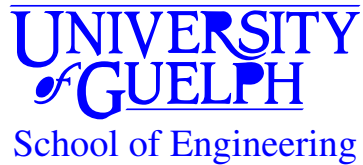


# ENGG\*3280 Machine Design

## Fall 2013



(Revision 0: August 29, 2013)

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## 1 INSTRUCTIONAL SUPPORT

### 1.1 Instructor

Instructor: Marwan Hassan, Ph.D., P.Eng.  
Office: THRN 2405, ext. 52429  
Email: [mahassan@uoguelph.ca](mailto:mahassan@uoguelph.ca)  
Office hours: TBA on Courselink or by appointment

### 1.2 Lab Technician

Technician: Ken Graham  
Office: THRN 1021, ext. 53924  
Email: [kgraha06@uoguelph.ca](mailto:kgraha06@uoguelph.ca)

Technician: David Wright  
Office: THRN 1019, ext. 53924  
Email: [dwrigh02@uoguelph.ca](mailto:dwrigh02@uoguelph.ca)

### 1.3 Teaching Assistants

GTA	Email	Office Hours
Salim El Bouzidi	<a href="mailto:selbouzi@uoguelph.ca">selbouzi@uoguelph.ca</a>	Mondays 10:00AM-11:00AM - Thornbrough GTA room
Yasser Selima	<a href="mailto:yselima@uoguelph.ca">yselima@uoguelph.ca</a>	Fridays 10:00AM-11:00AM- Thornbrough GTA room

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## 2 LEARNING RESOURCES

### 2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG\*3280 [Courselink](#) site. You are responsible for checking the site regularly.

### 2.2 Required Resources

1. Robert L. Norton *Machine Design: An Integrated Approach* Prentice Hall, 2011

### 2.3 Recommended Resources

1. Shigley's Mechanical Engineering Design (8th Edition in SI Units)
2. Design of machine elements, M. F. Spotts

### 2.4 Additional Resources

**Lecture Information:** Some of the lecture notes are posted on the web page (week #1-#12).

**Assignments:** Download the assignments according to the schedule given in this handout. All the solutions will be posted as indicated.

**Miscellaneous Information:** Lectures are the main source of material which includes important discussions and worked examples that might not be found elsewhere. Other information related to Machine Design are also posted on the web page.

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## 3 ASSESSMENT

### 3.1 Dates and Distribution

**Quizzes:** 10% (best 5 of 6)

- Sept 18, in class
- Sept 27, in class
- Oct 11, in class
- Oct 25, in class
- Nov 8, in class
- Nov 22, in class

**Project:** 30%

<b>Submission</b>	<b>Due</b>	<b>Description</b>
1	Week 1	Project Choice
2	Week 2	Introductory Project Pitch
3	Week 4	Design Alternatives
4	Week 7	Detailed Design
5	Week 9	Project Progress I
6	Week 10	Project Progress II
7	Week 11	Trade Show
8	Week 11	Final Report

**Note:** Each of the above submissions is accompanied with an oral presentation of the group. Both paper and electronic copies are to be submitted

**Midterm test 1: 20%**

Wed Oct 16, 17:30-19:30, Room TBA on Courselink

**Midterm test 2: 20%**

Wed Nov 13, 17:30-19:30, Room TBA on Courselink

**Final Exam: 20%**

Thurs Dec 11, 08:30AM - 10:30AM, Room TBA on Webadvisor

### 3.2 Course Grading Policies

**Missed Assessments:** If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

**Accommodation of Religious Obligations:** If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Consideration of Religious Obligations:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

**Passing grade:** In order to pass the course, you must pass exam course portion. Students must obtain a grade of 50% or higher on the exam portion of the course in order for the project portion of the course to count towards the final grade.

**Missed midterm tests or quizzes:** If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of any missed test/quiz will be added to the final exam weight. There will be no make-up midterm tests.

**Project Work:** You must attend oral presentations and submit all project milestone reports. If you miss a project report due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to submit the missed project. Late submissions of reports will not be accepted.

**Machine Shop Safety Test:** Failure to write and pass this test will result in an automatic loss of privilege to work in the machine area and a 0% mark for the project part of the course.

