## Teaching of engineering ethics working group

### How can I begin to teach engineering ethics?

**All engineering teachers and curricula are different** so there is no 'one size fits all' way of implementing this curriculum map. Teachers should customise the curriculum map so that ethics teaching occurs at those places where it naturally accompanies the technical engineering issues. Students then perceive its relevance and there will be minimal disruption to existing teaching provision. The most important thing is that teachers take the time to work out where engineering ethics sits best in their curriculum and how they can best assess it.

**Ethics provision should be regular but not necessarily frequent** so introducing ethics into the curriculum need not mean a drastic reworking of course contents and timetables. The teaching of design, for example, often does not involve teaching specific design modules, but is done by bringing a design element to existing courses. Like design, engineering ethics should comprise a continuous thread woven through the undergraduate programme with students being exposed to ethical issues on a regular basis.

**Ethics is easy to include** as there are ethical issues relating to virtually all aspects of engineering. This means that individual sessions on ethics can be easily integrated into an existing curriculum. Case studies which show how ethical issues arise in practical engineering settings are particularly well suited to one-off ethics sessions as well as demonstrating how ethics operates in everyday life. It is often a good idea to introduce the ethics as part of the design process. Design provides a context in which ethical issues typically arise naturally.

**Before beginning to teach ethics** departments could, where possible, set up an 'ethics theme team' charged with planning and implementing this teaching. This should consist of people committed to bringing ethics into the curriculum as well as those strategically placed to implement relevant changes, such as Directors of Learning and Teaching. If possible, the theme team should include a visiting professor committed to engineering ethics and an experienced teacher of ethics. Some departments might consider the benefits of including philosophers, ethicists or others with expertise in teaching applied or practical ethics.

The introduction of ethics into an existing curriculum is a **three-step process:**

- **Audit** existing ethics provision. Look at where ethics is already being taught in the curriculum; often ethics content is present even when it is not labelled as ethics, for example in modules that discuss safety, costs, and sustainability.
- **Plan** further ethics content. Identify other places in the curriculum where ethical issues have a natural fit. Design modules are excellent vehicles for introducing an ethical content. Other examples include professional studies or professional skills modules. Once appropriate modules have been selected, taking the teaching of ethics forward relies on the targeted activity of champions. Individual course leaders should also be consulted to determine what specific ethical content fits their syllabus. The ethics theme team should then survey the overall curriculum aiming to deliver ethics provision at every level.
- **Implement** the plan. It is best to implement ethics gradually, progressing through the levels as suggested in the map. A significant component of the development of ethics teaching should be the sensitive involvement of students. Assess the needs of teaching staff whose courses contain an ethics component - do they need training or other support?

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The Royal Academy of Engineering

# An engineering ethics curriculum map

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**Why do engineering students need to be taught ethics?**

The study of engineering ethics within an engineering course helps students prepare for their professional lives. A specific advantage for engineering students who learn about ethics is that they develop clarity in their understanding and thought about ethical issues and the practice in which they arise.

The study of ethics helps students to develop widely applicable skills in communication, reasoning and reflection. These skills enhance students' abilities and help them engage with other aspects of the engineering programme such as group work and work placements.

**Where students are taught about ethics, they will:**

- **Understand** the nature of professional responsibility
- Be able to **identify** the ethical elements in decisions
- Be able to **address** and **resolve** problems arising from questionable practice
- Develop critical thinking skills and professional **judgement**
- **Understand** practical difficulties of bringing about change
- **Develop** a professional ethical identity to carry forward in their working life

Many young people are concerned about ethical issues. So, showing that there are opportunities for learning about ethics within an engineering programme can be attractive to those seeking further study.

**Why do I need a curriculum map?**

This curriculum map is a guide for academics who are interested in teaching ethics to engineering students. It indicates how ethics could be integrated into an undergraduate engineering curriculum. The map is subject to interpretation and should be customised to suit the various forms that an engineering degree can take.  It is intended as a non-prescriptive resource; as a way of suggesting to educators how ethics might comprise a distinct theme in an engineering undergraduate degree.

