NANYANG TECHNOLOGICAL UNIVERSITY

Teaching, Learning and Pedagogy Division

Reg. No. 200604393R

PROPOSED COURSE OUTLINE FOR STUDENTS AT NTU

Academic Year	2018/19	**Semester**	1 & 2
Course Coordinator	Associate Professor Zhong Zhaowei Associate Professor Yeo Song Huat		
Course Code	MA2002		
Course Title	Theory of Mechanism		
Pre-requisites	MA1001 Dynamics		
No of AUs	3		
Contact Hours	Lectures: 26 hours Tutorials: 13 hours		
Proposal Date	3 May 2018		

Course Aims

The course aims to provide you with the fundamental knowledge in the kinematics and dynamics of planar mechanisms, such as linkages, gears, and cams. Both graphical and analytical techniques will be introduced and you will be able to apply the techniques in solving problems in mechanisms. The foundation acquired will prepare you for studies in the fields of mechanism design, robotics and precision machine design.

Intended Learning Outcomes (ILO)

Upon successful completion of the course, you will be able to:

1. Describe in terms of the kinematic properties when you see a mechanism.
2. Identify the types of links, joints, and the basic linkage type of a mechanism.
3. Perform the kinematic and dynamic analysis of planar mechanisms such as the slider-crank, the four-bar linkage, and combined linkages.
4. Explain the function of gears and calculate the speed ratio of simple, compound and planetary gear trains.
5. Determine the displacement, velocity and acceleration of the cam follower and generate the required cam profile for smooth operation.
6. Apply the knowledge in the design and analysis of mechanisms using the knowledge and skills learnt.

Course Content

	Topic	Hours
1.	**Fundamental Concepts of Mechanisms** Terminology and definitions, Planar mechanisms, Degrees of freedom, Classification of planar four-bar linkages: The Grashof criterion, Transmission angles, Limiting positions of slider-crank linkages, Application of mechanisms, Analysis and synthesis.	3
2.	**Gears and Gear Train** Gear Types, Terminology and definitions of spur gears, Fundamental law of Gearing, Involute property, Contact ratio, Interference and undercutting, Velocity ratios for spur gear trains, Simple and compound gear trains. Planetary gear trains. Gear train applications. Helical gears and others.	4
3.	**Motion in Mechanisms: Kinematic Analysis** Planar motion. Vectors, Basic concepts of kinematic analysis, Moving coordinate systems. Relative velocity. Velocity polygon. Graphical analysis of basic linkages. Centros, Kennedy's Theorem. Acceleration of a point and a rigid body. Relative acceleration. Acceleration polygon. Acceleration image. Analysis of combined linkages. Vector loop. Analytical approach for kinematic analysis.	8
4.	**Motion in Mechanisms: Static-Force Analysis** Basic Principles of Force Analysis, Free body Diagram. Static equilibrium, Graphical static-force analysis of linkages. Analytical Static-force analysis, Friction in mechanisms.	3
5.	**Motion in Mechanisms: Dynamic-Force Analysis** Newton's second law. Moment of inertia for rigid body, Rigid body kinematics, Rigid body dynamics. D'Alembert's Principle and inertia forces. Dynamic analysis of the linkage mechanisms. Shaking force & moment, Balancing of machinery & rotors. Static balancing, Dynamic balancing.	5
6.	**Design and Analysis of Cam-and-Follower Systems** Introduction to Cam-and-follower systems. Cam design based on follower displacement. Displacement-Velocity-Acceleration-Jerk (SVAJ) diagrams of cams. Analytical cam design.	3

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/ Individual	Assessment rubrics
1. Continuous Assessment 1 – Quiz 1	**LO1, LO2, LO3, LO4**	*EAB SLO a, b*	20%	Individual	
2. Continuous Assessment 2 – Quiz 2	**LO1, LO5, LO6**	*EAB SLO a, b*	20%	Individual	
3. Final Examination – Restricted Open Book; 2.5hrs, 60%	**LO1-LO6**	*EAB SLO a, b*	60%	Individual	
		Total	100%		

Formative feedback

General feedback and common misconceptions will be discussed after the Quiz during review lectures. Performance as a cohort will also be provided.

