UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Semester 2 2017

MMAN2100

Engineering Design 2

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Dr. Ang Liu
Office Location: Ainsworth Building (J17) Level 4, Room 408
Tel: (02) 9385 4080
Email: ang.liu@unsw.edu.au
Consultation Hours: 9:00am-10:30am every Thursday in the lecturer's office

In addition to the weekly consultation hours, all students and groups are encouraged to schedule additional face-to-face meetings with the lecturer from time to time. Since this is a very large class of 400 students, a meeting appointment via email beforehand is appreciated.

Contact details and consultation times for additional demonstrators

Please see the course Moodle.

2. Important links

- Moodle
- UNSW Mechanical and Manufacturing Engineering
- Course Outlines
- Student intranet
- UNSW Mechanical and Manufacturing Engineering Facebook
- UNSW Handbook

3. Course details

Credit Points

This is a 6 unit-of-credit (UoC) course, and involves **6** hours per week (h/w) of face-to-face contact.

The UNSW website states "The normal workload expectations of a student are approximately 25 hours per semester for each UoC, including class contact hours, other learning activities, preparation and time spent on all assessable work. Thus, for a full-time enrolled student, the normal workload, averaged across the 16 weeks of teaching, study and examination periods, is about 37.5 hours per week."

This means that you should aim to spend about 12 h/w on this course. The additional time should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

Contact hours

	Section	Day	Time	Location	Week
Lectures	A and Web	Tue	15:00 – 17:00	ChemicalSc M17 (K-F10-M17)	1-4, 6-13
		Thu	11:00 – 12:00	ChemicalSc M17 (K-F10-M17)	1-4, 6-13
Demonstrations	M09A	Mon	09:00 - 10:30	Webster 256 (K-G14-256)	2-9,10-13
		Wed	10:30 - 12:00	Civil Engineering G8 (K-H20-G8)	2-9,10-13
	M10A	Mon	10:30 - 12:00	Civil Engineering G8 (K-H20-G8)	2-9,10-13
		Wed	16:30 - 18:00	Civil Engineering G8 (K-H20-G8)	2-9,10-13
	M12A	Mon	12:00 - 13:30	Civil Engineering G8 (K-H20-G8)	2-9,10-13
		Wed	09:00 - 10:30	Civil Engineering G8 (K-H20-G8)	2-9,10-13
	M13A	Mon	13:30 - 15:00	Civil Engineering G8 (K-H20-G8)	2-9,10-13
		Wed	15:00 - 16:30	Civil Engineering G8 (K-H20-G8)	2-9,10-13
	T09A	Tue	09:30 - 11:00	Webster 256 (K-G14-256)	2-9,10-13
		Thu	13:00 - 14:30	Michael Hintze Theatre (K-H6-LG03)	2-9,10-13
	T12A	Tue	12:00 - 13:30	Civil Engineering G8 (K-H20-G8)	2-9,10-13
		Thu	14:30 - 16:00	Michael Hintze Theatre (K-H6-LG03)	2-9,10-13
	T13A	Tue	13:30 - 15:00	Civil Engineering G8 (K-H20-G8)	2-9,10-13
		Fri	12:00 - 13:30	Civil Engineering G8 (K-H20-G8)	2-9,10-13

Demonstrators for M09A:

- Panagiotis Thrasou p.thrasou@gmail.com
- Patrick Attfield Doherty pat.doherty@live.com.au

Demonstrators for M10A:

- Will Tran w.tran@redbackracing63.com
- Alexandra Claire Penn penn1956@gmail.com

Demonstrators for M12A:

- Alex Euripidou alexanderdanieleuripidou@gmail.com
- Moustafa Amr Nazeih A Ali moustafa.nazeih@hotmail.com

Demonstrators for M13A:

- Morgan Eveleigh morgan.eveleigh@gmail.com
- Garen Douzian g.douzian@student.unsw.edu.au

Demonstrators for T09A:

- Malik Muhammad Awais m.awais@student.unsw.edu.au
- Isaac Dylan Carr i.carr@unsw.edu.au

Demonstrators for T12A:

- Jake Robert Bradbury jake_bradbury@hotmail.com
- Jacky Sze Ho Yu jacky.yu@bigpond.com

Demonstrators for T13A:

- Thomas Renneberg renneberg381@gmail.com
- Bochao Xu bochao.xu@student.unsw.edu.au

Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes.

