SYLLABUS: KINEMATIC AND DYNAMICS OF MACHINES

Date / Revision August 22, 2017 / 22.08.17 /MaS
Faculty Engineering
Study Programm Mechatronics

SUBJECT: Kinematic and Dynamics of Machines

1 Basic Information

1.01	**Subject Name**	**Kinematic and Dynamics of Machines**
1.02	**Semester**	4
1.03	**Level**	1
1.04	**SKS**	3
1.05	**Mandatory / Curriculum**	Mandatory / D-03
1.06	**Subject Code**	MECH
1.07	**Subject Code**	MTE-D-MECH-4103
1.08	**Year**	2017 (7)
1.09	**Quality Control**	Final Test, OFSE, see evaluation
1.10	**Limitations**	Min 12 and Max 32 students in one class
1.11	**Combined with**	AVE, MEE, AUE
1.12	**Perquisite**	Statics and Mechanics of Materials
1.13	**Responsible**	Dean of Engineering Faculty
1.14	**Revision**	22-08-2017/MaS

2 Description of Subject

Displacement, velocity and acceleration analysis of linkage mechanisms; inertia force analysis of mechanisms; balancing of reciprocating and rotating masses; free and harmonic vibrations of single degree of freedom systems.

3 Objectives

- Introduces the concept of kenematics and the dynamics of mechanical system
- analyse the dynamics of mechanical system

PO Box 150, BSD CPA 15330
Tel. +62 85212318000
info@iuli.ac.id
www.iuli.ac.id
IULI – Eco Campus, The Breeze
Jl. BSD Grand Boulevard
BSD City 15345
Island of Java

- Analyze shaking forces and moments of a machines.

4 Competency

After having the course, students are expected have to:

- Recognize examples of mechanical systems in which the application of the principles discussed in this course is necessary to complete their design
- Select or design a mechanism for a specific purpose
- Analyze the position, velocity and acceleration of a linkage using graphical, analytical and computer-based methods
- Design and analyze cams and gear trains
- Analyze shaking forces and moments of a machine
- Balance a rotating machine to eliminate shaking forces and moments
- Compare and contrast the use of hand calculations, computer simulation, and experiments in designing and analyzing machines

5 Learning Approach / Methodology

- Lectures/ Class contact (time-tabled) supplemented with interactive questions and answers;
- Discussion, sample problem, group work;
- Student Study Effort: homework/assignment; preparation for test/quizzes/ examination.

6 Evaluation

5.1	**Absence maximum**	25%
5.2	**Participation in Discussion**	05 Points
5.3	**Homework / Classwork**	05 Points
5.4	**Presentation /Simulation**	10 Poins
5.5	**Daily Quiz**	20 Points
5.6	**Final Examination**	60 Points
	Total	100 Points

7 Text Book and Reference

1	**Main Text Book:** "Kinematics, Dynamics and Design of Machinery, 3rd Edition, 2016", Authors: Kenneth J. Waldron, Gary L. Kinzel, Sunil K. Agrawal, Publisher: Willey.
2	**Supplementary Text books:** • Dynamics for engineers-

PO Box 150, BSD CPA 15330
Tel. +62 85212318000
info@iuli.ac.id
www.iuli.ac.id
IULI – Eco Campus, The Breeze
Jl. BSD Grand Boulevard
BSD City 15345
Island of Java

8 Content / Topics of Lecture

Week	Content/ Topics of Lecturing	Text Book	Remark
1	**Introduction:** • Historical Perspective • Kinematics • Design Analysis and Synthesis • Mechanisms • Planar Linkages • Visualization • Constraint Analysis • Idle Degree of Freedom • Over-constrained Linkages • Uses of the Mobility Criterion • Inversion • Reference Frames • Motion Limits • Continuously Rotatable Joints • Coupler-Driven Linkages • Motion Limits for Slider-Crank Mechanisms • Interferences	Ch1[1]	
2	**Technique in Geometric Constraint Programming; Planar Linkage Design:** • Geometric Constraint Programming (GCP) • Constraints and Program Structure • Initial Setup for a GCP Session • Drawing a Basic Linkage Using GCP • Troubleshooting Graphical Programs Developed Using GCP • Two-Position Double-Rocker Design • Synthetic of Crank-Rocker Linkages for Specified Rocker • Amplitude • Motion Generation • Path Synthesis	Ch2,3[1]	
3	**Graphical Position, Velocity, and Acceleration Analysis for Mechanisms with Revolute Joints or Fixed Slides:** • Graphical Position Analysis • Planar Velocity Polygons • Graphical Acceleration Analysis • Graphical Analysis of a Four-Bar Mechanism • Graphical Analysis of a Slider-Crank Mechanism • Velocity Image Theorem • Acceleration Image Theorem • Solution by Geometric Constraint Programming	Ch4[1]	

PO Box 150, BSD CPA 15330
Tel. +62 85212318000
info@iuli.ac.id
www.iuli.ac.id
IULI – Eco Campus, The Breeze
Jl. BSD Grand Boulevard
BSD City 15345
Island of Java