You are encouraged to contact the instructors for constructive feedback.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lecture	Theory and content knowledge are presented and explained. Examples to highlight the concepts are discussed.
Tutorial	Tutorial problems are solved and discussed in class. You are encouraged to ask questions.

Reading and References

Textbook

1. Wilson, CE, Sadler, JP, Kinematics and Dynamics of Machinery, 3rd Edition in SI units, Prentice-Hall, 2003.

References

Nil

Course Policies and Student Responsibilities

As a student of the course, you are required to abide by both the University Code of Conduct and the Student Code of Conduct. The Codes provide information on the responsibilities of all NTU students, as well as examples of misconduct and details about how students can report suspected misconduct.

The university also has the Student Mental Health Policy. The Policy states the University's commitment to providing a supportive environment for the holistic development of students, including the improvement of mental health and wellbeing. These policies and codes concerning students can be found in the following link.
http://www.ntu.edu.sg/SAO/Pages/Policies-concerning-students.aspx

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty.

You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Chen I-Ming	N3.2-02-23	6790 6203	michen@ntu.edu.sg
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Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	**Kinematic Fundamentals** Introduction to Machinery. Links and Joints. Kinematic Diagrams. Examples of Kinematic Diagrams. Degree of Freedom for Planar Linkages. Classification of 4-Bar Linkages.	LO1, LO2,	Textbook: 1.1 to 1.4, 1.5, 1.6, 1.7, 1.8
2	**Spur Gears** Introduction to Gears. Gear Fundamentals. Contact Geometry. Contact ratio. Interference.	LO1, LO4	Textbook: 6.1 to 6.5, 6.6, 6.9
3	**Simple, Compound & Planetary Gear Trains** Introduction to Gear Train. Reverted Gear Train. Introduction and Formulation. Velocity Ratio of Simple PGT. Bicycle Hub Gear.	LO1, LO4, LO6	Textbook: 8.1, 8.2, 8.3, 8 .4
4	**Position & Velocity Analysis** Motion. Vectors. Basic concept. Moving coordinate systems. Relative velocity. Velocity polygon. Graphical analysis of basic linkages.	LO1, LO3	Textbook: 2.1, 2.2, 3.1, 3.9, 3.10
5	**Graphical Velocity & Acceleration Analysis** Velocity image. Analysis of combined linkages. Acceleration of a point and a rigid body. Relative acceleration.	LO1, LO3	Textbook: 3.11, 3.12, 3.14, 4.1
6	**Graphical Acceleration Analysis & Vector Method** Acceleration polygon.	LO1, LO3	Textbook: 4.6

	Acceleration image. Analysis of combined linkages. Vector loop. Analytical approach for linkage velocity & acceleration analysis.		
7	**Cams** Introduction to cam mechanisms. Jerk. Cam-and-follower systems. Follower motion functions.	LO1, LO5, LO6	Textbook: 5.1 to 5.6
8	**Cams & Static Force Analysis of Mechanisms** Construction of cam profile. Construction of cam profile with an off-set follower. Introduction to statics. 2-D static force analysis & free-body diagrams.	LO1, LO5, LO3	Textbook: 5.1 to 5.6, 9.1 to 9.3
9	**Static Force Analysis of Mechanisms** Solving equilibrium equations. Graphical method. Analytical method.	LO1, LO3	Textbook: 9.4, 9.5, 9.6
10	**Introductory Dynamics & Dynamic Force Analysis of Mechanisms** Newton's second Law. Rigid body dynamics. D'Alembert's Principle and inertia forces.	LO1, LO3	Textbook: 10.1, 10.2, 10.3
11	**Dynamic Force Analysis of Mechanisms** Mass Centre. Moment of inertia for rigid body.	LO1, LO3	Textbook: 10.1 to 10.5
12	**Dynamic Force Analysis of Mechanisms** Analysis of linkage mechanism and general mechanism. Analysis of complex linkage mechanism.	LO1, LO3, LO6	Additional materials
13	**Problem Solving and Review**	LO1, LO2, LO3, LO4, LO5, LO6	