Engineering Tripos Part IIA, 3C8: Machine Design, 2017-18

Module Leader
Dr D Cole [1]

Lecturers
Dr D Cole and Dr R Roebuck [2]

Lab Leader
Dr D Cole [1]

Timing and Structure
Michaelmas term. 16 lectures.

Aims
The aims of the course are to:

- Analyse the contact stresses and kinematical behaviour of solid contacts and to understand the design of rolling element bearings and other machine elements.
- Understand the design of involute gears and appreciate the stress limits and practical problems of gears.
- To analyse the behaviour of multiple gear drives and planetary gears.
- Understand how components are combined to make up a mechanical power transmission system, including power matching to achieve a desired operating point.
- Apply the principles of power matching to hybrid drives.
- Introduce methods for specifying the type and arrangement of rolling element bearings to meet a specified duty.

Objectives
As specific objectives, by the end of the course students should be able to:

- Calculate the strength limitations of solid contacts.
- Analyse the kinematical behaviour of contacts, especially in rotating machinery.
- Understand and analyse the performance of friction drives.
- Be familiar with the geometry and kinematics of involute gear wheels and racks.
- Understand the criterion for tooth bending failure and be able to derive the Hertz pressure at tooth contacts.
- Use power and torque calculations to analyse epicyclic gears and multiple gear drives.
- Understand how power transmission components are used as part of a system, including hybrid drives.
- Determine the operating point and calculate the optimum speed ratio for specified conditions.
- Select a rolling element bearing for a specific duty.

Content
Mechanics of contacts (5L) Dr Michael Sutcliffe
- Hertzian point contacts
- Stresses and stiffness
- Hertzian line contacts
- Applications in bearings and CVTs
- Traction drives and CVTs

Gears (6L) Dr David Cole
- Geometry and kinematics
- Failure, root bending and contact fatigue
- Design and applications
- Multiple drives and planetary gears
- Design calculations for planetary gears

Power matching (3L) Dr David Cole
- Introduction and applications: automotive transmission, bicycle transmission
- Sources and loads; devices and their characteristics
- Power matching using a simple gear ratio
- Hybrid drives

Rolling element bearings (2L) Dr David Cole
• Bearing types; life equation

• Shaft and bearing arrangements

Examples papers

Examples paper 1 - Mechanics of contacts (issued at lecture 1)

Examples paper 2 - Gears (issued at lecture 6)

Examples paper 3 - Power matching, rolling element bearings (issued at lecture 12)

Coursework

Laboratory experiment on power matching a human to a bicycle. The lab can be written up as a Full Technical Report. The lab takes place in the South Wing Mechanics Lab. Book a time slot online.

[Coursework Title]

Learning objectives:

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Practical information:

• Sessions will take place in [Location], during week(s) [xxx].
• This activity [involves/doesn't involve] preliminary work ([estimated duration]).

Full Technical Report:

Students [will/won't] have the option to submit a Full Technical Report.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [4] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes' (AHEP) document [5] which sets out the standard for degree accreditation.

The Output Standards Matrices [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition
document is addressed within the Engineering and Manufacturing Engineering Triposes.

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