GE6075 PROFESSIONAL ETHICS IN ENGINEERING

UNIT I-HUMAN VALUES

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

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Senses of „Engineering Ethics" – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg"s theory – Gilligan"s theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

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UNIT V-GLOBAL ISSUES

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility

TEXTBOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata Mc Graw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India,New Delhi, 2004.

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2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001

UNIT I
HUMAN VALUES

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1.0 OBJECTIVES (WHY ENGINEERING ETHICS?)

The objectives of this course on 'Professional Ethics and Human Values' are: (*a*) to understand the moral values that ought to guide the Engineering profession, (*b*) resolve the moral issues in the profession, and (*c*) justify the moral judgment concerning the profession. It is intended to develop a set of beliefs, attitudes, and habits that engineers should display concerning morality.

The prime objective is to increase one's ability to deal effectively with moral complexity in engineering practice.
Alternatively, the objectives of the study on Professional Ethics may be listed as:
(A) Improvement of the cognitive skills (skills of the intellect in thinking clearly)

1. Moral awareness (proficiency in recognizing moral problems in engineering)
2. Cogent moral reasoning (comprehending, assessing different views)
3. Moral coherence (forming consistent viewpoints based on facts)
4. Moral imagination (searching beyond obvious the alternative responses to issues and being receptive to creative solutions)
5. Moral communication, to express and support one's views to others.
6. (B) To *act* in morally desirable ways, towards moral commitment and responsible conduct Moral reasonableness i.e., willing and able to be morally responsible.
7. Respect for persons, which means showing concern for the well-being of others, besides oneself.
8. Tolerance of diversity i.e., respect for ethnic and religious differences, and acceptance of reasonable differences in moral perspectives.
9. Moral hope i.e., believe in using rational dialogue for resolving moral conflicts.
10. Integrity, which means moral integrity, and integrating one's professional life and personal convictions.

1.1 MORALS

Morals are the welfare principles enunciated by the wise people, based on their experience and wisdom. They were edited, changed or modified or evolved to suit the geography of the region, rulers (dynasty), and in accordance with development of knowledge in science and technology and with time.
Morality is concerned with principles and practices of morals such as: (*a*) What ought or ought not to be done in a given situation? (*b*) What is right or wrong about the handling of a situation? and (*c*) What is good or bad about the people, policies, and ideals involved?

Morality is different from Ethics in the following ways:

Morality	Ethics
1. More general and prescriptive based on customs and traditions.	1. Specific and descriptive. It is a critical reflection on morals.
2. More concerned with the results of wrong action, when done.	2. More concerned with the results of a right action, when not done.
3. Thrust is on judgment and punishment, in the name of God or by laws.	3. Thrust is on influence, education, training through codes, guidelines, and correction.
4. In case of conflict between the two, morality is given top priority, because the damage is more. It is more common and basic.	4. Less serious, hence second priority only. Less common. But relevant today, because of complex interactions in the modern society.
5. Example: Character flaw, corruption, extortion, and crime.	5. Example: Notions or beliefs about manners, tastes, customs, and towards laws.

As against morals and ethics, laws are norms, formally approved by state, power or national or international political bodies. Breaking the norms is called *crime*, and invite specific punishment.

1.2 VALUES

1.2.1 Definition

Humans have the unique ability to define their identity, choose their values and establish their beliefs. All three of these directly influence a person's behavior. People have gone to great lengths to demonstrate the validity of their beliefs, including war and sacrificing their own life! Conversely, people are not motivated to support or validate the beliefs of another, when those beliefs are contrary to their own. People will act congruent with their personal values or what they deem to be important.

A value is defined as a principle that promotes well-being or prevents harm." Another definition is: *Values are our guidelines for our success—our paradigm about what is acceptable."* Personal values are defined as: "*Emotional beliefs in principles regarded as particularly favorable or important for the individual."* Our values associate emotions to our experiences and guide our choices, decisions and actions.

A person's observations on its environment are filtered through his values to determine whether or not he should expend energy to do something about his experiences. A person who values gold and sees a large bag of gold (a positive value) in his path as he walks, will be motivated to reach down and pick it up. A person who values his life and knows about venomous snakes will retreat from the sound of a rattlesnake (a negative value) from nearby, when he is walking in the desert. Said in another way, *"Values are the scales we use to weigh our choices for our actions, whether to move towards or away from something."*

Not all values have the same weight or priority. Some are more important than others and must be satisfied before others can be addressed. **Dr. Abraham Maslow** illustrated this with his hierarchy of

human needs. Survival has a higher priority than security, which has a higher priority than social acceptance. Self-esteem can only be addressed to the degree that social acceptance is fulfilled. Similarly, self-actualization can only be pursued to the degree that self-esteem has been satisfied.

A person's beliefs, values and identity are usually acquired unconsciously based on his personal experience or observations of others' experiences as to what produces desirable or undesirable results in the environment. A baby's learning *to walk and talk* is a clear example of identifying with human adults, valuing the act of being able to have the mobility and communication ability of an adult and the belief, based on unconscious observation, that humans can do walk and do talk with each other.

Physiologists have identified the parts of the human brain that are involved in producing behavior in accordance with beliefs and values. All information collected by human senses is passed through a net-like group of cells, known as the Reticular Activating System (RAS), located near the top of the brain stem. The RAS compares the data received with accepted values, positive and negative (threats), and beliefs stored in memory and determines whether or not immediate action is required. The results of the RAS's comparison are communicated to the 'amygdala' near the mid-brain.

The 'amygdala' produces neuro-chemicals that cause emotions consistent with the nature of and proportional to the match between environment and values and beliefs. The neuro-chemicals initiate the chemical processes needed for the action to be taken. If the emotions produced are strong enough, the perceived information is blocked from reaching the logical, rational and conscious executive center of the brain, the pre-frontal lobes. In which case, the resulting behavior will be automatic, not necessarily logical or rational, and completely in accordance with the person's strongest held beliefs, values and/or identity.

By positive affirmations, one can modify or create new beliefs about a person's identity and/or what is important to him (values). Verbal repetition of statements intended to become new beliefs, and values will result in these being stored for use by the RAS for comparison with the environment being experienced. This is the mechanism how the beliefs or values are modified.

1.2.2 Types of Values

The five core human values are: (1) Right conduct, (2) Peace, (3) Truth, (4) Love, and (5) Nonviolence.

1. Values related to RIGHT CONDUCT are:

(*a*) SELF-HELP SKILLS: Care of possessions, diet, hygiene, modesty, posture, self reliance, and tidy appearance

(*b*) SOCIAL SKILLS: Good behavior, good manners, good relationships, helpfulness, No wastage, and good environment, and

(*c*) ETHICAL SKILLS: Code of conduct, courage, dependability, duty, efficiency, ingenuity, initiative, perseverance, punctuality, resourcefulness, respect for all, and responsibility

2. Values related to PEACE are: Attention, calmness, concentration, contentment, dignity, discipline, equality, equanimity, faithfulness, focus, gratitude, happiness, harmony, humility, inner silence, optimism, patience, reflection, satisfaction, self-acceptance, self-confidence, self-control, self-discipline, self-esteem, self-respect, sense control, tolerance, and understanding

3. Values related to TRUTH are: Accuracy, curiosity, discernment, fairness, fearlessness, honesty, integrity (unity of thought, word, and deed), intuition, justice, optimism, purity, quest for knowledge, reason, self-analysis, sincerity, sprit of enquiry, synthesis, trust, truthfulness, and determination.

4. Values related to LOVE are: Acceptance, affection, care, compassion, consideration, dedication, devotion, empathy, forbearance, forgiveness, friendship, generosity, gentleness, humanness, interdependence, kindness, patience, patriotism, reverence, sacrifice, selflessness, service, sharing, sympathy, thoughtfulness, tolerance and trust.

5. Values related to NON-VIOLENCE are:

(*a*) PSYCHOLOGICAL: Benevolence, compassion, concern for others, consideration, forbearance, forgiveness, manners, happiness, loyalty, morality, and universal love

(*b*) SOCIAL: Appreciation of other cultures and religions, brotherhood, care of environment, citizenship, equality, harmlessness, national awareness, perseverance, respect for property, and social justice.

PERSEVERANCE is defined as persistence, determination, resolution, tenacity, dedication, commitment, constancy, steadfastness, stamina, endurance and indefatigability. To persevere is described as to continue, carry on, stick at it (in formal), keep going, persist, plug away, (informal), remain, stand firm, stand fast, hold on and hang on. Perseverance builds character.

ACCURACY means freedom from mistake or error; conformity to truth or to a standard or model and exactness. Accuracy is defined as correctness, exactness, authenticity, truth, veracity, closeness to truth (true value) and carefulness. The value of accuracy embraces a large area and has many implications. Engineers are encouraged to demonstrate accuracy in their behavior through the medium of praise and other incentives. Accuracy includes telling the truth, not exaggerating, and taking care over one's work.

DISCERNMENT means discrimination, perception, penetration, and insight. Discernment means the power to see what is not obvious to the average mind. It stresses accuracy, especially in reading character or motives. Discrimination stresses the power to distinguish or select what is true or genuinely excellent. Perception implies quick and often sympathetic discernment, as of shades of feelings. Penetration implies a searching mind that goes beyond what is obvious or superficial. Insight suggests depth of discernment.

Definitions of other terms are given in the appropriate pages of this book.

1.2.3 Evolution of Human Values

The human values evolve because of the following factors:

1. The impact of norms of the society on the fulfillment of the individual's needs or desires.
2. Developed or modified by one's own awareness, choice, and judgment in fulfilling the needs.
3. By the teachings and practice of Preceptors (Gurus) or Saviors or religious leaders.
4. Fostered or modified by social leaders, rulers of kingdom, and by law (government).

1.3 ETHICS

Ethics is the word that refers to morals, values, and beliefs of the individuals, family or the society.
The word has several meanings. Basically it is an activity and process of inquiry. Secondly, it is different from non-moral problems, when dealing with issues and controversies. Thirdly, ethics refers to a particular set of beliefs, attitudes, and habits of individuals or family or groups concerned with morals. Fourth, it is used to mean 'morally correct'.

The study on ethics helps to know the people's beliefs, values, and morals, learn the good and bad of them, and practice them to maximize their well-being and happiness. It involves the inquiry on the

existing situations, form judgments and resolve the issues. In addition, ethics tells us how to live, to respond to issues, through the duties, rights, responsibilities, and obligations. In religion, similar principles are included, but the reasoning on procedures is limited. The principles and practices of religions have varied from to time to time (history), region (geography, climatic conditions), religion, society, language, caste and creed. But ethics has grown to a large extent beyond the barriers listed above. In ethics, the focus is to study and apply the principles and practices, universally.

1.4 INTEGRITY

Integrity is defined as the unity of thought, word and deed (honesty) and open mindedness. It includes the capacity to communicate the factual information so that others can make well-informed decisions. It yields the person's 'peace of mind', and hence adds strength and consistency in character, decisions, and actions. This paves way to one's success. It is one of the self-direction virtues. It enthuse people not only to execute a job well but to achieve excellence in performance. It helps them to own the responsibility and earn self-respect and recognition by doing the job.

Moral integrity is defined as a virtue, which reflects a consistency of one's attitudes, emotions, and conduct in relation to justified moral values. Further discussion on this is available in Chapter 2.

1.5 WORK ETHICS

Industry and Society are the two systems which interact with each other and are interdependent. Society requires industry/business system which provides manufacturing, distribution and consumption activities.

It needs investment (capital input), labor (input), supply (raw materials), production (industries, business organizations), marketing and distribution (transport), and consumption (public, customer). A lot of transactions (and interactions) between these sub-systems involving people are needed for the welfare of the society. It is here, the work ethics plays an essential role.

Work ethics is defined as *a set of attitudes concerned with the value of work, which forms the motivational orientation*. The 'work ethics' is aimed at ensuring the economy (get job, create wealth, earn salary), productivity (wealth, profit), safety (in workplace), health and hygiene (working conditions), privacy (raise family), security (permanence against contractual, pension, and retirement benefits), cultural and social development (leisure, hobby, and happiness), welfare (social work), environment (anti-pollution activities), and offer opportunities for all, according to their abilities, but without discrimination.

Many complex social problems exist in the industrial/business scenario, because:

1. The people desire to be recognized as individuals and treated with dignity, as living human beings. Work is intrinsically valuable so far as it is enjoyable or meaningful in allowing personal expression and self-fulfillment. Meaningful work is worth doing for the sense of personal identity and the self-esteem it holds.
2. Economic independence: Work is the major instrumental good in life. It is the main source of providing the income needed to avoid economic dependence on others, for obtaining desired materials and services, and for achieving status and recognition from others.
3. Pay as well as the pace of work should be in commensurate with the expertise required, acquired, and utilized in the persons. Exploitation and bargained pay should be discouraged.

