

# Engineering Ethics

The study of the moral values, issues, and decisions involved in engineering practice. The moral values take on forms including responsibilities, ideals, character traits, social policies, and relationships desirable from individuals and corporations engaged in engineering.

“An engineer has to be well qualified, well informed & committed to his obligations to the society”

# WHY ENGINEERING ETHICS ?

Students of engineering receive inputs in

- basic engineering sciences
- Design
- Manufacture
- Technical Problems Solving Abilities
- Software skills.

A technically gifted engineer but ethically weak engineer may cause  
harm & damage to the society

# Fundamental Aspects of engineering ethics

(An Engineer)

- ❖ Should identify & enlist the types of ethical issues that he or she is likely to confront in his or her engineering career.
- ❖ Should clarify the related concepts theories & standards involved
- ❖ Should guide & help in confronting & resolving ethical & moral dilemmas.
- ❖ Should stimulate critical & responsible reflection & useful discussion on these issues.
- ❖ It is a study of related questions about the moral ideas, character, policies & corporations involved in the activity related to the technology.

“Engineering ethics has many senses”

## Micro-ethics :

- ❖ Deals about some typical and everyday problems which play an important role in the field of engineering and in the profession of an engineer.

## Macro-ethics :

- ❖ Deals with all the societal problems which are unknown and suddenly burst out on a regional or national level.

## Dealing with 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 benefits and costs of alternate solutions.
- Decision making & optimization.
- Implementing the best solution.

# Four Senses :

1. It is an area of inquiry & activity.
2. It enables to distinguish between moral & non-moral problems.
3. It refers to a particular set of moral beliefs, attitudes and habits that a person or a group displays.
4. It refers to the principles of ideas ,obligations & rights which are morally justified.

## **VARIETY OF MORAL ISSUES**

Reasons for people including the employer and employees, behaving unethically may be classified into three categories

- ☐ Resource Crunch (individual diversity, dissent, and input to decision-making )
- ☐ Opportunity
- ☐ Attitude

“Giving ethics training for all, recognizing ethical conduct in work place, including ethics in performance appraisal, and encouraging open discussion on ethical issues”

### Difference between Moral & Ethics :

#### MORAL:

- 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

## **TYPES OF INQUIRIES :**

### ➤ **Normative Inquiry** (Based on values)

It seeks to identify and justify the morally-desirable norms or standards that should guide individuals and groups

