team works on a project and everyone participates in project proposal development, reporting, and the design process.
2. Apply a design process appropriate to the engineering problem at hand, including unstructured creativity as part of a structured design problem.
3. Generate and evaluate design concepts after gaining a sound understanding of the problem background and existing design concepts.

4. Identify a set of design variables and governing equations for the selected design concept that can be utilized to improve the design.
5. After finalizing the design details, construct the prototype and perform appropriate tests for possible design iterations.

Course Outcomes

When this course is completed, you should be able to achieve the following:

1. Given a qualitative and open-ended "real-world" engineering design problem that is relevant to contemporary issues, suggest a solution based on quantitative analysis. [a, b, c, j]
2. Learn to work effectively in engineering teams to resolve conflict and meet specific engineering objectives established during the project. Learn to communicate effectively with peers, project sponsors, advisors, and/or mentors. [d, f, g]
3. Learn to consider unstructured creativity as a natural part of a structured design process, and to systematically generate concepts using methods such as brainstorming and decomposition. [g]
4. Learn to make good assumptions and exercise sound judgment in solving open-ended problems. [e]
5. Manage and plan large design projects using time management tools, and be able to handle uncertain and incomplete information effectively to meet project goals.
6. Learn to clearly request and exchange quantitative information, and to communicate project results, to audiences of varying levels of expertise. [g]
7. Learn patent and literature search methods, benchmarking, and other general forms of background independent learning. [i]
8. Integrate past course materials to advance basic system concepts to a prototyping level, providing support for all design decisions by defensible engineering analysis and reasoning. [a, k]
9. Understand the potential impact of an engineering decision on human society. [c, f, h]

Enrollment & Late Arrival Policy

- All the students are expected to register before the semester starts and show up in the first class when the projects and teaming policy are announced.
- *Registration after the first Friday is NOT accepted.*
- *Dropping the course is NOT accepted after the first Friday.*
- *The final grade of the first-week absentees will be adjusted to one-level lower. For example, A will be changed to B, B+ to C+, and C to D.*
- *The final grade of the first two-week absentees will be F.*
- *If there is a SPECIAL reason for absence of the first or two weeks, please contact the course coordinator BEFORE the first week of the semester.*

Overview of Milestone and Deliverables

The schedule of deliverables intends to keep teams on track for a successful Design Expo demonstration of a functional prototype on **Dec. 11, 2019.**

Your capstone project preference selection will be due in the second week (the detailed time will be

announced later). If you are late, we will make an arrangement for you. Remember, missing the deadline is very likely lead to an unfavorable consequence. Once you select a project, you cannot drop the course.

Your first design review, Design Review #1, will be held on **Oct. 14**. Teams will have defined the engineering specifications for their projects, benchmarked the existing/competing products and identified the state-of-the-art. The teams are expected to present an overall understanding of their projects and demonstrate some initial conceptual ideas. *The written design report for DR#1 should incorporate the comments from the Judge Panel. Contents related to reviewers' comments should be clearly marked. The written report is due on **Oct. 21** at 2pm.*

Design Review #2 will be held on **Oct. 30** to review your concepts and concept selection. You should generate various design concepts in a systematic way and select the best concept. It is possible that even your No.1 choice will require significant modification (and perhaps a new design altogether), driven by feedbacks from the Judge Panel, your Section Instructor and/or your sponsor. If your selected concept should be modified, you are very likely to modify your experimentation plans and further analysis. No written design report is required for DR #2.

After Design Review #2, you are required to complete a final detailed design, including modeling for determining the dimensions, data structures, algorithm parameters, etc. Technical drawings and/or source codes (written by your team) should also be included for prototyping your design. For those teams that follow an experimentation path, prototyping in the machine shop will likely begin shortly after Design Review #2.