Summary and Aims of the course

This course focuses on the subject of engineering design, which plays the role in guiding an engineer or a team of engineers to think like a designer along a systemic, rational, and creative pathway, towards breakthrough innovations of new product/service. The course provides students with a holistic understanding of the big picture, wide spectrum, and structured process of engineering design. In particular, it focuses on the early stage design, with respect to functional design and conceptual design, which greatly determines the ultimate success of any new product development.

Unlike the purely technical engineering subjects, engineering design is characterized by the synergy between “analysis” and “synthesis”, between “rationality” and “optimality”, as well as between “do the right thing” and “do the thing right”. Therefore, this course aims to make you understand the sociotechnical nature of engineering design that concerns both social reality and physical reality, and provide you with the capacity of not only solving a given design problem using relevant engineering knowledge, but also formulating a new design problem.

Design thinking is a fundamental skill that every engineer must have for the 21st Century. It is one of the skills that profoundly distinguish human intelligence from artificial intelligence, which greatly impacts an engineer’s long-term career success in the workplace. Therefore, this course aims to equip you with the domain-independent and solution-neutral design thinking, which can be applied to whatever technical stream (e.g., aerospace, mechanical, manufacturing, mechatronic, or naval engineering) you choose to pursue in the future.

Today’s engineering problem is becoming too complex to be addressed by a single engineer based on separate disciplinary knowledge. Therefore, this course also aims to make you understand both opportunities and challenges of collaborative engineering design. Through the pedagogy of project-based learning, it’s expected that your collaborative communication, negotiation, and decision-making skills will be enhanced.

Student learning outcomes

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

After successfully completing this course, you should be able to:

Learning Outcome		EA Stage 1 Competencies
1	Follow a systemic process to conduct engineering design step by step	PE 1.1 and PE 2.4
2	Identify design opportunities by soliciting and analysing customer voices	PE 2.3
3	Formulate a design problem as a set of functional requirements	PE 3.3
4	Describe an artefact based on functional modelling	PE 1.5
5	Generate design concepts by making propositions systemically	PE 2.3
6	Evaluate design concepts based on generic design axioms	PE 1.2
7	Visualize design concepts via sketching, CAD drawing and prototyping	PE 1.5 and 2.2
8	Diagnose complexities and contradictions within an artificial system	PE 2.1
9	Collaborate with a team of engineers to jointly solve a design problem	PE 2.4 and PE 3.6
10	Practice with the patent searching and application process	PE 3.4

4. Teaching strategies

Design is the hallmark of human creativity in general and the essence of the engineering profession in particular. Engineering students can learn “design” most effectively when they:

- Profoundly understand the social-technical nature of engineering design, as well as the fundamental difference between “do the right thing” and “do the thing right”.
- Actively engage in continuous interactions with instructor, classmates, teammates, and practitioners to construct not only novel artifacts but also new knowledge, skill, wisdom, and entrepreneurship.
- Proactively employ the design insights gained in classroom to frame their daily life struggles, decisions, and observations as a unique innovation opportunity and to create both purposeful and functional “artifacts” to capture the opportunity.

Based on the above teaching philosophy, this course adopts the following teaching strategies: face-to-face lecture, demonstration, project-based learning, etc.

Face-to-Face Lecture: the purpose of lectures is to deliver design knowledge and deepen understanding of the delivered knowledge. Generally speaking, there are two kinds of lectures for this course: content-oriented and context-focused. The former is intended to deepen your theoretical understanding of relevant design theory and methodology, whereas the latter focuses on enhancing your practical skills of using design methods to address real-world problems. During the lecture time, you are expected to pay 100% of your attention. You are highly encouraged to take notes.

Demonstration: during demonstration sessions, the demonstrators will showcase how to use the design methods covered in the lectures to address real-world design problems, answer any questions about the course assignments, and provide guidance for your team project. Different from the lectures, there is no standard format for a demonstration session. The demonstrators should be treated, with full respect, as your “coach” who can only guide you through the practice instead of competing for you in the field. Before you attend a demonstration session, in the best interest of your own learning, it is critical that you thoroughly reflect on the lecture content and purposefully prepare a set of lead-in questions.

Project-based learning: the best way to learn design methods is through design practice based on a specific project together with other designers. Therefore, the class will be divided into a number of teams of 5-6 students, which will be tasked with employing relevant design methods in order to collaboratively accomplish a design project and its associated assignments. Note that, given the large class size of over 400 students, the team formation will be conducted within demonstration session. No teams can be formed across different demonstration sessions.

