Mechanical Engineering Department

ME 231 Kinematics of Machinery

(Required)

Catalog Description: ME 231 (3-0-3)

Design, selection, and evaluation of mechanisms for various applications. Topics include planar and spatial linkages, cams, gears, planetary and non-planetary gear systems, linkage synthesis, linkage dynamics, and an introduction to robotic manipulators using vector, matrix, and complex number methods. Projects involve using mathematics software for analysis and plotting of motion and inertial forces in planar and spatial linkages. CIS 101, Mech 234

Prerequisite(s):

Textbook(s)/Materials Required:

Norton *Dynamics of Machinery*
McGraw-Hill,
Recommended Software: Mathcad

Reference(s) (Not Required):none

Coordinator: Ian s. Fischer, Professor of Mechanical Engineeering.

Prerequisites by Topic:

1. Computer programming and problem solving
2. Statics and dynamics
3. Mathematics of the motion of particles and rigid bodies and the relation of force and motion of particles
4. Fundamental concepts and laws of mechanics including equilibrium and Newton's laws of motion
5. Differential calculus
6. Scalar and vector mechanics

Course Objectives[1]:

Objective 1. To develop skills for designing and analyzing linkages, cams, gears and other mechanisms.

Objective 2. To develop skills for use of mathematics software and for writing computer programs to solve kinematics problems.

Objective 3. To provide a foundation for the study of machine design.

Objective 4. Development of individual and team skills involving pre- and post-processing and interpretation computer-aided design and analysis data.

Objective 5. Development of individual and team communications skills.

Topics[2]:

1. Computer analysis of mechanisms, dot and cross product, inversere trigonometric functions, computer graphics (4 hours) (*1 hour)
2. Mechanisms & Machines – Degrees of Freedom, Classification of planar four - bar linkages Transmission angle, limiting positions, mechanism for specific applications (3 hours) (*1 hour)
3. Motion in Machinery – displacement analysis, analytical vector methods. Complex number methods, spatial linkages (4 hours) (*2 hours)
4. Spatial Linkage project (6 hours) (* hours)
5. Velocity Analysis – Moving coordinate systems. Relative velocity. Application of analytical vector methods complex number methods, spatial linkages (4 hours) (* hours) (*2 hours)
6. The velocity polygon – Velocity image. Analyzing combination of basic linkages (4 hours) (*2 hours)
7. Acceleration Analysis – Analytical vector methods complex number methods (3 hours) (*2 hours)
8. The acceleration polygon-equivalent linkages, Graphical analysis of sliding contact linkages (1 hour) (*1 hour)
9. Cams – disk cam designs for basic follower types & motions, displacement, velocity, acceleration and jerk analysis of cam follower motion. Cycloidal and polynominal cams (4 hours) (*2 hours)
10. Spur gears and gear terminology. Interference. Contact ratio. Internal gears. Gears. Gear tooth loads (4 hours) (2 hours)
11. Helical, worm & bevel gears – Helical gears on parallel shafts. Crossed helical gears. Worm gears. Bevel gears (2 hours) (*1 hour)
12. Planetary gear trains – Other drive train elements. Forces, torques and transmitted power in a planetary train (4 hours) (*3 hours)
13. Spatial linkage computer problem presentation. Statics and dynamics of linkages (4 hours) (*3 hours)
14. Linkage synthesis (4 hours) (*4 hours)
15. Introduction to robotic manipulators Review of course (5 hours) (*3 hours)
16. Exams (3 hours) plus final exam

Computer Usage:

1. Vector methods
2. Cam follower motion
3. Spatial linkage project
4. Mathcad software recommended for most work, particularly 3-D linkages.

Programming languages also used. Spreadsheets optional.

Laboratory projects (including major items of equipment and instrumentation used):
Computer projects.

Evaluation Method:

Schedule: Lecture/Recitation:
Laboratory:

Professional Component: Engineering Science 33%/Engineering Design 67%

Program Objectives Addressed:

Course Outcomes[3]:

Prepared by: Dr. Fischer **Date: October 18, 2006**

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[1] Capital Letters in parenthesis refer to the Program Objectives of the Mechanical Engineering Department. Listed in Sec 2 d Tables B-2-9, B-2-12. Table B-2-8 links Program Objectives with the ABET a-k Criterion.

[2] Topi**c** numbers in parenthesis refer to lecture hours. (three hours is equivalent to 1 week)

[3] Outcome numbers in parenthesis refer to evaluation methods used to assess the student performance. Lower case letters in parenthesis refer to ABET a-k outcomes.