Design Review #3 will be held on **Nov. 20**. You will present the final detailed design to the Capstone Judge Panel. The details of your final design should be supported by modeling, analysis and perhaps some validation experiments. You should also show the progress of your prototype, by including short animations and video clips of your design and experiments. *The written design report for DR#3 will be due on **Nov. 27** at 4pm to Canvas. The written design report for DR#3 should incorporate the comments of both DR#2 and DR#3 from the Judge Panel. The comments should be attached inside the report as a separate page. The responses to the comments should be marked using a different color in your report. A piece of footer should also be added to show which comment the marked paragraph is addressing. Fail to mark these responses will lead to a considerable deduction in your grade.*

Any changes to the design after this point must be documented by an Engineering Change Notice (ECN) and communicated immediately with the sponsor and Section Instructor.

The Final Prototype Review and Presentation will occur at the Design Expo on **Dec. 11**. The Final Design Report will be due on **Dec. 09 at 2pm**.

Lecture

VM450/VE450 is not just a project course. Many important course requirements are delivered through lectures and assignments to the project team.

Students will be assigned to groups of four or five that will work together for the entire semester on a single design project. Consequently, cooperative learning methods will be used during that time, which depend heavily on teamwork. The lectures will provide approaches, inspirations, and tools that can be used by teams as they progress from design to prototyping. Discussion sections will facilitate their application into projects.

Why have lectures? Initially, the lectures will cover how the design of mechanical, mechatronic, or electrical/computer systems can be approached as a process. These lectures will be applied directly to individual projects via discussion sections through worksheets, informal presentations, and meetings with the Section Instructor. The lectures will also cover topics not previously presented in core ME/ECE courses such as interactions with business and industrial leaders, environmental impact, materials and manufacturing process selection, entrepreneurship, and intellectual property protection.

Lecture Attendance Policy: Attendance is required at each regular lecture and invited lecture. All absences must be authorized by the coordinator. Entering class late or leaving before classes end, will also have a negative impact on your participation grade, so please communicate with the coordinator and the course TAs **prior to class** if attending any full lecture will be a problem for your schedule.

To facilitate the checking of lecture attendance, **each student will be assigned a seat** in the classroom. It is each student's own responsibility to sit in the assigned seat during the entire semester. Sitting in a wrong seat will result in your attendance being invalidated.

If you cannot attend the lecture due to sickness or family urgent matters, please follow the SJTU policy to get approved and then send the approved document to TAs directly. Remember, personal matters like internship, company interview, travelling, etc. will NOT be granted.

The absentee will lead to 1-point deduction for each lecture out of "10-point-Lecture Attendance & Participation."

Lecture Participation Policy: It is NOT allowed to play video games, text, email, or even take a nap by lying on the desk during the lectures. Plus, it is NOT allowed to use electronic devices (Laptop, cell phone, or iPad/iTouch) doing something which is not related to the course materials. Bottom-line: You should pay attention to the instructor or guest speaker and show RESPECT at all times!

Discussion Sections

Why have discussion sections? Discussion sections keep teams on track, and are a forum of interaction with the Section Instructor and Sponsor, which is especially important at the beginning of the semester. The discussion sections also assure the application of the *design process* to the final designs and prototypes by reinforcing lecture materials.

Discussion Section Structure. Up until Design Review #2, the discussion sections will be structured to assist the teams in "getting off the ground". From time to time, teams will be involved with informal presentations and worksheet preparations, in addition to having time to work on their projects. After Design Review #2, the format of the discussion sections will diverge significantly per the Section Instructor's discretion. In most cases, the Section Instructor will hold separate 30 minute team meetings once a week.

Discussion Section Attendance Policy. Attendance is expected at each discussion section. This is especially important as participation in the discussion sections will form a significant portion of your participation grade, along with lecture participation. The absence will lead to 1-point deduction out of "20-point-Section Instructor Evaluation."

Textbook and Lecture Notes

A reference textbook for the course is:

George Dieter and Linda Schmidt, *Engineering Design*, 4th Ed., 2008, McGraw Hill.

Lecture notes will be available in Canvas along with a number of general resources that will facilitate the application of a design process to your project. All class announcements will be posted in Canvas. In order not to miss any important class announcement, students are advised to check Canvas at least once per day.

Grading Policy

Not all students in the same team will receive the same grade in VM450/VE450.

