MODULE IV

MORALS/ MORALITY

Morals/ morality is concerned with **the principles of right and wrong in human behaviour,** mostly based on one's conscience. A thought, word or action is considered to be morally good if it agrees with the general perception of what is right and what is wrong. Most of the moral principles are teachings of wise men, religious leaders, etc.

Morals of a particular society may be different from another society. There will be differences according to time, place, religion, ideologies, etc. However, morals always stand for goodness and it promotes acceptable behaviour of individuals.

VALUES

Values are principles that reflect one's judgements of what is important in life. They help us promoting our well being. Values are more concerned with what is morally right. Personal values may be different from individuals to individuals. Some values may have priority over others depending up on the need level.

ETHICS

The word ethics is derived from the Greek word "ethos". Ethics is the set of codes of conduct or moral principles with which behaviour can be analysed as good or bad or right or wrong. It teaches the well disciplined behaviour and how to act according to the situations. Ethics is based on logic and reason. Often morals and values contribute to ethics. Therefore we can state that **morals + values = ethics.**

INTEGRITY

Integrity is a character trait that reflects a person's degree of honesty, adherence to moral principles and a complete harmony of one's thought speech and action. A person of integrity will be guided by morality and has consistency in character. He/ she will do what is right every time.

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The types of integrity are given below.

1. **Professional Integrity**
   It deals with the willingness to do the right thing in one's profession.

2. **Political Integrity**
   It deals with the mindset of politicians once they are elected by the people. They should work according to the promises they made during elections.

3. **Academic Integrity**
   Any academic endeavour must be pure and away from plagiarism. People in academic community should stick on to truthful information. A student who copies an assignment, a researcher who fabricate data, a writer who doesn't acknowledge his sources, etc lack academic integrity.

4. **Integrity in Daily Transactions**

   There will be incidents in our life in which there will be options to do the right thing or to do what benefits us. As responsible persons of integrity, we should do right always.

WORK ETHICS

Work ethics can be defined as a set of standards of behaviour or codes of conduct based on a set of values, in the workplace. Medical ethics, engineering ethics are examples. A strong set of work ethics promotes the well being of employees, organisational effectiveness and advancement of society.

The basic elements of a well formed code of work ethics in an oraganisation are given below.

1. **Integrity and Loyalty**
   Integrity at workplace means the quality of being honest and morally upright, always willing to do the right thing and adhering to the code of ethics, policies and procedure of the firm.

2. **Professionalism**
   Competence, good judgement and polite behaviour of a trained man who can deliver the best of him every time, are together called professionalism. A

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professional is consistent and he is ready to take responsibilities. He will have superior problem solving and leadership skills.

3. **Respect and Care**
   Respect is valuing a person for his professional expertise. Respect should be given to each and everyone of the group irrespective of the position, gender, ethnicity, nationality, etc.
   Caring is showing genuine compassion and concern for others, helping them in need, being kind, considerate and grateful.

4. **Cooperation**
   It is necessary for everyone to cooperate to meet deadlines. To achieve the organisational objectives, being cooperative is very helpful.

5. **Fairness**
   The management should make sure that fairness is ensured. Justice should be there to treat everyone equally well. Rules should not be biased.

6. **Trustworthiness**
   It is the extent to which someone's actions can be relied on in the absence of control.

SERVICE LEARNING

Service learning is a structured learning approach that incorporates community service along with formal instruction and explicit learning objectives. It involves identifying the concerns of the community, addressing them using the technical knowledge and reflecting on the experience. It is a part of experiential learning. **Through service learning, a student is able to,**

- ✓ Understand the relevance and the context in which service is provided.
- ✓ Reflect on the experience the service offers and its impact on academics
- ✓ Develop social awareness and civic skills
- ✓ Address the concerns of the society

CIVIC VIRTUES

Civic virtues are moral duties or standards of righteous behaviour of an individual as a responsible member of the community and an integral part of the environment.

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They are habits of citizens that contribute to the welfare of society.

Volunteering in community initiatives, voting in elections, attending important meetings, etc are some of the activities a person may do. Civic virtues are categorized as follow,

1. **Civic Knowledge**
   A citizen must be aware of his rights, duties and responsibilities. He should know The Constitution of India and be aware of the responsibilities of the government.

2. **Self Restraint**
   In democratic setup, we have limited government and it ensures equal rights and freedom for all of us. The citizens should control or restrain ourselves from untoward activities to maintain safety and law and order.

3. **Self Assertion**
   Self assertion comes from self esteem. We must respect ourselves and our rights. If a government acts against the rules and esteem of the people, it is the duty of the citizens to abolish the government.

4. **Self Reliance**
   It is a virtue to support oneself. A citizen should be careful not to be a burden to the society.

IMPORTANT CIVIC VIRTUES ARE GIVEN BELOW.

1. **RESPECT FOR OTHERS**

A man should respect himself first to get respect from others, i.e. self respect is very important. Respect for others include acknowledge the importance of other persons, their view points and rights. It is a positive feeling of appreciation for other people as human beings. Respect should be given irrespective of the position, job, ethnicity, gender, social and financial statuses, etc.

2. **LIVING PEACEFULLY**

A society is a peaceful society where wars and conflicts are minimal or nonexistent. Peaceful living enhances the quality of life. **Principles of peaceful living include the following.**

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- ✓ Respecting others and appreciating the differences
- ✓ Forgiving others
- ✓ Not interfering in other's matters unless it is necessary
- ✓ Giving credit for other's works
- ✓ Adapting to the circumstances you cannot change
- ✓ Engage yourself constantly in good deeds
- ✓ Ensuring the basic needs of everyone without exploiting the resources
- ✓ Nurture love for all living beings in this world.

