

Engineering Ethics

Engineering ethics is the study of moral issues that confront engineers and engineering organizations when some crucial decisions are taken. Engineering research and practice require that the task being performed considers all the pros and cons of a certain action and its implementation.

Professional engineering bodies like IEEE, ASME, IEI, etc., have evolved comprehensive ethics codes relevant to their respective professions, based on the rich experience of their members. Independent organizations like NSPE have prepared value-based ethical codes applicable to all engineering professions. These are mentioned below:

- Engineering is transforming science into useful products for human comfort.
- Engineering is something that engineers do, and what they do has profound effects on others.
- Engineering ethics is the ability as well as the responsibility of an engineer to judge his decisions from the context of the general well-being of society.

Factors Affecting Ethical Standards in Engineering

Engineering is a field that requires not only technical expertise but also a strong sense of ethical responsibility. Ethical standards in engineering refer to the moral principles and values that guide the behavior and decision-making of engineers in their professional and personal lives. Adhering to ethical standards is crucial to maintaining the public's trust and ensuring the safety and well-being of society. However, there are various factors that can influence the ethical standards of engineers, here some of those factors are listed below.

- Engineering as experimentation for the good of mankind is a notable factor involving far-reaching consequences
- Ethical dilemmas make engineering decisions relatively difficult to make.
- Risk and safety of citizens as social responsibility is a prime concern of an engineer
- Technological advancement can be very demanding on the engineering skill in the global context
- Moral values and responsible conduct will play a crucial role in decision-making.

Comparison Between Ethics and Engineering Ethics

Ethics is a branch of philosophy that deals with moral principles, values, and codes of conduct that govern human behavior. It is a field that is concerned with distinguishing right from wrong and providing guidelines for ethical decision-making. Engineering ethics, on the other hand, is a specialized branch of ethics that focuses on the ethical issues and considerations that arise in the field of engineering. The comparison between these two can be done as follows:

Ethics

- Study of right or wrong.
- Good and evil.
- Obligations & rights.
- Social and Political Deals.

Engineering Ethics

- Study of the moral issues and decisions confronting individuals and organizations engaged in engineering/profession.
- Study of related questions about the moral ideals, character, policies, and relationships of people and corporations involved in technological activity.
- Moral standards/values and system of morals.

Need to Study Engineering Ethics

Engineering is a profession that plays a critical role in shaping the world we live in. From designing buildings and infrastructure to developing new technologies, engineers have a significant impact on society. However, with this power comes a great responsibility to act in an ethical manner. The consequences of unethical engineering decisions can be severe, from endangering public safety to damaging the environment. Therefore, there is a growing need to study engineering ethics.

The study of engineering ethics involves examining the ethical considerations that arise in the practice of engineering. It is essential for engineers to understand the ethical principles and values that guide their profession and to apply them in their daily work. Through the study of engineering ethics, engineers can learn to recognize and navigate ethical dilemmas, make informed decisions, and maintain the public's trust in their profession.

Moreover, studying engineering ethics can help engineers develop a sense of responsibility towards society and the environment. They can learn to balance the competing demands of profitability, safety, and sustainability, and to prioritize the well-being of people and the planet over short-term gains. Overall, the study of engineering ethics is crucial to ensure that engineers act ethically and responsibly and contribute to a better and more just society.

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Scope of Engineering Ethics

The scope of engineering ethics is a very wide sense, here activities are mentioned that envelop the scope of the ethics in engineering.

1. Engineering as a social experimentation
2. Engineer's responsibility for safety
3. Role of engineers, managers, consultants, etc.
4. Rights of engineers
5. Moral Reasoning and ethical theories
6. Responsibility to employers
7. Global issues and concerns

Difference Between Morality and Ethics

Morality and ethics are very similar terms but these have many differences that are described below.

Morality

- Refers only to personal behavior.
- Refers to any aspect of human action.
- Social conventions about right or wrong conduct.

Ethics

- Involves defining, analyzing, evaluating, and resolving moral problems
- and developing moral criteria to guide human behavior.
- Critical reflection on what one does and why one does it.
- Refers only to professional behavior.

Important Points about Engineering Ethics

Engineering ethics are very broad to study, Here few important points are described to understand more about engineering ethics.

Method used to Solve an Ethical Problem

- Recognizing a problem or its need.
- Gathering information and defining the problem to be solved or goal to be achieved.
- Generating alternative solutions or methods to achieve the goal.
- Evaluate the benefits and costs of alternate solutions.
- Decision-making and optimization.
- Implementing the best solution.

Senses of Engineering Ethics

- An activity and area of inquiry.
- Ethical problems, issues, and controversies.