### ➤ **Conceptual Inquiry** (Based on meaning)

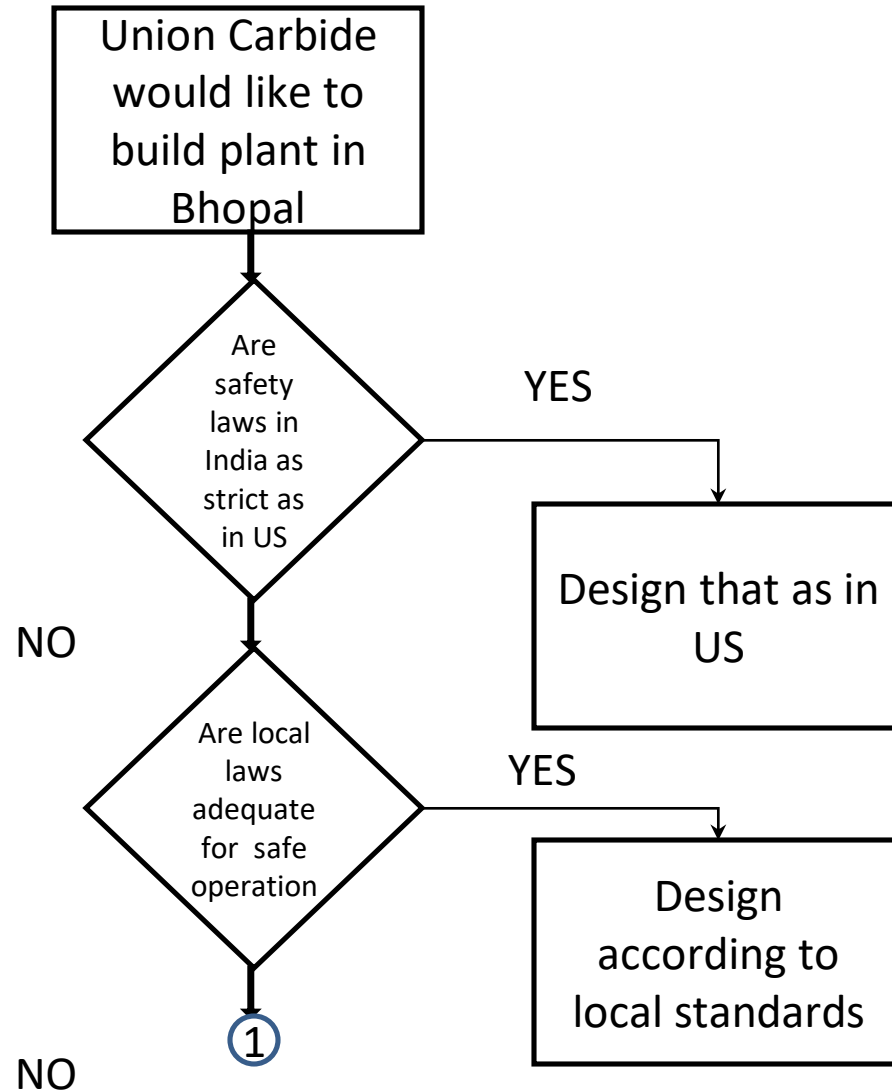
It is directed to clarify the meaning of concepts or ideas or principles that are expressed by words or by questions and statements.

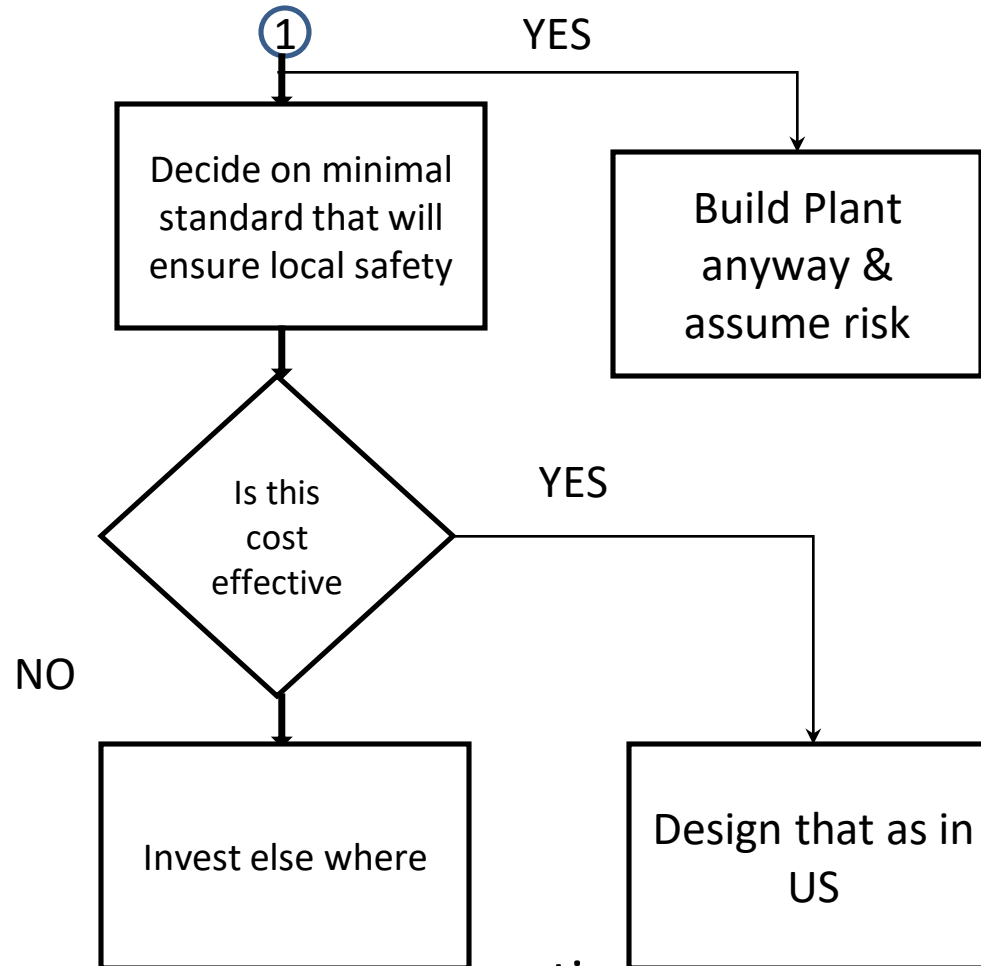
### ➤ **Factual or Descriptive Inquiry** (Based in facts)