3. CARING AND SHARING

Caring is expressing concern about others, their feelings and well being. Caring shouldn't be limited to one's family and friends. Caring should be given to neighbors, colleagues, with whom we deal with in our daily life, etc. Caring for environment and Nature should be there as it is the necessity of time.

Sharing of knowledge, facilities, goods, experiences, etc lead to the growth of society. The act of sharing should come voluntarily and without compulsion. It leads to peaceful living.

4. HONESTY

Honesty is the trait of adhering to truth even when it is inconvenient and unpopular. **In a workplace, honesty may be,**

- ✓ Stating the facts clearly without dilution, distortion or exaggeration
- ✓ Not hiding or withholding the fact or truth for selfish reasons
- ✓ Refraining from deceiving the customers
- ✓ Not resorting to bribes and nepotism
- ✓ Maintaining confidentiality and intellectual honesty
- ✓ Being straight forward, loyal and trustworthy in all relations
- ✓ Seeking truth before deciding and acting.

5. COURAGE

Courage is not the absence of fear. It is the ability to face fear and do something in spite of being afraid. It is the willingness to confront with pain, agony and uncertainty for something that we believe in. **Courage may be seen in these situations,**

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1. **Courage as a Part of Duty**
   This will be seen in a firefighter who saves people from a building which caught fire, a soldier who fights in the border, etc. These positions are synonymous to courage.

2. **Courage to Face Physical Challenges**
   Some people are engaged in very dangerous and adventurous sport item or activities by risking their lives to get the thrill.

3. **Courage in a Social Context**
   To challenge injustice, to fight against discrimination, to protest against ill treatment, to fight for freedom, etc. this courage is necessary.

4. **Intellectual Courage**
   It says about the courage to seek and speak truth even if it upsets the prevailing beliefs.

6. VALUING TIME

Today, people find difficulty to manage time. There are some ways to utilise the time effectively as given below.

- ✓ Be aware that time is a perishable resource
- ✓ Get your priorities right
- ✓ Be punctual
- ✓ Plan in advance
- ✓ Get rid of delaying

7. COOPERATION

Cooperation is the process of individuals or individual organisations working together synergistically towards the completion of common objectives without surrendering the individual freedom.

It can be a joint action or a process of working together consciously for common benefit and is a continuous process. **The pooling of complementary skills, gathering more ideas, enhanced man power, greater resources, minimum utilisation of time, etc are the advantages of cooperation**. Cooperation among different departments of a firm ensures better output, quality and efficiency.

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8. COMMITMENT

The quality of holding on to a cause that one believes in, even in difficulties and setbacks, with great attitude. In an organisation, **commitment often refers to the dedication** of an employee to his job and to the organisational goals by following the ethical principles.

Allen and **Meyer** proposed a three component model for organisational commitment, namely

1. Affective Commitment

Affective commitment happens when an employee loves his job and is aligned with the organisational goals and values. It is commitment due to affection and contributes to job satisfaction.

2. Continuance Commitment

Continuance Commitment happens when the employee is driven by the fear of the possible losses he could incur by leaving the company. The losses may be financial, career oriented or societal.

3. Normative Commitment

Normative commitment happens when the employee feels obligated or duty bound to stay with the organisation even if he is unhappy. This commitment may arise out of reasons like relations with the coworkers, personal beliefs about loyalty, etc.

There are 5 rules to enhance organisational commitment. They are,

- ✓ Commitment to people – first values
- ✓ Clarify and communicate the mission of the organisation.
- ✓ Guarantee the organisational justice
- ✓ Create a sense of community
- ✓ Support employee development

9. EMPATHY

Empathy is the ability and willingness to imagine oneself in another's place and see things in their perspective. It is about putting oneself in the other person's shoe. A person who empathizes with others will feel, understand and accept their emotions, motives and concerns. **Empathy in the workplace leads to,**

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- ✓ Better teamwork
- ✓ Better understanding of what motivates others
- ✓ Better appreciation of customer needs
- ✓ Better understanding of public perception of the company

10. CONFIDENCE

Confidence is the quality of believing in oneself and one's abilities. **Confidence encompasses two separate traits; 1. Self esteem 2. Self efficacy**

Self esteem is one's innate sense of self worth. It reflects the individual's evaluation of his/ her worth and value.

Self efficacy is the belief in one's own capacity to perform, accomplish specific tasks and reach the goal.

Presence of confident employees in the workplace leads to the following,

- ✓ Open sharing and expressing of opinions by the employees
- ✓ Setting of higher goals for the employees and organisation.
- ✓ Lesser tendency to complain
- ✓ Openness to change
- ✓ Better overall performance

Ways to Improve Confidence

- ✓ Be conscious about the present moment
- ✓ Believe that you always have choices and make conscious decisions
- ✓ Accept new challenges
- ✓ Practice resilience
- ✓ Learn to say NO to bad things
- ✓ Practice positive self talk
- ✓ Conquer fear by doing what you fear to do
- ✓ Don't hesitate to ask for help, if needed.

11. SPIRITUALITY

Spirituality is a broad concept involving a sense of connection to a higher transcendental reality and a quest for ultimate truth and meaning of life. Spiritual practices like meditation

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and prayer are meant to focus on one's inner life rather than going after material possessions. Spiritual thinking includes the thoughts on the following,

- ✓ Why are we here?
- ✓ What happens to us after death?
- ✓ Do things happen for a reason?

Spirituality believes that some questions in the universe cannot be answered by an average thinking hence a higher level of thinking is important and that is called spiritual thinking. Such thoughts are promoted by every religion. **Still then, spiritual thought is not only confined to religious thinking but it encompasses humanistic values like love, compassion, tolerance, harmony, etc.**

SENSES OF ENGINEERING ETHICS

Engineering ethics has different senses and each one referring to different aspects.