- The particular set of beliefs, attitudes, and habits.
- Morally correct.

Micro-ethics

It deals with some typical and everyday problems which play an important role in the field of engineering and in the profession of an engineer.

Macro-ethics

It deals with all the societal problems which are unknown and suddenly burst out on a regional or national level.

Types of Inquiry

- Normative Inquiry – Based on values.
- Conceptual Inquiry – Based on meaning.
- Factual Inquiry – Based on facts.

Need for Authority

Authority provides the framework in which learning can take place.

Criteria Required for a Profession

- Knowledge
- Organization
- Public Good

General Criteria to Become a Professional Engineer

- Attaining standards of achievement in education, job performance, or creativity in engineering that distinguish engineers from engineering technicians and technologists.
- Accepting as part of their professional obligations at least the most basic moral responsibilities to the public as well as to their employers, clients, colleagues, and subordinates.

Integrity

Integrity is the bridge between responsibility in private and professional life.

Compromise

In a negative sense, it means undetermined integrity by violating one's fundamental moral principles. In a positive sense, however, it means settling differences by mutual concessions or reconciling conflicts through adjustments in attitude and conduct.

Aspects of Honesty

- Truthfulness – meeting responsibilities concerning truth-telling.
- Trustworthiness – Meeting responsibilities concerning trust.

Self-respect

It is a moral concept; that refers to the virtue of properly valuing oneself.

Forms of Self-respect

- Recognition self-respect
- Appraisal self-respect

Self-esteem

It is a psychological concept; that means having a positive attitude toward oneself, even if the attitude is excessive or otherwise unwarranted.

Types of Theories about Morality

- Virtue ethics – Virtues and vices
- Utilitarianism – Most good for the most people
- Duty ethics – Duties to respect people
- Rights ethics – Human rights

Rawls's Principles

- Each person is entitled to the most extensive amount of liberty compatible with an equal amount for others.
- Differences in social power and economic benefits are justified only when they are likely to benefit everyone, including members of the most disadvantaged groups.

Tests Required to Evaluate the Ethical Theories

- Theory must be clear and formulated with concepts that are coherent and applicable.
- It must be internally consistent in that none of its tenets contradicts any other.
- Neither the theory nor its defense can rely upon false information.
- It must be sufficiently comprehensive to provide guidance in specific situations of interest to us.
- It must be compatible with our most carefully considered moral convictions about concrete situations.

Drawback of Duty Ethics

Duty ethics does not always lead to a solution that maximizes the public good.

Drawbacks of Rights Ethics

- How do we prioritize the rights of different individuals?
- It often promotes the rights of individuals at the expense of large groups or societies.

Ethical Egoism

It is the view that the right action consists in producing one's own good.

Ethical Relativism

It is the view that the right action is merely what the law and customs of one's society require.

Ethical Pluralism

Ethical pluralism is the view that there may be alternative moral perspectives that are reasonable, but no one of which must be accepted completely by all rational and morally concerned persons.

Religion

A religion is any set of articles of faith together with the observances, attitudes, obligations, and feelings tied up there, which, in so far as it is influential in a person, tends to perform two functions, one social and the other person.

Uses of Ethical Theories

- In understanding moral dilemmas
- Justifying professional obligations and ideals
- Relating ordinary and professional morality

General Features of Morally Responsible Engineers

- Comprehensive perspective.
- Purpose of various types of standards:
- Accuracy in measurement, interchangeability, and ease of handling.
- Prevention of injury, death, and loss of income or property.
- The fair value of price.
- Competence in carrying out tasks.
- Sound design, ease of communication.
- Freedom from interference.

Ethics of Technology

It is a sub-field of Ethics and is generally sub-divided into two areas:

- The ethics involved in the development of new technology – whether it is always, never, or contextually right or wrong, to invent and implement a technological innovation.

- The ethical questions that are exacerbated by the ways in which technology extends or curtails the power of individuals – how standard ethical questions are changed by the new powers.

Code

A code is a set of standards and laws.

Roles of Codes

- Inspiration and Guidance
- Support
- Deterrence and Discipline
- Education and Mutual Understanding
- Contributing to the Profession's Public Image
- Protecting the Status Quo
- Promoting Business Interests

Limitations of Codes

- Codes are restricted to general and vague wording.
- Codes can't give a solution or method for solving internal conflicts.
- Codes cannot serve as the final moral authority for professional conduct.
- Codes can be reproduced in a very rapid manner.

