DEPARTMENT OF MECHANICAL ENGINEERING

Small-Scale Engine

Mechanical Design A Project

Version 1.5

Department of Mechanical Engineering
The University of Birmingham

PROJECT BRIEF

Your design consultancy has been commissioned to design a small-scale two stroke, compression ignition engine for use in an expendable Unmanned Arial Vehicle (UVA) to be used in search and rescue missions. The engine must power the aircraft for least 15 minutes of flight

The engine must be capable of producing around 0.4 brake horse power (bhp) or $300\ W$ at a speed of approximately $16{,}000\ rev\ min^{-1}$. The engine, which should be air cooled shall be capable of driving a propeller of diameter $200\ mm$ x $100\ mm$ pitch at the required power and speed. The drive shaft should be a minimum of 5 mm in diameter.

The engine should be flexible and easy to start and operate. Thus it is suggested that you choose a side port layout rather than front or rear disc rotary valve arrangements as this configuration will give the characteristics required. You will probably need to make your design a short stroke engine, but this, of course, is up to you. You should also design a test bed, on which the engine can be fitted and connected to a pre-supplied dynamometer such that test engine data can be acquired

You are required to produce a series of component drawings (one per group member), a General Arrangement (GA) drawing of your design and also provide a validation report. The arrangement drawing should include a parts list containing materials specification and any treatments required. Where possible certain items (such as nuts and bolts) should be chosen from standard parts.

The company are particularly looking for good, innovative design, e.g. is there an alternative way to adjust compression, can the engine benefit from a form of supercharging? They are projecting a production run of initially of 5000 engines per year.

ASSIGNMENT

You are required to submit solutions for the above two-stroke engine and you must include the following:

1. A fully detailed and dimensioned components drawing selected from your design (one from each member of your group).

2. A short report validating your design, this may include [10.5 pages max]:
    a. An engine design summary [2-page max], including
        i. Basic engine parameters such as weight, stroke/ bore ratio, stroke length, bore and displacements
        ii. Details of porting arrangements
        iii. Details of any important aesthetic or ergonomic features
        iv. Engine mounting details
        v. Test frame and dynamometer connecting hub
        vi. Maintenance schedules etc.

        Think of this as the leaflet that would be included in the box!
    b. Engine and porting calculations [4 pages max], viz:
        i. Stroke/ bore ratio
        ii. Cylinder bore
        iii. Stroke length
        iv. Displacement
        v. Porting arrangements
        vi. Timing diagram.
    c. Design calculations [4 pages max]:
        i. Shaft analysis
        ii. Loads – stress state
        iii. Steady state loading - minimum diameter calculations
        iv. Fatigue life and factor of safety
        v. Bearing specification
        vi. Strength calculations for the test rig and hub coupling
    d. Feedback
        i. Include ½ page description of how feedback was used to develop your design further

3. A general assembly drawing to BS 8888 of your design (in third angle projection) containing:
    a. At least internal and external orthographic views, showing clearly all the main components, with sections as needed for detail and relative positions.
    b. Notes for layout and installation, service supply details, testing, relevant codes etc. so that a prospective buyer (an engineer) would have sufficient information to make a decision to order.
    c. Overall/ leading dimensions and engine weight.
    d. Parts list including component details – quantities, materials and supply.
    e. Separate items identified with leader lines to balloons that include the item reference number linking to the parts list.

N.B. Part 2 of the assignment does not require a lengthy report discussing why you chose the final design; rather you should focus on the technical aspects of your design, such as the assumptions you have made, the calculations and any comments on results. There is also no limit on the number of drawings that you choose to submit.

ASSESSMENT CRITERIA

Assessment of submissions will take account of the following factors:

Engineering integrity and the quality of design decisions

- Quality and practicality of design (location etc.)
- Engine parameters
- Porting and timing
- Fuel line
- Test bed and coupling hub

Application and understanding of engineering technology

- Material selection
- Manufacturability

Engineering Communication

- Quality of drawings, including:
    - Parts list
    - Adequacy of views
    - Dimensioning
    - Notes
- Report presentation

SUBMISSIONS

1. The component drawings are to be submitted through CANVAS on Friday 16th November 2018 by 23:59
2. The validation report is to be submitted through CANVAS on Friday 30th November 2018 by 23:59
3. The design drawings are to be submitted through CANVAS on Friday 14th December 2018 by 23:59

Also, it is worth noting presentation quality is considered in the assessment.

