FEEDBACK for Thermodynamics miniproject 2019/20

Thank you for taking the time to read the feedback.

The project was deliberately open ended, my hope being that you would produce reports which I would enjoy reading. The ramjet reports were slightly disappointing. I realise now that summarising a large body work is a task we don't ask you to do as often as, I feel, we should. Compared with last year (Nobel nomination) there was far more material available, and the challenge was to sift through, decide what was important, and present it clearly.

There's no "right answer" to these reports. First class marks could be obtained for a careful mathematical derivation or a well-written narrative relating the features of the engine to thermodynamics, physics and common sense. At this stage of your career, you should be able to pull together ideas from different courses, e.g. it's not obvious in Galilean relativity why burning fuel in a tube would cause it to move in one direction rather than the other!

The best reports began by explaining the hardware and concept of the ramjet, then how this can be mapped to the Brayton Cycle. This was generally done reasonably well. Figures for the PV and TS cycle are available on the web, along with schematic pictures of ramjets. Copying these (with accreditation) is fine, but a common failing was not directly relating the figures to the text. Worse, quite often the web-copied figures had some notation, and the report used a different one. This is always a no-no in scientific reports. You are entitled to use whatever notation and units you wish, per mole, per kg. T can be thrust or kinetic energy or Temperature. P may be pressure or momentum. But you always need to define it! The inlet temperature may be T0, or T1 or Tin but once defined, you must stick to that notation.

Efficiency is easy to define and Work/heat_in. More challenging is to write it in terms of meaningful thermodynamic quantities. The two option are to use velocities and temperature/pressure. Both are illuminating, the velocity definition tell you the the efficiency gets better the faster you move, the pressure/temperature shows that efficiency depends entirely on the first stage of the cycle - how much the air is heated/pressurised by the "ram". This is the surprising result that the efficiency doesn't depend on the fuel burning stage (provided the Brayton cycle approximation holds). Nobody explicitly mentioned that.

Derivations in a few lines are challenging, but its the way most papers are written - a readable explanation sketching the methods and bit of physics used (e.g. "using energy conservation is and isobaring process"), with the algebra covered by reference. In practice, you had to convince me you knew how to do the derivation without showing step-by-step. Its surprisingly easy to tell when you're bluffing, because finding the start and finish of the derivation online is easy, but finding them with consistent notation and units, also consistent with third-party figures, is unlikely.

A litany of minor failings: Copied figures which were illegible, terms in equations which were undefined, two pages means two pages, staples should not be required, but there was a lot of leeway with margins which could have been exploited. However I didn't feel any of the reports was too long, outside the spirit of the project, so ultimately I didn't penalise extra pages in marking. Of course the two page limit is arbitrary, but do bear this in mind - if you write overlength text in, e.g., job applications, its equivalent to writing "I can't follow simple instructions" on your c.v. (i.e, a bad idea)

Finally, I hope you enjoyed the course and the variety of teaching methods. It remains a concern that attendance at the tutorials, your chance to get feedback on your work, was so poor.   I'm very happy to hear and suggestions for improvements, but do bear in mind that different things work for different students.

Write a two page report on "The thermodynamics of a ramjet".

Notes.

The report should involve material you have learnt in the course, including relevant equations. It should be more technical than the wikipedia page, which you should read but not copy. Historical details are not important.

The report itself should be no more than two pages long (single column, 12 pt), and should contain relevant figures. References should be given for anything that would otherwise be plagiarism (e.g. quotes), or for any thermodynamics that you wouldn't have understood before taking the course and don't explain in the report (ideally, the report would be self contained so you wouldn't have anything like that).

The report should contain.

1/ An explanation of how parts of the physical ramjet can be mapped onto the idealised cycle of adiabats and isobars, including carefully defining the working substance, and an analysis of the cycle, including efficiency.

2/ Analysis of the state variables and the velocity of the gas at each stage of the process. You can assume conservation of momentum and energy, and you may treat the air as a diatomic ideal gas.

3/ A sensible definition and calculation for the "efficiency" (what you get out / what you put in).

Practicalities.

Two pages means you need to be concise, but any symbols ***must*** be defined and graph axes labelled. You may use without proof anything from the Thermodynamics notes, plus conservation of energy/momentum.   Do not start with other equations you may find on the internet!

You **may** work on the mini-project in self-organised groups of up to six. There is no obligation to do this, nor is there any constraint by degree program. If you do, you **must** hand in a single submission, with ALL barcodes attached.

Group submissions will have no reduction in marks.

The deadline for submitting project work to the teaching office with barcodes is by the end of Week 11 (2pm Nov 29th). We will be extremely sympathetic to extension requests. Given this sympathy, marks and feedback will not be available until next semester.

Note.

The ramjet was previously the first hand-in assessment. You can find that question online: it takes you through the various steps in a slightly contrived way, because it was designed to be done before considering the second law. It also contains some data which might be helpful.