Part IB guide

The Engineering Tripos comprises a two-year Part I followed by a two-year Part II. All CUED undergraduates study the same subjects for their first five terms. There is an element of choice in the sixth term, and in Part II students specialise in a chosen engineering area.

NB. Throughout this guide 'week' refers to Thursday to Wednesday of the normal teaching term.

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Aims & objectives

Teaching aims

The aims of Part I of the Engineering Tripos are to encourage and enable students to:

- develop a sound understanding of the fundamentals of engineering science across a broad range of engineering disciplines;
- acquire basic skills in modelling and analysis and the ability to solve straightforward technical problems;
- acquire basic design skills and the ability to create simple engineering designs using a multi-disciplinary approach;
- develop an awareness of the responsibilities of engineers in economic, social and environmental matters;
- develop practical skills and the ability to conduct and evaluate experiments;
- learn to create, use and evaluate computer software;
- develop communication skills, both oral and written;
- develop cooperative skills through group and teamwork activities;
- acquire basic study skills and develop independence of learning;
- develop a responsible and professional attitude.

General objectives

At the end of the Part I course students should:

- by means of lecture courses, associated examples papers and appropriate reading have learnt the fundamental principles of engineering science;
- by means of laboratory courses have witnessed phenomena associated with the material in the lecture courses, have gained an understanding of experimental methods and have experience of experimental techniques;
- by means of practical computing courses be able to create and evaluate software;
- by means of projects have been introduced to research and design;
- by means of a course in exposition and subsequent practice have developed powers of presentation both orally and in writing;
- by means of lecture courses, occasional lectures, essay assignments and industrial experience have gained an introduction to manufacturing, management and the economic, environmental and social

responsibilities of engineers.

The progress of each undergraduate is measured by Tripos examinations and by assessed coursework. Tripos classes and details of marks are notified to undergraduates through CamSIS or by their Colleges, and progress with coursework is communicated by staff marking individual coursework activities.

Achievement of the general objectives is dependent on an undergraduate reaching detailed objectives set for individual activities of the course. These are listed in the syllabuses for each series of lectures and the instruction sheets for coursework.

Part IB structure

Lectures

The 8 papers in Part IB are taken by all students. Papers 1-7 are of 2 hours' duration. Paper 8 is of 2.5 hours' duration, except for those students submitting coursework in one foreign language, where it is of 1.5 hours' duration. The papers are:

Paper 1	**Mechanics** (16 lectures)	
Paper 2	**Structures** (20 lectures)	
Paper 3	**Materials** (16 lectures)	
Paper 4	**Thermofluid mechanics** (26 lectures)	
Paper 5	**Electrical engineering:** Linear circuits and devices (10 lectures) Electrical machines (10 lectures) Electromagnetic fields and waves (6 lectures)	
Paper 6	**Information engineering:** Linear systems and control (14 lectures) Signal & data analysis (7 lectures) Communications (7 lectures)	
Paper 7	**Mathematical methods:** Vector calculus (14 lectures) Linear algebra (8 lectures) Probability (6 lectures)	
Paper 8	**Selected topics:** Electives (14 lectures)	
	Compulsory section: Business economics (8 lectures)	
	(i) Civil & structural engineering	Design and construction of underground space
	(ii) Mechanics, materials and design	Mechanical engineering for renewable energy
	(iii) Aerothermal engineering	Design of a jet engine
	(iv) Electrical engineering	Micro- and nano-electronic devices
	(v) Information engineering	Photo editing and image searching
	(vi) Bioengineering	Engineering of the human eye
	(vii) Manufacturing, management and design	Bringing technology innovations to market

All lectures for Papers 1-7 are scheduled during the Michaelmas and Lent terms, and have associated experimental work, and examples classes. Colleges arrange supervisions on these topics

Paper 8

Paper 8 consists of engineering activities taught in the context of design, and is divided into seven electives with the topics shown below. Students not submitting coursework in a foreign language are required to answer questions from two electives. Students who are submitting coursework in a foreign language are required to answer questions from one elective. The material in the electives is not considered prerequisite for Part IIA courses (although some preliminary reading may be expected by those who have not taken a particular elective).

In addition, all students are required to answer one question from the compulsory section on business economics, lectures for which are given in the Lent term. Lectures for all the other sections are given during the first four weeks of the Easter term. There are two examples papers per elective, for which fully worked solutions are available to students and examples classes included in the lectures. There are no supervisions for Paper 8.

Language programme for engineers

Students who take the language programme for engineers in Part IB may offer this course as one of their two options in Paper 8, or they may choose to enter for a language certificate. The certificate will record the level of their course (i.e. beginners', intermediate or advanced) and the standard achieved.

