UNIVERSITY OF CAMBRIDGE DEPARTMENT OF ENGINEERING

# FOURTH-YEAR ENGINEERING AREAS 2011-12

## Outline of fourth-year courses within Engineering Part IIB

Students choose eight modules from a list of eighty or so. Each module may have up to 16 lectures, or equivalent work, and is scheduled to be either wholly within the Michaelmas Term or wholly within the Lent Term (with the exception of a small number of vacation modules). There are no supervisions for fourth-year modules. Fourth-year modules may be assessed wholly by coursework, wholly by examination, or by a combination of the two (25% coursework, 75% exam). All module examinations are held in the first three weeks of the Easter Term.

The list of modules is subdivided into Groups A to G, I and M, as in the third-year, with the addition of Group R.

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|---|---|
| Group A | Energy, Fluid Mechanics and Turbomachinery |
| Group B | Electrical Engineering |
| Group C | Mechanics, Materials and Design |
| Group D | Civil, Structural and Environmental Engineering |
| Group E | Management and Manufacturing |
| Group F | Information Engineering |
| Group G | Engineering for the Life Sciences |
| Group I | Imported modules (from other courses in the University) |
| Group M | Multidisciplinary modules |
| Group R | Research modules (available to certain undergraduates) |

The number of modules in each of Groups A-G will normally be not less than six and not more than eleven, although the number and the topics covered will vary slightly from year to year.

Groups I, M and R

**Group I** modules are offered by Departments other than Engineering.

**Group M** includes, among others, the **Surveying Field Course** (which takes place in the summer vacation preceding the fourth-year), **mathematical modules**, and **foreign language modules** (which lead on from language skills developed in the third-year Easter Term Language Projects).

**Group R** modules are of interest principally to those wishing to pursue a career in research and acceptance on these is normally restricted to those who have gained a Class I result in Part IIA.

Fourth-year projects

Each student must undertake a major final-year project on which work proceeds over the whole of the year. 3/7 of the credit at Part IIB is associated with the project and 4/7 with the module examinations or assessed coursework.

Several hundred possible project titles are posted on the web at the start of the Easter Term. Third-year students may also make a proposal (as early as possible in the Lent Term) for a project of their own invention. Project preferences are entered into the computer early in the Easter Term and allocations are determined before the end of that Term.

Engineering Areas

University regulations require that for each undergraduate a minimum number of modules fall within one of the Engineering Areas defined by the Faculty Board of Engineering:

| **Engineering Area** | **Coordinator** | **email** |
|---|---|---|
| 1. Mechanical Engineering | Professor JA Williams | jaw@eng |
| 2. Energy, Sustainability and the Environment | Professor N Collings | nc@eng |
| 3. Aerospace and Aerothermal Engineering | Professor WN Dawes | wnd@eng |
| 4. Civil, Structural and Environmental Engineering | Dr SD Guest | sdg@eng |
| 5. Electrical and Electronic Engineering | Dr A Flewitt | ajf@eng |
| 6. Information and Computer Engineering | Professor RW Prager | rwp@eng |
| 7. Electrical and Information Sciences | Professor JM Maciejowski | jmm@eng |
| 8. Instrumentation and Control | Professor JM Maciejowski | jmm@eng |
| 9. Engineering for the Life Sciences | Dr ML Oyen | mlo29@eng |

For advice on Engineering Areas and module choices, your Director of Studies should be your first port of call, but if he/she specialises in an Engineering Area very different to the one you wish to study, the staff listed above will be happy to provide advice.

## 1. Mechanical Engineering

Mechanical Engineering covers a very broad field: the main areas are mechanics, fluid dynamics, thermodynamics, materials, and design, but topics in control and instrumentation are also relevant. Many students will choose to specialise either in the "dry" side of the subject (mechanics, materials, design) or the "wet" side (fluids and thermodynamics), but combinations of courses can be found to suit many different career paths, some of which cut across this divide. It would be prudent for students to discuss this with the Engineering Area Coordinator before choosing a very eclectic mix of courses, in case a lack of overlap makes the workload unusually high.