5. Course schedule

Week[a]	Date	Lecture Topic	Demonstration Topic	Deliverable Due
1	07/24--07/30	Definition of design, innovation, and design thinking	NO demonstration session in week 1	
2	07/31--08/06	Solicit customer voices and identify an innovation opportunity	Team building and logbook writing	Team Formation
3	08/07--08/13	Formulate a design problem as a set of functional requirements	Demonstrate functional modelling and report writing	
4	08/14--08/20	Map customer needs to functional requirements	Demonstrate QFD and report writing	T1: Design Exercise (1)
5[b]	08/21--08/27	Ideate design concepts by systemic design methods	Demonstrate concept generation and sketching	T3: Functional Design Report T3: Peer Evaluation (I)
6	08/25--09/03	Organize design concepts based on the independence axiom	Demonstrate concept organization and CAD drawing	
7	09/04--09/10	Evaluate design concepts based on the information axiom	Demonstrate concept evaluation and CAD drawing	T2: Logbook (First Submission)
8	09/11--09/17	Improve a design concept by resolving its contradictions	Demonstrate TRIZ and CAD drawing	
9	09/18--09/24	Improve a design concept by reducing its complexities	Demonstrate report writing and CAD drawing	T1: Design exercise (2)
TEACHING RECESS (No Class)				T3: Conceptual Design Report T3: Peer Evaluation (II)
10	10/02--10/08	Improve a design concept by making it more “intelligent”	Demonstrate different types of sensors	
11	10/09--10/15	Overview of design for X (i.e., production, assembly, etc.)	Demonstrate patent searching and application	
12	10/16--10/22	Overview of data-driven product design	Demonstrate presentation design	T3: Patent Application Report T3: Peer Evaluation (III)
13	10/23--10/29	Final Design Presentation Week		T4: Final Presentation T2: Logbook (Final Submission)

[a]The lecturer reserves the right to adjust the above schedule based on learning progression.
[b]The lecturer is on business travel in week 5. The lectures will be either cancelled or prerecorded, while the demonstration sessions will carry on as usual.

6. Assessment

Assessment overview

Task	Assessment	Length	Weight	Outcome	Assessment Guidelines	Submission	Due Date	Deadline of Absolute Fail	Return Marks
T1	Two design exercises	No length requirement	10%[a]	Outcome 2-8	• Will be posted on Moodle together with the assignment specification	• Digital report • PDF formats • Submit via Moodle	Week 4 and 9	1 day after due date and time	Within one week after the due date
T2	Logbook	Up to 100pages	40%[b]	Outcome 1-10	• Will be posted on Moodle together with the assignment specification	• Handwritten • Submit original hardcopy to tutors	Week 7 and 13	4 days after due date and time	Within two weeks after the due date
T3	Functional Design Report	Up to 20 pages	10%	Outcome 2-4	• Will be posted on Moodle together with the assignment specification	• Digital report • PDF format • Submit via Moodle	Week 5	2 days after due date and time	Within two weeks after the due date
	Conceptual Design Report	Up to 30 pages	15%	Outcome 5-8	• Will be posted on Moodle together with the assignment specification	• Digital report • PDF format • Submit via Moodle	Week 9	3 days after due date and time	Within two weeks after the due date
	Patent Application Report	5-8pages	5%	Outcome 10	• Will be posted on Moodle together with the assignment specification	• Digital report • PDF format • Submit via Moodle	Week 12	1 days after due date and time	Within one weeks after the due date
	Peer Evaluation for Reports	NONE	15%[c]	Outcome 9	• Will be posted on Moodle together with the confidential survey	• Online survey via Moodle	Week 5, 9, and 12	Not applicable	Within two weeks after the due date
T4	Final Presentation	15 minutes	5%	Outcome 9	• Will be posted on Moodle together with the assignment specification	• Digital format • Submit via Moodle	Week 13	2 days after due date and time	Within two weeks after presentation

[a] 5% is allocated to each design exercise
[b] 20% is allocated to the mid-term submission in week 7, and 20% is allocated to the final submission in week 13
[c] 5% is allocated to each peer evaluation

The final mark is determined based on the performance for the following assignments with different weights:

- 10% - Two (2) design exercises based on individual efforts
    - 5% - The 1st exercise due in week 4
    - 5% - The 2nd exercise due in week 9
- 40% - One (1) design logbook based on individual efforts
    - 20% - The first submission in week 7
    - 20% - The final submission in week 13
- 30% - Three (3) design reports based on team efforts
    - 10% - The functional design report
    - 15% - The conceptual design report
    - 5% - The patent application report
- 5% - One (1) final design presentation based on team efforts
- 15% - Three (3) peer-evaluations of individual contributions to team project

Students enrolled in the same demonstration session will be equally divided into multiple project teams, each team with 5-6 students. Students in the same design team will work together throughout the semester to collaboratively accomplish a design project and its associated assignments (i.e. design reports and presentation).

