# Engineering Tripos Part IIA Project, GA2: Turbo-expander, 2019-20

### Leader

Prof P Tucker [1]

### Timing and Structure

Thursdays 9-11am plus afternoons and Mondays 11-1pm

### Prerequisites

3A1 & 3A3 useful

## Aims

The aims of the course are to:

- To introduce students to the basic ideas governing the design of turbomachinery and teach them to make measurements both of overall performance and of the detailed fluid flow in such machines.

## Objectives

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

- Students will work groups to design different builds of both the compressors and the turbines for one set of apparatus.

## Content

This project involves the theory and design of turbomachinery.

The basic theory necessary to design a centrifugal compressor and a radial inflow turbine will be given. Students will then prepare designs of both compressor and turbine blades to fit onto a prescribed impeller. The blades will be made out of aluminium strip by the students and the resulting combination will be tested by sucking air through it. There will be scope for detailed experimental investigation of the fluid flow and for the results to be used to modify the design. Group design will be chosen and the sensitivity of design to manufacturing variations will be explored. This design will then be refined and contrasted with the optimal designs of other groups.

Test the vacuum cleaner to measure the variation of pressure rise with flow rate. Hence decide on the flow rate for the turboexpander with robust design in mind. Write a short report on this.

Lectures on the aerodynamic design of turbomachinery with special emphasis on radial flow machines. Decide on the design rotational speed and type of blading.

Design of rotor and stator blades for both a turbine and a compressor and produce an optimal group design. Write a short report on this.

Make multiple builds of the same design (blades cut out of aluminium strip and attach to rotors).

Test combinations of different rotors and explore influence manufacturing variations. Measure the overall performance and details of the casing pressure distribution and flow direction. Write a short report on this.

Modify the blades as necessary and retest for final optimal group design contrasting with best design from other groups. Final report.

## Coursework

| Coursework | Due date | Marks |
|---|---|---|
| Interim report 1 | Thursday 14 May 2020 | 15 |
| Interim report 2 | Thursday 21 May 2020 | 25 |
| Interim report 3 | Thursday 28 May 2020 | 20 |
| Final summary report | 4pm Thursday 4 June 2020 | 20 |
| | | 25% of the marks are alloca |

## Examination Guidelines

Please refer to Form & conduct of the examinations [2].

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**Links**
[1] mailto:pgt23@cam.ac.uk
[2] http://teaching.eng.cam.ac.uk/content/form-conduct-examinations