University of Macau
Department of Electromechanical Engineering
MECH306 - Machine Elements
Syllabus
1st Semester 2012/2013
Part A – Course Outline

Compulsory course in Electromechanical Engineering

Course description:

Introduction to machine elements. Screws, fasteners and the design of nonpermanent joints. Welding and the design of permanent joints. Mechanical springs. Rolling-contact bearings. Lubrication and journal bearings. Gears. Clutches, brakes and couplings. Shaft design. Flexible mechanical elements. Mechanical design and assembly. Professional ethics for design and maintenance of machine elements in mechanical systems.

Prerequisite:

MECH204 - Mechanics of Materials

Textbook:

- Richard G. Budynas, J. Keith Nisbett, *Shigley's Mechanical Engineering Design*, 9th Edition in SI units, McGraw-Hill, 2011. (ISBN: 0073529281, ISBN-13: 9780073529288)

Reference:

- James Carvill, *Mechanical Engineer's Data handbook*, CRC. (ISBN: 0849377803)
- George Ellwood Dieter, *Engineering Design: A Materials and Processing Approach*, 4th edition, McGraw-Hill, 2008. (ISBN-10: 0071263411, ISBN-13: 978-0071263412)

Course objectives:

To provide an opportunity to students to:

1. learn the design, applications, assembly and maintenance of machine elements for mechanical systems [a, c, f, h]
2. design and implementation of a mechanical system to meet desired needs within realistic constraints via group projects [c, d, e, k, h]
3. communicate effectively by using engineering drawings [g]

Topics covered:

1. **Introduction to machine elements** – Types of machine elements; Overview of mechanical systems/machines.
2. **Screws, fasteners and the design of nonpermanent joints** – Thread standards and definition; The mechanics of power screws; Threaded fasteners; Bolt strength; Relating bolt torque and bolt tension; Gasket joints; Bolted and riveted joints loaded in shear.
3. **Welding and the design of permanent joints** – Welding symbols; Butt and fillet welds; Stress in welded joints in torsion; Stress in welded joints in bending; The strength of welded joints.
4. **Mechanical springs** – Compression springs; Extension springs; Torsion springs; Belleville spring, Miscellaneous springs; Deflection of springs; Applications of springs.
5. **Rolling-contact bearings** – Bearing types; Lubrication; Mounting and enclosure; Selection of bearings.
6. **Lubrication and journal bearings** – Type of lubrication; Viscosity; Petroff's equation; Stable lubrication; Thick-film lubrication; Hydrodynamics theory; Design consideration; The relations of the variables; Clearance; Pressure-fed bearings; Load and materials; Bearing types; Thrust bearings.
7. **Gears-general** – Types of gears; Applications of gears; Nomenclature; Involute properties; Fundamentals; Gear trains; Planetary gear trains; Force analysis; The Lewis bending equation; Dynamic factor; Sizing of gear tooth.
8. **Clutches, brakes and couplings** – Internal expanding rim clutches and brakes; External contracting rim clutches and brakes; Band-type brakes; Frictional-contact axial clutches; Disk brakes; Cone clutches; Frictional materials;

Miscellaneous clutches and couplings.

9. **Shaft design** – Shaft layout; Miscellaneous shaft components.
10. **Flexible mechanical elements** – Belts; Flat-and Round-belt drives; V belts; Timing belts; Roller chain.
11. **Mechanical design and assembly** - Engineering drawing standards of machine elements; Units; General principle of mechanical design and safety factor; Assembly and disassembly; Applications of machine elements for mechanical design.
12. **Professional ethics with applications to design and maintenance of machine elements in mechanical systems** - Code of ethics and fundamental canons, Criteria for Interpretation of canons and examples.