Assignments

Design Exercises

Two design exercises will be assigned to assess your understanding of basic design methods taught in class. They must be finished by every individual student independently. Each exercise is completed within 2-3 weeks, and the result is due in weeks 4 and 9. Each exercise counts as 5% of the final mark.

Design Logbook

Every student is required to create and keep a personal design logbook. The purpose of the logbook is to keep a record of your individual work done towards the team project. In industry, the logbook serves as a professional and legal document that indicates the complete research, planning, and thinking process of an engineer working on that project, such that if a new engineer takes over the project, the logbook allow them start off right where the previous engineer finished. The logbook can also be used as timestamped proof for an engineer's original invention when filing for a patent.

In essence, the logbook is a comprehensive documentation of the design project, in which your unique contributions should be particularly highlighted. In practice, a commonly made mistake is only logging the individual contributions (i.e. separate pieces of a design project) without covering the entire project that is based on teamwork. A good logbook is characterized by a general (but complete) description of the whole project, with detailed explanations of your individual work. Note that you are required to add new entries to the logbook on a highly regular and consistent basis (i.e. twice a week). The Logbook is not a

document that can be made up overnight in a retrospective fashion. A detailed logbook marking guideline will be published on Moodle.

Also note that the logbook must be prepared and submitted as the original copy in your own handwriting, with dates added and signed off. No digital copy is allowed, unless pre-approved. Your logbook will be collected and marked in weeks 7 and 13. Each submission of your logbook counts 20% of the final mark.

Design Report

Throughout the semester, each team is required to submit a total of three (3) design reports to summarize the design progress and present the design outcome. These reports correspond to the three design phases: functional design, conceptual design, and patent application. A detailed specification of report requirements, format, and organization will be posted on Moodle. The functional design report, conceptual design report, and patent application report each count as 10%, 15%, and 5% of the final mark, respectively.

In light of the iterative nature of engineering design, a special resubmission policy applies: Specifically, each team is allowed to significantly revise its submitted report and resubmit it for remarking. Note that every team has only one chance of resubmission for each report round. Resubmission is also only allowed for the functional design report and conceptual design report (i.e. the patent application report cannot be resubmitted). The resubmission window is only open for 10 days after the initially submitted report is returned to students with comments and suggestions from the markers.

With respect to the mark calculation, in the case of resubmission, the first submission counts as half of the report mark, while the resubmission counts for the other half. Take the functional design report for example: if a team received 7 marks in the initial submission and 9 marks in the resubmission, then the final mark that appears in the gradebook is 8. That being said, the initial submission is equally important as the resubmission. Resubmission must be treated as an extra opportunity to revise your work instead of a buffer to lessen the effect of the initial submission.

Note that together with the resubmitted report, each team must provide a concise rebuttal document that clearly outlines where, how, to what extent, and in what ways the report has been revised, in correspondence to the comments and suggestions raised by the markers.

Design Presentation

At the conclusion of the project, every team is required to make a 15-minute presentation about their final design outcome in front of the lecturer, demonstrators and peer classmates. The presentation is scheduled in week 13 and organized as per each demonstration session. The design presentation counts 5% of the final mark.

Note that the top 10 highest-performing teams (as measured and ranked by the marks of the functional and conceptual design reports) will be invited to make their final presentations during the lecture hours in front of the whole class. Three (3) best presentations will be

selected and offered some bonus marks. The rest of teams will make their presentations during the regular demonstration hours.

Peer Evaluation

In correspondence to the three design reports, a total of three peer evaluations will be conducted to assess every individual's contribution to the team project. Specifically, each student will be asked to fill out a confidential questionnaire to evaluate other members' contribution to the project in different categories. The peer evaluation results will be used to find out every team member's individual contribution. Simply put, the more you contribute, the more marks you will receive. Based on previous experience, a team project can be successfully accomplished, if and only if every member is devoted to contributing actively and equally. The three peer evaluations, in total, count 15% of the final mark.