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## 4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

### 4.1 Calendar Description

This course provides the concepts, procedures, and analysis techniques necessary to design various mechanical elements commonly found in machines. Failure analysis such as yield criteria and fatigue are covered. Component design includes screws, fasteners, shafts, bearings and lubrication, and gears. The emphasis is on the use of readily available materials, standard component, and appropriate design approaches to achieve safe and efficient system design.

*Prerequisite(s):* ENGG\*2120, ENGG\*2230, ENGG\*2340, ENGG\*2400, ENGG\*2450

*Corequisite(s):* None

### 4.2 Course Aims

This course aims at: (1) equipping the students with an understanding of theory and practice of machine design, (2) developing the ability to integrate the knowledge that they have gained earlier in the previous two years in designing machine elements, (3) developing the ability to utilize analytical skills towards synthesis of solutions by working through the design of a mechanical device.

### 4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. formulate and analyze stresses and strains in machine elements and structures in 3-D subjected to various loads.
  - (a) define the most critically stressed point in a machine component.
  - (b) analyze strains and deflections.
2. specify appropriate tolerances for machine design applications.
  - (a) understand and to interpret tolerance on a dimension.
  - (b) Acquaintance with ISO system of tolerances.
  - (c) specify an appropriate tolerance on machine components.
  - (d) specify a fit for mating parts considering functional requirements.
3. apply multidimensional static failure criteria in the analysis and design of mechanical components.
  - (a) Knowledge of various static failure criteria for different materials.
  - (b) apply static failure criteria in the design and analysis of machine components.
  - (c) analyze and design components with non-uniform cross sections.
4. apply fatigue failure criteria in the analysis and design of mechanical components.
  - (a) Knowledge of fatigue failure and load-life relation.
  - (b) Knowledge of various fatigue failure criteria.

- (c) apply fatigue failure criteria in the design and analysis of machine components under various loading conditions.
5. analyze and design structural joints.
    - (a) Acquaintance with the terminology, and types of permanent and detachable joints.
    - (b) design and analyze bolted joints.
    - (c) design and analyze power screws.
  6. analyze and design power transmission shafts carrying various elements with geometrical features.
    - (a) Acquaintance with different types of shafts.
    - (b) design and analyze shafts with different geometrical features under various loading conditions.
    - (c) calculate critical speed of shafts and make the design decisions accordingly.
  7. design/select the material, thermo-mechanical condition and configuration of a variety of machine elements under a variety of environmental and service conditions. These would include:
    - (a) Shafts
    - (b) Bearings
    - (c) Spur gears
    - (d) Screws
  8. The acquaintance with standards, safety, reliability, importance of dimensional parameters and manufacturing aspects in mechanical design.
    - (a) Knowledge of standards for machine elements.
    - (b) Understanding of safety and reliability concepts in the design of machine elements.
    - (c) minimize the characteristic dimension of a machine element.
    - (d) An understanding of the influence of manufacturing processes in the design of machine elements.
  9. apply their skills to complete a major open-ended design project
    - (a) Devise solutions for complex mechanical engineering problem.
    - (b) Design mechanical linkage system including individual components that meet specified needs.
    - (c) utilize the basic machine shop tools such as lathe, milling, press drill, and welding.
  10. Demonstrate their ability to communicate their design ideas through technical reporting and presentation.
    - (a) justify a design project in a formal report.
    - (b) perform and present design calculations in a neat and organized manner.
    - (c) present the outcomes of the design in the form of engineering drawings.

#### 4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

<b>Graduate Attribute</b>	<b>Learning Objectives</b>	<b>Assessment</b>
1. Knowledge Base for Engineering	1-7	Quizzes, Exams
2. Problem Analysis	4,5,6	Quizzes, Exams, Project
3. Investigation	9	Project
4. Design	9	Project
5. Use of Engineering Tools	9	Project
6. Communication	10	Project
7. Individual and Teamwork	9	Project
8. Professionalism	-	-
9. Impact of Engineering on Society and the Environment	-	-
10. Ethics and Equity	-	-
11. Environment, Society, Business, & Project Management	9	Project
12. Life-Long Learning	-	-

#### 4.5 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on CourseLink/D2L but these are not intended to be stand-alone course notes. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and project.