It is aimed to obtain facts needed for understanding and resolving value issues. The facts provide not only the reasons for moral problems but also enable us to develop alternative ways of resolving moral problems.



# Flow Chart Technique :





Flow chart to show consideration for locating a gas plant in India

# Solving the Conflict Problems :

When a professional is faced with a problem of choosing one among the two conflicting values, each of which seem to be correct he or she will have to follow three ways

## **1. Easy Choice :**

The one which is more significant & important is selected.

## **2. Creative Middle Choice :**

It involves finding out & attempting some kind of compromise that will at least partially satisfy available choice & work for everyone.

## **3. Hard Choice :**

When both the above choices are not feasible, the need choice has to be attempted.

# MORAL DILEMMAS:

Moral dilemmas generally refer to situations in which a difficult choice has to be made based on conflicting moral issues involved.

## MORAL AUTONOMY : (self –determining or independence)

- It is a skill & habit of thinking rationally about ethical issues.
- It is concerned with decision making power of a person with regard to ethical issues.
- Engineering ethics is aimed at increasing the moral autonomy of an engineer.
- It enables the engineer to strengthen his or her professional values such as honesty, integrity etc...
- Level of moral autonomy of a person depends on his or her early upbringings or influence from the teachers, friends, neighbours etc..

# Skills for developing Moral Autonomy :

- To improve moral autonomy, the concerned person should develop proficiency in recognizing moral problem issues
- He or she should be able to comprehend, clarify & critically assess & analyze arguments on all aspects of the moral issues involved.
- Judgments should be based on moral considerations & the ethical expression & language should be precise.
- Knowledge about the importance of suggestion & choosing the best available solution for the moral problem will enhance the values of moral autonomy.

# Consensus and controversy:

*“Moral autonomy should be exercised with moral concern for others and good moral reasons must be properly recognized”*

- When ethical values and principles are applied to practical situations involving a number of people, a broad agreement on the issues among the parties involved may be reached, leading to consensus.
- Controversial issues and implications may also popup among the parties involved when there is difference of opinion.

For e.g.,

When two individuals exercise moral autonomy in similar situations ,they may not arrive at the same conclusion, since exercise of moral autonomy is not something like a mathematical or scientific procedure. Hence there may be a agreement leading to consensus or disagreement leading to conflict.