Issues in Computer Ethics

- Power Relationship
- Job Elimination
- Customer Relations
- Biased Software
- Stock Trading
- Unrealistic Expectations
- Political Power
- Military Weapons
- Property
- Embezzlement
- Data and Software
- Privacy
- Cyber crimes
- Computer Virus
- Technostress
- Cyber Scams and Frauds
- Internet Defamation
- Software Piracy
- Cyber Squatting
- Inappropriate Access
- Data Bank Errors
- Hackers

- Legal Responses
- Professional Issues
- Computer Failures
- Computer Implementation

Ways to Promote an Ethical Climate

- Ethical values in their full complexity are widely acknowledged and appreciated by managers and employees alike.
- The sincere use of ethical language must be recognized as a legitimate part of the corporate dialogue.
- The top-level management must establish a moral tone in words, in policies, by personal example, etc.
- The management must establish some procedures for resolving conflicts.

Usage of the Code of Conduct

- The code of conduct will help the engineers to have a set of standards of behavior.
- They act as guidelines for their behavior. It helps to create workplaces where employees are encouraged to make ethical implications.

IEEE Code of Ethics

The members of the IEEE, in recognition of the importance of their technologies affecting the quality of life throughout the world, and in accepting a personal obligation to their profession, its members, and the communities they serve, do hereby commit themselves to the highest ethical and professional conduct and agree.

- To accept responsibility in making engineering decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment.
- To avoid real or perceived conflicts of interest whenever possible and to disclose them to the affected parties when they do exist.
- To be honest and realistic in stating claims or estimates based on available data.
- To reject bribery in all its forms.
- To improve the understanding of technology, its appropriate application, and potential consequences.
- To maintain and improve their technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations.
- To seek, accept and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others.
- To treat fairly all persons regardless of factors such as religion, gender, disability, age, or national origin.
- To avoid injuring others, their property, reputation, or employment by false or malicious action.
- To assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

Code of Ethics of Engineers

- Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties.
- Engineers shall perform services only in the areas of their competence.
- Engineers shall issue public statements only in an objective and truthful manner.
- Engineers shall act in professional matters for each employer or client as faithful agents or trustees and shall avoid conflicts of interest.
- Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
- Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the profession.
- Engineers shall continue their professional development throughout their careers and shall provide opportunities for the professional development of those engineers under their supervision.

Code of Ethics by ASME

Engineers uphold and advance the integrity, honor, and dignity of the engineering profession by using their knowledge and skill for the enhancement of human welfare; being honest and impartial, and serving with fidelity their clients (including their employers) and the public; and striving to increase the competence and prestige of the engineering profession.

1. Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties.
2. Engineers shall perform services only in the areas of their competence; they shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
3. Engineers shall continue their professional development throughout their careers and shall provide opportunities for the professional and ethical development of those engineers under their supervision.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees and shall avoid conflicts of interest or the appearance of conflicts of interest.
5. Engineers shall respect the proprietary information and intellectual property rights of others, including charitable organizations and professional societies in the engineering field.
6. Engineers shall associate only with reputable persons or organizations.

Social Responsibility to Uphold Ethical Values of the Society

Ethical values of society consist of several parameters. Some of these parameters are described below.

- **Public Safety:** Engineers shall ensure the safety, health, and welfare of the public in the performance of their professional duties. The safety of the people must always come

first. They should promptly disclose to all concerned the factors that might endanger public safety or the environment.

- Compliance with social order: Engineers shall abide by the laws of the land in which the work is performed, respect the local customs, uphold human rights, safeguard public property; abjure violence and acts of terrorism.
- Impartiality and fairness: Engineers shall treat fairly all persons regardless of such factors as race, caste, religion, state, gender, or national origin.
- Environment Protection and Sustainable Development: Engineers shall strive to protect and maintain clean, healthy, and safe environments, sustainable development, and comply with the statutory requirements.

Responsibility for Maintain High Standards of Professional Quality

- Development of Technical and Managerial Skills: Engineers shall maintain state-of-the-art professional skills, continue professional development, and provide an opportunity for the professional development of those working under their command.
- Undertake Assignment where professionally competent: Engineers shall perform service only in the area of their technical competence.
- Performance Responsibility: Engineers shall seek work through fair and proper methods, and shall take full responsibility for the task undertaken by them.
- Proper Verification of Document and Production Processes: Engineers shall approve only those designs, which safely and economically meet the requirement of the client and shall not approve any engineering document, design, materials, or stages of work that they consider to be unsound.