1. **Engineering ethics as synonymous with morality in engineering (**Normative sense**).**
2. **Engineering ethics as an enquiry into desirable ethical practices in engineering (**Normative sense**).**
3. **Engineering ethics as followed by specific individuals or groups without recommending right action (**Descriptive sense**).**

In the first normative sense, engineering ethics is about understanding the moral values as well as responsibilities and rights to be followed by engineers.

The second normative sense involves examining specific moral problems as well as morally correct decisions and policies in an engineering context.

In the descriptive sense, engineering ethics refers to an empirical research into what specific individuals or groups believe as moral.

VARIETY OF MORAL ISSUES

Moral issues faced by and engineer can be broadly classified into micro level issues and macro level issues.

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1. **Micro Issues**

   This refers to the moral implications of decisions and practices by individual engineers as well as organisations while pursuing their objectives. It affects the firm and its employees only.

2. **Macro Issues**

   These issues are global and affect the entire humanity. It includes social issues as well.

Some Moral Issues Related to Engineering

1. **Problems Concerning Safety**
   Probable reasons for this may be compromising quality, use of cheap components, lack of maintenance, incompetence, corruption, etc.

2. **Problems Concerning the Environment**
   Includes lack of proper waste disposal methods and environmental awareness.

3. **Problems Concerning Product Safety**
   Includes profit motive without morals, unreliable suppliers, bad design, etc.

4. **Problems Concerning Transparency about Possible Hazards**
   Fear of taking responsibility, profit motive without morals, etc. are included.

5. **Problems Concerning Exploitation of Scarce Resources**

   Profit motive, inadequate laws, etc. are included.

MORAL DILEMMAS

Moral dilemmas are the situations in which two or more moral situations come together in which the professional feels difficulty to select the best out of them. Selecting more options to follow a certain action is not possible and that's the reason why one feels this situation.

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MORAL AUTONOMY

Moral autonomy is the capacity to think rationally and decide what is right instead of simply following a set of rules. It is about making decisions based on moral concern by reasoning rather than blindly following others. **Moral autonomy is about the following**,

- ✓ Moral concern
- ✓ Going through different perspectives of an ethical issue
- ✓ Application of reasoning
- ✓ Making decisions without the influence of others
- ✓ Acting boldly on the decision taken

TYPES OF ENQUIRY

Enquiries in engineering ethics fall under three categories namely,

1. **Normative Enquiries**
   Normative questions deal with what ought to be done. It is about identifying the values and practices that are morally right and ought to guide the decision makers.
   Example of normative question: - *what are the values that should guide a person working in genetic engineering?*

2. **Conceptual Enquiries**
   These enquiries throw light into the meaning of concepts, Values, principles and issues encountered in engineering ethics.
   Example: - *what differentiates a bribe from an acceptable gift?*

3. **Factual**

   These enquiries provide information regarding the moral practices of an engineer, an organisation or even a society without judging their moral rightness. This can also apply to questions regarding the facts about a moral problem related to engineering.

   Example: - *What caused the first Tesla Model S (self drive car) crash in May2016?*

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KOHLBERG'S THEORY OF MORAL DEVELOPMENT

Lawrence Kohlberg proposed a stage theory of moral development. In this, he identified six stages in the gradual progression of individuals' concept of right and wrong. The six stages are grouped into three levels as given below.

	LEVEL	STAGE	ORIENTATION
I	Pre conventional	1 2	Obedience & Punishment Individualism & Exchange
II	Conventional	3 4	Good Boy – Good Girl Law & Social Order
III	Post Conventional	5 6	Social Contract Universal Ethical Principles

Level I: Pre Conventional Morality

Stage 1: Obedience and Punishment

This is the first stage of moral development usually found in small children. A small number of adults never grow out of this stage. A child in this stage assumes that it should obey all the rules made by the authority, without question. Parents, teachers, etc. are seen as authority figures. The child's sense of right and wrong is determined by what gets punished and what doesn't.

Stage 2: Individualism and Exchange

At this stage, children become self absorbed and egotistical. Though they acknowledge individual points of view, actions are judged on the basis of how they serve individual needs. A child at this stage believes he or she is generous but is in fact self absorbed. **He or she is likely to expect a reward for every non selfish act and will do a favor to get a favor. Here disobedience and wrong doing are avoided in self interest.**

Level II: Conventional Morality

Stage 3: Good Boy – Good Girl Orientation

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Usually this stage occurs when children enter their teens where they see the approval of peers as very important. **Importance will be for nice behaviour and conformity.** Nice behaviour includes good intentions, sympathy, empathy, love and trust for others in any interpersonal relationship. They expect to live up to the expectation levels.

Stage 4: Law and Social Order

At this stage, people become concerned with society as a whole. **Emphasize will be on maintaining the social order**. Following the law, discharging one's duties, respecting authority, etc. are considered important as they help maintaining the social order. Moral judgement will be based on views taking into account the impact on society as a whole. Written law is of the most important here. Majority of adults do not grow beyond this stage.

Level III: Post Conventional Morality

Stage 5: Social Contract

People at this stage are aware of the importance of maintaining the social order but not at the expense of individual rights. They know that rigid laws must be changed for the welfare of the people. They value differing opinions, contrasting beliefs and diverse values. Laws must be formed by the society only through consensus. People at this stage believe that a good society should function for the welfare of all.

Stage 6: Universal Ethical Principles

This is the highest level of moral reasoning according to Kohlberg. Here moral reasoning is based on conscience, abstract reasoning and an evolved sense of justice that go beyond rules and laws. Very few people who have higher ethical principles reach this stage. Dignity and value of humanity are given priority to social customs and written laws. The principles of justice are universal and are applicable to everyone. For an example, *a law framed by a majority through a democratic procedure is not morally right if it hurts a minority or even a single individual.* People at this stage will have no self interest.

