MECH 326 Syllabus

Mechanical Design II: Design Analysis Tools

# Overview

MECH 326 is a mechanical design course involving analysis tools. It draws from and expands on the solid mechanics topics you have already seen, and explores them in a design context.

# Particulars

## People and Places

There are two sections for this course. Each section will be taught in the same way using the same approach and the same materials.

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| --- | --- | --- | --- | --- | --- | --- |
| **Instructor** | Peter Ostafichuk | | | | | |
| **Email** | [ostafichuk@mech.ubc.ca](mailto:ostafichuk@mech.ubc.ca) | | | | | |
| **Office** | CEME 2053A | | | | | |
| **Office hours** | No set hours – email or just drop by | | | | | |
| **TAs**  **(shared)** | TBD |  | | |  | |
| **Lectures (attend both)** | Wed 1:00-2:00  FRDM 153  [www.maps.ubc.ca/?523-2](http://www.maps.ubc.ca/?523-2) | | | Fri 1:00-2:00  IKB 182  [www.maps.ubc.ca/?516](http://www.maps.ubc.ca/?516) | | |
| **Tutorials (attend your section)** | T1A: Tues & Thurs, 5:00-6:30, MCLD 214 | | T1B: Mon & Wed, 5:00-6:30, MCLD 214 | | | T1C: Tues & Thurs, 3:30-5:00, DMP 301 |

## Textbook

The required course text is Budynas, R.G., Nisbett, J.K., *Shigley’s Mechanical Engineering Design* from McGraw Hill (any edition can be used). The book is available in the Bookstore and will also be used in MECH 325 and 328. **Note: the above text contains information in both SI and imperial units. If you choose to purchase an international edition instead, you will likely find it has SI units only – this is sufficient for MECH 326 but you should confirm with your MECH 325 instructors that it will work in that course. If you choose to purchase an ebook version, you will need access to a physical copy for the open book portions of midterm and/or final exams.** For editions other than the most recent (10th Ed.), you may need to reference a colleague’s text to ensure the page numbering is consistent. For other reference materials relevant to this course, see the section at the end of this syllabus.

# Course Aims and Objectives

Our overall aim of this course is to provide students with the background and skills to be able to understand, analyze, and design shafts, welds, and other mechanical elements to withstand failure under static and dynamic load conditions.

By the end of the course, you should be able to:

* **Describe** theories for predicting failure of mechanical elements due to static and dynamic forces
* **Analyze** mechanical elements in terms of likelihood of failure
* **Design** shafts, welds, and other mechanical elements to satisfy design requirements and minimize susceptibility to failure
* **Describe** the principles of finite element analysis (FEA), and **apply** FEA and fracture mechanics software to analyze and design basic components
* **Evaluate** and/or **justify** design choices and analysis approaches for a given application

# Schedule

The approximate course schedule, tutorials, assignments, and other special activities, are shown below. (This is a rough guide, subject to change as we progress through the course.)