4. Privacy (personal freedom) of the employee, including women, is to be protected. At the same time, confidentiality of the employer is also to be protected. Mutual trust and loyalty both ways play major roles in this aspect.
5. Security during job and upon retirement: This concept is being accepted only in government jobs, public limited companies, and corporate organizations. The western thought has influenced the Indian private industries and multinationals in a paradigm shift from 'lifelong employment' to policies such as 'merit only', 'hire and fire', 'pay and use' etc. This situation has no doubt created tension in the Indian scene.
6. Recognition to non-work activities, such as leisure, paid holiday on the day of visit of a dignitary, social service, and other developmental activities. The workers in prosperous countries are less willing to consider 'work' as their prime interest in life. They claim that such service activities give them *peace of mind* and *happiness*. However, such a trend is likely to decline the work ethics.

7. Hard work and productivity are very essential for the success of an industry. The quality of work life deserves to be improved. Hard labor, undignified jobs (human-drawn *rikshaw*, people carrying night soil), and hazardous jobs are to be made less straining, dignified, and safer. Automation and CNC systems to a large extent have been successful in lessening the human burden. Still, many a hard work can not be replaced by 'virtual work', in the near future.

8. Employee alienation: Absence of or inadequate 'recognition and reward system' and 'grievance redressal system', lack of transparency in policy implementation, factions in trade unions etc. lead to ethical problems, affecting the work ethics. Participative management, quality circles, job rotation, and flexible working hours are some of the measures to counter this situation.

9. A different view of work ethics: Work is considered as a necessary evil. It is a thing one must do in order to avoid worse evils, such as dependency and poverty. That is a major source of anxiety and unhappiness.

10. As per the Protestant Work Ethics, the financial success is a sign that is favored by God. It means making maximal profit is a duty mandated by God. It is to be obtained rationally, diligently, and without compromising with other values such as spending time with one's family and not exploiting or harming others.

To work (job), is not for monetary considerations only. Human beings believe that it is good to work. Work is good for the body and mind. It promotes self-respect, self-esteem, good for the family, and obligation to the society and allow the world to prosper. Work lays a moral and meaningful foundation for life. That is why, work ethics affirm s that, the work *per se* is worthy, admirable and valuable at personal and social levels. It improves the quality of life and makes life purposeful, successful, and happy.

By work ethics, duties to the self, family, society, and nation are fulfilled. Rights of the individuals are respected and nourished. Values and virtues are cultivated and enjoyed by all human beings. Further, the quality of life is improved and the environment protected. On the other hand, unemployment and under-employment lead to frustration, social tensions, and occasional militancy. For a developing economy and society, like ours, we need to *promote work ethics*, at all levels, to flourish as developed nation.

1.6 SERVICE LEARNING

Service learning refers to learning the service policies, procedures, norms, and conditions, other than 'the technical trade practices'. The service learning includes the characteristics of the work, basic requirements, security of the job, and awareness of the procedures, while taking decisions and actions. It helps the individuals to interact ethically with colleagues, to effectively coordinate with other departments, to interact cordially with suppliers as well as the customers, and to maintain all these friendly interactions.

Alternatively, the service learning may be defined as the *non-paid activity*, in which service is provided on voluntary basis to the public (have-nots in the community), non-profitable institutions, and charitable organizations. It is the service during learning. This includes training or study on real life problems and their possible solutions, during the formal learning, i.e., courses of study. In the industrial scenario, adoption, study, and development of public health or welfare or safety system of a village or school is an example of service learning by the employees. The engineering student analyzing and executing a socially-relevant project is another example of service learning.

The service learning is a methodology falling under the category of experiential education. It is one of the forms of experiential learning and community service opportunities. It is distinguished in the following ways:

1. *Connection to curriculum*: Integrating the learning into a service project is a key to successful service learning. Academic ties should be clear and built upon existing disciplinary skills.
2. *Learner's voice*: Beyond being actively engaged in the project, trainees have the opportunity to select, design, implement, and evaluate their service activity.
3. *Reflection*: Structured opportunities are created to think, talk, and write about the service experience. The balance of reflection and action allows the trainee to be constantly aware of the impact of their *work*.
4. *Partners in the community*: Partnership with community agencies are used to identify genuine needs, provide mentorship, and contribute input such as labor and expertise towards completing the project.

1.7 VIRTUES

Virtues are *positive* and *preferred* values. Virtues are desirable attitudes or character traits, motives and emotions that enable us to be successful and to act in ways that develop our highest potential. They energize and enable us to pursue the ideals that we have adopted. Honesty, courage, compassion, generosity, fidelity, integrity, fairness, transparency, self-control, and prudence are all examples of virtues.
Virtues are tendencies which include, solving problems through peaceful and constructive means and follow the path of the golden mean between the extremes of 'excess and deficiency'. They are like habits, once acquired, they become characteristics of a person. Moreover, a person who has developed virtues will naturally act in ways consistent with moral principles. The virtuous person is the ethical person.

1.7.1 Civic Virtues

Civic virtues are the moral duties and rights, as a citizen of the village or the country or an integral part of the society and environment. An individual may exhibit civic virtues by voting, volunteering, and organizing welfare groups and meetings.
The duties are:

1. To pay taxes to the local government and state, in time.
2. To keep the surroundings clean and green.
3. Not to pollute the water, land, and air by following hygiene and proper garbage disposal. For example, not to burn wood, tyres, plastic materials, spit in the open, even not to smoke in the open, and not to cause nuisance to the public, are some of the civic (duties) virtues.
4. To follow the road safety rules.

On the other hand, the rights are:

1. To vote the local or state government.
2. To contest in the elections to the local or state government.
3. To seek a public welfare facility such as a school, hospital or a community hall or transport or communication facility, for the residents.
4. To establish a green and safe environment, pollution free, corruption free, and to follow ethical principles. People are said to have the right to breathe in fresh air, by not allowing smoking in public.
5. People have inalienable right to accept or reject a project in their area. One has the right to seek legal remedy, in this respect, through public interest petition.
6. George Washington embodied the civic virtues as indispensable for a self-governing administration.

These virtues are divided into four categories:

1. Civic Knowledge

Citizens must understand what the Constitution says about how the government is working, and what the government is supposed to do and what not to do. We must understand the basis of our responsibilities as citizens, besides duties and rights. We must be able to recognize when the government or another citizen infringes upon our rights. It implies that the government requires the participation of the enlightened citizens, to serve and survive.

2. Self-Restraint

For citizens to live in a free society with limited government each citizen must be able to control or restrain himself; otherwise, we would need a police state—that is, a dictatorial government to maintain safety and order. He advocated for morality and declared that happiness is achieved and sustained through virtues and morals. He advocated and demonstrated self-restraint several times in his private and public life, and naturally he was a great leader.

3. Self-Assertion

Self-assertion means that citizens must be proud of their rights, and have the courage to stand up in public and defend their rights. Sometimes, a government may usurp the very rights that it was created to protect. In such cases, it is the right of the people to alter or abolish that government (e.g., voting rights, rights call back).

4. Self-Reliance

Citizens who cannot provide for themselves will need a large government to take care of them. Once citizens become dependent on government for their basic needs, the people are no longer in a position to demand that government act within the confines of the Constitution. Self-reliant citizens are free citizens in the sense that they are not dependent on others for their basic needs. They do not need a large provider-government, which has the potential to become an oppressive government, to meet those needs. Only a strong self-reliant citizenry will be able to enjoy fully the blessings of liberty. These civic virtues, applicable to local, state, and central governments, nourish freedom and civil liberty at the root of democracy.

1.8 RESPECT FOR OTHERS

This is a basic requirement for nurturing friendship, team work, and for the synergy it promotes and sustains. The principles enunciated in this regard are:

1. Recognize and accept the existence of other persons as human beings, because they have a right to live, just as you have.
2. Respect others' ideas (decisions), words, and labor (actions). One need not accept or approve or award them, but shall listen to them first. One can correct or warn, if they commit mistakes. Some people may wait and watch as fun, if one falls, claiming that they know others' mistakes before and know that they will fall! Appreciate colleagues and subordinates on their positive actions. Criticize constructively and encourage them. They are bound to improve their performance, by learning properly and by putting more efforts.
3. Show 'goodwill' on others. Love others. Allow others to grow. Basically, the goodwill reflects on the originator and multiplies itself on everybody. This will facilitate collinearity, focus, coherence, and strength to achieve the goals.

1.9 LIVING PEACEFULLY

To live peacefully, one should start install peace within (self). Charity begins at home. Then one can spread peace to family, organisation where one works, and then to the world, including the environment. Only who are at peace can spread peace. You can not gift an article which you do not possess. The essence of oriental philosophy is that one should not *fight* for peace. It is oxymoron. War or peace can be won only by peace, and *not by wars !*

One should adopt the following means to live peacefully, in the world:

Nurture

1. Order in one's life (self-regulation, discipline, and duty).
2. Pure thoughts in one's soul (loving others, blessing others, friendly, and not criticizing or hurting others by thought, word or deed).
3. Creativity in one's head (useful and constructive).
4. Beauty in one's heart (love, service, happiness, and peace).
5. Good health/body (physical strength for service).
6. Help the needy with head, heart, and hands (charity). Service to the poor is considered
7. holier than the service to God.
8. Not hurting and torturing others either physically, verbally, or mentally.

The following are the factors that promote living, with internal and external peace:

1. Conducive environment (safe, ventilated, illuminated and comfortable).
2. Secured job and motivated with 'recognition and reward'.
3. Absence of threat or tension by pressure due to limitations of money or time.
4. Absence of unnecessary interference or disturbance, except as guidelines.
5. Healthy labor relations and family situations.
6. Service to the needy (physically and mentally-challenged) with love and sympathy.

1.10 CARING

Caring is feeling for others. It is a process which exhibits the interest in, and support for, the welfare of others with fairness, impartiality and justice in all activities, among the employees, in the context of professional ethics. It includes showing respect to the feelings of others, and also respecting and preserving the interests of all others concerned. Caring is reflected in activities such as friendship, membership in social clubs and professional societies, and through various transactions in the family, fraternity, community, country and in international councils.

In the present day context, caring for the environment (including the *fauna and flora*) has become a necessity for our very survival. If we do not care for the environment, the environment will scare us.

1.11 SHARING

Primarily, caring influences 'sharing'. Sharing is a process that describes the transfer of knowledge (teaching, learning, and information), experience (training), commodities (material possession) and facilities with others. The transfer should be genuine, legal, positive, voluntary, and without any expectation in return. However, the proprietary information it should not be shared with outsiders. Through this process of sharing, experience, expertise, wisdom and other benefits reach more people faster. Sharing is voluntary and it can not be driven by force, but motivated successfully through ethical principles. In short, sharing is 'charity'

For the humanity, 'sharing' is a *culture*. The 'happiness and wealth' are multiplied and the 'crimes and sufferings' are reduced, by sharing. It paves the way for peace and obviates militancy. Philosophically, the sharing maximizes the happiness for all the human beings. In terms of psychology, the fear, divide, and distrust between the 'haves' and 'have-nots' disappear.

Sharing not only paves the way to prosperity, early and easily, and sustains it. Economically speaking, benefits are maximized as there is no wastage or loss, and everybody gets one's needs fulfilled and satisfied. Commercially speaking, the profit is maximized. Technologically, the productivity and utilization are maximized by sharing. In the industrial arena, code-sharing in airlines for bookings on air travels and the common Effluent Treatment Plant constructed for small-scale industries in the industrial estates, are some of the examples of sharing. The co-operative societies for producers as well as consumers are typical examples of sharing of the goods, profit and other social benefits.

Here is an anecdote that illustrates the benefits of sharing, for the young minds!

The shouting...the screaming…the fighting. That was the breaking point for me as I poured out my woes to my mother. "How can I get them to *share* as well as we did as kids?", I pleaded. Laughter was her reply. "Well, thanks a lot, mom," I said. "I'm sorry," she chuckled, "but you didn't always share." She went on to explain about the "Box of Misbehaved Toys." Every time we fought over a toy, she would quietly take that and put it into the box.

Yes, I did remember that box. I also remember it wasn't always fair since one person may have caused all the commotion. But my mother was consistent. No matter what the reason for the struggle was, the toy disappeared into the box for one week. No questions asked, and no chance of parole. My siblings and I soon learned that sharing a toy was better than losing it. Often, one person would decide to just wait for a time when no one else was playing with the toy, rather than fight and lose it. It was not a perfect system, but I tried it anyway

That box was a shock to my kids and it was close to full, within a few days…..As the weeks progressed, I noticed the box was emptier and the arguing was less. Today, I heard quiet music to my ears as my son said to his sister, "That's OK, you can play with it." This story illustrates the worthy joy of sharing as compared to the pain of losing.

1.12 HONESTY

Honesty is a virtue, and it is exhibited in two aspects namely,
(*a*) Truthfulness and
(*b*) Trustworthiness.

Truthfulness is to face the responsibilities upon telling truth. One should keep one's word or promise. By admitting one's mistake committed (one needs courage to do that!), it is easy to fix them. Reliable engineering judgment, maintenance of truth, defending the truth, and communicating the truth, only when it does 'good' to others, are some of the reflections of truthfulness. But *trustworthiness* is maintaining integrity and taking responsibility for personal performance. People abide by law and live by mutual trust. They play the right way to win, according to the laws or rules (legally and morally).
They build trust through reliability and authenticity. They admit their own mistakes and confront unethical actions in others and take tough and principled stand, even if unpopular. Honesty is mirrored in many ways.