Design reviews, in-class activities, and prototypes will be submitted and graded on a team basis. Participation in the course will be graded on an individual basis. The participation grade will be determined by class attendance, lecture participation, discussion section participation, peer evaluations, oral presentations, and contributions to the written reports and prototype. If the participation percentage is very low, signifying that a student did not participate fully in the class, the entire grade for the course will be adjusted downward at the discretion of the Section Instructor and Course Coordinator. The student's final grade will reflect actual participation and grade deserved.

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| Design Reviews (Team grade) | 25% |
| <ul style="list-style-type: none"> • DR#1 Oral Presentation: 5% • DR#1 Written Design Report: 5% • DR#2 Oral Presentation: 5% • DR#3 Oral Presentation with Animations and Video Clips for Prototyping Demo: 5% • DR#3 Written Design Report: 5% | |
| Final (Team grade) | 40% |
| <ul style="list-style-type: none"> • Poster and Brochure for Design Expo: 5% • Final Written Design Report: 10% • Final Presentation: 15% <ul style="list-style-type: none"> ○ Corporate-Sponsored projects (except Covidien) <ul style="list-style-type: none"> ▪ Company Final Delivery: 7.5% ▪ Oral Defense: 7.5% ○ Faculty-sponsored & Covidien project: <ul style="list-style-type: none"> ▪ Oral Defense: 15% • Design Expo (Final Prototype): 10% | |
| Lecture Attendance & Participation (Individual grade) | 10% |
| Peer Evaluation (Individual grade) | 5% |

Section Instructor/Sponsor Evaluation (Individual grade) **20%**

The grading structure could be subject to minor changes by the Capstone Grading Committee. Any modifications would be announced before Design Review #3. With no modifications, the current grading structure will be adopted.

Honor Policies

All students in the class are presumed to be decent and honorable, and all students in the class are bound by the Honor Code of the UM-SJTU Joint Institute. You may not seek to gain an unfair advantage over your fellow students; you may not consult, look at, or possess the unpublished work of another without their permissions; and you must appropriately acknowledge your use of another's work.

All group work is to be completed only within your own group. You may receive help from the course instructors and you may consult with members of other groups in the course, but you must complete your group's analysis and project write-up on your own.

Any violation of the above honor policies appropriate to each piece of course work will be reported to the Honor Council, and if guilt is established penalties may be imposed. Such penalties can include, but are not limited to, letter grade deductions, disciplinary sanctions, or expulsion from the Institute and the University. **If you have any questions about this course policy, please consult the course instructors.**

Disability Policy

If you have any disability that might interfere with your ability to turn in assignments on time or in the form required, please contact the instructors and the Academic & Student Affairs Office at the start of the term so that arrangements can be made to accommodate you.

Team Budget Policy

Each project will be allocated with a team budget. *Consult your team budget with your Budget Controller* who is either your Session Instructor or Faculty Advisor. The list of Budget Controller will be confirmed during Financial Seminar. Please note a budget is the amount of money your team can spend at most. It doesn't mean your team is entitled to spend the money on your own. All the expenditure shall be confirmed by your Budget Controller.

Lecture & Design Review Schedule (tentative)

(Business formal dressing code is a required for all activities in purple and red colors)

| Week | Date | Lecture Title | Instructor |
|------|------|---|------------|
| 1 | 9/09 | Course Overview | Mian Li |
| | 9/11 | The Design Process and IDEO Video Capstone Design Project Description | Mian Li |
| | 9/13 | No lecture. Mid-Autumn Festival holiday. | |
| 2 | 9/16 | Developing Engineering Specifications and QFD | Mian Li |
| | 9/18 | Developing Engineering Specifications and QFD | Mian Li |
| | 9/20 | No lecture. Project Selection (Project selection form submitted to TAs before 12 noon) | |
| 3 | 9/23 | Concept Generation and Selection | Mian Li |

