Tribology of Machine Elements

MEC411

Dr Matt Marshall

m.b.marshall@sheffield.ac.uk

Course Content

1. Introduction to Tribology - Tribological Failure Analysis
2. Wear Analysis Process
3. Wear Mechanisms
4. Surface Examination and Characterisation
5. Contact Mechanics
6. Roughness, hardness, friction
7. Wear Testing
8. Wear Modelling and Mapping
9. Case Study – Twin Disc Testing
10. Surface Engineering

wear, friction, contact mechanics

The Leonardo Tribology Centre

Course Content

11. Lubrication and Lubricants 1 – Properties of Lubricants
12. Lubrication and Lubricants 2 – Lubrication Regimes
13. Lubrication and Lubricants 2 – Design of Lubricants (Guest)
14. Hydrodynamic Lubrication 1 – Reynold's Equation
15. Hydrodynamic Lubrication 2 – Fluid Wedges & Pad Bearings
16. Hydrodynamic Lubrication 3 – Plain Journal Bearings
17. Hydrodynamic Lubrication 4 – Plain Journal Bearings
18. Elasto-hydrodynamic Lubrication
19. Assessment / Tutorial (Double Session)
20. Review
21. Tutorial

Lubricants, lubricant films

The Leonardo Tribology Centre

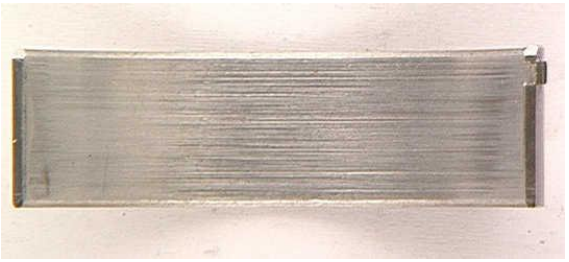
Course Objectives

- Machine elements like gears, bearings, brakes, clutches, cams, chains, and seals all have moving parts.
- The surfaces of these moving parts rub against each other.
- The contact zone is frequently the origin of failures.
- These failures include wear, seizure, excessive friction, or contact fatigue.
- Tribology is the science of relative surfaces in relative motion.
- It encompasses the study of friction, wear, contact mechanics, and lubrication.
- The objective of this course is to give students a basic understanding of the principles of Tribology.
- This is intended to prepare students so that they can solve industrial tribological related failures when they occur in their later working life.

The Leonardo Tribology Centre

Case Studies

- Case Studies on the Way
  - Engineering lubricants (Case study Shell)
  - Automotive valve recession
  - Wheel/rail contact – (including guest lecture)
  - Human tooth wear
  - Engine bearing shells
  - Rice chute abrasion



The Leonardo Tribology Centre

Tutorial Sheets

- Properties of Lubricants
- Hydrodynamic lubrication & thrust pads
- Journal bearing lubrication
- Elasto-hydrodynamic lubrication
- Wear Mechanisms
- Contact Mechanics
- Wear Modelling and Materials Selection

The Leonardo Tribology Centre

Assessment

- Exam and Assessment Day Exercise
- Weighting – 80% Exam, 20% Assessment Day
- Exam:

  Part 1 – 30 Marks – Compulsory short response questions (5 marks).

  Part 2 – Answer one question from two – Lubrication topics (25 marks).

  Part 3 – Answer one question from two – Wear topics (25 marks).

- Course Text

  Engineering Tribology by JA Williams, Oxford University Press.
  Tribology by I Hutchings, Edward Arnold
  Engineering Tribology by Stachowiak & Batchelor, Butterworth-Heinnemam
  Lubricant Selection – A R Lansdown, PEP Ltd.

The Leonardo Tribology Centre

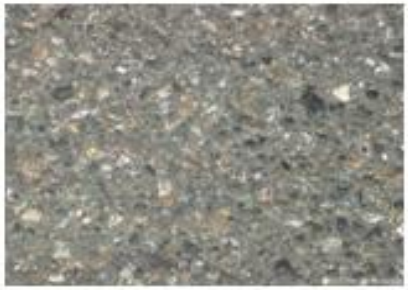
Assessment Day Exercise

The University Of Sheffield.

MEC411 Tribology of Machine Elements
Consultancy Exercise – Shoe Wear

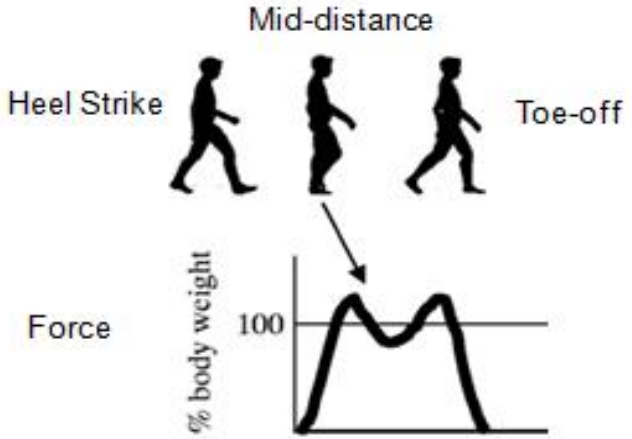
Shoes

The soles of shoes are designed to give comfort and good grip. They are made from a number of materials including leather (on expensive shoes), rubber, etc. – materials designed to grip well, but that are quite soft.



Pavement surfaces, with which shoes contact, can be rough and hard.

Walking Motion and Forces



Wear Features

Assessment Day Exercise

Example Problem – Shoe Wear

Have a look at the poster and the shoe provided. Make sure you can visualise how it operates. Then answer the following questions:

1 What has caused the wear scars to form? (write one answer in the box provided)

[1 mark]

(a) Plastic deformation
(b) Adhesive wear
(c) Two-body abrasive wear
(d) Three-body abrasive wear
(e) None of the above

C

2 How could the wear be reduced? (write one operational or design change and one material change in the boxes provided) **[2 marks]**

Operational or design change	• Reduce forces by redesigning shoe/sole
Material change	• Increase hardness of sole material

The Leonardo Tribology Centre