University of Macau
Department of Electromechanical Engineering
MECH403 - Computer-aided Design
Syllabus
1st Semester 2012/2013
Part A – Course Outline

Compulsory course in Electromechanical Engineering

Course description:
Introduction to the fundamentals of geometric modeling and computer graphics theory for product design. It introduces how geometric information about mechanical products is represented, manipulated and displayed in computers. Topics to be covered include design specification, representation and manipulation of curves and surfaces, solid modeling, geometric transformations, graphical visualization, tolerance analysis, and data exchange. The lab practice with prevailing CAD packages enable students to intelligently use them for solving engineering design problems.

Prerequisite:
None

Textbook
- Zeid, I. ***Mastering CAD/CAM***, 2nd Edition, McGraw-Hill, 2005. ISBN: 007-123933-2

References:
- Lee, K., Principles of CAD/CAM/CAE Systems, Addison Wesley, 1999. ISBN: 0-201-38036-6
- Mario Hirz and Wilhelm Dietrich. 3D-CAD Design Methods in Vehicle and Engine Development Processes (VDI-Buch). Springer, 1st Edition, 2011. ISBN-10: 3642119395.

Course objectives:
1. Introduce to students the fundamental geometric modeling and computer graphics theory for system and product design. [a, c]
2. Introduce to students how geometric information about mechanical products is represented, manipulated and displayed in computers. [a, e]
3. Train students to master at least one of the prevailing CAD packages through Lab and project practices and intelligently use them to help solving engineering design problems. [k, l]
4. Train students the capability of collaboration and representing innovative design intention in engineering language by means of computer via group project. [e, g, k, l]

Topics covered:
1. **Introduction**
   Review of Syllabus; Introduction of the background and recent development of computer aided design technology; Introduction of the content covered in the course.
2. **Geometric transformation techniques**
   Basic concepts of graphics; Object affine transformation (translation, mapping, scaling, rotation, projections); Coordinate System Transformation; Views.
3. **Graphics visualization**
   Scientific visualization, Virtual environments; Hidden line/surface removal algorithm; shading.
4. **Design specification: 3D modeling and viewing**
   Design representation using projection and multi-view drawing; 3D modeling approaches; Coordinate systems Basic construction features and coordinate features; Modeling strategies
5. **Representation and manipulation of curves**
   Curve basis and types; Review of vector algebra; Equations of analytic curves (line, conic sections); Equations of synthetic curves (Hermite Curves, Bézier Curves, B-Spline Curves, NURBS); Property and manipulation of curve geometry.

6. **Representation and manipulation of surfaces**
   Surface Entity Types; Surface Equations (Nonparametric equation, Parametric equation); Equations of analytic surfaces (planar surface, coon's patch); Equations of synthetic surface (Bézier surface, B-Spline surface, NURBS surface); Property and manipulation of surface geometry.
7. **Solid Modeling**
   3D Solid modeling requirements; Geometry and topology, CSG (Constructive Solid Geometry), Regularized set operation, BREP (Boundary Representation).
8. **Design Features**
   Design feature types; Parametric definition of design features; Manipulation of features; Interrelationship among design features; design principles.
9. **Product data exchange**
   International standard for product data exchanges (IGES, STEP, ACIS); Definition of fundamental geometric entities, and design/manufacturing features; Application of STEP tools; Production data management.

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	0	2	14	70	4	2 / 3 hours

Topic Outline: (Optional)

Week No.	No. of hours	Topics
1	5	**Introduction** Review of Syllabus; Introduction of the background and recent development of computer aided design technology; Introduction of the content covered in the course.
1, 2	5	**Design specification: 3D modeling and viewing** Design Representation using Projection and Multi-view Drawing; 3D Modeling Approaches; Coordinate Systems; Basic Construction Features and Coordinate features; Modeling Strategies **Laboratory Experiment** ProEngineering tools environment, functions, coordinate system.
3, 4	10	**Geometric transformation techniques** Basic Concepts of Graphics; Coordinate Systems Conversion; Object Affine Transformation (translation, mapping, scaling, rotation, projections); Coordinate System Transformation; Views. **Laboratory Experiment** Assembly of features
5	5	**Graphics visualization** Scientific visualization, Virtual environments; Hidden line/surface removal algorithm; shading. **Laboratory Experiment** Group Project works
6, 7, 8	10	**Representation and manipulation of curves** Curve Basis and Types; Review of Vector Algebra; Equations of Analytic Curves (line, conic sections); Equations of Synthetic Curves (Hermite Curves, Bézier Curves, B-Spline Curves, NURBS); Property and manipulation of Curve geometry. **Laboratory Experiment** Fundamental design features construction (2D profile drafing)
9, 10	5	**Representation and manipulation of surfaces** Surface Entity Types; Surface Equations (Nonparametric equation, Parametric equation); Equations of Analytic Surfaces (planar surface, coon's patch); Equations of Synthetic Surface (Bézier surface, B-Spline surface, NURBS

		surface); Property and manipulation of surface geometry. **Laboratory Experiment** Fundamental surface features construction
11, 12	10	**Solid Modeling** 3D Solid Modeling Requirements; Geometry and Topology, CSG (Constructive Solid Geometry), Regularized Set Operation, BREP (Boundary Representation). **Laboratory Experiment** Fundamental 3D design features construction (sweeping, protrusion, rotating, lofting, etc.)
13	5	**Design Features** Design feature types; Parametric definition of design features; Manipulation of features; Interrelationship among design features; design principles. **Laboratory Experiment** Fundamental 3D design features construction (sweeping, protrusion, rotating, lofting, etc.)
14	5	**Product data exchange** International standard for product data exchanges (IGES, STEP, ACIS); Definition of fundamental geometric entities, and design/manufacturing features; Application of STEP tools; Production data management. **Project works** Project presentation