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| | 9/25 | Financial & Reimbursement Seminar (Seating Chart starts) | Jiawei Chu & Mian Li |
| | 9/27 | Kickoff Meeting with Sponsors Corporate kickoff: 1. The purpose of the kickoff meeting is to make sure everyone on the team understands the PROBLEMS and NEEDS of your project. 2. Present your sponsor the team profile (a short PPT presentation) which includes background, strengths, special skills, and the role of each team member. 3. Professionalism: After the kick-off meeting, the team leader shall email the contact info of all the members and team schedule with AVAILABLE TIMESLOTS to the company mentor/sponsor and c.c. your instructor and corporate assistant. | |
| 4 | 9/30 | Kickoff Meeting with Sponsors Corporate kickoff: | |
| | 10/01 – 10/06 | National Holiday, no lecture | |
| 5 | 10/07 | National Holiday, no lecture | |
| | 10/09 | Literature Survey (Workshop, Bring your own laptop), Team xx | Mian Li |
| | 10/11 | Literature Survey (Workshop, Bring your own laptop), Team yy | Mian Li |
| 6 | 10/14 | Design Review #1: Team Presentation and Report (DR#1 written design report due on Oct. 22 at 2pm to Canvas) | Capstone Judge Panel |
| | 10/16 | Today's Manufacturing | Mian Li |
| 7 | 10/21 | No Lecture (Meet with Sponsors, Instructors, or Faculty Advisors) | DR#1 written design report due at 2pm |
| | 10/23 | No Lecture (Meet with Sponsors, Instructors, or Faculty Advisors) | |
| 8 | 10/28 | No lecture | |
| | 10/30 | Design Review #2: Team Presentation (NO written design report for DR#2 is required.) <u>Special Notice: Based on instructors' evaluation, the JI Office will send a notice to those who are likely to be failed.</u> (Corporate Final Delivery Scheduling Starts: Team leaders shall contact your TA for scheduling.) | Capstone Judge Panel |
| 9 | 11/04 | Improving Your Technical Communication for Design Reviews (Each team shall prepare 4-slide PPT for your own project: Problem, Needs, Solutions, & Concept Diagram.) Confirm with your instructor before you make any purchases | Mian Li |

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|----|----------------|--|--|
| | 11/06 | Improving Your Technical Communication for Design Reviews (Each team shall prepare 4-slide PPT for your own project: Problem, Needs, Solutions, & Concept Diagram.) | Mian Li |
| 10 | 11/11 | No Lecture (Meet with Sponsors, Instructors, or Faculty Advisors) | |
| | 11/13 | No Lecture (Meet with Sponsors, Instructors, or Faculty Advisors) | |
| 11 | 11/18 | No Lecture (Meet with Sponsors, Instructors, or Faculty Advisors) | |
| | 11/20 | Design Review #3: Team Presentation and Report (DR#3 presentation due on 11/21 at 4pm to Canvas, and DR#3 written design report due on 11/28 at 4pm to Canvas) | Capstone Judge Panel |
| 12 | 11/25 | No Lecture (Meet with Sponsors, Instructors, or Faculty Advisors) | |
| | 11/27 | No Lecture <i>Special Notice: During the 12th weekly meeting with instructors, student teams need to show the prototype to the instructors. The instructor has a Yes/No evaluation to allow the team for the final review or not (an early failure).</i> (Design Expo Poster [electronic version] due on 11/29 at 6pm) | DR#3 written design report due on at 4pm |
| 13 | 12/02 | No Lecture (Meet with Sponsors, Instructors, or Faculty Advisors) | |
| | 12/04 | Corporate Projects Final Delivery Corporate Final Delivery: | |
| 14 | 12/09 | Corporate Projects Final Delivery Corporate Final Delivery: | (FINAL written design report due at 2pm) (Peer Evaluation due at 2pm) |
| | 12/10 (Tue) | Prototype setup at Longbin Bldg. (6pm-7:30pm) | TAs |
| | 12/11 | Final Oral Defense (9am-12pm) Design Expo (1am-4pm) | Capstone Judge Panel |

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| Lecture | |
| Sponsor meeting | |
| Student Activities | |
| Invited Talk | |
| Design Review | |
| No lecture | |