The common reflections are:

(a) Beliefs (intellectual honesty).
(b) Communication (writing and speech).
(c) Decisions (ideas, discretion).
(d) Actions (means, timing, place, and the goals). and
(e) Intended and unintended results achieved.

As against this, some of the actions of an engineer that leads to dishonesty are:
1. *Lying*: Honesty implies avoidance of lying. An engineer may communicate wrong or distorted test results intentionally or otherwise. It is giving *wrong* information to the *right* people.
2. *Deliberate deception*: An engineer may judge or decide on matters one is not familiar or with insufficient data or proof, to impress upon the customers or employers. This is a self deceit.
3. *Withholding the information*: It means hiding the facts during communication to one's superior or subordinate, intentionally or otherwise.
4. *Not seeking the truth*: Some engineers accept the information or data, without applying their mind and seeking the truth.
5. *Not maintaining confidentiality*: It is giving *right* information to *wrong* people. The engineers should keep information of their customers/clients or of their employers confidential and should not discuss them with others.
6. Giving professional judgment under the influence of extraneous factors such as personal benefits and prejudice. The laws, experience, social welfare, and even conscience are given a go-bye by such actions. Certainly this is a higher-order crime.

1.13 COURAGE

Courage is the tendency to accept and face risks and difficult tasks in rational ways. Self-confidence is the basic requirement to nurture courage.

Courage is classified into three types, based on the types of risks, namely

(a) Physical courage,
(b) Social courage, and
(c) Intellectual courage.

In ***physical courage,*** the thrust is on the adequacy of the physical strength, including the muscle power and armaments. People with high adrenalin, may be prepared to face challenges for the mere 'thrill' or driven by a decision to 'excel'. The ***social courage*** involves the decisions and actions to change the

order, based on the conviction for or against certain social behaviors. This requires leadership abilities, including empathy and sacrifice, to mobilize and motivate the followers, for the social cause. The ***intellectual courage*** is inculcated in people through acquired knowledge, experience, games, tactics, education, and training. In professional ethics, courage is applicable to the employers, employees, public, and the press.

Look before you leap. One should perform Strengths, Weakness, Opportunities, and Threat (SWOT) analysis. Calculate (estimate) the risks, compare with one's strengths, and anticipate the end results, while taking decisions and before getting into action. Learning from the past helps. Past experience (one's own or borrowed!) and wisdom gained from self-study or others will prepare one to plan and act with self-confidence, succeed in achieving the desired ethical goals through ethical means. Opportunities and threat existing and likely to exist in future are also to be studied and measures to be planned. This anticipatory management will help any one to face the future with courage.

Facing the criticism, owning responsibility, and accepting the mistakes or errors when committed and exposed are the expressions of courage. In fact, this sets their mind to be vigilant against the past mistakes, and creative in finding the alternate means to achieve the desired objectives. Prof. Sathish Dhawan, Chief of ISRO, was reported to have exhibited his courage and owned responsibility, when the previous space mission failed, but credited Prof. A.P.J. Abdul Kalam (now our revered President), when the subsequent mission succeeded.

The courageous people own and have shown the following characteristics, in their professions:
(*a*) Perseverance (sustained hard work),
(*b*) Experimentation (preparedness to face the challenges, that is, unexpected or unintended results),
(*c*) Involvement (attitude, clear and firm resolve to act), and
(*d*) Commitment (willing to get into action and to reach the desired goals by any alternative but ethical means).

1.14 VALUING TIME

Time is rare resource. Once it is spent, it is lost for ever. It can not be either stored or recovered. Hence, time is the most perishable and most valuable resource too. This resource is continuously spent, whether any decision or action is taken or not.

The history of great reformers and innovators have stressed the importance of time and valuing time. The proverbs, 'Time and tide wait for nobody' and 'Procrastination is the thief of time' amply illustrate this point.

An anecdote to highlight the 'value of time' is as follows: To realize the value of one year, ask the student who has failed in the examinations;. To realize the value of one month, ask the mother who has delivered a premature baby; to realize the value of one week, ask the editor of weekly; to realize the value of one day, ask the daily-wage laborer; to realize now the value of one hour, ask the lovers longing to meet; to realize the value of one minute, ask a person who has missed the train; to realize the value of one second, ask the person who has survived an accident; to realize the value one milli second, ask the person who has won the bronze medal in Olympics; to realize the value of one micro second, ask the NASA team of scientists; to realize the value of one nano-second, ask a Hardware engineer!; If you have still not realized the value of time, wait; are you an Engineer?

1.15 COOPERATION

It is a team-spirit present with every individual engaged in engineering. Co-operation is activity between two persons or sectors that aims at integration of operations (synergy), while not sacrificing the utonomy of either party. Further, working together ensures, coherence, i.e., blending of different skills required, towards common goals.

Willingness to understand others, think and act together and putting this into practice, is cooperation. Cooperation promotes collinearity, coherence (blend), co-ordination (activities linked in sequence or priority) and the synergy (maximizing the output, by reinforcement). The whole is more than the sum of the individuals. It helps in minimizing the input resources (including time) and maximizes the outputs, which include quantity, quality, effectiveness, and efficiency.

According to professional ethics, cooperation should exist or be developed, and maintained, at several levels; between the employers and employees, between the superiors and subordinates, among the colleagues, between the producers and the suppliers (spare parts), and between the organisation and its customers.

The codes of ethics of various professional societies insist on appropriate cooperation to nourish the industry. The absence of cooperation leads to lack of communication, misinformation, void in communication, and undue delay between supply, production, marketing, and consumption. This is likely to demoralize and frustrate the employees, leading to collapse of the industry over time and an economic loss to the society.
The impediments to successful cooperation are:

1. Clash of ego of individuals.
2. Lack of leadership and motivation.
3. Conflicts of interests, based on region, religion, language, and caste.
4. Ignorance and lack of interest. By careful planning, motivation, leadership, fostering and rewarding team work, professionalism and humanism beyond the 'divides', training on appreciation to different cultures, mutual understanding 'cooperation' can be developed and also sustained.

1.16 COMMITMENT

Commitment means *alignment to goals and adherence to ethical principles during the activities*. First of all, one must believe in one's action performed and the expected end results (confidence). It means one should have the conviction without an iota of doubt that one will succeed. Holding sustained interest and firmness, in whatever ethical means one follows, with the fervent attitude and hope that one will achieve the goals, is commitment. It is the driving force to realize success.

This is a basic requirement for any profession. For example, a design engineer shall exhibit a sense of commitment, to make his product or project designed a beneficial contribution to the society. Only when the teacher (Guru) is committed to his job, the students will succeed in life and contribute 'good' to the society. The commitment of top management will naturally lead to committed employees, whatever may be their position or emoluments. This is bound to add wealth to oneself, one's employer, society, and the nation at large.

1.17 EMPATHY

Empathy is social radar. Sensing what others feel about, without their open talk, is the essence of empathy. Empathy begins with showing concern, and then obtaining and understanding the feelings of others, from others' point of view. It is also defined as the ability to put one's self into the psychological

frame or reference or point of view of another, to know what the other person feels. It includes the imaginative projection into other's feelings and understanding of other's background such as parentage, physical and mental state, economic situation, and association. This is an essential ingredient for good human relations and transactions.

To practice 'Empathy', a leader must have or develop in him, the following characteristics

1. *Understanding others*: It means sensing others feelings and perspectives, and taking active interest in their welfare.
2. *Service orientation*: It is anticipation, recognition and meeting the needs of the clients or customers.
3. *Developing others*: This means identification of their needs and bolstering their abilities. In developing others, the one should inculcate in him the 'listening skill' first. Communication = 22% reading and writing + 23% speaking + 55% listening One should get the feed back, acknowledge the strength and accomplishments, and then coach the individual, by informing about what was wrong, and giving correct feedback and positive expectation of the subject's abilities and the resulting performance.
4. *Leveraging diversity* (opportunities through diverse people): This leads to enhanced organizational learning, flexibility, and profitability.
5. *Political awareness*: It is the ability to read political and social currents in an organization.

The benefits of empathy include:

1. Good customer relations (in sales and service, in partnering).
2. Harmonious labor relations (in manufacturing).
3. Good vendor-producer relationship (in partnering.)

Through the above three, we can maximize the output and profit, as well as minimizing the loss. While dealing with customer complaints, empathy is very effective in realising the unbiased views of others and in admitting one's own limitations and failures. According to Peter Drucker, purpose of the business is not to *make a sale*, but to *make and keep a customer*. Empathy assists one in developing courage leading to success!

1.18 SELF-CONFIDENCE

Certainty in one's own capabilities, values, and goals, is self-confidence. These people are usually positive thinking, flexible and willing to change. They respect others so much as they respect themselves.

Self-confidence is positive attitude, wherein the individual has some positive and realistic view of himself, with respect to the situations in which one gets involved. The people with self-confidence exhibit courage to get into action and unshakable faith in their abilities, whatever may be their positions. They are not influenced by threats or challenges and are prepared to face them and the natural or unexpected consequences.

The self-confidence in a person develops a sense of partnership, respect, and accountability, and this helps the organization to obtain maximum ideas, efforts, and guidelines from its employees.

The people with self-confidence have the following characteristics:

1. A self-assured standing,
2. Willing to listen to learn from others and adopt (flexibility),
3. Frank to speak the truth, and
4. respect others' efforts and give due credit.

On the contrary, some leaders expose others when failure occurs, and own the credit when success comes.
The factors that shape self-confidence in a person are:

1. Heredity (attitudes of parents) and family environment (elders),
2. Friendship (influence of friends/colleagues),
3. Influence of superiors/role models, and
4. Training in the organization (e.g., training by Technical Evangelists at Infosys Technologies).

The following methodologies are effective in developing self-confidence in a person:

1. Encouraging SWOT analysis. By evaluating their strength and weakness, they can anticipate and be prepared to face the results.
2. Training to evaluate risks and face them (self-acceptance).
3. Self-talk . It is conditioning the mind for preparing the self to act, without any doubt on his capabilities. This make one accepts himself while still striving for improvement.
4. Study and group discussion, on the history of leaders and innovators (e.g., Sam Walton of Wal-Mart, USA).

1.19 CHALLENGES IN THE WORK PLACE

The biggest workplace challenge is said to be the employee's work ethics: showing up to work every day (interest in work and attendance), showing up to work on time (punctuality), taking pride in the quality of their work, commitment to the job, and getting along with others. This situation demands inculcation of good character in the workplace by employees.

1.19.1 Character

It is a characteristic property that defines the behavior of an individual. It is the pattern of virtues (morally-desirable features). Character includes attributes that determine a person's moral and ethical actions and responses. It is also the ground on which morals and values blossom.

People are divided into several categories, according to common tendencies such as ruthless, aggressiveness, and ambition, constricting selfishness, stinginess, or cheerfulness, generosity and goodwill. Individuals vary not only in the type of their character but also in the degree. Those whose lives are determined and directed by the prevailing habits, fashions, beliefs, attitudes, opinions and values of the society in which they live have at best a developed *social* as opposed to an *individual* character.

The character is exhibited through conduct. Character is determined by the expectations of society. Many act and live within its norms, refusing to fall below the required social minimum, failing to rise above the maximum expected of a normal member of the group. On one extreme are those that do not even conform to the minimum standards, and fail to acquire the socially-required behaviors, attitudes and values. These individuals have an unformed social character. At the other extreme are those whose beliefs, attitudes and values are determined internally by the strength of their own convictions. These are individuals with developed minds and formed characters of their own.

Individuals do not live or act in a vacuum. They exist and act in a human social environment of other people that constantly act on them and react to their actions. They also live in a natural environment of physical objects and material forces such as the winds and rains. And those with occult and spiritual traditions recognize that there is also a subtle environment of other planes of existence, both higher planes of spiritual influence and lower planes of negative forces in universal nature seeking to act on the

lives. All of the social, material and the occult planes constitute the field of human activity. Each of them functions according to its own laws or principles. Each of them has its own characteristic modes of action and influence on human life.

Character is the expression of the personality of a human being, and that it reveals itself in one's conduct. In this sense every human has a character. At the same time only human beings, not animals have character: it implies rationality. But in addition to this usage, the term is also employed in a narrower sense, as when we speak of a person "of character". In this connotation, character implies certain unity of qualities with a recognizable degree of *constancy* in mode of action. Psychology analyzes the elements of character to trace the laws of its growth, to distinguish the chief agencies which contribute to the formation of different types of character, and to classify them. Many psychologists world over, during the last 40 years have given a large quantity of acute observations on the topic of character. Still these contributions do not constitute a science.

1.19.2 The Four Temperaments

The original endowment or native element in character with which the individual starts life is practically identical with what the Ancients recognized as *temperament*. From the times of Hippocrates, they distinguished four main types of temperaments: the Sanguine, the Choleric, the Phlegmatic, and the Melancholic. The modern speculation accepts the same classification, but under other names. These different types of temperaments are accounted for differences in physiological conditions of the tissues of the body, by diverse rates of activities in the processes of nutrition and waste, in the changes of nerve-energy, or in circulation, and by differences of tonicity in the nerves. Irrespective of the physiological explanation, the four-fold classification seems to be fair. Moreover, though scientists are still far from agreeing upon the precise elements in the organism on which temperament depends, the fact that different forms of temperaments have an organic basis such as *hormones* seems certain.