# Characteristics of a profession:

## ➤ Profession, professional and professionalism:

- Profession is not merely a job or occupation through which one earns a living
- It is a life career which requires special knowledge, extended practical training and continuous in-service training, with a clearly defined membership of a particular group evolving its own code of ethics.
- The practice of the profession should result in ultimate public good.
- A professional engineer is one who earns a degree in engineering at an institution approved and recognized by a duly constituted authority like the AICTE
- HE/SHE should be officially registered with a particular society, institutions and properly licensed as a professional
- To achieve professionalism one must have a sound theoretical knowledge(knowing that) and sophisticated skills(knowing how)

# Models of professional roles:

- Engineering profession or any profession should take care of public safety welfare and health.
- In order to perform and achieve the goals, an engineer will have to adapt himself to the following professional roles or models.
- An engineer has to play the role of,

## ❖ **A Savior:**

An engineer has to protect and safeguard the society from poverty, inefficiency, waste, excessive manual and from other harmful effects

## ❖ **A guardian:**

An engineer is expected to act as a guardian of the Technological advancements, knowing the best direction in which the technology should develop and improve .



### ❖ **A bureaucratic servant:**

An engineer as an employee has to receive and translate the directive of his superiors.

### ❖ **A social servant :**

As a servant of the society ,an engineer provides service with responsibility to the society and satisfies the desires of the society.

### ❖ **A social enabler and catalyst:**

An engineer is needed to help the management and the society by understanding their own needs and to take decisions about technological developments.

### ❖ **A game player:**

Engineer are neither servants nor masters of anyone . They play their part according to the economic game rules, and come out successful within organizations ,enjoying both the pleasure of technological achievements and satisfaction of winning.

# MORAL DEVELOPMENT THEORIES:

## Kohlberg's theory:

- Moral problems may arise during the course of a professional work.
- A professional will have to develop certain practical skills to understand the problems and solve them
- Everyone has his or her own perception about moral autonomy brought about their own experiences.
- Lawrence Kohlberg developed a psychological theory of moral development. according to him there are three levels they are,

## ➤ Pre-conventional level:

- This is the most primitive level
- Any conduct is taken to be right which benefits the individual
- Primary motive of any individual is to satisfy themselves ,to escape punishments and obeying implicitly to authority.
- This behavior is seen in children and many of the grown-ups do not raise themselves above this level.

## ➤ Conventional level:

- Individuals try to satisfy others by implicitly obeying the dictates of the family or the group even at the cost of one's own self-interest.
- Loyalty and identification are the hallmarks of this level
- From his studies Kohlberg comes to the conclusion that most adult do not cross or think beyond this stage

## ➤ Post-conventional level:

- The individual at this level is able to think of principles of rights and right conduct and general good regardless of conventions and individual interest.
- These people do not simply follow customs
- They are called autonomous by Kohlberg since they are not susceptible to customs and beliefs unless they are for public good
- They seek to do what is morally reasonable and to maintain integrity
- Most people reach this level of moral development by the early moral training from their elders and the foundation of moral training and moral reasoning give them moral responsibility.

- **GILLIGAN'S THEORY:**

- Carol Gilligan, a student and colleague of Kohlberg in her book "In a different voice" differs from the views of Kohlberg and charges him by saying that his studies are primarily with male subjects with a typically male dominated general rules and rights.
- Women on the other hand try to maintain and retain personal relationship with all people involved in moral problems or dilemma
- In this way Gilligan's emphasis on personal relationships leads to ethics of care rather than the ethics of rules and rights.
- The three levels of moral development which is slightly different from those of Kohlberg and can be described as follows:

- I. **Pre-conventional level:**

This is almost the same as in Kohlberg's theory where the person involved is pre-occupied with self-centered reasoning.

- II. **Conventional level:**

At this level instead of being self-centered one develops

one develops into thinking about others ,not hurting them and willing to help or nurture others. Women easily succumb to culture –oriented practices and start caring for others.

### **III. Conventional level:**

The individual at this level is able to find reasonable balance between caring for others and establishing their own individual interests and rights.

#### **➤ Right action –ethical theories:**

- **Virtue ethics:**

- The oldest ethical theory is virtue ethics
- Wisdom which enables good judgement is taken as the most important virtue
- In order to live an active life in accordance with reason to attain real happiness,as distinguished from the extremes of pleasure and contentment ,one has to follow moral virtue.