Students intending to qualify in this Engineering Area in Part IIB must include at least four of the modules listed.

| **ID** | **Module title** | **Set** |
|---|---|---|
| 4A2 | Computational fluid dynamics | M3 |
| 4A3 | Turbomachinery I | M7 |
| 4A4 | Aircraft stability and control | M2 |
| 4A7 | Aerodynamics | L4 |
| 4A8 | Environmental fluid mechanics | L2 |
| 4A9 | Molecular thermodynamics | M6 |
| 4A10 | Flow instability | L5 |
| 4A11 | Turbomachinery II | L8 |
| 4A12 | Turbulence and vortex dynamics | L3 |
| 4A13 | Combustion and IC engines | M10 |
| 4A15 | Aeroacoustics | M9 |
| 4B13 | Electronic sensors and instrumentation | L2 |
| 4B19 | Renewable electrical power | M2 |

| | | |
|---|---|---|
| 4C2 | Designing with composites | M5 |
| 4C3 | Electrical and nano materials | M6 |
| 4C4 | Design methods | M1 |
| 4C5 | Design case studies | L3 |
| 4C6 | Advanced linear vibrations | M4 |
| 4C7 | Random and non-linear vibrations | M8 |
| 4C8 | Applications of dynamics | L1 |
| 4C9 | Continuum mechanics | M7 |
| 4C15 | MEMS: design | L6 |
| 4C16 | Advanced machine design | L9 |
| 4D6 | Dynamics in civil engineering | L2 |
| 4D17 | Plate and shell structures? | L6 |
| 4F1 | Control system design | M7 |
| 4F7 | Digital filters and spectrum estimation | M8 |
| 4G4 | Biomimetics | M9 |
| 4G6 | Cellular and molecular biomechanics | M10 |
| 4M6 | Materials and processes for microsystems (MEMS) | M1 |
| 4M12 | Partial differential equations and variational methods | L11 |
| 4M13 | Complex analysis and optimisation | M12 |
| 4M16 | Nuclear power engineering | L11 |

## 2. Energy, Sustainability and the Environment

Power generation and environmental engineering are central to the advancement of a sustainable future in developed and emerging economies. Energy engineering and sustainability are broad interdisciplinary subjects. This Engineering Area offers the opportunity to draw together modules across electrical, mechanical and civil engineering, with application areas ranging from power generation in gas and steam turbine plants, to fuel cells and renewable energy technologies, to buildings and infrastructure.

Students intending to qualify in this Engineering Area in Part IIB must include at least four of the modules listed.

| **ID** | **Module title** | **Set** |
|---|---|---|
| 4A2 | Computational fluid dynamics | M3 |
| 4A3 | Turbomachinery I | M7 |
| 4A8 | Environmental fluid mechanics | L2 |
| 4A9 | Molecular thermodynamics | M6 |
| 4A11 | Turbomachinery II | L8 |
| 4A13 | Combustion and IC engines | M10 |
| 4B14 | Solar electronic power: generation and distribution | M4 |
| 4B19 | Renewable electric power | M2 |
| 4D11 | Building physics | M5 |
| 4D13 | Architectural engineering | M12 |
| 4D14 | Contaminated land and waste containment | M1 |
| 4D15 | Sustainable water engineering | L4 |
| 4I7 | Electricity and environment | M18 |

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| 4M14 | Sustainable development | M13 |
| 4M15 | Sustainable energy | L10 |
| 4M16 | Nuclear power engineering | L11 |

## 3. Aerospace and Aerothermal Engineering

Aerospace and Aerothermal Engineering is an interdisciplinary blend of subjects ranging from fluid mechanics, thermodynamics, structures, instrumentation, control, electronics and design to manufacturing. In essence Aerospace Engineering is concerned with flight and Aerothermal Engineering with the associated propulsion systems. In the past, development in these fields has been driven by technological issues. In the future, environmental concerns, minimising noise and pollution, and relentless pressure on design and manufacturing turnaround time will force novel solutions and paradigm shifts.

The essential interdisciplinary nature of the subject is reflected in the diversity of the recommended companion modules drawn from across the spectrum of the Department's teaching. This diversity increases in Part IIB.

Students intending to qualify in this Engineering Area in Part IIB must include one of the following combinations in their selection of modules:

- *either* four Part IIB core modules,
- *or* three Part IIB core modules + two Part IIB companion modules.