#### 4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

#### 4.7 Relationships with other Courses & Labs

##### Previous Courses:

**ENGG\*1210:** Mechanical system fundamentals such as force, torques, friction, moments, free body diagrams

**ENGG\*1500:** Solving systems of linear equations, matrix algebra, complex numbers

**MATH\*1200 & MATH\*1210:** Limits, differentiation, integration, series expansion

**ENGG\*2120** Mean, standard deviation, normal distribution

**ENGG\*2230** Viscosity, Bernoulli and continuity equation

**ENGG\*2340** Kinematics, Dynamics, and gear analysis

**ENGG\*2400** Second order system, natural frequency

**ENGG\*2450** Fundamental circuit theorems

**Follow-on Courses:**

**ENGG\*4160:** Application of mechanical design principles

**ENGG\*4220:** Application of mechanical design principles

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## 5 TEACHING AND LEARNING ACTIVITIES

### 5.1 Timetable

**Lectures:**

Monday		08:30AM - 09:20AM	LA, Room 204
Wednesday		08:30AM - 09:20AM	LA, Room 204
Friday		08:30AM - 09:20AM	LA, Room 204

**Tutorials:**

Monday	Sec 01	02:30PM - 03:20PM	MACK, Room 226
Friday	Sec 02	02:30PM - 03:20PM	MACK, Room 227
Monday	Sec 03	02:30PM - 03:20PM	MACK, Room 226
Friday	Sec 04	02:30PM - 03:20PM	MACK, Room 227
Monday	Sec 05	02:30PM - 03:20PM	MACK, Room 226
Friday	Sec 06	02:30PM - 03:20PM	MACK, Room 227
Monday	Sec 07	02:30PM - 03:20PM	MACK, Room 226
Friday	Sec 08	02:30PM - 03:20PM	MACK, Room 227
Monday	Sec 09	02:30PM - 03:20PM	MACK, Room 226
Friday	Sec 10	02:30PM - 03:20PM	MACK, Room 227

**Laboratory:**

Tuesday	Sec 01	02:30PM - 04:20PM	THRN, Room 1015
Tuesday	Sec 02	02:30PM - 04:20PM	THRN, Room 1015
Wednesday	Sec 03	09:30AM - 11:20AM	THRN, Room 1015
Wednesday	Sec 04	09:30AM - 11:20AM	THRN, Room 1015
Wednesday	Sec 05	03:30PM - 05:20PM	THRN, Room 1015
Wednesday	Sec 06	03:30PM - 05:20PM	THRN, Room 1015
Thursday	Sec 07	02:30PM - 04:20PM	THRN, Room 1015
Thursday	Sec 08	02:30PM - 04:20PM	THRN, Room 1015
Friday	Sec 09	03:30PM - 05:20PM	THRN, Room 1015
Friday	Sec 10	03:30PM - 05:20PM	THRN, Room 1015

## 5.2 Lecture Schedule

<b>Lectures</b>	<b>Lecture Topics</b>	<b>References</b>	<b>Learning Objectives</b>
1	Review of simple stresses	Chapter 4	1
2-3	Combined stresses	Chapter 4	1
4	Stress concentration	Chapter 4	1
5-7	Static theories of failure	Chapter 5	3
8-10	Failure Due to Variable Loading	Chapter 6	4
11-14	Shafts, Keys, and Couplings	Chapter 9	6,7,8
15-20	Screws, Fasteners, and Connections	Chapter 14	5,7,8
21-25	Lubrication and Journal Bearings	Chapter 10	7,8
26-30	Rolling Contact Bearings	Chapter 10	7,8
31-33	Fits and tolerances	Notes	2,8
34-36	Gears	Chapter 11-12	7

## 5.3 Design Project Schedule

<b>Week</b>	<b>Topic</b>	<b>Location</b>
1-3	Introduction to Lab Equipment and Safety Training	Machine Shop
1	Project Identification	Design Room
2-4	Solution alternatives	Design Room
5-6	Detailed design	Design Room
7	Machining of the mechanical parts	Machine Shop
8	Power and electrical assembly	Design Assembly Room
9	Mechanical Assembly	Design Assembly Room
10	Physical prototype Testing	Design Assembly Room
11	Trade show	Engineering Atrium

Attendance of the Safety Training is mandatory. Student who does not attend the Training is mandatory will not be allowed to work in the machine shop area.