GILLIGAN'S THEORY OF MORAL DEVELOPMENT

Carol Gilligan was a student of Kohlberg and her theory is founded on the inadequacy of Kohlberg's theory to explain female psychology of moral development.

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Gilligan's theory was based on **care** and **contextual reasoning.** She argued that **the moral sense of female revolves around the ethics of care and compassion** and women give more importance to relationships than men do. Gilligan's theory **proposes three stages and unlike Kohlberg's theory, the transition to higher stages is due to increased self awareness rather than cognitive development.**

Care Based Morality & Justice Based Morality

Gilligan proposed the **Stages of the Ethics of Care** theory, which addresses what makes actions right or wrong. Gilligan's theory focused on both care based morality and justice based morality.

Care Based Morality is based on the following principles:

- ✓ Emphasizes interconnectedness and universality.
- ✓ Acting justly means avoiding violence and helping those in need.
- ✓ Care based morality is thought to be more common in girls because of their connections to their mothers.
- ✓ Because girls remain connected to their mothers, they are less inclined to worry about issues of fairness.

Justice Based Morality is based on the following principles:

- Views the world as being composed of autonomous individuals who interact with another.
- Acting justly means avoiding inequality.
- Is thought to be more common in boys because of their need to differentiate between themselves and their mothers.
- Because they are separated from their mothers, boys become more concerned with the concept of inequality.

Researchers have found a tendency for males to adopt the justice perspective and for females to be more likely than males to adopt the caring perspective.

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CONSENSUS AND CONTROVERSY

Consensus refers to **agreement** and **controversy** refers to **disagreement.**

While exercising moral autonomy, individuals may differ in their decisions. Each may have different perspectives about morality and particular moral issues. There may be occasions in

which the moral reasoning of one person will be in conflict with that of the other. During such occasions, each will resort to his moral autonomy which leads to controversy. Here, to avoid conflicts, everyone should discuss matter and reach a consensus.

MODELS OF PROFESSIONAL ROLES

Engineering is a profession which applies scientific principles for the betterment of individuals and the society.

Engineers often identify themselves with some of the roles given below.

1. **Saviour**
   Engineer assumes the role of someone who saves the society from all its evils. He may use technology to save them from poverty and ill health. By using appropriate and advanced technology, efficiency and effectiveness can be ensured in all activities related to social planning which intern results in material prosperity and happiness.

2. **Guardian**
   An engineer can play a crucial role in determining the needs of the society. He can guide and regulate the technological advancement keeping in mind the best interest and welfare of the common man.

3. **Bureaucratic Servant**
   Here the role of engineer is confined to the development of engineering solutions to the problems handed to them by the organisation. The management decides what to develop and the engineer assigned the technical side of the problem. His duty is to come up with concrete engineering solutions.

4. **Social Servant**
   In this role, the engineer looks up to the society as his master. He constantly listens to the aspirations of the society and acts to fulfill those needs.

5. **Social Enabler and Catalyst**
   In this role, an engineer doesn't single handedly decide what is good for the society, nor does he simply goes by the directions of the society. Instead he assists the management to make informed decisions based on the best interests of the society.

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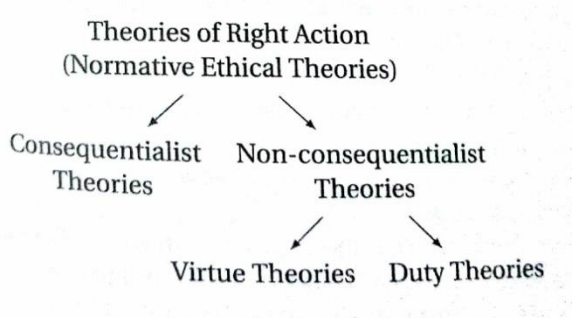
He helps the society to understand its needs. Here management makes the decisions. But the engineer plays a vital role in the process by way of guidance to society as well as management by making them aware of the impact of technical advancement on people and environment. He helps transform the society and acts as a catalyst for technological growth.

6. **Game Player**

   These engineers do not see themselves as masters or servants. They are motivated by the economic and technological challenges at any given time. They play by the current economic game rules, getting excited by the profession and deriving satisfaction from winning in a competitive role.

THEORIES OF RIGHT ACTION

Principles of right action may be used to guide human beings in their lives. These principles are used to decide whether a particular action is right or wrong. The theory of right action is an investigation and an attempt to answer the questions like "what ought I do?" or "what is the right thing to do?". The theory of right action helps answering these questions and by identifying a set of principles that may be used to determine right actions.



Consequentialist Theories

Consequentialism is the view that morality of an action is solely a function of the goodness or badness of its outcomes. Consequentialist theories are otherwise called **teleological theories,** origin of the term from a Greek word "telos" which means end, since the end result is considered the only criterion for moral judgement.

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These theories are about good intentions than following any rigid rule but there are dilemmas like “being good to whom?” and “best consequences to whom?”. Various categories of consequentialist theories are given below.

1. **Ethical Egoism**
   This theory takes the view that an action is morally right if its consequence is good for the agent performing the action. In other words, it is always moral to do something if it promotes one’s own good or self interest regardless of its impacts on others.

2. **Ethical Altruism**
   This takes the view that an action is morally right if its consequence is good for individuals other than the agent who performs the action. It is something like self sacrifice. Here the moral value of an action solely depends on the impact on others regardless of its effect on oneself.

3. **Utilitarianism**
   It holds the view that right actions are those that maximize total utility, that is, the greatest good for greatest number. Instead of self promotion or self sacrifice, this approach makes a cost benefit analysis of consequences affected by all parties concerned and choosing an action that results in maximum happiness of all.