|  |  |  |  |
| --- | --- | --- | --- |
| **Module** | **Day** | **Class Topic** | **Tutorial (up to two days later)** |
| 0: Course Introduction | Sep 7 | Course introduction | No tutorial | |
| Sep 9 | Review: loading | Loading | |
| Sep 14 | Review: combined loading | Combined loading | |
| Sep 16 | Review: distortion energy | Static failure | |
| 1: Fracture Mechanics | Sept 21 | **RAP Quiz 1: Fracture Mechanics** | Work time\* | |
| Sep 23 | Introduction to fracture mechanics | Fracture mechanics | |
| Sep 28 | Fracture mechanics – static loading | AFGROW intro | |
| Sep 30 | Fracture mechanics – variable loading | AFGROW appl’n | |
| 2: Fatigue Failure | Oct 5 | **RAP Quiz 2: Fatigue Failure** | Work time | |
| Oct 7 | The SN Diagram | SN Diagram | |
| Oct 12 | Infinite life models | Infinite life I | |
| Oct 14 | Design for infinite life | Infinite life II | |
| 3: Shaft design | Oct 19 | **RAP Quiz 3: Shafts** | Work time | |
| Oct 21 | Shaft design procedure | Fracture / fatigue | |
| Oct 26 | Shaft deflection | Shaft defl’n | |
| Oct 28 | **Midterm Exam** | None | |
| Nov 2 | Other considerations in shaft design | Shaft speed | |
| 4: Weld design | Nov 4 | **RAP Quiz 4: Weld Design** | Work time | |
| Nov 9 | Intro to welds; static design | Weld analysis I | |
| Nov 11 | Remembrance Day – no class | No tutorial | |
| Nov 16 | Welds with variable loads | Weld analysis II | |
| 5: FEA | Nov 18 | **RAP Quiz 5: FEA** | Work time | |
| Nov 23 | FEA fundamentals | FEA intro lab | |
| Nov 25 | Interpreting FEA output | FEA work time I | |
| Review | Nov 30 | Assignment debrief | FEA worktime II | |
| Dec 2 | Review | None | |

\* “**work time**” = time in tutorial to work on assignment; unless noted, the TA will be present to answer questions and provide assistance as requested.

# Course Format

## Team-Based Learning

MECH 326 will be presented in a team-based learning (TBL) format. [[1]](#footnote-1) This format will be familiar to those who have taken the MECH 223 design course. You will also see this approach in MECH 325. In a conventional lecture-based course, basic information is gained in the classroom, skill development begins in tutorials, and challenging problems are tackled outside of class, with little input from the instructor. Moreover, numerous studies show that students retain less than 20% of the content presented a conventional lecture – even immediately after the lecture has ended! – suggesting this is not a particularly effective use of time. The philosophy with TBL is to make better use of the student and instructor time by switching where various learning activities take place:

* Initial exposure to material is gained out of class through reading assignments
* Key points are reinforced by the instructor using mini-lectures, and then exercises and active learning take place in the classroom and the tutorial room
* Realistic, challenging problems are completed by students in and out of class, and conclude with debriefings and discussions by the instructor in class.

This ensures you see the course material multiple times and in multiple different ways. The other important aspects of TBL are the Readiness Assurance Process (RAP) quizzes following the readings, and the formation of diverse, heterogeneous teams.

## Readiness Assurance Process

The Readiness Assurance Process (RAP) is a technique in team-based learning. It is used to ensure that students are familiar with background information on a topic so that class time can be used more effectively. The steps in the RAP in class are:

1. Individual RAP quiz: an individual multiple-choice test based on a general understanding of material from assigned readings
2. Team RAP quiz: the same multiple-choice test as conducted by individuals but this time taken as a team
3. Feedback: immediate feedback by instructor to ensure all students understand the material before proceeding with more advanced topics

## Team Structure

Teams of five or six students will be formed prior to the course. As much as possible, students are grouped with others in the same program to make it easier to collaborate out of class if necessary.

# Evaluation and Grading Structure

Many of the activities will be evaluated with a single mark assigned per team but with each student still individually responsible for the material. There will also be individual evaluations; all exams will be done as individuals. The elements that contribute to the final course grade are shown below. The instructor reserves the right to adjust or modify the course grading as necessary.

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **No.** | **Weight** | **Team or Individual**\* |
| RAP Quizzes (individual)  RAP Quizzes (team) | 5  5 | 7.5%  7.5% | I  T |
| Assignments\*\* | 5 | 20%+10% | T+I |
| Midterm exam | 1 | 20% | I |
| Final exam | 1 | 35% | I |

\* see “Peer Evaluation” below

\*\* see “Assignments” below

## Peer Evaluation

The team component of your grade will be subject to a peer assessment (using the *iPeer* software), which is designed to prevent people from letting the team carry them along without they themselves contributing. Each person will be asked to recommend an allocation of the team marks to all other team members and to provide reasons for their recommendation. Each student’s scores they receive from the peer evaluations will be averaged to create a multiplier to scale the team scores in order to determine each student’s final grade. There will be a “dry run” peer assessment early in the course so that you will be able to identify any issues early and make changes to how your team is functioning.