Core modules

| ID | Module title | Set |
|---|---|---|
| 4A2 | Computational fluid dynamics | M3 |
| 4A3 | Turbomachinery I | M7 |
| 4A4 | Aircraft stability and control | M2 |
| 4A7 | Aerodynamics | L4 |
| 4A9 | Molecular thermodynamics | M6 |
| 4A10 | Flow instability | L5 |
| 4A11 | Turbomachinery II | L8 |
| 4A12 | Turbulence and vortex dynamics | L3 |
| 4A15 | Aeroacoustics | M9 |

Companion modules

| ID | Module title | Set |
|---|---|---|
| 4B13 | Electronic sensors and instrumentation | L2 |
| 4C2 | Designing with composites | M5 |
| 4C4 | Design methods | M1 |
| 4C5 | Design case studies | L3 |
| 4C6 | Advanced linear vibrations | M4 |
| 4C7 | Random and non-linear vibrations | M8 |
| 4C9 | Continuum mechanics | M7 |
| 4C15 | MEMS: design | L6 |
| 4F1 | Control system design | M7 |
| 4F2 | Robust and non-linear control | L4 |
| 4F3 | Optimal and predictive control | L6 |

## 4. Civil, Structural and Environmental Engineering

Intending Civil, Structural or Environmental Engineers are advised to study the broadest possible range of relevant courses.

**NB.** Module 4D16 'Construction and management' can be counted as one of your two management modules for the purposes of accreditation by the Institution of Structural Engineers (this module is not running in 2011-12, but is expected to run in 2012-13).

Students intending to qualify in this Engineering Area in Part IIB must include at least four of the modules listed.

| ID | Module title | Set |
|---|---|---|
| 4D5 | Foundation engineering | M4 |
| 4D6 | Dynamics in civil engineering | L2 |
| 4D7 | Concrete and masonry structures | L10 |
| 4D8 | Pre-stressed concrete | L9 |
| 4D10 | Structural steelwork | M8 |
| 4D11 | Building physics | M5 |
| 4D13 | Architectural engineering | M12 |
| 4D14 | Contaminated land and waste containment | M1 |
| 4D15 | Sustainable water engineering | L4 |
| 4D17 | Plate and shell structures | L6 |
| 4M9 | Surveying field course | LV1 |
| 4M14 | Sustainable development | M13 |
| 4M15 | Sustainable energy | L10 |

## 5. Electrical and Electronic Engineering

Electrical and Electronic Engineering covers the range of topics which best represent the current trends in circuits, devices and systems for hardware implementations.

Students intending to qualify in this Engineering Area in Part IIB must include at least four of the modules listed.

| ID | Module title | Set |
|---|---|---|
| 4B5 | Nanotechnology | M10 |
| 4B6 | Solid state devices and chemical/biological sensors | L3 |
| 4B7 | VLSI design, technology and CAD | L1 |
| 4B11 | Photonic systems | M9 |
| 4B13 | Electronic sensors and instrumentation | L2 |
| 4B14 | Solar-electronic power: generation and distribution | M4 |
| 4B18 | Advanced electronic devices | L8 |
| 4B19 | Renewable electrical power | M2 |
| 4B20 | Display technology | L9 |
| 4C3 | Electrical and nano materials | M6 |
| 4C15 | MEMS: design | L6 |
| 4F5 | Advanced wireless communications | L5 |
| 4M6 | Materials and processes for Microsystems (MEMS) | M1 |

## 6. Information and Computer Engineering

Information and Computer Engineering covers the digital representation and processing of signals and systems. It extends from the theory of signals and systems, through to the manipulation of data via computer programs. In addition to all of the information modules, this professional area includes modules from the Computer Science Tripos.

Candidates with a strong interest in control should also consider 'Instrumentation and Control' as an alternative.

Students intending to qualify in this Engineering Area in Part IIB must include at least four of the modules listed.

| ID | Module title | Set |
|---|---|---|
| 4F1 | Control system design | M7 |
| 4F2 | Robust and non-linear control | L4 |
| 4F3 | Optimal and predictive control | L6 |
| 4F5 | Advanced wireless communications | L5 |
| 4F6 | Signal detection and estimation | M5 |
| 4F7 | Digital filters and spectrum estimation | M8 |
| 4F8 | Image processing and image coding | M6 |
| 4F10 | Statistical pattern processing | M3 |
| 4F11 | Speech and language processing | L1 |
| 4F12 | Computer vision and robotics | M2 |
| 4F13 | Machine learning | L10 |
| 4M13 | Complex analysis and optimisation | M12 |
| 5R1 | Stochastic processes and optimisation methods | L7 |

## 7. Electrical and Information Sciences

Electrical and Information Sciences covers a very broad area. The B modules cover a wide range of electronic circuits and devices, while the F modules cover the digital representation and processing of signals, and the manipulation of data in computers.