Non Consequentialist Theories

Virtue Theory/Virtue Ethics

Virtue theory/Virtue ethics recognizes the virtue of mind and character as the most important elements of ethics and moral philosophy. Individual’s virtues are emphasized rather than doing one’s duty or acting to bring about good consequences.

Duty or Deontological Theories

Deontological (duty based theories) are of the view that morality of an action is solely dependent on the quality of the action.

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SELF INTEREST

Engineers are human beings with desires and ambitions and they are also tempted to act according to their own interest. A healthy amount of self interest is essential for survival but if it increases, professional ego will be the result.

An engineer without self interest and self esteem may easily be tempted to unethical behaviour.

ENGINEERING AS SOCIAL EXPERIMENTATION

Earlier the development of a society was analysed by the education of the people, their financial welfare, etc. Now the development of a society and nation can be easily assessed by the technical advancement. Engineers are responsible for the development in this regard.

While developing the technology, an engineer should fore see the impact on the following.

- ✓ The end user
- ✓ The social fabric in terms of relationships, work, cultural exchange, etc.
- ✓ The health of people in the long run.
- ✓ The distribution of wealth

There are some similarities between engineering as experimentation and standard experimentation as given below.

- ✓ One cannot be sure about all the outcomes of both the cases
- ✓ Gaining of knowledge by constant monitoring is crucial to both.

There are some differences between engineering as experimentation and standard experimentation as given below.

- ✓ In standard experiments, there will be a control group which serves as a reference and an experimental group on which the experiment is conducted. In engineering as experimentation, there is no such control group.
- ✓ In standard experiments, consent of the human subject is mandatory. But in engineering as experimentation, the people must be informed and no consent is required.

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ENGINEERS AS RESPONSIBLE EXPERIMENTERS

There is a great responsibility of engineers to guide and make the people aware of the technical advancements, risks and updated information. **The essential characteristics of an engineer, as a responsible social experimenter are given below.**

1. **Conscientiousness**
   It is about being careful, thoughtful and vigilant with commitment to values and sensitivity to moral issues. Conscientious engineers think above the narrow self interest and profit motive.

2. **Comprehensive Perspective**
   It is getting the big picture and fully understanding the moral context of one's work. Getting the complete information about anything is very important in this regard.

3. **Moral Autonomy**
   It is the capacity to reflect and self impose the moral law rather than passively adopting the social, religious and professional conventions. If an engineer goes by the moral views of his company even if his conscience is against them, he is deceiving his moral autonomy.

4. **Accountability**

   It is the moral obligation of the engineer to account for his actions, decisions and responsibilities.

CODES OF ETHICS

A professional association is a nonprofit organisation that offers membership to practitioners of a particular profession. It provides organized platform for the professionals and helps them increasing the skills. The members in such organisations are expected to meet certain criteria and also to adhere to rules and regulations, i.e. **codes of ethics.**

The codes of ethics serve as guidelines for all the members of the organisation. **Some of the features common to most of these codes are given below.**

- ✓ Protection of public safety, health and welfare
- ✓ Actively discouraging bribery and plagiarism
- ✓ Practicing no discrimination

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- ✓ Dissemination of clear and correct information
- ✓ Protecting confidentiality of employer
- ✓ Maintaining dignity

BALANCED OUTLOOK ON LAW

Legislation or laws have very important role in a society. They help in the appropriate use of technology and provide frameworks for engineers to operate. Absence or too much legislation will result in chaos and the growth of technology will be retarded. So law makers and engineers should resort to maintaining the balance in enforcement of legislation and laws.

MULTINATIONAL CORPORATIONS

A multinational corporation (MNC) is an enterprise operating in more than one country and managed from the home country. Usually any enterprise that gets a quarter of its revenue from operations outside its home country is considered as an MNC. Most MNC's belong to developed countries but operate in developing countries like India.

The advantages MNC's enjoy when doing business in developing countries are given below.

- ✓ Cheap resources
- ✓ Cheap labour
- ✓ Favourable tax arrangement
- ✓ Unexplored market

The advantages the host country receives are as follow.

- ✓ Fresh jobs
- ✓ Transfer of advanced technology
- ✓ Better products and services
- ✓ Higher pay packages
- ✓ Economic growth
- ✓ Transfer of skills

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ENVIRONMENTAL ETHICS

Environmental ethics is the branch of ethics which deals with the relationship between humans and the environment including other forms of life. It also gives importance to non living and non human things as well.

Environmental ethics deals with many issues like the following.

- ✓ Utilisation of natural resources
- ✓ Destruction of forests
- ✓ Pollution
- ✓ Harm to animals

Environmental Ethics and Engineer

Health and public safety should be the chief concern of any practicing engineer. An engineer should be careful enough to work for the sustainable development of the environment. **Engineers are expected to**

- ✓ Develop understanding and awareness about environmental sustainability and related issues.
- ✓ Ask for exert help in need to work for the upliftment of environment.
- ✓ Apply professional judgement in matters concerning environment
- ✓ Integrate environmental planning and management into the projects.
- ✓ Actively work to promote and propagate understanding of the environment and sustainability.

COMPUTER ETHICS

Computer ethics is the branch of applied ethics that addresses the ethical and moral issues that are aggravated, transformed or created by computer technology. It makes appropriate ethical guidelines to make use of computer technology effectively.

Ethical issues in computing can be,

- ✓ Using computers for unethical purposes like hacking, privacy and copyright violations, etc.
- ✓ Problems arising out of use of computers of ethical purposes. These include possible job loss due to computerization, environmental damage due to

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improper disposal of computer and computer parts, health issues like computer vision syndrome, etc.

- ✓ Artificial intelligence and ethical problems.