Together with every design report, each team is required to submit a concise teamwork report, which summarizes every member's contribution to the report. The teamwork report will be used as a reference to cross-examine the accuracy and consistency of the questionnaire result. The weekly demonstration sessions are specifically reserved for teamwork. Therefore, your attendance to the demonstration sessions will be recorded and used as another reference for determining your peer evaluation mark. Finally, the logbook will also be referenced when determining the peer evaluation marks.

Note that if there are inactive members who fail to contribute at all (e.g. neither attending team meetings nor fulfilling assigned duties), you should inform the lecturer and demonstrator as early as possible. The lecturer reserves the right to redistribute the peer evaluation marks of the inactive student(s) to other active team members who undertake heavier workloads.

Presentation

All non-electric submissions (i.e. design logbook) should have a standard School cover sheet which is available from this course's Moodle page.

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Submission

Late submissions will be penalised 5 marks per calendar day (including weekends). An extension may only be granted in exceptional circumstances. Special consideration for assessment tasks must be processed through student.unsw.edu.au/special-consideration.

It is always worth submitting late assessment tasks when possible. Completion of the work, even late, may be taken into account in cases of special consideration.

Where there is no special consideration granted, the 'deadline for absolute fail' in the table above indicates the time after which a submitted assignment will not be marked, and will achieve a score of zero for the purpose of determining overall grade in the course.

Marking

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Examinations

There are NO examinations for this course.

Special consideration and supplementary assessment

For details of applying for special consideration and conditions for the award of supplementary assessment, see the School intranet, and the information on UNSW's Special Consideration page.

7. Attendance

For those enrolled in face-to-face lectures and demonstrations, students are required to attend a minimum of 80% of all classes, including lectures and demonstrations. It is possible to fail the course if your total absences equal to more than 20% of the required attendance. Please see the School intranet and the UNSW attendance page for more information.

8. Expected resources for students

No textbook is required for this course; however, you are encouraged to gain easy access to some recommended reference books as the following:

[1] "Axiomatic Design – advances and applications", by Nam Suh, Oxford University Press.
[2] "Engineering design – A systematic approach", G. Pahl and W. Beitz, Springer-Verlag.
[3] "Systematic Innovation – an introduction to TRIZ", by John Terninko, Alla Zusman, and Boris Zlotin, St. Lucie Press.

UNSW Library website: https://www.library.unsw.edu.au/

Some additional reading materials will be regularly published on the Moodle course page.

Moodle: https://moodle.telt.unsw.edu.au/login/index.php

9. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion in the final class for the course, and the School's Student/Staff meetings. Your feedback is taken seriously, and continual improvements are made to the course based, in part, on such feedback.

In this course, recent improvements resulting from previous student feedback include: (1) reengineering the report resubmission policy; (2) adding more illustrative examples in the lecture content; (3) adjusting the assessment schedule; (4) adjusting the peer evaluation methods; and (5) redistributing the marks among assignments.

10. Academic honesty and plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism: student.unsw.edu.au/plagiarism The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

If plagiarism is found in your work when you are in first year, your lecturer will offer you assistance to improve your academic skills. They may ask you to look at some online resources, attend the Learning Centre, or sometimes resubmit your work with the problem fixed. However more serious instances in first year, such as stealing another student's work or paying someone to do your work, may be investigated under the Student Misconduct Procedures.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis) even suspension from the university. The Student Misconduct Procedures are available here: www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Further information on School policy and procedures in the event of plagiarism is available on the intranet.

11. Administrative matters and links

All students are expected to read and be familiar with School guidelines and polices, available on the intranet. In particular, students should be familiar with the following:

- Attendance, Participation and Class Etiquette
- UNSW Email Address
- Computing Facilities
- Assessment Matters (including guidelines for assignments, exams and special consideration)
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Student Support Services

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex problem solving
	PE2.2 Fluent application of engineering techniques, tools and resources
	PE2.3 Application of systematic engineering synthesis and design processes
	PE2.4 Application of systematic approaches to the conduct and management of engineering projects
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (professional and lay domains)
	PE3.3 Creative, innovative and pro-active demeanour
	PE3.4 Professional use and management of information
	PE3.5 Orderly management of self, and professional conduct
	PE3.6 Effective team membership and team leadership