Although our original temperament is given to us independently of our will by heredity, we play an important part in moulding our character, and we thus become responsible for certain ethical qualities in it.

Character has been defined as "*natural temperament completely fashioned by the will*". It is, in fact, a resultant of our acquired habits with our original disposition. The regular use of the intellect, the controlled activity of the imagination, the practice of judgment and reflection, all contribute to the formation and refinement of habits of mind. The frequent indulgence in particular forms of emotion, such as anger, envy, sympathy, melancholy, fear, and the like, fosters tendencies towards these sentiments which give a subconscious bent to a large part of man's behavior. But finally, the exercise of the will plays the predominant role in moulding the type of character. The manner and degree in which currents of thought and waves of emotion are initiated, guided, and controlled by the will, or allowed to follow the course of spontaneous impulse, has more effect in determining the resultant type of character than the quality of the thoughts or emotions themselves.

The life of the animal is entirely ruled by instinct from within, and by accidental circumstances from without. It is therefore incapable of acquiring a character. A human, through reasoning and the growth of reflection, by the exercise of choice against the impulse, gradually develops self-control; and it is by the exercise of this power that moral character is formed and reformed. Character is in fact the outcome of a series of volitions, and it is for this reason we are responsible for our characters, as we are for the individual habits which go to constitute them.

1.19.3 Types of Character

From the four fundamental temperaments, various classifications of character have been adopted by different psychologists. The intellectual, the emotional, and the volitional or energetic are the chief types with A. Bain. M. Pérez, based on the phenomenon of movement, distinguishes characters as lively, slow, ardent, and well-balanced. M. Ribot, with more subjective division and excluding indefinite types as 'characterless', recognizes the forms as:

(a) the sensitive (humble, contemplative and emotional,
(b) the active (great and the mediocre), and
(c) the apathetic (purely apathetic or dull), and
(d) the intelligent.

1.19.4 Ethics and Character

Whilst psychology investigates the growth of different types of character, ethics considers the relative value of such types and the virtues which constitute them. The problem of the true moral ideal is a question of the relative value of different types of character. The effect on the person's character of a particular form of conduct is a universally accepted as a test of its moral quality. Different systems of ethics emphasize different virtues in constituting the ideal moral character. With the utilitarian, who places the ethical end in the maximum happiness for the whole community, *benevolence* will form the primary element in the ideal character. For the stoic, fortitude and *self-control* are the chief excellences.

In all conceptions of ideal character, firmness of will, fortitude, constancy in adhering to principle or in pursuit of a noble aim are held important. A man of character is frequently equivalent to being capable of adhering to a fixed purpose. Another essential is the virtue of justice, the recognition of the rights, duties, and claims of others. The richer the culture of the mind, the larger the intellectual horizon, the broader the sympathies, the more will the character approximate to the ideal of human perfection.

1.19.5 Education and Character

The aim of education is not only the cultivation of the intellect but also the formation of moral character. Increased intelligence or physical skill may as easily be employed to the detriment or benefit of the community, if not accompanied by improved will. It is the function of ethics to determine the ideals of human character. The theory and science of education are to study the processes by which that end may be attained.

1.19.6 Building Character in the Workplace

Managers have to influence and employ creative means of stressing the importance of good character in the workplace, in the following ways,

1. Employee Hiring, Training, and Promotion Activities

(*a*) Institute and adopt an organization policy statement to positive character in the workplace. For example, commitment to civility pledges. This may be communicated through printing on the back of the business cards of the employees.

(*b*) Prominently and explicitly include character considerations in recruiting procedures, during interviews and in the hiring deliberations.

(*c*) Emphasize the importance of character and adherence to the 'six pillars' of character in orientation, initial job training, and during in-service training. The six pillars of character are the ethical values, such as: trustworthiness, respect, responsibility, fairness, caring and citizenship. Respect means showing high regard for self, others, authority, property and country. It includes showing appreciation for cultural diversity by valuing all people as human beings.

Responsibility is

(i) being accountable for one's actions,
(ii) being dependable in carrying out obligations and duties,
(iii) being reliable and consistent in word and action, and
(iv) being committed to community development. Integrity or fairness means showing the inner strength and courage to be truthful, trustworthy, fair and honest in all things. It includes acting justly and honorably. Caring means being kind, considerate, courteous, helpful, friendly and generous to others, and being compassionate by treating others as you would like to be treated. Citizenship means accepting and adopting civic rights and duties as a citizen of the country.

(*d*) Include evaluation of fundamental character values such as honesty, promise keeping, accountability, fairness, and caring, in appraisals/reviews.

(*e*) Institute recognition and reward system for the employees who exemplify the positive character. for example, awards and medals.

(*f*) Think of your employees, especially the younger ones, as people whose personal and work values will be influenced by what you expect of them and how you treat them.

(*g*) Think of your employees as present or future mentors, coaches, and volunteers.

2. Internal Communication

Use internal communication channels to create a friendly environment that praises positive role modeling at the workplace and in the community by encouraging voluntarism, and mentoring, e.g., through

(a) Internal newsletters,
(b) Workplace posters in canteens and recreation rooms,
(c) Mailers, and
(d) Electronic mails.

3. External Communication

In relations with customers, vendors and others, consciously communicate affirming messages about character and ethics, such as

(a) Advertise and market honoring consensual values (the six pillars),
(b) Assure that none of your products and services undermines character building,
(c) Include positive messages about voluntarism and celebrate, and
(d) 'Character counts' week in advertising, billings and other mailers.

4. Financial and Human Resources

(a) Support local and national 'character' projects and the activities of the members by encouraging staff members to get involved. Offer incentives such as paying employees for the time they contribute at a local youth-service organization.
(b) Sponsor 'character' movement through financial support.

5. Community Outreach

(a) Use public outreach structures to encourage mentoring and other character-building programs.
(b) Encourage educational and youth organizations to become active in character building.
(c) Use corporate influence to encourage business groups (chambers of commerce, conference boards, and Rotary clubs) and other companies to support 'character' building.

1.20 SPIRITUALITY

Spirituality is a way of living that emphasizes the constant awareness and recognition of the spiritual dimension (mind and its development) of nature and people, with a dynamic balance between the material development and the spiritual development. This is said to be the great virtue of Indian philosophy and for Indians. Sometimes, spirituality includes the faith or belief in supernatural power/ God, regarding the worldly events. It functions as a fertilizer for the soil 'character' to blossom into values and morals.

Spirituality includes creativity, communication, recognition of the individual as human being (as opposed to a life-less machine), respect to others, acceptance (stop finding faults with colleagues and accept them the way they are), vision (looking beyond the obvious and not believing anyone blindly), and partnership (not being too authoritative, and always sharing responsibility with others, for better returns).

Spirituality is motivation as it encourages the colleagues to perform better. Remember, lack of motivation leads to isolation. Spirituality is also energy: Be energetic and flexible to adapt to challenging and changing situations. Spirituality is flexibility as well. One should not be too dominating.

Make space for everyone and learn to recognize and accept people the way they are. Variety is the order of the day. But one can influence their mind to think and act together. Spirituality is also fun. Working is okay, but you also need to have fun in office to keep yourself charged up. Tolerance and empathy are the reflections of spirituality. Blue and saffron colors are said to be associated with spirituality.

Creativity in spirituality means conscious efforts to see things differently, to break out of habits and outdated beliefs to find new ways of thinking, doing and being. Suppression of creativity leads to violence. People are naturally creative. When they are forced to crush their creativity, its energy turns to destructive release and actions. Creativity includes the use of color, humor and freedom to enhance productivity. Creativity is fun. When people enjoy what they do, it is involvement. They work much harder.

1.20.1 Spirituality in the Workplace

Building spirituality in the workplace: Spirituality is promoted in the workplace by adhering to the following activities:

1. Verbally respect the individuals as humans and recognize their values in all decisions and actions.
2. Get to know the people with whom you work and know what is important to them. Know their goals, desires, and dreams too.
3. State your personal ethics and your beliefs clearly.
4. Support causes outside the business.
5. Encourage leaders to use value-based discretion in making decisions.
6. Demonstrate your own self-knowledge and spirituality in all your actions.
7. Do unto others as you would have them do unto you.

1.20.2 Sprituality for Corporate Excellence

The spiritual traits to be developed for excellence in corporate activities are listed as follows:

1. *Self-awareness* — Realization of self-potential. A human has immense capability but it needs to be developed.
2. *Alertness in observation and quickness in decision making*, i.e., spontaneity which includes quick reflexes, no delay but also no hasty decisions.
3. *Being visionary and value based* — This includes an attitude towards future of the organization and the society, with clear objectives.
4. *Holism* — Whole system or comprehensive views and interconnected with different aspects. Holistic thinking, which means the welfare of the self, family, organization and the society including all other living beings and environment.
5. *Compassion* — Sympathy, empathy and concern for others. These are essential for not only building the team but also for its effective functioning.
6. *Respect for diversity* — It means search for unity in diversity i.e., respect others and their views.
7. *Moral Autonomy* — It means action based on rational and moral judgment. One need not follow the crowd or majority i.e., band-wagon effect.
8. *Creative thinking and constant reasoning* — Think if we can do something new and if we can improve further?
9. *Ability to analyze and synthesize* — Refrain from doing something only traditional.
10. *Positive views of adversity* — Make adversities one's source of power—a typical Karma yogi's outlook! Every threat is converted into opportunity.
11. *Humility* — The attitude to accept criticism (it requires courage!) and willing to correct. It includes modesty and acknowledging the work of colleagues.
12. *Sense of vocation* — Treat the duty as a service to society, besides your organization.

UNIT –II
ENGINEERING ETHICS

Syllabus: Senses of 'Engineering Ethics' - variety of moral issues - types of inquiry - moral dilemmas - moral autonomy-Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories.

2.1 SENSES OF ENGINEERING ETHICS:

The word ethics has different meanings but they are correspondingly related to each other. In connection with that, engineering ethics has also various senses which are related to one another. Comparison of the senses of Ethics and Engineering Ethics

ETHICS	ENGINEERING ETHICS
1. Ethics is an activity which concerns with making investigations and knowing about moral values, finding solutions to moral issues and justifying moral issues and justifying moral judgments.	1. Like the ethics, engineering ethics also aims at knowing moral values related to engineering, finding accurate solutions to the moral problems in engineering and justifying moral judgments of engineering.
2. Ethics is a means of contrasting moral questions from non-moral problems.	2. Engineering Ethics gives a total view of the moral problems and how to solve these issues specifically related to engineering field.
3. Ethics is also used as a means of describing the beliefs, attitudes and habits related to an individual's or group's morality. Eg. : Ethics given in the Bhagavat Gita or the Bible or the Quran.	3. Engineering ethics is also using some currently accepted codes and standards which are to be followed by group of engineers and engineering societies.
4. As per the definition of dictionaries 'moral principles' is about the actions and principles of conduct of the people. i.e. ethical or unethical.	4. Engineering ethics also concerns with discovering moral principles such as obligation, rights and ideals in engineering and by applying them to take a correct decision.

From these senses of engineering ethics, one can realize that it is the study of morality.

What is morality?

The term 'morality' concerns with (a) what ought or ought not to be done in a given situation, (b) what is right or wrong in handling it, (c) what is good or bad about the persons, policies and principles involved in it.

If an action is said to be morally right or a principle is said to be morally good, then they are said to be had some moral reasons in supporting it.

Moral reasons include respecting others and ourselves, respecting the rights of others, keeping promises, avoiding unnecessary problems to others and avoiding cheating and dishonesty, showing gratitude to others and encourage them to work.

So, if an engineering decision is said to be a good one, it has to meet out all the specifications. These specifications must be covered both the technical and the moral specifications such as safety of the product, reliability, easy maintenance and the product should be user-friendly with environment.

2.2 VARIETY OF MORAL ISSUES

There are so many engineering disasters which are greater / heavier than the level of acceptable or tolerable risk. Therefore, for finding and avoiding such cases such as nuclear plant accident at Chernobyl (Russia), Chemical plant at Bhopal (India) where a big disaster of gas leakage, occurred in 1980, which caused many fatal accidents. In the same way, oil spills from some oil extraction plants (the Exxon Valdez plant), hazardous waste, pollution and other related services, natural disasters like floods, earth quake and danger from using asbestos and plastics are some more cases for engineering disasters. These fields should be given awareness of engineering ethics. Hence, it is essential for engineers to get awareness on the above said disasters. They should also know the importance of the system of engineering.

When malfunction of the system is a rapid one, the disaster will be in greater extent and can be noticed immediately. When they ate slow and unobserved, the impact is delayed. So, the engineers should not ignore about the functions of these systems.

These cases also explain and make the engineers to be familiar with the outline of the case in future and also about their related ethical issues.

Approaches to Engineering Ethics:

i. ***Micro-Ethics:*** This approach stresses more about some typical and everyday problems which play an important role in the field of engineering and in the profession of an engineer.

ii. ***Macro-Ethics:*** This approach deals with all the social problems which are unknown and suddenly burst out on a regional or national level.