## Assignments

Assignments will be submitted and peer graded using the *peerScholar* system (linked on Connect). Each assignment will have three phases:

1. **Phase 1 – Submit**: The team completes the assignment together and produces a .pdf document to be submitted to *peerScholar*. ***Each team member submits a copy of the team document to* peerScholar *before the assignment due date*** – without an individual submission, you will not be able to complete the full assignment and you will not be eligible for full marks. You can also opt to submit after the due date but before a late submission deadline for a slightly lower maximum mark.
2. **Phase 2 – Assess**: After the late submission deadline, each individual will review and assess several assignments from other teams, again through the *peerScholar* tool. The assignments you are to grade will be randomly determined by *peerScholar*, and it is possible (although unlikely) that you could get your team’s assignment to review. TAs will also grade all assignments using the same grading scheme you will see in *peerScholar*. Each individual is responsible to ensure the grading of the assignments they are given in *peerScholar* is completed on time, by a deadline to be shown in *peerScholar*. Members in a team may collaborate with each other to complete their grading, but it is up to each individual to ensure they submit their assigned assessments.
3. **Phase 3 – Reflect and Assess Feedback**: After Phase 2 is complete, you will get a chance to see and reflect on the peer assessments of your work. At this point, you will be required to evaluate the quality of the feedback you received in the peer assessments, and to comment on how you would modify you team’s assignment. Again, each individual is responsible to submit their assigned tasks for Phase 3, but they may collaborate with their teammates in completing the reflection and assessment of the feedback you receive from other teams.

The assessments your team receives in Phase 2 from the other teams, equally weighted with the assessment from the TA, will be used to determine the team component of your assignment grade. Submitting your individually assigned tasks for Phases 1 to 3 above will be used to determine your individual portion of the assignment grade.

## Requirements to Pass

In order to pass the course, you must both:

* achieve an overall course grade of at least 50%, and
* achieve an average grade of at least 50% on the combined midterm and final exam grade (each weighted as shown above).

If you satisfy the requirements above to pass the course, but your *individual* grade components (i.e. those marked with “I” in the table above) fall below 50%, your course grade will be capped at a maximum of 50%.

# Additional Reference Material

The following texts provide an alternate presentation of the course topics

Collins, J.A., *Mechanical Design of Machine Elements and Machines: A Failure Prevention Perspective*, Wiley, New Jersey, 2003.

Mott, R.L., *Machine Elements in Mechanical Design*, 4th Edition. Prentice-Hall, New Jersey, 2004.

Norton, R.L., *Machine Design: An Integrated Approach*, 3rd Edition. Prentice-Hall, New Jersey, 2006.

Spotts, M.F., Shoup, T.E., Hornberger, L.E., *Design of Machine Elements*, 8th Edition. Prentice-Hall, New Jersey, 2004.

Ugural, A.C., *Mechanical Design: And Integrated Approach,* McGraw-Hill, Toronto, 2004.

# Professional Standards

All students in this course and in engineering at UBC are expected to conduct themselves in accordance with the high standards demanded of the profession of engineering. This includes, but is not limited to, acting in accordance with University policies on academic conduct. The UBC Calendar articulates what acceptable academic conduct is, and it is the responsibility of each student to inform themselves of the standards.

See: <http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,54,111,959>

If you have any doubt about what is acceptable practice, please see one of the course instructors for guidance.

1. Michaelsen, Larry K., Arletta Bauman Knight & L. Dee Fink. “Team-Based Learning.” Stylus Publishing, Sterling, 2004. [↑](#footnote-ref-1)