- Different kinds of virtues sometimes overlap among themselves like integrity,honesty,self-respect and responsibility.
- There are four types of theories of morality including virtue ethics as listed below.

THEORY		BASIC CONCEPT
1.Virtue ethics	-	virtues
2.Utilitarianism	-	most good for most people
3.Duty ethics	-	Duty
4.Right ethics	-	Human rights

- **Utilitarianism:**

- It simply means maximizing the utility which again points to producing most good for most people.
- Any action of a professional may have good consequences or bad consequences
- Any project can exhibit good feature or bad feature
- Utility of a action ,a product or a project by a professional is the overall balance of good over bad consequences

- **Act-utilitarianism:**

- To attain maximum utility one has to maximize goodness
- John Stuart Mill deals about action which will bring maximum utility
- According to him only happiness is intrinsic good ,good in itself and desirable
- All other goods are taken as “instrumental goods” which provides way to happiness



- Act-utilitarianism lays emphasis on individual actions ,rather than general rules and an act is said to be right when it produces most good for most people
- **Rule-utilitarianism:**
  - Acts are taken to be morally right ,when they are done under a widely accepted rule which produces most good for most people
  - Rule –utilitarianism is based not on individual actions ,but on moral codes
  - For example things like friendship, love,understanding and appreciation of beauty even if they do not lead to happiness are to be taken as satisfying the rational desire and as such they are intrinsically good
  - It differs from act-utilitarianism

- **USES OF ETHICAL THEORIES:**

concepts of ethical theories have three important uses:

- i. Ethical theories help us to understand and resolve moral dilemma
- ii. They help to justify and moral obligations and
- iii. They help to relate professional morality and general morality

➤ **Moral dilemmas –understanding and resolving:**

- Based on ethical theories ,one is first able to identify moral considerations and moral reasons leading to dilemma.
- Ethical theories provides a means of understanding what are relevant kinds of information required to solve a moral dilemma.
- They offer opportunitises to rank the order of importance of various moral reasons and considerations whenever moral problem and dilemma occur.
- Ethical theories help us to categorize the full moral ramification

of different alternative course of action.

- They help us to use appropriate moral terms with precise meanings.
- This helps us to in providing the basis for moral reasoning when the moral moral issues are discussed with colleagues.
- They strengthen the ability to reach correct ,balanced,and insightful moral judgements.

## ➤ Justifying moral obligations:

- Ethical theory serve as a pointer to justify the general obligations of professionals like engineers and others involved in technological activities.
- Engineering ethics in one way or other ,involves in promotion of safety while introducing useful technological products to the society.
- All theories point to the fact that engineers are obliged to protect the safety, health and welfare of public while performing their duties

- The figure illustrates how the moral claims of an engineer about safety in engineering is justified by basically adhering to ethical theories.
- The ethical theories point to direct link between basic human rights and moral obligations of professionals.
- Laws, codes and employment agreements provide the link to the theories to ensure that the safety obligations are fulfilled.

## ➤ Relating professional and ordinary morality:

- The same ethical theories that are useful to explain normal everyday actions, morality and experiences are also applicable to professionals for justifying the obligations and moral actions of professionals .
- This can be understood by the following four views:
  - ✓ Laws and codes governing engineering practices enforce moral obligations concerning safety.
  - ✓ Special obligations of engineers arise due to their joining a professional society or body agreeing to abide by its code of

of ethics and conduct

- ✓ Contracts and agreements entered into by the engineer when hired by companies demand safety obligations .
- ✓ Engineers ,on taking up the profession accept and agree to a tacit and implicit promise to the public to ensure and product obligations while performing their tasks.

