

Mech Eng 2D03 – Course Outline

Mechanical Engineering Design Elements

Instructor:	Daniel Pinelli, M.Eng, P.Eng pinelld@mcmaster.ca Office Hours: TBD Following First Lecture
Teaching Assistants:	Maia Antolic antolicm@mcmaster.ca Mary Hanna hannam45@mcmaster.ca Ansh Bhargava bhargava9@mcmaster.ca Nishanth Kulkarni kulkarn@mcmaster.ca Hanqi (Tommy) Dong dognh39@mcmaster.ca Kalle Makai Brown Stewart stewak35@mcmaster.ca
Lectures:	Thursdays 7 pm – 10 pm (TSH 120)
Tutorials:	T01 Monday 11:30 am – 12:20 pm (T13 125) T02 Monday 2:30 pm – 3:20 pm (JHE 326H) T03 Tuesday 10:30 am – 11:20 am (CNH 106)
Exams:	Midterm 1: Tuesday, October 20, 7 – 9:30 pm in PGCLL B138 Midterm 2: Tuesday, December 1, 7 – 9:30 pm in PGCLL B138 Final Exam: Date, Time & Location TBD by Registrar's Office
Course Description:	Design concepts, mechanical advantage, simple & compound machines, study & analysis of standard design elements, machine design, engineering case studies
Course Topics:	1. Design – Design Principles, Material Selection, Simple Machines 2. Shafts – Shaft Elements, Tolerances, Shaft Design 3. Gears – Gear Principles, Gear Types, Gear Trains, Gear Strength 4. Transmissions – Manual, Automatic, CVT, DCT 5. Drives – Belts & Chains, Brakes & Clutches, Hydraulics 6. Mechanisms – Cams, Linkages, Mobility, Position Analysis 7. Connections – Welding, Fasteners, Bolt Strength 8. Bearings – Bearing Types, Bearing Life 9. Machine Design – Cordless Drill, Jet Engine 10. Case Studies – Hyatt Hotel Walkway Collapse, Apollo 13
Course Materials:	Textbook – None (Shigley's Mechanical Engineering Design is optional) Calculator – McMaster standard calculator is required (Casio FX-991MS) Drawing Instruments – Set containing ruler, compass & protractor is required
Evaluation:	20% Assignments (4 worth 5% each) 50% Midterm Exams (2 worth 25% each) 30% Final Exam

Course Content (*Optional depending on time availability and previous student knowledge)

1. Design
 - 1.1. The Design Process* – Conflict, Natural Design, 7 Step Design Process
 - 1.2. Design Considerations – Design For X, Safety Factor, Standards & Codes, Intellectual Property
 - 1.3. Material Selection* – Metals, Ceramics, Polymers, Composites
 - 1.4. Simple Machines – Mechanical Advantage, Simple & Compound Machines – **Example: Windlass**
2. Shafts
 - 2.1. Shaft Elements – Keyse, Splines, Couplings (U Joint, CV Joint, Fluid Coupling)
 - 2.2. Tolerances – Terminology, Types of Tolerances, Tolerance Stackup
 - 2.3. Shaft Design – Shear Stress, Angular Deflection, Critical Speed – **Example: Turbocharger**
3. Gears
 - 3.1. Gear Principles – Gear Geometry, Gear Ratio, Pressure Angle
 - 3.2. Gear Types – Gears (Spur, Helical, Herringbone, Bevel, Worm), Differential
 - 3.3. Gear Trains – Simple & Compound Gear Trains – **Example: Compound Gear Train**
 - 3.4. Gear Strength – Tooth Load, Lewis Formula – **Example: Gear Strength**
4. Transmissions
 - 4.1. Manual Transmission – Manual Gearbox, Gear Ratios – **Example: Manual Transmission**
 - 4.2. Planetary Gears – Configurations, Gear Ratios, Geometry – **Example: Planetary Gears**
 - 4.3. Automatic Transmission – Ravigneux Gearset, Configurations
 - 4.4. CVT (Continuously Variable Transmission) – Components, Operation
 - 4.5. DCT (Dual Clutch Transmission) – Comparison, Applications
5. Drives
 - 5.1. Belts & Chains – Belts, Chains, Bicycle Derailleur – **Example: Chain Drives**
 - 5.2. Brakes & Clutches – Brakes (Disc, Drum & Rim), Clutches (Plate, Centrifugal & Dog)
 - 5.3. Hydraulics – Pascal's Law, Conservation of Volume – **Example: Hydraulic Press**
6. Mechanisms
 - 6.1. Cams – Disk Cam, Linear Cam, Camshafts, Valve Float
 - 6.2. Linkages – Kinematic Diagrams, Linkage Effectiveness, 4 Bar Linkages, Grashof Criteria
 - 6.3. Mobility – Degrees of Freedom, Mobility – **Example: Water Pump**
 - 6.4. Position Analysis – Sketching Process – **Example: Mountain Bike Suspension**
7. Connections
 - 7.1. Welding – Arc, MIG, TIG & automated Welding, Weldability, Distortion
 - 7.2. Fasteners – Thread Dimensions, Threaded Fasteners, Dowel & Alignment Pins
 - 7.3. Bolt Strength – Proof load & Preload, Bolted Joints – **Example: Bolt Strength**
8. Bearings
 - 8.1. Bearing Types – Bearings (Plain, Ball & Roller), Wheel Bearings
 - 8.2. Bearing Life – Radial Loading, Combined Loading – **Example: Bearing Life**
9. Machine Design
 - 9.1. Cordless Drill – Switches, Planetary Gearbox, Clutch, Chuck
 - 9.2. Jet Engine – Compressor, Combustor, Turbine, Fan, Afterburner
10. Case Studies*
 - 10.1 Hyatt Hotel Walkway Collapse – Design Comparison, Lessons Learned
 - 10.2 Apollo 13 – Mission Overview, Lessons Learned