Contribution of course to meet the professional component:

This course prepares students to work professionally in the area of **engineering 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;
(e) An ability to identify, formulate, and solve engineering problems;
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice appropriate to the degree discipline;
(l) An ability to use the computer/IT tools relevant to the discipline along with an understanding of their processes and limitations.

The course secondarily contributes to Electromechanical Engineering Programme outcomes that develop student abilities to:

(d) An ability to function on multidisciplinary teams;
(g) An ability to communicate effectively;
(h) The broad education necessary to understand the impact of engineering solution in a global, economic, environmental, and societal context, especially the importance of health, safety and environmental considerations to both workers and the general public;
(j) A knowledge of contemporary issues;

Course content:

Maths	Basic Science	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies	Total 100%
15	0	10	40	0	35	100

Course modulator:

Dr. Seng Fat Wong

Persons who prepared this description:

Dr. Zhixin Yang, Dr. Seng Fat Wong, Dr. Tze Wood Ching

Part B – General Course Information and Policies

1st Semester 2012/2013

Instructor: Dr. Zhixin Yang
Office: N406
Office Hour: Tue 2-6pm or by appointment
Phone: (853) 8397-4456
Email: zxyang@umac.mo

Time/Venue:

Every Thursday, 9:30 a.m. - 11:30 a.m., Room U105
Every Wednesday, 8:30 a.m. - 09:30 a.m., Room U105
Every Tue, 11::30 a.m. - 01:30 p.m., Innovative Design and Integrated Manufacturing Lab

Assessment:

Final assessment will be determined on the basis of:

Homework:	15%
In-class Quizzes:	5%
Course Project:	20%
Mid-term:	30%
Final Exam:	30%

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

Comment:

The objectives of the lectures are to explain and to supplement the text material. Students are responsible for the assigned material whether or not it is covered in the lecture. Students who wish to succeed in this course should read the assignments prior to the lecture and should work all homework and lab assignments. You are encouraged to look at other sources (other texts, notes and webpage, etc.) to complement the lectures and text.

Homework Policy:

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

- There will be approximately 5 homework assignments.
- Homework is due one week after assignment unless otherwise noted, 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.

Quizzes/Mid-terms Exams:

One mid-term exam and one 15-minutes in class quiz will be held during the semester.

Note:

- Recitation session is important part of this course and attendance is strongly recommended.
- Check UMMoodle (webcourse.umac.mo) for announcement, homework and lectures. Report any mistake on your grades within one week after posting.
- No make-up exam is give except for CLEAR medical proof.
- No exam is given if you are 15 minutes late in the midterm exams and 30 minutes late in the final exam. Even if you are late in the exam, you must turn in at the due time.
- 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.
Multi-disciplinary teams	Team consists of members from two or more different engineering/science/business fields (this could contain some members not actually enrolled in the course but interacting as part of a competition, collaboration, etc.)	Team consists of members from two or more concentrations within the Department of Electromechanical Engineering	Team consists of members from the same concentration within the Department of Electromechanical Engineering

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

Rubric for (g)	5 (Excellent)	3 (Average)	1 (Poor)
Professional Impact	Student's/Team's/Group's document(s)/presentation(s) is/are considered to be of professional quality	Student's/Team's/Group's document(s)/presentation(s) is/are considered acceptable for college level work	Student's/Team's/Group's document(s)/presentation(s) is/are considered unacceptable for college level work
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.
Oral Component	Presentation is consistent, uniform, clear, direct, complete and captivating with very clear fonts and graphics with an excellent layout that clearly presents the technical content	Presentation is somewhat inconsistent between speakers, occasionally difficult to hear, with an acceptable layout containing acceptable fonts and graphics that adequately presents the technical content	Presentation is very inconsistent between speakers, difficult to hear with a poor layout containing illegible fonts and graphics that poorly presents the technical content. Would be considered unacceptable

Rubric for (j)	5 (Excellent)	3 (Average)	1 (Poor)
Relevance to the Present Time	Student displays an understanding of the theoretical or practical impact and an ability to correlate a subject, perception, communication, association and reasoning from a global and societal perspective.	Student is able to display an understanding of current topics and issues with some knowledge regarding their impact in a bigger global and societal sense.	Student has difficulty demonstrating an awareness or familiarity with current topics and issues relevant to most current global and societal affairs.

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.

Rubric for (l)	5 (Excellent)	3 (Average)	1 (Poor)
Use modern computer and software tools in engineering practice	Student uses the computer and software to correctly analyze engineering problems and/or create engineering designs, and understands the limitations of the software.	Student uses the computer and software to correctly analyze engineering problems and/or create engineering designs.	Student does not use the computer and software to correctly create engineering designs and/or does not correctly interpret the results.