So, it is necessary for an engineer to pay attention on both the approaches by having a careful study of how they affect them professionally and personally. The engineers have to tolerate themselves with the everyday problems both from personal and societal point of view.

Where and How do Moral Problems arise in Engineering?

Any product or project has to undergo various stages such as planning, idea, design, and manufacturing which is followed by testing, sales and services. This has to be done by engineers of various branches like Civil, Mechanical, Electrical, Chemical etc. These engineers may be grouped together as a team or they may be separated from each other with an interconnection or co-ordination.

Inspite of the engineers' full attention and care, sometimes the product or project may be unsafe or less useful. This may be due to some reasons 1) The product or project may be designed for early obsolescence or 2) due to under pressure because of running out of time, budgetary etc or 3) by

ignorance on the size of the project, or 4) because of the large number of a products sold on the mass market, people may be affected.

Some cases with which different areas covered by engineering ethics:

1. An inspector finds a faulty part in the manufacture of a machine, which prevents the use of that machine for a longer period. But his superior, takes this as a minor mistake and orders that the faulty part to be adjusted so that the delay in the process has to be avoided. But the inspector doesn't want this and so he is threatened by the supervisor.
2. An electronic company applies for a permit to start a Nuclear Power Plant. When the licensing authority comes for visit, they enquire the company authorities on the emergency measures that have been established for safety of the surroundings. The engineers inform them about the alarm system and arrangements have been made in local hospitals for the treatment of their employees and they have no plan for the surrounding people. They also inform that it is the responsibility of the people.
3. A Yarn Dyeing company which dumps its wastes in the nearby river. It causes heavy damage to the people those who are using the river. The plant engineers are aware of this, but they do not change the disposal method because their competitors also doing similarly as it happens to be a cheaper. They also say that it is the responsibility of the local government.

The above given examples clearly explain how the ethical problems arise most often because of wrong judgments and expectations of engineers. These necessitate for establishing some codes of conduct which has to be imposed on engineers' decisions on the basis of ethical view.

2.3 TYPES OF INQUIRY

Inquiry means an investigation. Like general ethics, Engineering ethics also involves investigations into values, meaning and facts. These inquiries in the field of Engineering ethics are of three types.

1. Normative Inquiries
2. Conceptual Inquiries
3. Factual or Descriptive Inquiries

Normative Inquiries

These inquiries are mostly helpful to identify the values which guide the individuals and groups in taking a decision. These are meant for identifying and justifying some norms and standards of morally desirable nature for guiding individuals as well as groups. In most of the cases, the normative questions are given below:

1. How do the obligations of engineers protect the public safety in given situations?
2. When should an engineer have to alarm their employers on dangerous practices?
3. Where are the laws and organizational procedures that affect engineering practice on moral issues?
4. Where are the moral rights essential for engineers to fulfill their professional obligations?
   From these questions, it is clear that normative inquiries also have the theoretical goal of justifying moral judgments.

Conceptual Inquiries

These are meant for describing the meaning of concepts, principles, and issues related to Engineering Ethics. These inquiries also explain whether the concepts and ideas are expressed by single word or by phrases. The following are some of the questions of conceptual inquiries:

1. What is the safety and how it is related to risk?
2. What does it mean when codes of ethics say engineers should protect the safety, health and welfare of the public?
3. What is a 'bribe'?
4. What is a 'profession' and 'professional'?

Factual / Descriptive Inquiries

These help to provide facts for understanding and finding solutions to value based issues. The engineer has to conduct factual inquiries by using scientific techniques. These help to provide information regarding the business realities such as engineering practice, history of engineering profession, the effectiveness of professional societies in imposing moral conduct, the procedures to be adopted when assessing risks and psychological profiles of engineers. The information about these facts provide understanding and background conditions which create moral problems. These facts are also helpful in solving moral problems by using alternative ways of solutions.

These types of inquiries are said to be complementary and interrelated. Suppose an engineer wants to tell a wrong thing in an engineering practice to his superiors, he has to undergo all these inquiries and prepare an analysis about the problem on the basis of moral values and issues attached to that wrong thing. Then only he can convince his superior. Otherwise his judgment may be neglected or rejected by his superior.

2.4 MORAL DILEMMAS

Why study engineering ethics?

Engineering ethics is not only teaching moral behaviour in knowing about immoral and amoral in a set of beliefs, but also increasing the ability of engineers and other professionals to face boldly with the moral problems arising from technological advancements, changes and other related activities. This can be possible be imparted among the engineers, only through college courses, seminars, etc. which are involved individual study.

Moral Dilemmas

Dilemmas are certain kind of situations in which a difficult choice has to be made.

Moral dilemmas can also be called **moral problems**. Moral dilemmas have two or more foldings - moral obligations, duties, rights, goods or ideals come into disagreement with each other. One moral principle can have two or more conflicting applications for a particular given situation. Moral dilemmas can be occurred in so many ways. For example, suppose one gives a promise to his friend that he will meet him on the evening of a particular day, but unfortunately on the same day his brother has met with an accident and he has to take him to hospital. The dilemma here consists of a conflict between the duty to keep promise and obligations to his brother. In this situation, to solve his moral problem, he can make a phone call to his friend and make apology for his inability to come. So, from the above it is clear that the duty to keep promise always has two different and conflicting applications.

The moral dilemmas cannot easily be addressed or resolved always. It requires an elaborate searching which sometimes causing extreme suffering and reflection of a situation. The modern engineering practice compels that all the engineers have to face boldly about the moral dilemmas in their careers.

To find a simple and clear solution to the moral problems in the field of engineering, there must be some provision to allocate time to for learning ethics in engineering courses. But at the same time, it should not be ignored in the following three categories of complex and gloomy moral situations:

The Problem of Vagueness

The problem of vagueness is related to individuals. The individuals may not know how to moral considerations or principles in resolving a moral problem at a particular situation. For example, an engineer in a higher position of a company, is responsible and having the sole right to make purchases on his own and behalf of the company. There may be many suppliers for supplying materials. In this situation, a sales representative from one of the suppliers approaches him with a moderating gift. In this case, the engineer may have some doubts like (i) Whether this is an acceptance of a bribe? (ii) Does it create a conflict of interest? The solution is only with that engineer. He can also discuss with his colleagues about the problem. The colleague may find the solution on the basis of previous experiences, - it may not be a kind of bribe, but at the same time it should not be encouraged in future because there is the possibility of supplying substandard materials. It is difficult to arrive at the conclusion whether the gift is an innocent amenity or an unacceptable bribe.

The Problems of Conflicting reasons

These occur more frequently. In a difficult situation of a moral problem, an individual may clearly know about what moral principle has to be applied to resolve the problem. When it arises, there are two or more principles with clear solutions lead into conflict with one another or one particular moral principle. Simultaneously there can be

of two different directions. In this case, that individual has to choose a better one among them on the basis of the importance and the applicability. For example, an engineer has given a promise to his employer and another one to a colleague. If it is difficult to fulfill both the promises, he can drop off one promise which is of least importance. If he explains the situations to his colleagues, it can be understood.

The Problems of disagreement

The individuals and groups in engineering companies may disagree with resolving moral problems in difficult situations. The disagreement will be normally about how to interpret, apply and balance the moral problems. In this situation they have to use the following steps to resolve the problems.

Steps / Procedures in facing / confronting moral dilemmas

All the above said three problems pave the way for the need of several steps in resolving the moral dilemmas. All the steps are interrelated and they can also be used jointly.

1) Identifying the relevant moral factors and reasons: i.e. Finding solutions for
   (i) the conflicting responsibilities (ii) the competing rights and (iii) the clashing ideals involved.

2) Collecting and gathering all the available facts which are relevant to the moral factors while resolving.
3) Ranking the moral considerations or principles on the basis of importance as applicable to the situation. But sometimes it is not possible when the objective is to find a way to meet equally urgent responsibilities and to promote equally important ideals.

4) Considering alternative courses of action for resolving the problems and tracing the full implications of each. i.e. conducting factual inquiries.
5) Having talked with the colleagues, friend about the problem getting their suggestions and alternative ideas on resolving that dilemma and
6) Arriving at a careful and reasonable judgment or solution by taking into consideration of all important moral factors and reasons on the basis of the facts or truths. But it seems to be difficult.

To conclude, only the study of Engineering Ethics can help in developing the skills and attitudes to follow the above steps in resolving a moral problem among the engineers and other professionals by means of case studies, class room discussions and debating.

2.5 MORAL AUTONOMY

Autonomy means self-governing or self-determining i.e act independently. Moral autonomy means the right or the wrong conduct which is of independent on ethical issues. It deals with the improvement of an individual's moral thoughts which make hi to adopt good habits. Moral autonomy is concerned with the independent attitude of a person related to ethical issues. It helps to improve the self-determination among the individuals.

The need for moral autonomy in the field of engineering ethics

The objectives of engineering ethics are not related to implanting particular moral beliefs on engineers. In other way they help the engineers and other professionalists to strength their professional values such as honesty, respect the colleagues and think for the welfare of the general public. Though the above said values have been already in the minds of the engineers, engineering ethics helps to improve these qualities in a better manner among the engineers, and not inculcating newly. The structural objective of engineering ethics is to be enable the individuals to understand the moral responsibilities in a clear and careful manner. So, the main aim of studying engineering ethics is to increase the moral autonomy within him.

Moral autonomy is a skill and habit of thinking ethical problems in a rational manner. These ethical issues are to be found out on the basis of moral problems. These general responsiveness of moral values are derived only from the training what we have received as a child with response to the sensitive and right of others and ourselves. Suppose the training is not given in the childhood itself, those children may be ill-treated or neglected by the society. These children in future may grow up with lack of senses on moral issues and they become as sociopaths. They are never morally autonomous. They won't regret for their mistakes and wrong doings.

These moral concerns can be initiated or imparted among the engineers, mainly engineers of various subjects and also by the way of their friends, or by social events occurring around them or by books and movies. So the main aim of all the courses of Applied Ethics is only to improve their abilities in order to face the moral issues critically. This can only be achieved by improving the practical skills which are helping in producing effective independent or self-determination thoughts among the individuals about the moral problems.

Skills for improving moral autonomy

1. The engineers must have the competence for identifying the moral problems and ethical issues related to the field of engineering – they must have the ability to distinguish and relate these moral problems with the problems of law, economics, religions principles etc. They must

possess the skills of understanding, clarifying and assessing the arguments which are against the moral issues.

2. They must have the ability to suggest the solutions to moral issues, on the basis of facts. These suggestions must be consistent and must include all the aspects of the problem.
3. They must have the imaginative skill to view the problems from all view points and also be able to suggest a proper alternative solution.
4. They must be able to tolerate while giving moral judgments and decisions which may cause trouble. i.e. they have to understand the difficulties in making moral decisions.
5. They must have adequate knowledge and understanding about the use of ethical language so as to defend or support their views with others.
6. They must have some better knowledge in understanding the importance of suggestions and better solutions while resolving moral problems and also about the importance of tolerance on some critical situations.
7. They must understand the importance of maintaining the moral honesty i.e. the personal convictions and beliefs and individual's professional life must be integrated. They must have this skill of doing so.

2.6 KOHLBERG'S THEORY

Moral Autonomy is based on the psychology of moral development. The first psychological theory was developed by Jean Piaget. On the basis of Piaget's theory, Lawrence kohlberg developed three main levels of moral development which is based on the kinds of reasoning and motivation adopted by individuals with regard to moral questions.

The Pre Conventional Level

It is nothing but self-centered attitude. In this level, right conduct is very essential for an individual which directly benefits him. According to this level, individuals are motivated by their willingness to avoid punishment, or by their desire to satisfy their own needs or by the influence of the power exerted by them. This level is related to the moral development of children and some adults who never want to go beyond a certain limit.

The Conventional Level

The level deals with the respect for conventional rules and authority. As per this level the rules and norms of one's family or group or society has been accepted as the final standard of morality. These conventions are regarded as correct, because they represent with authority. When individuals are under this level, always want to please/satisfy others and also to meet the expectations of the society and not their self-interest. Loyalty and close identification with others have been given much importance. No adult tries to go beyond this level.

The Post Conventional Level

This level is said to be attained when an individual recognizes the right and the wrong on the basis of a set of principles which governing rights and the general good which are not based on self-interest or social conventions. These individuals are called "autonomous", because they only think for themselves and also they do not agree that customs are always correct. They want to live by general principles which are universally applied to all people. They always want to maintain their moral integrity, self-respect and the respect for other autonomous peoples.

Kohlberg's theory of moral development is very much related to the goals of studying ethics at college level. To become morally responsible, an individual must be able and willing to undergo with moral reasoning. Moral responsibility comes out of the foundation of early moral training given by an

individual's parents and culture. This early training helps to complete the above said three levels of moral development by an individual.

As per Kohlberg's view only few people would reach the post conventional level which is based on assumption that movement towards autonomous is morally desirable.

2.7 GILLIGAN'S THEORY

Gilligan's argument

Caorl Gilligan was one of the students of Kohlberg. She criticizes Kohlberg's theory on the basis of approached made by both male and female towards morality. On the basis of her studies and researches, she criticizes Kohlberg's theory which is only based on male bias and his studies are of typically male preoccupation with general rules and rights.