A student in this area will be seeking to gain a broad overview of systems from the signals that flow through them to the hardware platforms that implement them. Although many students will choose to do mostly B modules or mostly F modules depending on their inclination towards the electrical or information side, students who prefer to specialise exclusively in one or the other should consider one of the other B/F engineering areas.

Students intending to qualify in this Engineering Area in Part IIB must include at least six of the modules listed.

| ID | Module title | Set |
|---|---|---|
| 4B5 | Nanotechnology | M10 |
| 4B6 | Solid state devices and chemical/biological sensors | L3 |
| 4B7 | VLSI design, technology and CAD | L1 |
| 4B11 | Photonic systems | M9 |
| 4B13 | Electronic sensors and instrumentation | L2 |
| 4B14 | Solar-electronic power: generation and distribution | M4 |
| 4B18 | Advanced electronic devices | L8 |
| 4B19 | Renewable electrical power | M2 |

| | | |
|---|---|---|
| 4B20 | Display technology | L9 |
| 4C3 | Electrical and nano materials | M6 |
| 4C15 | MEMS: design | L6 |
| 4F1 | Control system design | M7 |
| 4F2 | Robust and non-linear control | L4 |
| 4F3 | Optimal and predictive control | L6 |
| 4F5 | Advanced wireless communications | L5 |
| 4F6 | Signal detection and estimation | M5 |
| 4F7 | Digital filters and spectrum estimation | M8 |
| 4F8 | Image processing and image coding | M6 |
| 4F10 | Statistical pattern processing | M3 |
| 4F11 | Speech and language processing | L1 |
| 4F12 | Computer vision and robotics | M2 |
| 4F13 | Machine learning | L10 |
| 4M6 | Materials and processes for microsystems (MEMS) | M1 |
| 4M12 | Partial differential equations and variational methods | L11 |
| 4M13 | Complex analysis and optimisation | M12 |
| 5R1 | Stochastic processes and optimisation methods | L7 |

## 8. Instrumentation and Control

Instrumentation and Control covers a range of topics which are important to the monitoring and control of modern systems. The B modules cover basic circuits and device technology and the F modules cover the representation, capture and manipulation of signals. The C modules cover the relevant engineering aspects of mechanical systems.

Students intending to qualify in this Engineering Area in Part IIB must include at least four of the modules listed.

| **ID** | **Module title** | **Set** |
|---|---|---|
| 4B11 | Photonic systems | M9 |
| 4B13 | Electronic sensors and instrumentation | L2 |
| 4C6 | Advanced linear vibrations | M4 |
| 4C7 | Random and non-linear vibrations | M8 |
| 4C15 | MEMS: design | L6 |
| 4F1 | Control system design | M7 |
| 4F2 | Robust and non-linear control | L4 |
| 4F3 | Optimal and predictive control | L6 |
| 4F5 | Advanced wireless communications | L5 |
| 4F6 | Signal detection and estimation | M5 |
| 4F7 | Digital filters and spectrum estimation | M8 |
| 4F8 | Image processing and image coding | M6 |
| 4F10 | Statistical pattern processing | M3 |
| 4F11 | Speech and language processing | L1 |
| 4F12 | Computer vision and robotics | M2 |
| 4F13 | Machine learning | L10 |

## 9. Engineering for the Life Sciences

Engineering for the Life Sciences is a rapidly growing field encompassing the use of engineering tools to solve problems in medicine and biology as well as new quantitative approaches to biological systems based on engineering principles.

Students intending to qualify in this Engineering Area must include at least four of the modules listed of which at least two must be G modules.

| ID | Module title | Set |
|---|---|---|
| 4G1 | Systems Biology | L16 |
| 4G2 | Biosensors | L8 |
| 4G4 | Biomimetics | M9 |
| 4G6 | Cellular and molecular biomechanics | M10 |
| 4C4 | Design methods | M1 |
| 4C5 | Design case studies | L3 |
| 4C9 | Continuum mechanics | M7 |
| 4F8 | Image processing and image coding | M6 |
| 4F12 | Computer vision and robotics | M2 |
| 4F13 | Machine learning | L10 |
| 4I8 | Medical physics | L15 |