Coursework

See the Part IB coursework introduction for an outline of the activities, together with the timetabled sessions allocated to them.

Part IB coursework & labs overview

Introduction

Outlines of the Part IB coursework activities and experiments are given below, together with the number of timetabled sessions allocated to them.

Also see the general information about Part I labs & coursework.

Integrated coursework

An integrated coursework activity links four of the short labs (in vibration, structures, soils and signal processing) together round the common topic of "earthquake-resistant structures", with students choosing one extension activity to pursue in more depth, leading to a report and presentation.

It consists of:

1. an introductory lecture to set the scene and define the problems;
2. 4 short experiments in vibrations, soil mechanics, signal processing and structures including a risk assessment;
3. an extension exercise, in which you will design and conduct a follow-up to any aspect of the short experiments (taking 1-2 lab sessions);
4. a report and short presentation on your extension activity.

The integrated coursework runs over a four-week period, in the term in which you are not doing the IDP. The goals of this lab are to make the coursework open-ended and inter-disciplinary, to relate the labs more closely to Part IA and IB lectures, and to promote teamwork and presentation skills.

Computing

The Michaelmas term computing course provides an introduction to Octave/Matlab. Four practical sessions are timetabled, covering the Matlab language and environment, and students undertake exercises to display data and solve various numerical problems. The first session for each block of students (Mondays and Tuesdays in weeks 1 or 5) will be preceded by a short introductory talk in LR6. There are 12 qualifying marks of standard credit associated with this practical work. Students must attend all sessions promptly, until the last exercise has been marked.

The Lent term computing course consists of four programming exercises which reinforce the C++ programming skills introduced in the Part IA computing course.

Integrated design project

Students work in teams of six to design, build and test a mobile robot vehicle as an integrated design project (IDP). Various tasks, typical of those faced by the automated guided vehicles used in modern manufacturing plants, are set for the vehicles. Each team member is individually responsible for a particular sub-system, e.g. structure and drive train, power supply, sensors, electronic control or software integration, as well as contributing to the overall system design and optimisation. The project builds on Part IA teaching in electronics, computing, mechanics and structures, and aims to develop teamwork and communication skills. Students spend three two-hour sessions for four weeks working on this project. The resulting vehicles are tested in a competition to determine the best. Assessment is by quality of the robot vehicle and of team, sub-team and individual reports.

For further details see the IDP website.

Sustainable engineering

In the Michaelmas term, a series of five lectures presents contemporary applications of the different disciplines to sustainable engineering. The lectures are delivered by a mixture of internal and external speakers and provide an opportunity to hear first-hand from some of the most influential workers in the field. Assessment is through a poster on a topic selected by the student, prepared over the Christmas vacation and submitted in electronic format at the start of the Lent term.

For further details see the sustainable engineering syllabus. Coursework instructions will be given during the lecture course.

Coursework activities

Term	Coursework	No. of timetabled 2-hour (morning) lab sessions + afternoons
Michaelmas and Lent	Experiments Computing Integrated coursework Integrated design project	16 plus sign-up for long labs 8 5 + 2 or 3 morning/afternoon 13 + 1 afternoon lecture
Christmas Vacation	Poster on 'sustainable engineering'	

Aims and purposes of Part IB labs

- To acquire practical skills from using different types of equipment and a variety of measuring techniques and to develop a critical approach to assessing the limitations and accuracy of the methods used.
- To learn to work to a sensible number of significant figures.
- To obtain direct experience of physical phenomena, such as the annealing of a metal or the reflection of an electric wave.
- To learn more deeply by doing. Lab work is designed to reinforce the treatment of topics covered in lectures.
- To foster interest and understanding in the subject through practical work that demonstrates engineering applications.
- To gain experience of situations where practical experiments are better than mathematical methods for solving problems.
- To develop an awareness of the limitations of mathematical modelling by testing the validity of models and the assumptions on which they are based against physical observation and experiment; and to reject unsatisfactory models and assumptions if necessary.
- To acquire presentational skills through practice in (a) recording accurately and in a professional manner observations made in the laboratory and (b) writing concise accounts of what has been observed, the significance of the results and the conclusions that can be drawn.
- To develop skills in organisation and co-operation through working in pairs or in larger groups on a common task to meet a specified deadline.
- To develop an awareness of the safety of the individual and the group through the safe and careful operation of potentially hazardous equipment.

This is a long list of aims to be achieved, and others could be added to it. Remember that departures from expected behaviour can be more interesting and thought-provoking than results that fit the predictions exactly. Experiments are the physical reality: if you find that to within the accuracy of your measurements there are discrepancies within the theory, then it is the theory or more likely the assumptions on which it is based that are wrong. Respect your measurements and remain sceptical about theories until the physical evidence is convincing.