## 5.4 Other Important Dates

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# 6 LAB SAFETY

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.



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## 7 ACADEMIC MISCONDUCT

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community faculty, staff, and students to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member.

### 7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:

<http://www.academicintegrity.uoguelph.ca/>

Please also review the section on Academic Misconduct in your [Engineering Program Guide](#).

The School of Engineering has adopted a Code of Ethics that can be found at:

<http://www.uoguelph.ca/engineering/undergrad-counselling-ethics>

**ENGG\*3280**  
**Machine Design**  
**LAB SAFETY RULES**

These rules have been established for protecting the health and safety of anyone working in this lab. Please read and understand the rules below. Adherence is required when working in this lab. Access to the machinery in the shop is allowed in the lab-dedicated time only.

- Consult the machine shop technical staff Ken Graham or Dave Wright to answer any questions.
- Material safety
- Conduct yourself in a responsible manner at all times in the lab.
- You must wear safety glasses.
- Do not operate any equipment without proper training and permission.
- Follow all written and verbal instructions carefully. If you do not understand a direction or part of a procedure, ask your supervisor before proceeding with the activity.
- Be prepared for your work in the lab. Read all procedures thoroughly before entering the machinshop.
- Horseplay, practical jokes, and pranks are dangerous and are prohibited.
- NO FOOD, DRINK AND ONLY SHOES OR BOOTS ALLOWED!
- Be alert and proceed with caution at all times in the laboratory. Notify the technologist immediately of any unsafe conditions you observe.
- Know the locations and operating procedures of all safety equipment including: first aid kit(s), and fire extinguisher. Know where the fire alarm and the exits are located.
- Know the Emergency Exit plan for the lab.
- If the fire alarm sounds, please exit the lab immediately, calmly and in an ordered manner.
- Follow the guidance of the emergency exit plan.
- The Emergency Electrical Power Shutoff (Big Red Button) is on a hairpin trigger. Be careful around it, and use it responsibly.
- Clean up your work area before you leave the lab.
- Safety goggles must be worn at all times.

If you have any questions or concerns regarding lab safety contact the lab technologist at room 2308 or call at Ext 53729

Emergency accident illness phone number: Ext: 52000 (safety security department, University of Guelph)

**ENGG\*3280**  
**Design Project**  
**Machine shop Safety Quiz**

Note: It is recommended that you save your response as you complete each question.

**Question 1 (1 point)**

Shop safety is whose responsibility?

- Everyone associated with the shop
- Yours.
- No ones.
- The shop supervisor.

**Question 2 (1 point)**

What should you do if you notice a shop safety issue?

- Report it to a TA, faculty or shop supervisor.
- Ignore it.
- Report it to the main departmental office.
- Report it to the course instructor.

**Question 3 (1 point)**

Loose clothing is ...

- Dangerous for anyone to wear in a shop.
- Safe to wear around moving machinery.
- Dangerous only around moving machinery.
- Safe for bystanders to wear in a shop.

**Question 4 (1 point)**

Shop coats are..

stylish.

- Optional.
- Mandatory.
- Recommended

**Question 5 (1 point)**

When uncertain about tools or equipment you should?

- Give it a try.
- Ask someone who seems to know.

- Ask advice from a shop supervisor.
- Ask a friend or teammate

**Question 6 (1 point)**

Breaking shop safety rules will result in?

- Completing your work faster.
- Embarrassment.
- Nothing.
- The loss of shop privileges.

**Question 7 (1 point)**

What should you do if you need a specific tool or material that has not been provided?

- Ask the shop supervisor.
- Take it out of the shop store room or one of the technician's tool boxes.
- Do without.
- Walk through the shop and find it.

**Question 8 (1 point)**

The proper wearing of shop safety glasses

- is optional.
- is mandatory in the shop when working on the lathe or milling machines.
- is mandatory in the shop when working on any machine in the shop.
- is mandatory in the shop at all times.