**How does the map work?**

The Map demonstrates how ethics could be introduced into the curriculum by providing guidance in four key areas:

- The **Location** explains the focus of ethics teaching appropriate for each level of the undergraduate degree and indicates places where ethics may be usefully introduced at that level.
- **Learning Outcomes** illustrate the expected learning outcomes at each level and the map as a whole demonstrates how students' abilities should progress throughout the degree programme.
- **Content** indicates possible topics in engineering ethics which might be relevant for students at each level.
- **Process** gives examples of teaching methods that are suited to teaching ethics at each level.

This curriculum map complements The Royal Academy of Engineering and EC<sup>UK</sup>'s Statement of Ethical Principles, available here: **www.raeng.org.uk/policy/ethics/pdf/Statement_of_Ethical_Principles.pdf**

## 1. LOCATION

| Level | Focus | Points of Delivery |
|---|---|---|
| **1** | Awareness of issues, obligations and responsibilities; sensitising students to ethical issues | Induction |
| | | Modules |
| **2** | Resolving practical problems; enabling students to identify ethical issues and to examine and weigh up opposing arguments | Modules |
| | | Placement preparation |
| **3** | Reflection and critique of ethical issues; consolidation of ethics skills and practice; specialist study | Design Project |
| | | Core Modules |
| | | Ethics-specific optional modules |
| **4** | Further reflection and critique of ethical issues; specialist study | Research-oriented module on ethics |

## 2. LEARNING OUTCOMES

**Students should be able to:**

Level 1:
1. give examples of ethical issues related to engineering;
2. recognise ethical responsibilities of engineers;
3. describe in outline an ethical framework for engineering.

Level 2:
1. identify ethical issues related to an engineering situation;
2. suggest ways to deal with ethical issues in engineering;
3. illustrate the ethical dimension of practical engineering

Level 3:
1. undertake an ethical audit;
2. discuss ethical dilemmas in engineering;
3. justify an ethical stance.

Level 4:
1. articulate ethical problems in engineering;
2. reach an ethically justified or morally reasoned practical solution to an ethical problem with an appropriate plan of action;
3. propose policy relating to ethical questions in engineering

## 3. CONTENT

**Topics**

Level 1:
- Professionalism; codes of conduct; obligations to the public
- Duty of care; trust; introduction to applied ethics; ethical dimensions to engineering problem solving. Introduction to a theoretical ethical framework based on deontology (duty), rights, utilitarianism, autonomy/consent and virtues (this topic could be introduced at Level 2)

Level 2:
- Ethical cases in engineering; developed study of the ethical framework introduced at Level 1
- Professional practice of oneself and others; differentiating between good and bad employers

Level 3:
- Ethics audit of final year project
- Ethically ambiguous scenarios
- Philosophy of engineering; further ethical theory; engineering ethics and environmental ethics

Level 4:
- Research principles and ethics; risks and benefits of novel technologies; broader context of engineering; business ethics; corporate social responsibility

## 4. PROCESS

**Example Techniques**

Level 1:
- Interactive small group sessions during student induction; developing case studies from newspaper or magazine articles.
- Identify existing modules which can be modified to establish a clear ethical focus for the engineering programme. Each module will have illustrations, topics and exercises covering key ethical issues. Introductory modules to engineering would be ideal starting points.

Level 2:
- Existing modules can be modified to include topics and exercises which address ethical issues from a practical standpoint. Give an ethical angle to traditional engineering exercises. Encourage group work and use familiar, non-specific engineering situations by way of introduction, such as plagiarism and negotiation.
- Set up role-playing scenarios and debates between students; run intensive workshops for placement preparation.

Level 3:
- Self study and application to a student led project.
- Challenge students to defend their actions from an ethical standpoint by holding group debates.
- Present case studies and dilemmas and give students practice in solving morally ambiguous scenarios. Encourage analysis, synthesis and report back of ethical issues.

Level 4:
- Present case studies and dilemmas and give students practice in solving morally ambiguous scenarios. Encourage written analysis and reports.