Experiments (Michaelmas/Lent terms)

All students undertake 20 experiments, as listed below. There is a mixture of long and short experiments.

Associated paper	Experiment number and title	Long or short
Integrated coursework: (interdisciplinary)	A1. Dynamic vibration absorber A2. Model structures A3. Soil mechanics A4. Fourier signal analysis	S S S S
Mechanics:	D1. Rotor dynamics	S
Structures:	S1. Plastic collapse	S
Materials:	M1. Materials characterisation M2. Heat treatment M3. Torsion testing	S + L S L
Thermofluid mechanics:	T1. Peltier heat pump T2. Pipe-flow T3. Boundary layers T4. Heat transfer	S S L S
Electrical engineering:	E1. Power amplifier E2. Synchronous machine E3. Induction motor E4. Wave transmission	S S S L

Associated paper	Experiment number and title	Long or short
Information engineering:	I1. Spectrum analysis I2. Process control I3. Position control	L S S

Part I labs & coursework: general info

General guidelines

- **Charts** in the individual lab expand the lab/coursework schedule into particular activities. Check beforehand that you know the location of your next exercise.
- **Penalties** apply for students arriving late to labs.
- Be aware of the procedure for **rearranging** missed coursework sessions.
- Read the note on **safety** and observe any special instructions on safety in individual labs. You should bring safety glasses, issued at the start of the year, for all materials labs (in the Lent and Easter terms) and for the structural design course practical work. You may be excluded from labs if you do not bring them.
- Students are advised to read the handout for the experiment online before attending the lab session. Printed copies of the handout will be available at the start of each lab.
- For much of the Part I lab work in the Lent and Easter terms you will need to use your **lab book** for recording data and taking notes during laboratory experiments. You are encouraged to word-process lab reports, which should be glued or stapled into your lab book.
- Experiments are classified as either **short** or **long**:
    - A short experiment occupies on 2-hour period and is completed and signed-up in that time.
    - A long experiment occupies 2 hours in the lab and is then written up as a report.
- Any urgent **problems** with an experiment or exercise should be reported to a demonstrator or the lab leader in charge of the laboratory.
- The report for each long lab should be set out in the lab notebook provided at the start of the year. Your report, together with that of your partner, will be **marked** by a demonstrator at a signing session. This must take place within 15 days of the date of the experiment.
- **Signing** sessions should be booked during the blank periods on the lab schedule. Demonstrators will give guidance on the form and content of the report expected for a particular experiment. It is important that you bring your lab notebook with you to each long experiment.
- **Credit** for the satisfactory performance of a short experiment is 2 marks. Credit for a long experiment is on the scale 0-6, with 4 marks for completion of the experiment and minimally acceptable work, 5 marks for satisfactory work and 6 for exceptional work. Late submission of a report incurs a deduction of 1 mark for each week, or part of a week, after the due date.

See the guidance on lab start times and allowances.

The lab record and long report

It is essential that you bring your lab notebook with you whenever you are timetabled to perform a long experiment. The notebook should be used to record all the readings, observations and calculations that you make, unless the instruction sheet specifically states otherwise. Do not use loose sheets of paper: these are easily misplaced. Charts and other records should be glued or stapled into your notebook.

Your lab record should start on a new page for each experiment performed. It should follow good professional practice and be correctly headed and dated. When there are several readings to enter, arrange these in tabular form, and make sure that the column headings show the quantity measured and the units used. Decide on how many columns you need and set out the table before you start taking readings. Whenever feasible, plot graphs as the experiment proceeds so that serious divergence from the expected behaviour can be checked there and then. Label the axes of the graphs and, where appropriate, indicate the accuracy of the data points on the graph.

The "report writing guide" covers all aspects of report writing in the Engineering Tripos. Specific sections are introduced via IA Exposition classes. For experiments and reports in Part I, you are referred in particular to the following sections:

- Report writing in the Engineering Tripos: long lab records and reports
- Introduction to technical writing: integrity, record-keeping, plagiarism and referencing

Difficulties with the lab report

If you need advice on a particular aspect of your report or you are otherwise held up on some point, then seek help. You can obtain help from a demonstrator in the laboratory or your supervisor. Do this in good time and you will not be rushed into producing an unsatisfactory report.

Copying the work of others is unacceptable. However, discussing your work with colleagues, supervisors or demonstrators is encouraged and can bring about improvements to the standard of the report you submit. The report itself must be your work, written in your own words. Students who submit the work of others as their own will have their reports referred to the appropriate authorities.