Communication Methods

Please use email or in person discussion to get in touch with me. I am available for in person discussion after the lecture times stated above and during my scheduled office hours. I monitor email frequently and endeavour to provide prompt and meaningful responses. Please allow at least 48 hours for a response before following up. While Microsoft Teams is an excellent collaboration tool, sending a message while I am not online is not effective as I do not get notified of these messages until the next time I open Teams. For this reason, please use email or in person discussion for questions.

Communication Conduct

All communications throughout the course are expected to be made with integrity and purpose. Be polite and professional in your communications and you are much more likely to get a positive response. Be clear and concise about the purpose and goal of your request. Use a descriptive subject line when sending emails to help the recipient understand immediately what you are talking about. Do not attempt to get a question answered within a few hours of a due date. Be proactive by reviewing course work and reaching out with questions early to address issues before they become imminent problems.

Submissions

Course submissions will be a combination of electronic file submission through Avenue and in person submission of written work. Assignments will be submitted electronically to the relevant Avenue dropbox. The midterms and final exams will be submitted in person as written work. For electronic submission, the Avenue dropbox is the only acceptable location for file submission. Do not email your work directly to the instructor or a TA (it will not be accepted or graded). The required format of all electronic submissions throughout the course is PDF in a single file (multiple files not permitted).

MSAF

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work". An MSAF request must be submitted to the department and the instructor notified immediately. The instructor and student will then engage in a dialogue about making up the missed work. The preference is to extend the due date for the missed work to a mutually agreed upon later deadline. Other options will be considered under special circumstances only. The MSAF cannot be used on the midterms or final exam.

Lectures

Lectures will be delivered in person at the times and location stated above. The lecture notes will be posted to Avenue in advance of the lecture times. The course is organized into 10 weeks of lecture topics each containing multiple sections relevant to the topic. It is recommended to review the lecture notes both before and after the lectures to solidify your understanding of the course concepts. At the end of certain classes, example problems will be solved in class related to the lecture content. Solutions will be posted to Avenue as lecture problems at the end of each week.

Tutorials

Tutorials will be delivered in person by TA's beginning the second week of term. There are 3 sections per week at the times and locations stated above, each delivering the same content. Each tutorial will present an example problem related to the previous week's lecture content. There are no grades assigned for the tutorials and nothing to be submitted. The tutorial problems are provided as regular weekly practice for the students. It is encouraged to work in groups and make effective use of the tutorial time.

Assignments

Assignments will be released through Avenue approximately every other week and due one week after their release, starting mid September and continuing throughout the term with the exclusion of reading week and the weeks preceding the midterms. There are 4 assignments in total worth 5% each of the final grade. The assignments will be an evaluation of the student's understanding of the content learned in the weeks preceding its release. Submission for all assignments will be electronic through Avenue.

Exams

The midterm and final exams will be completed and submitted in person. The date, time and location of the midterm and final exams are stated above. Only the McMaster standard calculator may be used during the exams as an authorized aid. The use of any other aid (including cell phones, watches or ear pods) is not permitted and will result in immediate failure of the exam. The standard numeric to letter grade conversion will be used to assign the appropriate letter grade at the end of the course.

McMaster Policies

Academic Integrity

You are expected to exhibit honesty and ethical behaviour in all aspects of the learning process. Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. It is your responsibility to understand what constitutes academic dishonesty. Please refer to McMaster's Academic Integrity Policy at www.mcmaster.ca/academicintegrity.

Academic Accommodations for Disability

Students requiring academic accommodation due to disabilities should contact Student Accessibility Services (SAS) early in the term to make arrangements with a Program Coordinator. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail at sas@mcmaster.ca.

Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (severe weather, labour disruptions). Changes will be communicated through standard McMaster communication channels such as McMaster Daily News or Avenue to Learn.