The Ten Commandments of Computer Ethics

1. Don't use a computer to harm other people.
2. Don't interfere with other people's computer work.
3. Don't snoop around in other people's computer files.
4. Don't use a computer to steal.
5. Don't use a computer to bear false witness.
6. Don't copy or use proprietary software for which you have not paid.
7. Don't use other people's computer resources without authorization or proper compensation.
8. Don't appropriate other people's intellectual output.
9. Think about the social consequences of the program you are writing or the system you are designing.
10. Always use a computer in ways that considers and respect the fellow humans.

WEAPONS DEVELOPMENT

It discusses developing weapons for the war purposes. An engineer's conscience may not support making something which results in the killing of people, but can be justified if the weapons are developed for the safety of the nation and its people.

ENGINEERS AS MANAGERS

There are several reasons why an engineer moves into managerial positions. Some of the reasons are as follow,

- ✓ A well planned career move
- ✓ As a reward for good work as an engineer
- ✓ As part of regular organisational promotion

It is the duty of the manager to set ethical rules and principles for his subordinates.

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A manager has to do the following,

- ✓ Communicate the ground rules clearly to his team.
- ✓ Instruct the subordinates to move away from unethical activities.
- ✓ Exemplify ethical principles through his actions and words.
- ✓ Find ways for problem resolutions.

An engineer has to acquire certain qualities to be successful managers. Like,

- ✓ Skill of delegating tasks to others.
- ✓ Foster motivation among others.
- ✓ Try to remove all the barriers.
- ✓ Maintain good relationship with everyone.
- ✓ Concentrate on the customer
- ✓ Seek advice when needed
- ✓ Avoid favoritism.

CONSULTING ENGINEERS

Consulting engineers are engineers who work independently for different employers. They do not have a regular salary but are free to choose the projects that employers may offer to them. A consultant too has several ethical issues to take care of.

Responsibilities about safety of the project, confidentiality (keeping the secrets of a firm**), advertisement and self promotion, etc are some important points a consultant should follow.**

ENGINEERS AS EXPERT WITNESSES

In certain cases expert engineers may be required to appear before the judicial bodies as expert witnesses. They may be asked to give testimony at informal pre hearings, formal judicial proceedings and enquiry commissions. Witnesses in such proceedings are of two types, **fact witnesses and expert witnesses.**

Fact witnesses are those who give testimony to the actual events, i.e. what they have actually seen, heard and understood. They are not allowed to express their opinions.

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Expert witnesses are allowed and expected to express opinions about matters within their area of expertise. It is believed that the expert witness has considerable knowledge about a particular subject than the common man has.

The main functions of expert witnesses are given below.

- ✓ Give opinions about matters within their area of expertise.
- ✓ Interpret relevant technical information for those who don't have it.
- ✓ Act as neutral and impartial servants of the body they appear before.
- ✓ Apply the expertise to the process which is ongoing.

ENGINEERS AS ADVISORS

Engineers may be called upon as advisors on the matters related to technology, development, etc. they may be called by **government and semi government and local bodies, private firms, companies and individuals.**

Before giving advice, engineers must study the things and situations very thoroughly. They must follow the code of ethics of the profession and consider the public safety and health. The economic feasibility, technical aspects, etc to be studied. The advice provided must be unbiased.

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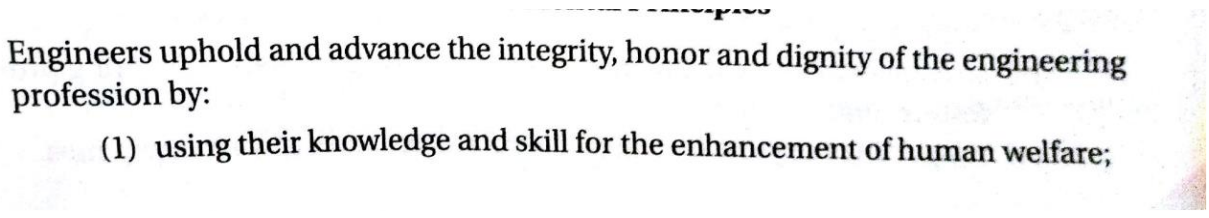
SAMPLE CODE OF ETHICS

1. **ASME (American Society of Mechanical Engineers)**



Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:

(1) using their knowledge and skill for the enhancement of human welfare;

(2) being honest and impartial, and serving with fidelity their clients (including their employers) and the public; and
(3) striving to increase the competence and prestige of the engineering profession.

The Fundamental Canons

Engineers shall

(1) hold paramount the safety, health and welfare of the public in the performance of their professional duties.
(2) 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) continue their professional development throughout their careers and shall provide opportunities for the professional and ethical development of those engineers under their supervision.
(4) 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) respect the proprietary information and intellectual property rights of others, including charitable organizations and professional societies in the engineering field.
(6) associate only with reputable persons or organizations.
(7) issue public statements only in an objective and truthful manner and shall avoid any conduct which brings discredit upon the profession.
(8) consider environmental impact and sustainable development in the performance of their professional duties.
(9) not seek ethical sanction against another engineer unless there is good reason to do so under the relevant codes, policies and procedures governing that engineer's ethical conduct.
(10) Engineers who are members of the Society shall endeavor to abide by the Constitution, By-Laws and Policies of the Society, and they shall disclose knowledge of any matter involving another member's alleged violation of this Code of Ethics or the Society's Conflicts of Interest Policy in a prompt, complete and truthful manner to the chair of the Ethics Committee.

2. ASCE (American Society of Civil Engineers)

American Society of Civil Engineers

Fundamental Principles

Engineers uphold and advance the integrity, honor, and dignity of the engineering profession by:

(1) using their knowledge and skill for the enhancement of human welfare and the environment;
(2) being honest and impartial and serving with fidelity the public, their employers and clients;
(3) striving to increase the competence and prestige of the engineering profession; and
(4) supporting the professional and technical societies of their disciplines.