RESOURCES

During the course formal inputs are offered on the topics of mechanical design techniques, engine theory, manufacturing and materials and their effects on component design. Informal inputs can also be sought from the course tutors who are to be considered as consultants. Drawings should be produced using the SolidWorks software suit or similar software. Please refer to the introductory presentation for further details

RECOMMENDED TEXT

Simmons, C H. and Maguire, D E. (2007). Manual of Engineering drawing to British and International Standards, Elsevier, ISBN: 0-7506-5120-2

Budynas, R G and Nisbett, J K (2015). Shigley's Mechanical Engineering Design (Si), 10Ed, McGraw Hill, ISBN: 933922163X

Website: http://www.roymech.co.uk

ADDITIONAL INFORMATION

This information is offered to assist you in understanding what is required and should be read carefully.

Drawings should be in third angle projection and contain a full parts list specifying bought-out as well as in-house (designed and manufactured) parts.

There are a number of ways in which the required engine can be achieved. The 'best' solution will only emerge when you draw a few ideas. Even then the outcome will depend on what additional requirements (if any) you think are needed or would enhance the product. It is very important to take into account the manufacturing constraints associated with materials and their respective processing technologies in order to produce the engine components/sub-assemblies cost-effectively in the required quantities (batch sizes).

Get used to drawing your ideas, on a drawing board preferably (although these are limited in Mechanical Engineering, an A2 sketch pad can be very useful however), so corrections can be easily be rubbed out. This is the professional approach – hand sketches done in biro on A4 paper and not to scale cannot give the 'feel' necessary to determine whether the design or even a small design feature is a good idea or not.

Always draw in full size; by doing this you will better appreciate the various design problems as they emerge as well as showing the client exactly what they are getting. In addition the tutors can only be of assistant if you have something positive to show them each week.

You should aim to have your preliminary designs completed by the midpoint of the semester. You should do this to enable the course tutors to give you feedback on your design and the 'go-ahead' for the final design work and the individual material/manufacturing reports. To be at this point at week 7 will require assembly drawings that show all the necessary views such that a professional engineer can understand exactly how your design operates and also how key engine components can be manufactured.

LEARNING OUTCOMES

1. Understanding the technical requirements of a project brief, i.e.
    a. the operating cycle of a two stroke engine
    b. the piston/cylinder porting requirements
    c. Awareness of the influence of stroke/bore ratios in engine design
2. Designing components to specific requirements, i.e.
    a. Appreciating the tolerances needed in small engine design
    b. Appreciating the cooling and lubrication requirements of small two-stroke engines
    c. Understanding the fuel oil mixtures required by two stroke engines
    d. Understanding a simple carburettor
3. Designing with consideration of the technology of manufacturing processes and material choice, i.e.
    a. Appreciating the choice of materials available and using this information to make good decisions regarding materials selection
    b. Appreciating the limitations of manufacturing processes and materials in achieving satisfactory product performance
    c. Assessing the environmental impact of different phases in the engine live-cycle (energy requirements and carbon emissions/footprint)
4. Presenting a case for a chosen design neatly and persuasively, including the use of British Standards
5. Interfacing design and manufacturing stages in product development with viable process planning decisions
6. Understanding the communication needed between engineers in delegating component design.

OPPORTUNITIES FOR FEEDBACK

Formative feedback / assessment

(definition: https://en.wikipedia.org/wiki/Formative_assessment)

1. Product Design Specification [See Dr Dearn when it is done]
2. During *Design Forums*
3. *'Flash Feedback'*

Summative feedback/ Assessment
(definition: https://en.wikipedia.org/wiki/Summative_assessment)

1. Feedback on submissions
2. Video and provided through CANVAS, 15 working days after submission.

ACADEMIC INTEGRITY

Plagiarism will not be tolerated. It is the act of a Student claiming as their own, intentionally or by omission, work which was not done by that Student. Plagiarism also includes a Student deliberately claiming to have done work submitted by the Student for assessment which was never undertaken by that Student, including self-plagiarism and the other breaches. Sanctions of a plagiarism include the Student failing the Programme of study

UNIVERSITY OF BIRMINGHAM ASSESSMENT AND FEEDBACK STUDENT TEMPLATE

Section One

Reflecting on the feedback that I have received on previous assessments, the following issues/topics have been identified as areas for improvement: (add 3 bullet points). NB – for first year students in the first term, this may refer to assessments in their previous institution, or verbal feedback given in a teaching session.

Section Two

In this assignment, I have attempted to act on previous feedback in the following ways (3 bullet points).

Section Three

Feedback on the following aspects of this assignment (i.e. content/style/approach) would be particularly helpful to me: (3 bullet points).