Feedback on labs & experiments

If you have comments about any experiment, please tell us about them using the fast feedback facility. Urgent problems with an experiment should be reported immediately to a demonstrator or senior technician in the lab, or contact the member of staff in charge of the lab. Please be constructive in your comments and suggestions.

Finally please complete the coursework section of the online survey during the year.

Coursework credit

Coursework in Engineering includes lab work and projects, plus a number of other marked assignments.

Coursework for standard credit at Part I

In Parts IA and IB, all coursework is for standard credit, which means that once students achieve a satisfactory standard in the various groups of activities the associated marks are capped at the qualifying level. Students who fail to reach the qualifying marks, or who fail to attend or hand in certain coursework, will have the shortfall deducted from their total in the Tripos. The marks available and qualifying marks are shown in the Faculty Board Part IA and Part IB coursework credit notices.

The standard credit scheme has been designed to encourage students to attend coursework sessions punctually, to complete each laboratory-based activity within an appropriate time to a satisfactory standard so as to achieve the main objectives of the activity, and to submit any written work for marking within a specified timescale.

The system aims to help students by discouraging them from spending an inordinately long time on any one coursework activity, at the expense of other aspects of their study. It also encourages innovation in design work, as there is not an undue loss of marks for a less successful outcome.

The majority of students are expected to gain the qualifying standard.

Rearranging coursework & allowances: general rules

Introduction

The Faculty Board of Engineering has issued the following guidelines about the circumstances under which coursework activities may be rearranged or allowances granted. The Head of Department delegates all the responsibilities mentioned in this document to the Director of Undergraduate Education. All forms are processed via the Teaching Office.

In Parts IA and IB students' coursework assignments are set by the lab rotas issued by the Teaching Office. In Parts IIA and IIB students are to a great extent responsible for setting their own coursework timetables by signing up for lab experiments etc. associated with the modules they are doing.

Main rules

1. Students should make **all reasonable efforts** to complete any missed exercises at a later date and so must first try and make rearrangements with the lab leader.
2. Applications should be made at the time rearrangement proves not to be possible, and at latest by the end of the relevant term.
3. Any application for an allowance must be made on the **standard form**. This form must be completed in full by both student and Tutor. The Tutor may be required to submit supporting medical evidence (e.g. if the period affected is over 7 days).
4. Forms should be submitted as soon as it is clear that an allowance may be required. **No forms will be accepted after the deadlines.**
5. A total allowance of more than four weeks coursework will not normally be given, in any year.

Types of allowance

The granting of an allowance implies either:

1. an **extension** of the scheduled period for completion and submission of an activity (applicable to both standard credit and positive credit activities); or
2. the **allocation of a number of marks** for the activity missed, if it proves impossible to rearrange or catch up the activity. For standard credit activities, the mark allocated will normally be the qualifying mark for the activity. For positive credit exercises, any mark allocated will depend upon the student's performance in related assessed activities.

In all cases, the Director of Undergraduate Education will consider the allowance form submitted by the student and Tutor, and decide upon the type and extent of any allowance to be made. These are incorporated in the final coursework marks sent to the Chairmen of Examiners. The Teaching Office will notify the Tutor and the student of the outcome of any application.

Allowances for individual activities are described in more detail for each Part:

- Parts IA and IB
- Part IIA
- Part IIB
- MET Parts IIA and IIB

Reasons for arranging coursework

Reasons for seeking to rearrange course work fall into one of the following five categories:

Illness

Educationally it is always preferable to rearrange coursework missed through illness, and this should be attempted wherever practicable. If rearrangement is not possible, then students should apply for the appropriate allowance.

'Illness' is defined as any illness, injury or other grave cause which, in the opinion of both the student's tutor and the Director of Undergraduate Education, prevents the student from completing their scheduled coursework activities on time, or in some cases at all.

Compassionate or religious grounds

Students will, wherever practicable, be allowed to rearrange coursework on compassionate or religious grounds (for instance, to enable them to attend a funeral, or because the coursework is scheduled on the day of a religious festival). The student concerned should try to rearrange the coursework in advance. If rearrangement proves impossible, then an application for an allowance may be made with the support of the student's tutor.

Interviews

When applying for jobs, work placements or sponsorship, students may be invited for interview on days that conflict with coursework activities. Students should in the first instance seek to rearrange the interview rather than the coursework. If this proves impossible, then the student should try to rearrange the coursework. Allowances are not normally given for coursework missed through interviews.

Sporting commitments

Coursework may **not** be rearranged to accommodate **College** sporting commitments. Students will, wherever practicable, be allowed to rearrange coursework that conflicts with **University** sporting competitions (i.e. representing the University of Cambridge in a competitive event) but not for training sessions.