She also suggested that men are always more interested in resolving moral dilemmas by applying some most important moral rules. But women always want to keep up the personal relationship with all those involved in a situation and they always give attention only on the circumstances responsible for that critical situation and not on general moral rules.

She also states that Kohlberg's theory is only on ethics of rules and rights. But her theory is known as ethics of care. i.e. context oriented emphasis required to maintain the personal relationship.

Levels of Moral Development

Gilligan recasts Kohlberg's three levels of moral development on the basis of her own studies of women, as follows:

The Pre-Conventional Level

This is more over the same as Kohlberg's first level i.e. Right conduct is a selfish thing as solely one what is good for oneself.

The Conventional Level

This level differs from Kohlberg's second level. According to her, women don't want to hurt others and want to help others i.e. women always want to give up their interests in order to help the others to fulfill their needs.

The Post Conventional Level

This level is also differed from Kohlberg's level. In this level, individual (particularly women) want to balance between caring about other people and their interests. The main aim here is to balance an individual's needs with those of others on the basis of mutual caring. This can be achieved only through context-oriented reasoning and not by abstract rules.

Heinz's Dilemma

Gilligan's criticism on the Kohlberg's theory can be made very clear with the help of a famous example used by Kohlberg in his questionnaires and interviews. This is called Heinz's Dilemma.

This example was about a woman and Heinz, her husband living in Europe. The woman was affected by cancer. The doctors told her to use an expensive drug to save her life. The pharmacist who also invented that medicine charged ten times the cost of making the drug. Besides his poverty, Heinz took a lot of effort to borrow money, but he could get only half of the amount needed. He approached to the pharmacist and begged him to sell the medicine at a cheaper price or allow him to pay for it later. But the pharmacist refused to do so. Finally, without any hope, Heinz forcibly entered into the pharmacy and stolen the drug. The question here is "Was the theft morally right or wrong?"

By asking this question among the male, Kohlberg has received two sets of answers: One is based on the conventional level i.e. Heinz did a wrong thing. Another one is based on the post conventional level i.e,Heinz was correct as the life of the wife is more important than the property right of the pharmacist.

But when the same question was asked among the women, they gave (all women) same answers. They replied that Heinz was wrong. They further told that instead of stealing the medicine, Heinz could have tried other alternative solutions. They also told that Heinz should have convinced still the pharmacist to get the medicine.

From the above, Kohlberg concluded that women's decisions are always based on conventional rule and they always have different opinions in applying the general moral rules and principles about the right to live.

On the basis of the Kohlberg's comment on the women, Gilligan came to a different conclusion. She tells that it shows greater sensitivity to people and personal relationships. She concluded that the decision taken by women is context-oriented and not on the basis of general rules ranked inorder of priority.

Now, the question here is, how Gilligan's theory of moral development relates to moral autonomy as a goal of studying ethics at the college level?

Autonomy requires independent reasoning on the basis of moral concern and not separated from other people. As per Gilligan's theory and Kohlberg's theory, moral autonomy should be consistent with context-oriented and also with an awareness of general moral principles and rights.

2.8 CONSENSUS AND CONTROVERSY

Consensus means 'agreement' and 'controversy' means disagreement. The consensus and the controversies are playing the vital roles while considering the moral autonomy.

When an individual exercises the moral autonomy, he cannot get the same results as others get in applying moral autonomy. Surely there must be some moral differences i.e. the results or verdicts will be of controversy. This kind of disagreements is unavoidable. These disagreements require some tolerances among individuals those who are autonomous, reasonable and responsible.

As per the principle of tolerance, the goal of teaching engineering ethics is not merely producing an agreed conformity on applying moral principles among engineers but also to reveal the ways of promoting tolerances to apply moral autonomy.

Both the goals of engineering ethics and the goals of engineering courses have some similarities. These similarities have to be extended with the help of exercising authority. For example, in the class room, the teachers are having the authority over students and in the work place, the managers are having the authority over engineers.

There are two general points regarding the relationship between autonomy and authority with reference to the class room:

1) Moral autonomy and respect for the authority cannot be differentiated or separated from each other. Moral autonomy is exercised on the basis of moral concern for other people and also recognition of good moral reasons. Authority provides for the framework in which learning can

take place. It is based on the acceptance of authority by both the students and the professors. Without this acceptance, the classes cannot be conducted in a smooth way. On the other hand, cheating will be encouraged and the trust between faculty and the students may be reduced to some extent. These kind of deviations are due to the absence of moral views and respect for authority. They must be coincide with each other.

2) Generally a tension may arise among the individuals regarding the need for consensus about authority and need for autonomy. This tension can be reduced by discussing openly regarding a moral issue between students and faculty with the help of the authority.

In short, conflicts will arise between autonomy and authority, when the authority is misused. For example, in small classes, the students are having the authority to express their own views. But when the professor doesn't allow them to do so, he misuses his authority. This will create some moral problems between the students and the faculty.

2.9 MODELS OF PROFESSIONAL ROLES

The main aim of the profession of engineering is to improve the public safety, wealth and welfare. In order to perform these functions, the engineer has to play various models to channalise his attitudes towards the achievements of objectives. They are as follows:

1. ***Savior***

   The engineers are responsible for creating an utopian society in which everything is possible and can be achieved without much effort – This can only be achieved through technological developments made by the engineers for safe-guarding the society from poverty, inefficiency, waste and manual labour.

2. ***Guardian***

   Engineers only know the directions through which technology will be developed. So, they should be given position of high authority based on their expertise skills in determining what is in the best interests of the society.
   They should act as guardians to the technological improvements.

3. ***Bureaucratic Servant***

   Engineer's role in the management is to be the servant who receives and translates the directive of management into better achievements. They have to solve the problems given by the management, within the limits set by the management.

4. ***Social Servant***

   The role of engineers is not only providing service to others but also their responsibility to the society. The interests of the society can be expressed to the engineers either directly or indirectly. So, the engineers, with the co-operation of the management have the work of receiving society's directives and satisfying the desires of the society.

5. ***Social enabler and Catalyst***

   The engineer has to play a role of creating a better society and should be the cause of making social changes. Service given by the engineers to the society includes carrying out the social directives. Engineers are needed to help the management and the society to understand their needs and to create decisions about technological development.

6. ***Game Player***

   We cannot say that engineers are servants or masters of anyone. They are playing the economic game rules which may be effective at a given time. Their aim is to play successfully within the organization enjoying the happiness of technological work and the satisfaction of winning and moving ahead in a completive world.

2.10 THEORIES ABOUT RIGHT ACTION

There are four types of theories on ethics, which help to create the fundamental principles of obligation suitable and applicable to professional and personal conduct of a person in his everyday life. These theories are essential for cause of right action and morality. They are:

1. ***"Golden mean"*** ethics (Aristotle, 384 – 322 B.C.). The best solution is achieved through reason and logic and is a compromise or "golden mean" between extremes of excess and deficiency. For example, in the case of the environment, the golden mean between the extremes of neglect and exploitation might be protection.
   Problem: Variability from one person to another in their powers of reasoning and the difficulty in applying the theory to ethical problems.

2. ***"Rights – based"*** ethics (John Locke, 1632 – 1704). Every person is free and equal and has the right to life, health, liberty and possessions (in effect prohibiting capital punishment, medical charges, jails and income taxes).
   Problem: One person's right may be in conflict with another's rights.

3. ***"Duty – based"*** ethics (Immanual Kant, 1724 – 1804). Each person has a duty to follow a course of action that would be universally acceptable for everyone to follow without exception. (Thus we would all be honest, kind, generous and peaceful).
   Problem: Universal application of a rule can be harmful.

4. ***"Utilitarian"*** ethics (John Stuart Mill, 1806 – 1873). The best choice is that which produces the maximum benefit for the greatest number of people (which could endanger minority rights).
   Problem: Qualification of the benefits can be difficult.

All these theories can be differentiated on the basis of what they provide for moral concept, good results for all, duties and human rights.

2.11 SELF – INTEREST, CUSTOMS AND RELIGION

Moral justifications and principles form a distinct category of value, which are different from other category of values. This can be more clear by relating and contrasting moral values to three other types of values namely self-interest, customs and religion. Focus must be made in each case, how we can reduce morality to these types of value.

Self –Interest and Ethical Egoism

Self-interest is nothing but one's personal good. It refers to the goodness of oneself in the long run.

Each of the ethical theories recognizes the importance of self-respect. Utilitarian considers one's own good as well as the good of others. Duty ethicists stresses duties to ourselves and for won well-being. Ethicists of rights emphasize our rights to pursue our own good. Virtue ethicists accent the importance of self – respect.

Each of these theories insists that the pursuit of self – interest must be balanced and kept under control by moral responsibilities to other people. Now let us consider a view called "ethical Egoism" which challenges all the ethical theories and it tries to reduce morality to the pursuit of self-interest. It is called 'egoism', because it says that the main duty of us is to maximize our own good. According to Thomas Hobbes and Any Rand, moral values are reduced to concern for oneself but always a rational concern which requires consideration of a person's long-term interests.

The Supporters of ethical egoism make a differentiation between narrower and wider forms of self-interest. When a person who selfishly preoccupies his own private good and disregard for the good of others, will be off from rewarding friendships and love. Personal well-being generally requires taking some large interest in others. But the rational egoist insists that the only reason for showing an interest in others is for the sake of oneself.

Ethical Egoists try to protect their positions by arguing that an ironic importance of everyone rationally pursuing one's self-interest is that every one get benefited. The society benefits mostly when individuals pursue their private good and corporations pursue maximum profits in a competitive free market. The main idea here is that leads to the improvement of economy through which benefiting everyone.

Because, both the individual and the corporation know very well that what is good for them and how best to pursue that good.

As per ethical egoism, people should always and only pursue their self – interest in a very cautious manner to value the interest rationally on the basis of facts.

Morality essentially needs a willingness on the part of both individuals and corporations to place some restrictions on the pursuit of private self – interests. Accepting these constraints is presupposed in what is meant by moral concern Engineering Ethics also has one task of exhibiting the moral limits on the pursuit of self interest in the Engineering profession.

The above said remarks do not constitute a wrong proof for ethical egoism.
Morality stresses that we have to give value and we are concerned for the good of other people. Ethical egoism is not a persuasive or probable theory to state what is morality but it is only a convinced rejection of morality.

Customs and Ethical Relativism

As we live in a society which is of increasingly diverse nature, it is more important to have tolerance for various customs and outlooks. Hence the concept of ethical pluralism emerges. It views that there may be alternative moral attitudes that are reasonable. But none of the moral perspectives can be accepted completely by all the rational and the morally concerned persons. Ethical pluralism allows the customs which plays an important role in deciding how we should act. Moral values are many, varied and flexible. So, these moral values allow considerable variation in how different individuals and groups understand and apply them in their day-today activities. In other words, to be precise, reasonable persons always have reasonable disagreement on moral issues, including issues in engineering ethics.

Ethical Relativism, an objectionable view, should not be confused with Ethical Pluralism. As per Ethical relativism says that actions are morally right when they are approved by law or custom and they are said to be wrong when they violate laws or customs. Ethical relativism tries to reduce moral values to laws, conventions and customs of societies.

What is the necessary for a person to accept ethical relativism? There are so many reasons for accepting ethical relativism –

I. The laws and customs seem to be definite, real and clear – cut. They help to reduce the endless disputes about right and wrong. Moreover, laws seem to be an objective way to approach values. The above argument is some what weak. This reason underestimates the extent to which ordinary moral reasons are sufficiently objective to make possible criticism of individual prejudice and bias. Moreover, moral reasons allow objective criticism of the given laws as

morally inadequate. For example, the apartheid laws (racial segregation) in south Africa. This law violated the human rights are not given any legal protections to the majority of the blacks, but morally ought to be.

II. The second reason for accepting ethical relativism is because it believes the values are subjective at the cultural level. They also state that the moral standards are varied from one culture to another. The only kind of objectivity is relative to a given set of laws in a given society. This relativity of morality encourages the virtue of tolerance of difference among societies.

The above said argument is also confusing one. It assumes that ethical relativism is implied by descriptive relativism. i.e., values and beliefs differ from culture to culture. There is nothing self-certifying about the laws and beliefs. This can be explained by the following illustration. Ethical relativism would allow that Hitler and his followers (Nazis) acted correctly when they killed 6 million Jews, for their laws, customs, and beliefs which were based on anti – Semitism (hostile to Jews).

So, ethical relativism refers anything but for the tolerant doctrine it pretends to be. But there is nothing tolerant in accepting Nazi beliefs about morality Admitting intolerant anti-semitic beliefs is not an act of tolerance.

The supporters of ethical relativism, generally say that an action is right "for cultures" when believe it as the right one.i.e., it is right "for them" though not "for us". So, beliefs, however customary or widely shared, are not self-certifying whether we are talking about moral beliefs or scientific beliefs.