Obligation to Maintain a High Standard of Personal Behavior in a Responsible Manner

- Honesty and Integrity in Professional Dealing: Engineers shall maintain a high degree of honesty and personal integrity in all their professional dealings. They shall conduct themselves in a fair, honest, and respectable manner.
- Compensation for Services rendered: Engineers shall not engage in unhealthy competition.
- Professional Opinion: Engineers shall seek and offer honest criticism of technical work, acknowledge errors, and give proper credit for the contribution of others. Where necessary, engineers shall issue public statements in an objective and truthful manner.
- Professional Relationship with the Employer: Engineers shall act faithfully as trustees of the employer/client on professional matters.
- Information Communication with employers: Engineers shall keep their employer and client fully informed on all matters relating to the progress of business including financial aspects, which may affect the assigned work.
- Mutual Obligation and Trust: Engineers shall not, maliciously or falsely, injure the professional reputation of another engineer or organization.
- Self Promotion: Engineers shall build their reputation based on the merits of services to the customers and shall not falsify or misrepresent their contribution.
- Employer's Business Secrets: Engineers shall not disclose by any means, confidential information of the employer or client unless otherwise authorized.
- Personal Conflicts: Engineers shall disclose real or perceived conflicts of interest to affected parties and avoid these where possible.

Practice Questions Engineering Ethics

Here, 10 questions on Engineering Ethics are given that help to practice the concept of the subject. These are mentioned below.

1. An engineer designs a small structural steel building for a client, using pirated structural design software obtained from the Internet. The engineer later learns that the software gives accurate stress analysis for tension, but does not properly predict the buckling of columns in compression. The computer program is patched, and a revised analysis shows that the building is not as safe as first believed. An extreme snowfall could cause the supporting columns to buckle, and the building might collapse completely. Such severe snowfall occurs about once every 10 years. What should the engineer do?
 1. Destroy all evidence of the revised analysis and hope for good weather.
 2. Contact the client, disclose the problem, and tell the client to sue the software developer.
 3. Hire a good defense lawyer for the Association's disciplinary hearing against the engineer for negligence and unprofessional conduct.
 4. Contact the client, disclose the problem, and try to negotiate a way to reinforce the columns.
2. The main purpose of the code of ethics is to
 1. conform to the tradition established by technical societies.
 2. conform to the tradition established by other professions.
 3. protect the public.
 4. improve the image of the engineering profession.
3. Occasionally, a conflict of interest may occur accidentally or unavoidably. In such cases, the best course of action is to
 1. keep the conflict of interest secret, but try not to let it affect your decisions.
 2. disclose the conflict to a fellow engineer and ask for advice.
 3. ignore the conflict of interest; it is one of the benefits of a professional job.
 4. disclose the conflict to your employer and anyone else directly involved.
4. Which of the following reprehensible actions is clearly a conflict of interest?
 1. Accepting a secret commission from a supplier for buying the supplier's products.
 2. Making public statements that are not based on firm knowledge and conviction.
 3. Sealing a drawing by an unlicensed person, not under your direct supervision.
 4. Failing to correct or report a situation that may endanger the public.
5. Which of the following is a basis for disciplinary action under the professional engineering licensing Act in your province or territory?
 1. Physical or mental incapacity.
 2. Incompetence and Negligence.
 3. Conviction of a serious criminal offense.
 4. All of the above
6. Codes of ethics state the engineer's duties to society, to employers, to clients, to colleagues, to subordinates, and to the profession. However, when these duties conflict, which group should take precedence?

1. Colleagues and subordinates.
 2. Employers and clients.
 3. Society (the public).
 4. The profession.
7. When rough drafts of drawings or reports are prepared and circulated for information or discussion, how should they be marked?
1. They should be signed, but marked as "preliminary" or "not for construction".
 2. They should be signed, sealed, and dated the same as the final drawings.
 3. They should simply be signed by the engineer who is the author.
 4. They should be signed but marked as "confidential".
8. Which of the following activities is an offense for a person who is not licensed under the professional engineering Act in your province or territory?
1. Using a seal that leads to the belief that the person is licensed.
 2. Practicing professional engineering.
 3. Using a term or title to give the belief that the person is licensed.
 4. All of the above.
9. The code of ethics in your provincial licensing Act is
1. a voluntary guide to professional conduct.
 2. a voluntary guide, but strongly recommended by the licensing Association.
 3. a compulsory guide to professional behavior, enforced by the law courts.
 4. a compulsory guide to professional behavior, enforced by the licensing Association.
10. A person who has graduated from an engineering program at an accredited university, but has not obtained a license to practice engineering
1. must follow the code of ethics of a technical society if the person practices engineering.
 2. must not practice engineering.
 3. must not practice engineering, except under the supervision of a licensed engineer.
 4. must follow the code of ethics, if the person practices engineering.

Practice Quiz Keys

1. (d), 2. (c), 3. (d), 4. (a), 5. (d), 6. (c), 7. (a), 8. (d), 9. (d), 10. (c)