MECH541 Kinematic Synthesis

Course Information – Fall 2005

www.mcgill.ca/cden/courses

Lecture Time & Room (New): Tuesdays & Thursdays, from 4:05 p.m. to 5:25 p.m. in ENGMD279

Prof. J. Angeles, Rm. 452 MD Office Hours: W. & Th. 9:30–10:30
Secretary: I. Cartier (cartier@cim.mcgill.ca), Rm. 461 MD, local 6313.

On-Line Tutoring: Please submit your queries by email (angeles@cim.mcgill.ca) to obtain a prompt reply.

Course Outline

Objective

To learn techniques enabling the mechanical designer to dimension geometrically a mechanical system intended to accomplish a specified positioning task.

Topics

1. Kinematic chains: Lower and upper kinematic pairs; single-loop and multiloop chains. Mechanism representations.

2. Mobility analysis of mechanical systems: displacement groups; kinematic bonds; the Chebyshev-Grübler-Kutzbach-Hervé formula. Series and parallel arrays of kinematic subchains: Applications to the qualitative synthesis of parallel-kinematics machines.

3. Function-generation: The synthesis matrix and its condition number; data conditioning. Transmission index and transmission angle. Transmission quality and its maximization. Zero-mean linkages: Application to quick-return and drag-link mechanisms. Planar and spherical function generators. Application of dual numbers to the synthesis of spatial function generators.

4. Motion generation (a.k.a. rigid-body guidance): The planar Burmester problem for three, four, and five poses of the guided body. The centre-point and the circle-point curves for four poses. The spherical and spatial Burmester problem. Application of dual numbers to the synthesis of spatial function-generators. Semigraphical solutions to the Burmester problem.

5. Path generation: The coupler curves of planar four-bar linkages. Special loci of the coupler link: the cubic of stationary curvature and the inflexion circle. Applications to the synthesis of six-bar mechanisms with dwell. Spherical and spatial path-generating linkages.

6. Synthesis of cam mechanisms. The synthesis of planar, spherical, and spatial mechanisms. Pressure angle.

Marking Scheme:

The final mark is based on both projects (75%) and a final class test (25%). Three projects will be assigned during the term, which will require numerical and symbolic computations using commercial software: Maple, Mathematica, and Matlab. Visualization of the results will require computer animations using ADAMS, Pro/E, SyMech, Unigraphics, Working Model, MOBILE, I-DEAS, or similar packages.

Policy for project- marking: 2/3 for technical content and 1/3 for presentation.

Course is based on

Angeles, J., 2005, *MECH541 Kinematic Synthesis Lecture Notes* (in progress), Department of Mechanical Engineering, McGill University, Montreal.

Otherwise, reading assignments will be handed out, and frequent reference will be made to

- Angeles, J., 1982, *Spatial Kinematic Chains. Analysis, Synthesis, and Optimisation*, Springer-Verlag, Berlin.
- Denavit, J. and Hartenberg, R. S., 1964, *Kinematic Synthesis of Linkages*, McGraw-Hill Book Inc., New York.
- Kimbrell, J. T., 1991, *Kinematics Analysis and Synthesis*, McGraw-Hill Book Inc., New York.
- McCarthy, J. M., 2000, *Geometric Design of Linkages*, Springer-Verlag, New York.

Note: McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offenses under the code of student conduct and disciplinary procedures (see www.mcgill.ca/integrity for more information).