**Question 9 (1 point)**

Dirty or smudged shop safety glasses are acceptable.

- True
- False

**Question 10 (1 point)**

Damaged safety equipment is acceptable to use as long as it still works.

- True
- False

**Question 11 (1 point)**

Spills on the shop floor can be left until later for cleaning.

- True

- False

**Question 12 (1 point)**

Tripping hazards are fine as long as you can see them.

- True
- False

**Question 13 (1 point)**

What should you do if you find a tool is damaged?

- Report it to the shop supervisor.
- Use it anyway.
- Find another tool to use.
- Fix the damage yourself.

**Question 14 (1 point)**

Floor areas should be...

- clear, dry and unobstructed.
- clear and unobstructed
- dry
- used when extra storage space is needed.

**Question 15 (1 point)**

Rushing will be tolerated in the shop?

- True
- False

**Question 16 (1 point)**

Safety rules are normally important but unessential

- True
- False

**Question 17 (1 point)**

Injuries in the shop ...

- are your problem.
- are embarrassing.
- should be ignored.
- should be brought to the attention of the shop supervisor, TA or faculty immediately.

**Question 18 (1 point)**

Dust can be a health hazard when working in a shop?

- True
- False

**Question 19 (1 point)**

Chemicals are a potential hazard in a shop?

- True
- False

**Question 20 (1 point)**

Sharp objects are the only hazard in a shop?

- True
- False

**Question 21 (1 point)**

Burns, cuts, concussions, dismemberment, blindness and death are all potential outcomes of incorrect shop use?

- True
- False

**Question 22 (1 point)**

When the safety rules refer to "horseplay," the meaning of the term is

- for animals.
- games for horses.
- fooling around.
- throwing hay.

**Question 23 (1 point)**

If you have long hair, how should you prepare yourself for work on the job?

- Get a haircut.
- Wash and dry your hair.
- Use mousse or styling gel on your hair.
- Tie your hair back or wear it under a cap.

**Question 24 (1 point)**

Which footwear contributes to shop safety?

- safety shoes with nonskid soles

- open-toed shoes
- open-toed sandals
- safety shoes with buckles

**Question 25 (1 point)**

You can help prevent slips and falls by

- keeping an even layer of sawdust on the floor.
- wearing leather-soled shoes.
- keeping the floor free of clutter and wiping up spills
- using short ladders.

**Question 26 (1 point)**

When using hand tools, always wear

- eye protection.
- leather work shoes.
- leather gloves.
- ear protection.

**Question 27 (1 point)**

If you are going to use a screwdriver on a part,

- hold the screwdriver in your left hand.
- sharpen the screwdriver.
- secure the part.
- paint the part first.

**Question 28 (1 point)**

Tools and machines may not be used until student has scored \_\_\_ percent on the safety test for that tool or machine.

- 80
- 60
- 100
- 70

**Question 29 (1 point)**

Which of the following should not be worn when operating machine shop machinery.

- Shop apron

- Gloves
- Safety shoes
- Long pants

**Question 30 (1 point)**

Playing around is not allowed:

- On breaks
- In the Machine Shop area
- Near an operating machine
- In center of shop floor

**Question 31 (1 point)**

Machinery and equipment can only be operated when:

- Guards are in place
- shop instructor is present
- Floor is free of oil and grease
- All of the above

**Question 32 (1 point)**

When a machine is being cleaned, oiled, or minor adjustments are being made:

- Turn off the motor
- Turn on the motor
- Run the spindle at low speed
- Put the machine in reverse gear

**Question 33 (1 point)**

It is dangerous for others to divert the machine operator's attention by:

- Touching the person
- Talking to the person
- Making loud noises
- It is dangerous for others to divert the machine operator's attention in any way

**Question 34 (1 point)**

When an unsafe condition is found or a person is not acting in a safe manner, you must:

- Ignore it as the Instructor will find it
- Have someone correct condition



- Report it to the Instructor immediately
- Report it to the Safety Committee

**Question 35 (1 point)**

When changing, or adjusting tools, and removing workpieces from machines, you should:

- Stop the spindle, as well as making sure all movement is stopped
- Decrease spindle speed
- Reverse the spindle direction
- Both B and C