The third reason is based on the moral relationalism or moral contextulaism. This states that moral judgments must be made in relation to some factors which varies from case to case. Making simple and absolute rules are impossible in this way. In most of the cases, customs and laws are considered as morally important factors for making judgments. All philosophers accepted this moral relationalism. But contemporary duty and right ethicists like 'Kant' do not accept. As per their views, respecting people require some sensitiveness to special circumstances. The virtue ethicists stress the role of practical wisdom in identifying the facts which are relevant to assessment of conduct based on virtual manner.

The ethical relativism was accepted by early cultural anthropologists because they had a specified tendency to overstress the scope of moral difference between cultures. Absorbed with unusual practices such as head – hunting, human sacrifices and cannibolism (cannibal is a person who eats human flesh); these persons who shifted their idea quickly form moral views differ greatly to "Morality is a simply a culture as such". But modern anthropologists states that all cultures by virtual show some commitment to promote social co-operation and protect their members against needless death and suffering. Moral differences are based only on the circumstances and facts, not on the difference in moral attitudes. For example, we can consider the practice of human sacrifice in the Aztecs. [Members of a former Indian people who ruled Mexico before the 16th century]. This practice seems to be a sign of cruelty an lack of concern for life. But a full examination of their beliefs reveal that they believed their gods are pleased by such sacrifice to ensure the survival of their people and also it was considered an honour for the victims. Refer to the sacrifice or placing chicken and goal to god.

Religion and Divine Command Ethics

Moral responsibilities and religious belief are interwined in many positive ways. First, they are related historically. Our moral views have been shaped by the most known central moral values within the major world religions. For example, the Judeo-Christian tradition has been influential in Western countries like England, USA etc. Islam has been having a great influence in middle east countries such

as Saudi Arabia, Kuwait, Pakistan etc. Confucianism has been influential in China and Buddhism, Hinduism and Taoism have been famous in Asian countries.

Second, most of the people still having beliefs and show some important and inevitable psychological connections between their moral and religious beliefs. Religious views frequently support moral responsibility by providing additional motivation for being moral. Faith in Religions or religious hopes imply trust. This trust gives an inspiration to be moral.

The main social functions of religion is motivating right action based on ethical principles. Religion supports many people to follow their beliefs and promote tolerance and moral concern for others. Many of the engineers are motivated by the religious beliefs. Thirdly, religions form a set of higher moral standards. For example, Christianity suggests for loving neighbors. Many religions include virtue ethics that stresses about particular virtues.

For example, the ethics if Christianity focuses in the virtue of hope, faith and love. Buddhism emphasizes a feeling of pity (compassion). Islam pressures "insane" (being religious and pursuit of excellence).

Sometimes, religious set standards below the level of acceptable moral standards. Some religions do not give equal rights to women, as in Islam (particularly in Iran, Iraq). In this situation the conflict is not only between secular morality and religion but also among other religions. By giving stress on the positive connections between secular morality and religion, we go for defining Divine Command ethics. It views that right action is defined by the commands of God, and without a belief in God there could be no moral values and if an action is said to be wrong, it means that it is forbidden by God.

The Major difficulties in Divine Command ethics are: how to know what God's commands are and whether God exists or not. Judaism, Christianity, Islam and Hinduism are mostly God-centered i.e., they believe in God. But some other religions such as Buddhism, Taoism and Confucianism calls for only faith in a right path from which code of ethics can be derived. For example in Buddhism the right path included eight steps such as ***right understanding, right intention, right , intention, right action, right livelihood, right effort, right mindfulness and right concentration.***

Divine Command ethics has things backwards. A morally divine being commands on the basis of moral reasons which determines the wrongness of actions and rightness of other actions. Moral reasons are presupposed as the foundation for making certain commands. Moral reasons can not force hard to religious matters. Religious beliefs provides an added inspiration for responding to moral reasons.

2.12 USES OF ETHICAL THEORIES

Ethical theories have so many uses. Out of them, the following three are the most important uses:

- ✓ Understanding moral dilemmas.
- ✓ Justifying professional obligations and ideas and
- ✓ Relating ordinary and professional morality

UNIT – III

ENGINEERING AS SOCIAL EXPERIMENTATION

Syllabus: Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics- A Balanced Outlook on Law.

3.1 ENGINEERING AS EXPERIMENATATION

Experimentation plays an important role in the process of designing the product. When it is decided to change a new engineering concept into its first rough design, preliminary tests or simulation should be conducted. Using formal experimental methods, the materials and methods of designing are tried out. These tests may be based on more detailed designs. The test for designing should be evolved till the final product produced. With the help of feedback of several tests, further modification can be made if necessary. Beyond these tests and experiments, each engineering project has to be viewed as an experiment.

Similarities to Standard Experiments

There are so many aspects, which are of virtual for combining every type of engineering works to make it suitable to look at engineering projects as experiments. The main three important aspects are:

i) Any engineering project or plan is put into practice with partial ignorance because while designing a model there are several uncertainities occurred. The reason to the fact that engineers don't have all the needed facts available well in advance before starting the project. At some point, both the theoretical examining and the laboratory testing must be by-passed for the sake of completing the project. Really, the success of an engineer is based on the his talent which is exactly being the ability to succeed in achieving jobs with only a partial knowledge of scientific laws about the nature and society.

ii) The final outcomes of engineering projects are generally uncertain like that of experiments what we do.
In engineering, in most of the cases, the possible outcomes may not be known and even small and mild projects itself involve greater risks.

The following uncertainities occur in the model designs:

1. Model used for the design calculations
2. Exact characteristics of the material purchased.
3. Constancies of materials used for processing and fabrication.
4. About the nature of the pressure the finished product will encounter.

For instance, a reservoir may cause damage to the surroundings and affect the eco- system. If it leaks or breaks, the purpose will not be served. A special purpose fingerprint reader may find its application in the identification and close observation on the disagreeing persons with the government. A nuclear reactor may cause unexpected problems to the surrounding population leading to a great loss to the owners. A hair dryer may give damage to the unknowing or wrong users from asbestos insulation from its barrel.

iii) Good and effective engineering depends upon the knowledge possessed about the products at the initial and end stages.

This knowledge is very useful for increasing the effectiveness of the current products as well as for producing better products in future. This can be achieved by keenly observing on the engineering jobs by the way of experimentation. This monitoring is done by making periodic observations and tests by looking at for the successful performance and the side effects of the jobs. The tests of the product's efficiency, safety, cost-effectiveness, environmental impact and its value that depends upon the utility to the society should also be monitored. It also extends to the stage of client use.

Learning from the past

It has been expected that the engineers have to learn not only form their own design and the production system but also the results of others. Due to lack of communication, prejudiced in not asking for clarification, fear of law and also mere negligence, these things can happen to the continuation of past mistakes. The following are some of the examples:

1. The tragedy of 'Titanic' happened because of the sufficient number of life boats. The same disaster took place in the steamship "the Arctic" some years before, because of the same problem.

2. The fall down of "the Sunshine Skyline Bridge" in the bay of Thamba at Sweden in 1980, on a moving ship due to improper matching of horizontal impact forces in mind. This could have been avoided of the engineers had known about the striking of the ships with the Maracaibo Bridge at Venezulea in 1964 and the Tasman Bridge of Australia in 1975.

3. The nuclear reactor accident at Three Mile Island on March 1979, was due to malfunctioning of the valves. Valves though minute items, are being among the least reliable components of hydraulic systems. It was a pressure relief valve and lack of information about its opening or closing state contributed to a nuclear reactor accident at Three Mile Island. This malfunction was already happened because of the same reasons at other locations.

4. The disaster of Tettron Dam in Los Angles was due to rapid flow of water and sudden break down. The builder didn't consider the case of the Fontenelle Dam, which was also collapsed due to the same problem.

So, to say that engineers should not fully depend on handbooks and they should have some review of the past cases relating to their current task.

Comparisons with standard Experiments

Engineering is entirely different from standard experiments in few aspects. Those differences are very much helpful to find out the special responsibilities of engineers and also help them in knowing about the moral irresponsibilities which are involved in engineering.

1. Experimental Control

Members for two groups should be selected in a standard experimental control, i.e Group A and Group B. The members of the group 'A' should be given the special experimental treatment. The group 'B' do not receive the same though they are in the same environment. This group is called the ***'control group'***

Though it is not possible in engineering but for the projects which are confirmed to laboratory experiments. Because, in engineering the experimental subjects are human beings who are out of the control of the experimenters. In engineering, the consumers have more control as they are the selecting authority of a project. So in engineering it is impossible to follow a random selection. An engineer has

to work only with the past data available with various groups who use the products.So engineering can be viewed as a natural experiment which uses human subjects. But today, most of the engineers do not care for the above said Experimental Control.

2. Informed Consent

Engineering is closely related to the medical testing of new drugs and techniques on human beings as it also concerned with human beings.

When new medicines have been tested, it should be informed to the persons who undergo the test. They have moral and legal rights to know about the fact which is based on **"informed consent"** before take part in the experiment. Engineering must also recognize these rights. When a producer sells a new product to a firm which has its own engineering staff, generally there will be an agreement regarding the risks and benefits form that testing.

Informed consent has two main principles such as knowledge and voluntariness:

First, the persons who are put under the experiment has to be given all the needed information to make an appropriate decision. Second, they must enter into the experiment without any force, fraud and deception. The experimenter has also to consider the fundamental rights of the minorities and the compensation for the harmful effects of that experiment.

In both medicine and engineering there may be a large gap between the experimenter and his knowledge on the difficulties of an experiment. This gap can be filled only when it is possible to give all the relevant information needed for drawing a responsible decision on whether to participate in the experiment or not.

In medicine, before prescribing a medicine to the patient, a responsible physician must search for relevant information on the side effects of the drug. The hospital management must allow him to undergo different treatments to different patients and finally the patient must be ready to receive that information from the physician. Similarly it is possible for an engineer to give relevant information about a product only when there is a better co-operation by the management and quick acceptance from the customers.

The following conditions are essential for a valid informed consent

a. The consent must be given voluntarily and not by any force.
b. The consent must be based on the relevant information needed by a rational person and should be presented in a clear and easily understandable form.
c. The consenter must be capable of processing the information and to make rational decisions in a quick manner.
d. The information needed by a rational person must be stated in a form to understand without any difficulty and has to be spread widely.
e. The experimenter's consent has to be offered in absentia of the experimenter by a group which represents many experiments.

Knowledge Gained

Scientific experiments have been conducted to acquire new knowledge. Whereas engineering projects are conducted as experiments not for getting new knowledge. Suppose the outcomes of the experiment is best, it tells us nothing new, but merely affirms that we are right about something. Mean while, the unexpected outcomes put us search for new knowledge.

3.2 ENGINEERS AS RESPONSIBLE EXPERIMENTERS

The engineers have so many responsibilities for serving the society

1. Having a clear awareness of the experimental nature of any project, thoughtful forecasting of its possible side effects, and an effort to monitor them reasonably. [A comprehensive perspective or relative information].
2. Unrestricted free personal involvement in all the steps of a project. [Autonomy]
3. Being accountable for the results of a project [Accountability]
4. Exhibiting their technical competence and other characteristics of professionalism.

Conscientiousness

Conscientiousness implies consciousness (sense of awareness). As holding the responsible profession with maintaining full range moral ethics and values which are relevant to the situation. In order to understand the given situation, its implications, know- how, person who is involved or affected, Engineers should have open eyes, open ears and open mind.

The present working environment of engineers, narrow down their moral vision fully with the obligations accompanied with the status of the employee. More number of engineers are only salaried employees, so, they have to work within large bureaucracies under great pressure to work smoothly within the company. They have to give importance only to the obligations of their employers. Gradually, the small negative duties such as not altering data by fraud, not violating patent right and not breaking confidentiality, may be viewed as the full extent of moral desire.

As mentioned, engineering as social experimentation brings into light not only to the person concerned but also to the public engineers as guardians of the public interest i.e., to safeguard the welfare and safety of those affected by the engineering projects. This view helps to ensure that this safety and welfare will not be affected by the search for new knowledge, the hurry to get profits, a small and narrow follow up of rules or a concern over benefits for the many and ignoring the harm to the few.

The social experimentation that involved in engineering should be restricted by the participants consent.

Relevant Information

Without relevant factual information, conscientious is not possible. For showing moral concern there should be an obligation to obtain and assess properly all the available information related to the fulfillment of one's moral obligations. This can be explained as:

1) To understand and grasp the circumstance of a person′s work, it is necessary to know about how that work has a moral importance. For example, A person is trying to design a good heat exchanger. There is nothing wrong in that. But at the same time, if he forgets the fact that the heat exchanger will be used in the manufacture of an illegal product, then he is said to be showing a lack of moral concern. So a person must be aware of the wider implication of his work that makes participation in a project.
2) Blurring the circumstance of a person′s work derived from his specialization and division of labour is to put the responsibilities on someone else in the organization. For example if a company produces items which are out of fashion or the items which promotes unnecessary energy wastage, then it is easy to blame sales department.

The above said means, neglecting the importance of a person's works also makes it difficult in acquiring a full perspective along a second feature of factual information i.e., consequence of what one does.

So, while giving regard to engineering as social experimentation, points out the importance of circumstances of a work and also encourage the engineers to view his specialized activities in a project as a part of a large social impact.