Fundamental Canons

Engineers shall

(1) hold paramount the safety, health, and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties.
(2) perform services only in areas of their competence.
(3) issue public statements only in an objective and truthful manner.
(4) act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest.
(5) build their professional reputation on the merit of their services and shall not compete unfairly with others.
(6) act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession and shall act with zero tolerance for bribery, fraud, and corruption.
(7) continue their professional development throughout their careers, and
(8) shall provide opportunities for the professional development of those engineers under their supervision.

3. IEEE (Institute of Electrical and Electronics Engineers)

Institute of Electrical & Electronics Engineers (IEEE)

The members of IEEE are expected

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

4. The Institution of Engineers (India)

The code of ethics of IEI is based on the values of truth, honesty, justice, trustworthiness, respect and safeguard of human life and welfare, competence and accountability. A summary of the code is given below.

The Institution of Engineers (India)

The code of ethics of IEI (India) is based on the values of truth, honesty, justice, trustworthiness, respect and safeguard of human life and welfare, competence and accountability. A summary of the code is given below

The concerns of an engineer

(1) Concern for ethical standard;
(2) Concern for social justice, social order and human rights;
(3) Concern for protection of the environment;
(4) Concern for sustainable development;
(5) Public safety and tranquility.

The tenets of the code of ethics

A Corporate Member

(1) shall utilise his knowledge and expertise for the welfare, health and safety of the community without any discrimination for sectional or private interests.
(2) shall maintain the honour, integrity and dignity in all his professional actions to be worthy of the trust of the community and the profession.
(3) shall act only in the domains of his competence and with diligence, care, sincerity and honesty.
(4) shall apply his knowledge and expertise in the interest of his employer or the clients for whom he shall work without compromising with other obligations to these Tenets.
(5) shall not falsify or misrepresent his own or his associates' qualifications, experience, etc.
(6) wherever necessary and relevant, shall take all reasonable steps to inform himself, his employer or clients, of the environmental, economic, social and other possible consequences, which may arise out of his actions.
(7) shall maintain utmost honesty and fairness in making statements or giving witness and shall do so on the basis of adequate knowledge.
(8) shall not directly or indirectly injure the professional reputation of another member.
(9) shall reject any kind of offer that may involve unfair practice or may cause avoidable damage to the ecosystem.
(10) shall be concerned about and shall act in the best of his abilities for maintenance of sustainability of the process of development.
(11) shall not act in any manner which may injure the reputation of the Institution or which may cause any damage to the Institution financially or otherwise.

5. Indian Institute of Materials Management

Indian Institute of Materials Management (IIMM)

IIMM is a professional body formed to 'secure a wider recognition and promote the importance of efficient Materials Management in commercial and industrial undertakings.IIMM's Code of Ethics states that an IIMM member is obliged

(1) To consider first the total interest of one's organisation in all transactions without impairing the dignity and responsibility of one's office.
(2) To buy without prejudice seeking to obtain the maximum ultimate value for each Rupee of expenditure.
(3) To subscribe and work for honesty and truth in buying and selling, to denounce all forms and manifestations of commercial bribery and to eschew anti social practices.
(4) To respect one's obligations and those of one's organisation consistent with good business practice.

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THE CHALLENGER CASE STUDY

Fig. 8.1. The Challenger STS-51-L spacecraft at the moment of liftoff.

Fig. 8.2. Mission Insignia of STS-51-L

Fig. 8.3. The seven crew members

On 28th January, 1986 NASA launched it's Challenger space shuttle STS-51-L from Kennedy Space Center, Florida carrying seven astronauts including schoolteacher Christa McAuliffe - the first civilian to set out on a space mission. Florida had been experiencing particularly cold weather, and during the night before the temperatures had dipped as low as -13^{o} C. The Challenger spacecraft consisted of a liquid-hydrogen powered orbiter designed to come back to earth, two solid-fuel booster rockets to help take the space shuttle into orbit and a fuel tank that could be discarded once empty.

Lift-off was at 11.38 am. Cameras recorded small plumes of smoke near the joints one of the solid rocket booster (SRB)s but the rocket continued upwards. About a minute past launch, flames became visible around the joint and they spread to the external fuel tank resulting in a massive explosion. The space craft was completely destroyed and all seven astronauts aboard were killed.

Further investigation revealed that the rubber O-rings which seal the field joint on the SRB were not cleared for use in low temperatures, and it is the failure of one such O-ring had caused the catastrophe. Hot combustion gases escaped through the faulty joint and burned through the external fuel tank. The orbiter which contained the crew was torn away and fell from a height of 20 kilometres before it hit the Atlantic Ocean and disintegrated.

Case Summary

Morton Thiokol Incorporated was the firm employed by NASA for building the Solid Rocket Boosters. The director of the Solid Rocket Motors Project was **Alan McDonald**, a chemical engineer from Morton Thiokol was present at Kennedy Space Center during the launch. On prior missions using the same kind of SRBs problems with the O-ring had been noted especially at lower temperatures and Morton Thiokoil had been working on solving it.

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Alan McDonald was concerned about whether the O-rings would work satisfactorily at the freezing temperatures on the launch site.

The Challenger launch had already been postponed several times owing to the weather as well as several operational delays and NASA was under a lot of pressure from different quarters to launch it soon. Before any shuttle takes off all the members of the flight deck and flight control are required to check that their part of the shuttle is in perfect condition and ready for launch.This is usually done the night before the launch. On the night of 27th January, not all the members had a good chance to review their part of the shuttle. However, all the members okayed the launch except for McDonald who refused to sign. He argued that the O-rings had never been tested in the freezing weather conditions. McDonald said that if the O-rings became too cold prior to launch, they would freeze and then crack open from the immense heat at take off thus creating a crack in the booster rocket.