NB. Allowances are not normally available if such rearrangement is possible.

Other reasons

If a student wishes to seek to rearrange coursework for any reason not covered by the four categories above, they should discuss the matter with the Director of Undergraduate Education.

How to rearrange coursework

Part I coursework

For Part I coursework (including sign-up sessions) students should identify an appropriate replacement slot in the timetable, in discussion with the appropriate chief technician, and then clear this with the lab leader in charge of the activity.

Part II coursework

For Part II coursework, students should contact the staff member in charge of the coursework activity (e.g. lab/EAA leader or module leader). Wherever possible, arrangements should be made in advance – failure to do so when the need for rearrangement was foreseeable may result in the request being refused. In some cases, it may be necessary to apply for an extension to a deadline to allow coursework to be completed.

Distinguishing between cooperation & cheating

Coursework marks contribute significantly to your overall Tripos mark. Because this work is not carried out under examination conditions, the distinction between beneficial cooperation and deliberate cheating should be clearly

understood.

The following information applies to **all students**. There is also supplementary information for Part IIB students.

Cooperation

It is perfectly acceptable to discuss continuously assessed work with other students, or with demonstrators or supervisors. Such discussions are beneficial and are to be encouraged. Effective use of such discussions can lead to higher marks, always provided that the student has made the main contribution to the work submitted and understands all of it.

Cheating

Cooperation can go too far, however, especially if one student is effectively carried by another or by the demonstrators. For example, while it may well be beneficial for students to discuss a problem in computing, it is unacceptable for two students to submit effectively identical programs. The named author must have made the main contribution to the work submitted and the report must be in his or her own words.

Electronic exchange of lab work is likewise acceptable up to a point. Results obtained jointly in the lab may have only been recorded by one student in a pair, due to time constraints, and it may be more practical to pass these on in electronic format (e.g. for a word-processed report). But analysis of the data, or production of graphs for the write-up, and all written sections of the report **must** be done individually, and may not be exchanged electronically.

Any deliberate attempt to pass off the work of others as being produced by the named author is cheating. Students suspected to have cheated will be reported to the Director of Undergraduate Education, and interviewed by an appropriate member of staff. For each coursework submission found to have been even partially copied, a mark penalty will be imposed and the student's Director of Studies informed. The examiners may be informed and might take further action. Serious cheating will be referred to the University proctors.

Inclusive teaching

The Equality Act (2010) requires higher education institutions to take positive steps to make their education accessible to disabled students and to make 'reasonable adjustments' to provision to ensure that disabled students are not disadvantaged. Disabilities may include physical or mental impairments: the majority of these students have specific learning difficulty (SpLD) in the form of dyslexia. Cambridge University Disability Resource Centre has some standard recommendations for appropriate academic support for such students. Further provision may be required in particular cases.

In an organisation of our size and complexity, individual variations in provision are potentially disruptive. However, many of the suggested adjustments are just good educational practice, so represent things we should be doing anyway as a Department that takes pride in the excellence of its teaching. Indeed, we already follow many of the recommendations (e.g. provision of cribs). The approach we have adopted is therefore to aim to have inclusive standard procedures for all teaching activities. Students are expected to make use of available resources to suit their needs, and to contact staff themselves (e.g. lecturers, lab leaders) if additional material is required.

Link to list of IA lecturers, IB lecturers and lab leaders for IA and IB.

Contact details of part II lecturers can be found on the relevant syllabus pages.

Any enquiries should be addressed to the CUED Director of Undergraduate Education.

The following recommendations have been agreed by the Faculty Board (12 November 2012):

- Electronic versions of handouts should be made available on-line 24h in advance of lectures or other

teaching sessions (e.g. labs). [This allows students who do have special requirements to produce their own customised hard copy if they wish: e.g. single-sided; large format; non-white background].

- Filled-in versions of notes should be made available on-line after lectures.
- Recording lectures (audio) is often recommended to students as a learning aid. They must sign an agreement to use the recording only for their own personal study, and acknowledging IP and copyright. The agreement form can be found here, and students are asked to provide the Teaching Office with a copy. Lecturers are asked to consent to their lectures being recorded under these conditions. A list of students who have completed agreement forms can be made available on request.
- In labs, instruction should be provided in both written and verbal form.
- Lecturers should remember to pay attention to ‘signposting’ e.g. statement a start of each lecture of what is being covered; tracking progression throughout lecture; summary of main teaching points at end.
- All staff should make particular effort to put new vocabulary into context and explain new concepts. It is helpful to provide some repetition.