Class schedule and credits:

Timetabled work in hours per week			No of teaching weeks	Total hours	Total credits	No / Duration of exam papers
Lecture	Tutorial	Practice				
3	1.64	0.36	14	70	3	1 / 2 hours

Topic outline:

Week No.	No. of hours	Topics
1	1	Introduction to course outline
1	1	Introduction to machine elements
1	1	Engineering drawing standards of machine elements
1	2	General principle of mechanical design and safety factor
2-3	7	Screws, Fasteners and the design of nonpermanent joints
3	1	Shaft and shaft components
3	2	Mechanical design and assembly exercise I
4-5	6	Welding and the design of permanent joints
5	2	Mechanical springs
5-6	4	Rolling-contact bearings and shaft design
6	2	Mechanical design and assembly exercise II
6-8	8	Lubrication and journal bearings
8-9	8	Gears-general
10	1	Discussion of model answer of Assignment 1
10	2	Mid-term exam
10	2	Mechanical design and assembly exercise III
11	1	Discussion of model answer of Mid-term exam
11- 13	7.5	Clutches, brakes and couplings
11- 13	4	Hand on practice of mechanical assembly
13-14	4.5	Flexible mechanical elements
14	1.5	Engineering ethics for design and maintenance of machine elements
14	1	Discussion of model answer of Assignment 2

Contribution of course to meet the professional component:

This course prepares students to work professionally in the areas of **machine elements** and **mechanical design**.

Relationship to EME Programme objectives and outcomes:

This course primarily contributes to electromechanical engineering Programme outcomes that develop student abilities to:

(a) An ability to apply knowledge of mathematics, science, and engineering;

(c) An ability to design a system, component, or process to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.

The course secondarily contributes to electromechanical engineering Programme outcomes that develop student abilities to:

(d) An ability to function on multidisciplinary teams;
(e) An ability to identify, formulate, and solve engineering problems;
(f) An understanding of professional and ethical responsibility;
(g) An ability to communicate effectively;
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context, especially the importance of health, safety and environmental considerations to both workers and the general public.
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice appropriate to the degree discipline;

Course content:

Maths	Basic Science	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies	Total 100%
0	0	66.67%	33.33%	0	0	100%

Persons who prepared this description:

Prof. Pak Kin Wong

Part B – General Course Information and Policies

1st Semester 2012/2013

Instructor: Prof. Pak Kin Wong
Office: N506
Office Hour: By appointment
Phone: (853) 8397-4956
Email: fstpkw@umac.mo

TA: Mr. Wong Ka In
Office: Automotive Engineering Lab
Email: imkain@gmail.com
Tel. 83974292

Time/Venue:

Every Tuesday, 2:30 p.m. - 4:30 p.m. (Lecture)/U101
Every Wednesday, 9:30 a.m.- 11:30 a.m. (Tutorial/practice) /U102
Every Thursday, 3:00 p.m. – 4:00 p.m. (Lecture) /U101

Assessment:

Final assessment will be determined on the basis of:

Homework:	20%
Mechanical assembly practice:	2%
Mechanical design project (group project):	14%
Mid-term exam (open-book):	14%
Final Exam (2-hour comprehensive open-book exam):	50%

Grading System:

The credit is earned by the achievement of a grade from 'A' to 'D'; 'F' carries zero credit.

Grades are awarded according to the following system:

Letter Grades	Grade Points	Percentage
A	4.0 (Excellent)	93-100
A-	3.7 (Very good)	88-92
B+	3.3	83-87
B	3.0 (Good)	78-82
B-	2.7	73-77
C+	2.3	68-72
C	2.0 (Average)	63-67
C-	1.7	58-62
D+	1.3	53-57
D	1.0 (Pass)	50-52
F	0 (Fail)	Below 50

Homework Policy:

The completion and correction of homework is a powerful learning experience; therefore:

- There will be approximately 2 homework assignments.
- No late homework is accepted.
- Possible revision of homework grades may be discussed with the grader within one week from the return of the marked homework
- The homework grade will be based on the average of the assignment grades.

Mid-term Exam:

One open-book mid-term exam will be held during the semester. There will be a 100-minute exam.

Note

- Attendance is strongly recommended.
- No make-up exam is given except for CLEAR medical proof.
- Cheating is absolutely prohibited by the university.