He organized a last minute tele-conference between the management at Morton Thiokol and NASA officials. Engineers working on the project, **Roger Boisjoly** and **Arnold Thompson**, reiterated that the launch should be halted as there is no data regarding the performance of the O-rings at low temperatures but the available data pointed to decreased reliability. However the top management at Morton Thiokol was more interested in the renewal of their contract with NASA and insisted that McDonald must okay the launch. NASA officials did not effectively convey McDonald's concerns to higher management since they too, were eager to go ahead with the launch. But Alan McDonald still refused to sign the document. He was overruled by his boss Joseph Kilminster who signed the document according to the wishes of Larry Mulloy of NASA.

On the next day, however, the disaster showed that McDonald, Boisjoly and Thompson's concern were well-founded.

Key Players

- NASA - National Aeronautics and Space Administration
- Morton Thiokol Inc.- Contractor for NASA who built the Solid Rocket Boosters
- Larry Mulloy - NASA official who persuaded the engineers to okay the launch
- Alan McDonald - Director, Solid Rocket Motors Project
- Robert Ebeling, Arnold Thomson & Roger Boisjoly - Engineer who worked under McDonald
- Joseph Kilminster - Engineer in a management position

Analysis of the incident

The key aspects of the case are as listed below.

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Bureaucracy & Political Pressure

- NASA was under significant pressure to complete the launch. One of the missions planned for the crew of the Challenger was to observe Halley's Comet. The USSR was also planning a mission with the same aim, NASA wanted to be first.
- In addition to scientific exploration, the Space Shuttle program also had several commercial and military aims. NASA was forced to develop the space shuttle into a commercial vehicle for communication satellites. So, they had to plan for a too-large number of launches - as high as a proposed 714 space flights between 1978 and 1990 - at the expense of engineering and safety concerns.
- Pressures from external factors transformed to internal goals for NASA. This put a great strain on individual decision makers who were hard pressed.
- Data gathering, viewing the mission with an academic interest etc. took a distinct backseat to ensuring funding and proving the program's worth to the American public, the White House and the Pentagon.
- Gradual sliding of standards and blindness to risk, especially after the Apollo programme. Safety concerns competed with cost control.
- At Thiokol, even managers with an engineering background were forced to bend their opinions to ensure they retained the contract with NASA. Business concerns overrode technical expertise. Even after the disaster, the whistle blowers Boisjoly and McDonald were treated badly by their company for making the discussions public.

Failure of Communication

- Concerns about the O-ring were known to Level III and Level IV managers at NASA. However, Level I and II officials were not alerted in spite of the critical nature of the issue. This tendency to 'solve' problems at the lower levels reinforces the idea that bad news seldom travels upwards within organizations
- The engineers at Thiokol - Boisjoly & Thomson - had little time to prepare their data to present to NASA. The graphs, charts and images had all the relevant data but were not simple and clear. The gravity of the issue at hand could not be highlighted in them, and the chart was quite uncommunicative.
- The inability of Thiokol engineers to conclusively prove their point was taken by NASA as an approval for launch.

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Desensitization to risk

- Familiarity with the project had, it seems, bred contempt. Missions were treated as 'routine'. The fact that the Challenger space shuttle was *experimental* and not yet a fully-proven technology was almost forgotten.
- Deformation and damage of the O-rings had been noted on almost all the previous flights. However, this was not given due importance since none of the failures were catastrophic, it was filed away as an "acceptable but unavoidable risk."
- The warnings about bad weather were also neglected. Strong wind shear caused the damage to spread.
- Tests on O-rings should have been conducted down to lower temperatures.

Design Issues

- Criticality-1 components are those whose failure will most likely cause the death of the crew. The design of the Challenger had an astounding 700 components - including the O-Rings - which were classified as Criticality 1!
- Even with such high criticality levels, NASA estimated the risk of catastrophe to be 1 in 1,00,000 even after repeated warnings by the engineers who designed it.
- There was no 'safe exit' plan for the crew in the event of an accident. Even though an abort module a part of the initial design, it was avoided later because of the extra expense and complexity involved. Since the estimated chance of failure was so low, it was considered unnecessary to go for it.

Moral / Ethical Issues

- The astronauts were not aware of the risk in which they were being placed. The fact that Alan McDonald declined to okay the launch was not communicated to them. So they did not give 'informed consent' to go on the mission.
- Loyalty to the company's goals prompted Joe Kilminster and Larry Mulloy to go ahead with the launch.However, the first duty of an engineer is to "hold paramount the safety, health and welfare of the public in the performance of their professional duties." This was grossly violated.
- Instead of awarding those engineers who held to their views and voted to postpone the launch they were ill-treated and ignored. This attitude would discourage others from stating their concerns to the appropriate authority and force them togo with the groupthink.

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- The Challenger disaster did not occur because of any 'villains' in the story. When complex technology is being used,it is necessary to put external controls and monitoring mechanisms in place. It is simply not sufficient to rely on the moral sense of individuals (who may be under severe stress themselves) to make single-handed decisions regarding vital issues.

Lessons Learnt

- Improve organizational communication
- Always put safety and ethical conduct first
- Systematize decision making, rather than place weight on the shoulders on individuals
- Ensure clarity in standards, testing procedures etc.
- Protect whistleblowers from backlash

Questions for reflection

(1) Engineers have a 'social contract' to adhere to. How does this feature in the Challenger case?

(2) What could NASA have done differently in the launch decision procedure?

(3) What, if any, professional responsibilities were neglected by each of the key players in this case?

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Reference: "Life Skills for Engineers", by Ramesh S and Vishnu RG.