**ME571 KINEMATIC ANALYSIS OF MECHANISMS**

**Course content:**

**INTRODUCTION**

Basic Definitions; Concepts in Kinematic Analysis of Mechanisms (3 hrs)

**3x3 ROTATION MATRICES**

Properties of 3x3 Rotation Matrices; Euler Angle Sequences; Angle-Axis Representation and Conversions; Analysis of Spherical Linkages; Examples: spherical 2R chain and spherical 4-bar linkage (3 hrs; Ref: McCarthy &Soh, 2010)

**4x4 HOMOGENEOUS TRANSFORMATION MATRICES**

The Denavit-Hartenberg (DH) Convention: Analysis of Spatial Serial Chains; Example: Direct/Inverse kinematics of a 6-dof serial manipulator (3 hrs; Ref: McCarthy &Soh, 2010)

**KINEMATIC ANALYSIS OF A 3-UPU PARALLEL MANIPULATOR**

An example of a kinematotropic multi-dof spatial parallel manipulator (6 hrs; Ref: paper by Kiper & Söylemez, 2011)

**LIE GROUPS & LIE ALGEBRAS**

Lie Groups; Chasles's Theorem; The Exponential Mapping (6 hrs; Selig, 2005)

**VELOCITY & ACCELERATION ANALYSIS WITH SCREWS**

Screws; Velocity and Accelation Analysis (6hrs; Ref: paper by Gallardo-Alvarado, 2015)

**CLIFFORD ALGEBRAS**

Complex Numbers; Quaternions; Clifford Algebras; Planar Rotations; Planar Displacements; Spatial Rotations; Spatial Displacements (6 Hrs; Ref: Lecture notes of Husty, 2009)

**PLANAR KINEMATIC MAPPING**

Planar kinematic mapping; Example: 3-RPR planar parallel manipulator (3 Hrs; Ref: Lecture notes of Husty, 2009)

**SPATIAL KINEMATIC MAPPING**

Spatial kinematic mapping (Ref: Lecture notes of Husty, 2009); Example: 3-UPU parallel manipulator revisited (6 Hrs; Ref: Kiper (unpublished))

**References**


Bottema, O., Roth, B. (1979). Theoretical Kinematics, North-Holland Publishing Company.

Davidson, J. K., Hunt, K. H. (2004) Robots and Screw Theory: Applications of Kinematics and Statics to Robotics, Oxford University Press.

McCarthy, J. M., Soh, G. S. (2010). Geometric Design of Linkages. 2nd Ed. Springer.

Selig, J. M. (2005). Geometric Fundamentals of Robotics, Springer.

Söylemez, E. (2013). Mechanisms, METU Press, 5th Edition.

Tsai, L-W. (1999). Robot Analysis – The Mechanics of Serial and Parallel Manipulators, John Wiley & Sons.