4	**Linkages with Rolling and Sliding Contacts and Joints on Moving Sliders:** • Reference Frames • General Velocity and Acceleration Equations • Special Cases for the Velocity and Acceleration Equations • Linkages with Rotating Sliding Joints • Rolling Contact • Cam Contact • General Coincident Points • Solution by Geometric Constraint Programming	Ch5[1]	
5	**Instant Centers of Velocity:** • Definition • Existence Proof • Location of an Instant Center from the Directions of Two • Velocities • Instant Center at a Revolute Joint • Instant Center of a Curved Slider • Instant Center of a Prismatic Joint • Instant Center of a Rolling Contact Pair • Instant Center of a General Cam-Pair Contact • Centrodes • The Kennedy-Aronhold Theorem • Circle Diagram as a Strategy for Finding Instant Centers • Using Instant Centers to Find Velocities • Finding Instant Center Using Geometric Constraint • Programming	Ch6[1]	
6	**Computational Analysis of Linkages:** • Position, Velocity and Acceleration Representations • Analytical Closure Equations for Four-Bar Linkages • Analytical Equations for a Rigid Body After the Kinematic • Properties of Two Points are Known • Analytical Equations for Slider-Crank Mechanisms • Other Four-Bar Mechanism with Revolute and Prismatic • Joints • Closure or Loop Equation Approach for Compound • Mechanism • Closure Equation for Mechanism with Higher Pairs • Notational Differences	Ch7[1]	
7	**Special Mechanisms:** • Special Planar Mechanisms • Spherical Mechanisms • Constant-Velocity Couplings • Automotive Steering and Suspension Mechanisms • Indexing Mechanisms	Ch8[1]	
8	**MIDTERM SEMESTER BREAK**		

PO Box 150, BSD CPA 15330
Tel. +62 85212318000
info@iuli.ac.id
www.iuli.ac.id
IULI – Eco Campus, The Breeze
Jl. BSD Grand Boulevard
BSD City 15345
Island of Java

9	**Computational Analysis of Spatial Linkages:** • Spatial Mechanisms • Robotic Mechanisms • Direct Position Kinematics of Serial Chains • Inverse Position Kinematics • Rate Kinematics • Closed-Loop Linkages • Lower-Pair Joints • Motion Platforms	Ch9[1]	
10	**Profile Cam Design:** • Cam-Follower Systems • Synthesis of Motion Programs • Analysis of Different Types of Follower-Displacement • Functions • Determining the Cam Profile	Ch10[1]	
11	**Spur Gears:** • Spur Gears • Condition for Constant-Velocity Ratio • Involutes • Gear Terminology and Standards • Contact Ratio • Involutometry • Internal Gears • Gear Manufacturing • Interference and Undercutting • Nonstandard Gearing • Cartesian Coordinates of an Involute Tooth Generated with a Rack	Ch11[1]	
12	**Helical, Bevel, and Worm Gears; Gear Trains** • Helical Gears • Worm Gears • Involute Bevel Gears • General Gear Trains • Direction of Rotation • Simple Gear Trains • Compound Gear Trains • Planetary Gera Trains • Harmonic Drive Speed Reducers	Ch12,13[1]	
13	**Static and Dynamic Force Analysis of Mechanisms:** • Forces, Moments, and Couples • Static Equilibrium • Free-Body Diagrams • Solution of Static Equilibrium Problem • Transmission Angle in a Four-Bar Linkage • Friction Considerations • In-Plane and Out-of-Plane Forces Systems • Conservation of Energy and Power • Virtual Work • Gear Loads • Problem Solvable Using Particle Kinetics • Dynamic Equilibrium of Systems of Rigid Bodies • Flywheels	Ch14,15[1]	

PO Box 150, BSD CPA 15330
Tel. +62 85212318000
info@iuli.ac.id
www.iuli.ac.id
IULI – Eco Campus, The Breeze
Jl. BSD Grand Boulevard
BSD City 15345
Island of Java

14	**Static and Dynamic Balancing; Integration of Computer Controlled Actuators:** • Single-Plane (Static) Balancing • Multi-Plane (Dynamic) Balancing • Balancing Reciprocating Masses • Expression for Inertial Forces • Balancing Multi-Cylinder Machines • Static Balancing of Mechanisms • Reactionless Mechanisms • Computer Control of the Linkage Motion • The Basics of Feedback Control • Actuator Selection and Types • Hands-On Machine-Design Laboratory	Ch16,17[1]	
15	**Rehearsal and Tutorial:** Rehearsal of all subject and students can ask for more detail.		
16	**Final Examination**		

PO Box 150, BSD CPA 15330
Tel. +62 85212318000
info@iuli.ac.id
www.iuli.ac.id
IULI – Eco Campus, The Breeze
Jl. BSD Grand Boulevard
BSD City 15345
Island of Java