Department of Mechanical Engineering
University of California at Berkeley

Tribology (ME226)

SAMPLE SYLLABUS

Instructor: Professor K. Komvopoulos

Course Content

Introduction

Surface interactions at various scales; historical development of the study of nanomechanical surface interactions; early friction and wear theories; basic aspects of tribology problems; nano-/macro-topography; AFM and STM surface imaging; surface roughness parameters; fractals.

Basic Material Properties

Bulk and surface material properties; chemical reactivity; surface energy; work of adhesion; material compatibility; real area of contact (scale effects).

Contact Surface Interactions

The genesis of friction; analysis of various friction nano-/micro-mechanisms; friction force measurement at different scales; friction-space concept; friction mechanisms and adhesion in NEMS/MEMS and information storage systems; nanoscale friction mechanisms; implications of friction to nanotechnology and biotechnology.

Lubrication

Lubrication regimes; effect of load, speed, and roughness on lubrication efficiency; solid film lubrication; boundary lubrication and modeling; self-assembled monolayers (SAMs); solid-like behavior on confined monolayers; frictional heating and lubricant effect; chemical reactivity and additive functionality; EP lubricants and viscosity improvers; antiwear additives; behavior of

ultrathin solid and liquid films at various temperatures; rheological behavior of lubricant monolayers; basic elastohydrodynamic lubrication.

Wear

Types and uses of wear; measurement of wear; adhesion; asperity removal during sliding; size and shape of adhesive particles; abrasion; polishing; grinding; surface fatigue; impact; corrosion; erosion; fretting; stick-slip; nano-/micro-scale wear processes; tabulation of wear coefficients.

Response of Materials to Surface Traction

Introduction to contact mechanics; Hertz analysis; contact analysis of layered media; scale effects on contact deformation; response of elastic-plastic solids to sliding/rolling contact loading; plastic flow of the near-surface layer; shakedown, cyclic plasticity, and ratchetting; void and crack nucleation; crack propagation under mixed-mode loading; delamination wear; microstructure effects on delamination; ultrathin-film mechanical property characterization methods; nanoindentation and nanowear measurement, molecular dynamics analysis.

Friction and Wear of Polymers and Polymeric Composites

Phenomenological observations; basic friction mechanisms of polymers; wear model for fiber-reinforced polymer composites; friction and wear of biopolymers; molecular analysis of stretched polymers; basic surface physical chemistry of polymers.

Wear Due to Chemical Instability

Brief introduction to metal cutting; cutting tool materials; abrasion; solution and diffusion wear; tool wear monitoring techniques; protective hard overcoats.

Novel Methods for Improving Friction and Wear Properties

Surface texturing at various scales; Modulated/patterned surfaces; soft and hard overcoats; ion implantation; chemical and physical chemical vapor deposition; RF sputtering; plasma spraying; cathodic vacuum arc deposition; laser surface nanomachining and nanostructuring.