The special professional obligations of engineers regarding safety ,directly mesh with an assessment of human rights and other basic moral considerations and this establishes the link between engineering and moral philosophy

# ENGINEERING AS SOCIAL EXPERIMENTATION

## INTRODUCTION:

- Experimentation is commonly recognized to play an essential role in the design process .Preliminary tests ,simulations,materials testing , process planning are done to convert a new engineering concept into a product . Beyond those specific tests and experiments ,each engineering project in total is viewed as an experiment.
- Social experimentation is a research process. The ethics in experimentation is concerned with the application of moral principles in the conduct of research in relation to humanbeings to protect the rights and welfare of the humanbeings involved in the research process. Eventhough the research causes harm sometimes in the initial stages,it may do well for the society on successful completion .
- Therefore a balanced view of justifying any experimentation should be taken considering the amount of harm and benefit to society.

# SIMILARITIES OF ENGINEERING PROJECTS TO STANDARD EXPERIMENTS:

➤ Tests are conducted at the production stage and fine tuning is carried out to bring out the final product. Thus several features of every kind of engineering practices virtually combine to make it appropriate to view engineering projects as experiments. Three such important features are,

1. Any project is carried out in partial ignorance; hence engineer has to perform with uncertainties as he cannot wait till he gets all the relevant exact data from the ocean of scientific laws about nature and society in order to accomplish the assigned task in time.

2. The final outcomes of engineering projects, like those of experiments, are generally uncertain. Unexpected dangers to people being near a nuclear powerplant, the possibility of a break of LPG storage tank etc., are examples to quote a few.

3. Effective engineering relies upon knowledge gained about products both before and after they leave the factory.

Knowledge needed for improving the current products and creating better ones is gained by study of performance at client site and through continuous process of learning.

## ➤ Learning from the past:

Learning from the past is a continuous process in all stages from conception to commissioning of any engineering project. Learning from the past is not effective in organizations due to lack of channels of communication, misplaced pride, fear of litigation and plain neglect.

There are many examples to illustrate why it is not sufficient for engineers to rely on hand books alone. Let us see a few

- ✓ Decades earlier the steamship “Arctic” met with a watery grave due to non-availability of enough number of life boats and yet this aspect was not taken into account in the case of Titanic ship which also met with similar accident, a major disaster in sea.
- ✓ In the Union Carbide plant at Bhopal, leaky valves in MIC system had been a problem on at least six occasions earlier to the accident.



The same company had a plant at West Virginia,USA where there were 28 leaks of MIC over the previous five years and an internal memo warning the management had not been transmitted to the plant in India by Union Carbide.

Therefore Engineering ,just like experimentation demands practitioners to remain alert, well informed at every stage of project's history and learn from the past

## ➤ Contrast of engineering projects with standard experiments:

Engineering differs from standard experimentation in some respects demanding engineers to take up special responsibilities.

- Experimental control:

It is not possible to have 'experimental group' and 'control group' similar to standard experimentation ,as the experimental subjects are human beings in case of engineering projects

- Informed consent :

Engineering experimentation closely parallels medical testing of new drugs and techniques on human beings .

As human beings are involved in all engineering products,they have moral rights to know about the facts i.e. informed consent.

A success 'Informed consent' for experimentation has two main elements:

- Knowledge :

All the information needed to make a reasonable decision.

- voluntariness:

They must enter into the experiment without force .fraud and deception

- Conditions for 'informed consent':

- The consent must be given voluntarily

- The consent must be based on the information presented to them in understandable form.

- The consent must be competent to process the information and make rational decisions.
- The information should be widely disseminated
- A group representing many subjects may offer consent.

## ➤ Knowledge gained through experimentations:

Engineering projects are experiments that are not necessarily designed to produce very much knowledge.

## ➤ Engineer as responsible experimenter:

### ➤ **Conscientious: (Conscientiousness)**

- ✓ The engineer should exhibit a 'conscientious' commitment to live by moral values.
- ✓ Engineers should act as guardians of the public interest and to guard the welfare and safety of those affected by engineering projects.
- ✓ He should not force his own views upon the society.

✓ The social experimentation involved in engineering should be restricted by participant's consent.

➤ **A comprehensive perspective:**

✓ An engineer should be aware of the experimental nature of any project undertaken by him.