Appendix - Rubric for Programme Outcomes

Rubric for (a)	5 (Excellent)	3 (Average)	1 (Poor)
Understand the theoretic background	Students understand theoretic background and the limitations of the respective applications.	Students have some confusion on some background or do not understand theoretic background completely.	Students do not understand the background or do not study at all.
Use a correct model and formulation correctly	Students choose a model correctly and properly apply correct techniques.	Students choose a wrong model sometime, use a wrong formula, or a different technique.	Students use a wrong model and wrong formula, or do not know how to model.
Compute the problem correctly	Students use correct techniques, analyze the problems, and compute them correctly.	Students sometime solve problem mistakenly using wrong techniques.	Students do not know how to solve problems or use wrong techniques completely.

Rubric for (c)	5 (Excellent)	3 (Average)	1 (Poor)
Design capability and design constraints	Student understands very clearly what needs to be designed and the realistic design constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	Student understands what needs to be designed and the design constraints, but may not fully understand the limitations of the design constraints.	Student does not understand what needs to be designed and the design constraints.
Process to meet desired needs	Student understands very clearly the process of the design.	Student understands what the needs of the process design, but may not fully understand the limitations of the design constraints.	Student does not understand the process.

Rubric for (d)	5 (Excellent)	3 (Average)	1 (Poor)
Ability to work in teams	Performance on teams is excellent with clear evidence of equal distribution of tasks and effort as well as frequent meetings of the team members.	Performance on teams is acceptable with one or more members carrying a larger amount of the effort as well as infrequent meetings of the members or one or more members being absent from several meetings.	Performance on teams is poor to unacceptable with one or two members clearly carrying the majority of the effort as well as inadequate team meeting or one or more members missing the majority of the meetings.

Rubric for (e)	5 (Excellent)	3 (Average)	1 (Poor)
Identify problems in engineering systems	Students understand problem and can identify fundamental formulation.	Students understand problem but cannot apply formulation.	Students cannot identify problems.
Modeling, problem formulation	Students choose and properly apply the correct techniques.	Students model correctly but cannot select proper technique or model incorrectly but solve	Students at loss as to how to solve a problem.

and problem solving		correctly accordingly.	

Rubric for (f)	5 (Excellent)	3 (Average)	1 (Poor)
Professional Engineering Practice	Understand the professional and ethical practice in mechanical design, assembly, maintenance and hardware fabrication.	Have knowledge of professional and ethical practice in mechanical design, assembly, maintenance and hardware fabrication but cannot completely demonstrate.	No awareness of professional and ethical practice in mechanical design, assembly, maintenance and hardware fabrication.

Rubric for (g)	5 (Excellent)	3 (Average)	1 (Poor)
Illustration Component	Students can properly use engineering drawings or graphics to present their ideas and technical contents clearly, and all the illustrations are nearly error free.	Students can demonstrate the use of engineering drawings or graphics to present their ideas and technical contents, and some illustrations have minor mistakes.	Students cannot properly use engineering drawings or graphics to present their ideas and technical contents.
Written Component	Document is nearly error free with sophisticated use of vocabulary, formatted properly, with well-developed concise sentences and paragraphs.	Document contains some errors with a somewhat colloquial vocabulary, minor formatting issues, with some organizational issues that do not interfere with communication.	Document contains many errors, very colloquial vocabulary, with severe organizational issues that interfere with communication. Document would be considered unacceptable.

Rubric for (h)	5 (Excellent)	3 (Average)	1 (Poor)
Workshop and lab safety	Demonstrate a good understanding of workshop and lab safety in design implementation and mechanical assembly practice.	Demonstrate a little knowledge of workshop and lab safety in design implementation and mechanical assembly practice.	No awareness of workshop and lab safety.
Board consideration in engineering design	The design considers the aspect of environmental protection, health and safety issues.	The design demonstrates a minor consideration of environmental protection, health and safety issues.	No health, safety and environmental consideration at all.

Rubric for (k)	5 (Excellent)	3 (Average)	1 (Poor)
Use modern hardware tools in engineering practice	Student uses the hardware to measure and/or build engineering systems/designs correctly, and understands the limitations of the hardware.	Student uses the hardware to measure and/or build engineering systems/designs correctly.	Student does not use the hardware correctly.