✓ He should put in a reasonable effort to monitor them.

✓ The public hopes that the engineer must undertake some preventive measures in the development of technology.

✓ Engineers should bear in mind that solution to the problem is achieved by adopting preventive technology.

✓ The engineer should have personal involvement and keep in touch with the course of handed over project.

➤ **Moral autonomy:**

✓ The engineer should exhibit personal involvement in all steps of project.

✓ Moral beliefs and attitudes must be integrated into core of

an individual's personality in a manner that leads to committed actions.

- ✓ Moral autonomy suffers because of the influence by groups ,society and the deadline fixed to complete the project which puts constraints on the autonomy of an engineer.
- ✓ It is further affected adversely when there is no moral support or protection from professional society.

## ➤ Accountability:

- It is the willingness to submit one's action to moral scrutiny and be open and responsive to the critical assessments of others.

The accountability is affected in engineering due to several reasons:

- ✓ Each person making only small contribution to something much larger leads to a lessened sense of personal accountability.
- ✓ Diffusion of accountability takes place in larger institutions in which most engineers work are designed to delimit areas of personal accountability within hierarchies of authority.

- ✓ Pressure to take up new projects before handing over the running ones makes the engineer meet the schedule somehow.
- ✓ The engineer's preoccupation with legalities makes one wary of becoming morally involved in matters beyond one's strictly defined role.

## ➤ Codes of ethics:

- A code also serves as a statement from the profession to the public as to what to expect from its member ,thus promoting public trust in the professional .
- The code of ethics are established by professional engineering organizations and professional societies.
- A code of ethics provides a frame work and serves as guidelines for ethical judgement to a professional and helps to resolve ethical issues.
- It is not a legal document but it emphasizes commitments to safety,public health and environmental protection.

- All profession are expected to have a code of ethics and members of the profession are expected to adhere to it.

## ➤ Roles of codes:

- ✓ Inspiration and guidance:

The code provide a healthy framework and guidance so the engineers are inspired and motivated by support found in code of ethics.

- ✓ Support:

The code can act as legal support for engineers who act ethically against the odds they face in the organizations.

- ✓ Deterrence and discipline:

Codes form the basis for identifying unethical act and facilitate possible actions by society. For eg, Medical council of India takes action on its members for misconduct and error by withdrawing the license to practise. This puts pressure on professionals to act ethically.

✓ Education and mutual understanding:

Professionals can adopt ethical culture in any organizations by the education by which he has been exposed to ethics.

✓ Contributing to the profession's public image:

Codes help engineers to acquire positive image amongst public about the ethically committed profession they are in and to serve effectively and engineers acquire greater powers of self regulations.

✓ Protecting the status quo:

Codes help in promoting an agreed minimum level of ethical conduct .All member should be treated at par when they commit mistakes.

✓ Promoting business interests:

Nobody, even if they are not members of the society ,should be prevented from quoting for doing a job.



## ➤ Codes and the experimental nature of the engineering:

- ✓ The desirable primary functions in engineering codes are the supportive functions which enable the engineers to express freely their views, especially about safety.
- ✓ Inspiration, guidance and educational functions of the codes help to promote mutual understanding among those affected by them.
- ✓ Disciplinary function occupies secondary importance as law and legal procedures are in general available.
- ✓ Public image, status quo and business interests occupy the next position.

“codes need not to be treated as ‘sacred documents’”

## ➤ Limitations of codes:

- ✓ New developments in technology and transition of social /organizational structures into new ones, when combined, result in

unpredictable conditions. Therefore the codes are often restricted to general and vague wording.

- ✓ Different entries in codes conflict with each other sometimes landing the professionals in dilemma.
- ✓ Therefore the engineers must make reasonable assessments of the options keeping the public interest in mind before taking final actions. Codes cannot serve as the final moral authority for professional conduct.
- ✓ Codes convey the public view that none of the codes is 'really right' and the ethical conduct is more relative than it is.