Moral Autonomy

This refers to the personal involvement in one's activities. People are morally autonomous only when their moral conduct and principles of actions are their own i.e., genuine in one's commitment to moral values.

Moral beliefs and attitudes must be integrated into an individual's personality which leads to a committed action. They cannot be agreed formally and adhered to merely verbally. So, the individual principles are not passively absorbed from others. When he is morally autonomous and also his actions are not separated from himself.

When engineering have seen as a social experimentation, it helps to keep a sense of autonomous participation in a person's work. An engineer, as an experimenter, is undergoing training which helps to form his identity as a professional. It also results in unexpected consequence which helps to inspire a critical and questioning attitudes about the current economic and safety standards. This also motivates a greater sense of personal involvement in a person's work.

Accountability

The people those who feel their responsibility, always accept moral responsibilities for their actions. It is known as accountable. In short, 'accountable' means being culpable and hold responsible for faults. In general and to be proper, it means the general tendency of being willing to consider one's actions to moral examinations and be open and respond to the assessment of others. It comprises a desire to present morally convincing reasons for one's conduct when called upon in specific circumstances.

The separation of causal influence and moral accountability is more common in all business and professions and also in engineering. These differences arising from several features of modern engineering practices are as follows:

1. Large – scale engineering projects always involve division of work. For each and every piece of work, every person contributes a small portion of their work towards the completion of the project. The final output us transmitted from one's immediate work place to another causing a decrease in personal accountability.
2. Due to the fragmentation of work, the accountability will spread widely within an organization. The personal accountability will spread over on the basis of hierarchies of authority.
3. There is always a pressure to move on to a different project before finishing the current one. This always leads to a sense of being accountable only for fulfilling the schedules.
4. There is always a weaker pre-occupation with legalities. In other words this refers to a way a moral involvement beyond the laid down institutional role. To conclude, engineers are being always blamed for all the harmful side effects of their projects. Engineers cannot separate themselves from personal responsibilities for their work.

3.3 CODE OF ETHICS

The codes of ethics have to be adopted by engineering societies as well as by engineers. These codes exhibit the rights, duties, and obligations of the members of a profession. Codes are the set of laws and standards.

A code of ethics provides a framework for ethical judgment for a professional. A code cannot be said as totally comprehensive and cover all ethical situations that an engineer has to face. It serves only as a starting point for ethical decision-making. A code expresses the circumstances to ethical conduct shared by the members of a profession. It is also to be noted that ethical codes do not establish the new ethical principles. They repeat only the principles and standards that are already accepted as responsible engineering practice. A code defines the roles and responsibilities of professionals.

Roles of codes and its functions

1. **Inspiration and Guidance**

   Codes give a convinced motivation for ethical conduct and provide a helpful guidance for achieving the obligations of engineers in their work. Codes contribute mostly general guidance as they have to be brief. Specific directions may also be given to apply the code in morally good ways. The following engineering societies have published codes of ethics.

   AAES - American Association of Engineering Societies
   ABET - Accreditation Board for Engineering and Technology (USA)
   NSPE - National Society of Professional Engineer (USA)
   IEEE - Institute of Electrical and Electronics Engineering (USA)
   AICTE - All India Council for Technical Education (India)

Most of the technological companies have established their own codes such as pentagon (USA), Microsoft etc. These codes are very much helpful to strengthen the moral issues on the work of an engineer.

2. **Support**

   Codes always support an engineer who follows the ethical principles. Codes give engineers a positive, a possible good support for standing on moral issues. Codes also serve as a legal support for engineers.

3. **Deterrence and Discipline**

   Codes act as a deterrent because they never encourage to act immorally. They also provide discipline among the Engineers to act morally on the basis of codes does not overrule the rights of those being investigated.

4. **Education and Mutual Understanding**

   Codes have to be circulated and approved officially by the professionals, the public and government organizations which concern with the moral responsibilities of engineers and organizations.

5. **Contributing to the profession's Public Image**

   Codes help to create a good image to the public of an ethically committed profession. It helps the engineers in an effective manner to serve the public. They also gives self-regulation for the profession itself.

6. **Protecting the Status Quo**

   Codes determine ethical conventions which help to create an agreed upon minimum level of ethical conduct. But they can also suppress the disagreement within the profession.

7. **Promoting Business Interests**

   Codes help to improve the business interests. They help to moralize the business dealings to benefit those within the profession.

Limitations of Codes

1. Codes are restricted to general and vague wordings. Due to this limitation they cannot be applicable to all situations directly. It is also impossible to analyze fully and predict the full range of moral problems that arises in a complex profession.
2. Engineering codes often have internal conflicts. So they can't give a solution or method for resolving the conflict.
3. They cannot be treated as the final moral authority for any professional conduct.

   Codes represent a compromise between differing judgments and also developed among heated committee disagreements.
4. Only a few practicing engineers are the members of Professional Societies and so they can not be compelled to abide by their codes.
5. Many engineers who are the members of Professional Societies are not aware of the existence of the codes of their societies and they never go through it.
6. Codes can be reproduced in a very rapid manner.
7. Codes are said to be coercive i.e., implemented by threat or force.

3.4 A BALANCED OUTLOOK ON LAW

A balanced outlook on laws stresses the necessity of laws and regulations and their limitations in directing engineering practice.

In order to live, work and play together in harmony as a society, there must be a balance between individual needs and desires against collective needs and desires. Only ethical conduct can provide such a balance. This ethical conduct can be applied only with the help of laws. Laws are important as the people are not fully responsible and because of the competitive nature of the free enterprise system which does not encourage moral initiative.

The model of engineering as social experimentation allows for the importance of clear laws to be effectively enforced.

Engineers ought to play an effective role in promoting or changing enforceable rules of engineering as well as in enforcing them. So the codes must be enforced with the help of laws. The following are the two best examples.

1. **Babylon's Building Code: (1758 B.C.)**

   This code was made by Hammurabi, king of Babylon. He formed a code for builders of his time and all the builders were forced to follow the code by law. He ordered

   "If a builder has built a house for a man and has not made his work sound, and the house which he has built was fallen down and so caused the death of the householder, that builder shall be put to death. If it causes the death of the house holder's son, they shall put that builder's son to death. If it causes the death of the house holder's slave, he shall give slave to the householder. If it destroys property he shall replace anything it has destroyed; and because he has not made the house sound which he has built and it has fallen down, he shall rebuild the house which has fallen down from his own property. If a builder has built a house for a man and does not make his work perfect and the wall bulges, that builder shall put that wall in to sound condition at his own cost".

The above portion of Babylon's building code was respected duly. But the aspects find only little approval today. This code gives a powerful incentive for self- regulation.

2. The United States Steamboat Code: [1852 A.D]

Steam engines in the past were very large and heavy. James Watt, Oliver Evans and Richard Trevethik modified the old steam engines by removing condensers and made them compact. Beyond careful calculations and guidelines, explosions of boiler happened on steam boats, because of the high speed of the boats. The safety valves were unable to keep steam pressure up causing explosion. During that period in 18th century, more than 2500 people were killed and 2000 people were injured because of the explosion of boilers in steam boats.

Due to this, the ruling congress in USA passed a law which provided for inspection of the safety aspects of ships and their boilers and engines. But his law turned out to be ineffective due to the corruptions of the inspectors and also their inadequate training regarding the safety checking. Then Alfred Guthiro, an engineer of Illinoise had inspected about 200 steam boats on his own cost and found out the reasons for the boiler explosions and made a report. His recommendations were published by a Senator Shields of Illinoise and incorporated in senate documents. With the help of this, another law was passed. Now it is in the hands of the American Society of Mechanical Engineers who formulated the standards for producing steam boats.

THE CHALLENGER CASE STUDY

The world has known about many number of accidents. Among them the explosion of the space shuttle 'Challenger' is the very familiar one. In those days this case had been reviewed vigorously by media coverage, government reports and transcripts of hearings. This case deals with many ethical issues which engineers faced. It poses many questions before us. What is the exact role of the engineer when safety issues are concern? Who should have the ultimate authority for decision making to order for a launch? Whether the ordering of a launch be an engineering or a managerial decision?

Challenger space shuttle was designed to be a reusable one. The shuttle mainly consisted of an orbiter, two solid propellant boosters and a single liquid-propeller booster. All the boosters was ignited and the orbiter was lifted out the earth. The solid rocket booster was of reusable type. The liquid propellant booster was used to finish the lifting of the shuttle in to the orbit. This was only a part of the shuttle which has been reused.

The accident took place on 28th January 1986, due to the failure of one of the solid boosters. In the design of the space shuttle, the main parts which needed careful design of the fields joints where the individual cylinders were placed together. The assembly mainly consists of tang and clevis joints which are sealed by two O-rings made up of synthetic rubber only, not specifically hat resistant. The function of the O-rings are to prevent the combustion gases of the solid propellant from escaping. The O-rings were eroded by hot gases, but this was not a serious problem, as the solid rocket boosters were only for reuse initially for the few minutes of the flight. If the erosion of the O-rings could be in a controlled mannaer, and they would not completely burnt through, then the design of the joint would be acceptable, however the design of the O-rings in this shuttle was not so.

In the post flight experiment in 1985, the Thiokol engineers noticed black soot and grease on

the outside of the boosters due to leak of hot gases blown through the O-rings. This raised a doubt on the resiliency of the materials used for the O-rings. Thiokol engineers redesigned the rings with steel billets to withstand the hot gases. But unfortunately this new design was not ready by that time of flight in 1986.

Before launching, it was necessary to discuss the political environment under which NASA was operating at that time. Because the budget of NASA has decided by Congress. These factors played the main cause for unavoidable delay in the decision to be taken for the shuttle performance, the pressures placed for urgency in launching in 1986 itself, before the launch of RUSSIAN probe to prove to the congress that the program was on processing. The launching date had already been postponed for the availability of vice president GEORGE BUSH, the space NASA supporter. Later further delayed due to a problem in micro switch in the hatch-locking mechanism. The cold weather problem and long discussions went on among the engineers. The number of tele-conferences further delayed the previous testing in 1985 itself. The lowest temperature was 53°F but O-ring temperature during the proposed launch period happened to be only 29 ^{o}F, which was far below the environment temperature at which NASA had the previous trail. Somehow, the major factor that made the revised final decision was that previous trial. Somehow, the major factor that made the revised final decision was that with the available data at that time there seemed to be no correlation between the temperature and the degree at which O-rings had eroded by the blow-by gas in the previous launch. Assuming a safety concern due to cold weather, though the data were not concluded satisfactorily, a decision was taken not to delay further for so many reasons, and the launch was finally recommended.

But unexpectedly the overnight temperature at the time of launch was 8 ^{o}F colder than ever experienced. It was estimated that the temperature of the right hand booster would be only at 28 ^{o}F. The camera noticed a puff of smoke coming out from the field joints as soon as the boosters were ignited. But the O-rings were not positioned properly on their seats due to extreme cold temperature. The putty used as heat resistant material was also too cold that it failed to protect the O-rings. All these effects made the hot gases to burn past both the O- rings, leading to a blow-by over an arc around the O-rings. Though immediately further sealing was made by the by-products of combustion in the rocket propulsion, a glassy oxide formed on the joints. The oxides which were temporarily sealing the field joints at high temperature, later were shattered by the stresses caused by the wind. Again the joints were opened and the hot gases escaped from the solid boosters. But the boosters were attached to the large liquid fuel boosters as per the design. This made the flames due to blow-by from the solid fuel boosters quickly to burn through the external tank. This led to the ignition of the liquid propellant making the shuttle exploded.

Later the accident was reviewed and investigations were carried out by the number of committees involved and by various government bodies. President Regan appointed a commission called Rogers Commission which constituted many distinguished scientists and engineers. The eminent scientists in the commission after thorough examination and investigations gave a report on the flexibility of the material and proved that the resiliency of the material was not sufficient and drastically reduced during the cold launch.

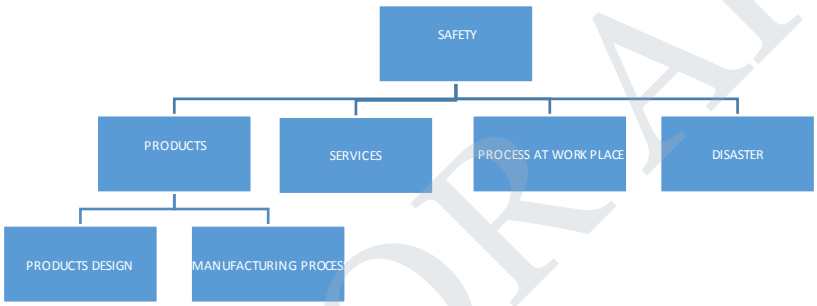
UNIT IV
SAFETY, RESPONSIBILITIES AND RIGHTS

Syllabus: Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk -Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

4.1.1 Safety:

A thing is safe, if were its risks fully known and their risks could be judged acceptable in the light of settled value principles. More fully, a thing is safe with respect to a given person or group at a given time if, were they fully aware of its risks and expressing their most settled values, they would judge those risks to be acceptable.

If people know the risks, and were biasing their judgments on their most settled values. safety is relative term 'fairly safe' or highly safe. A comparison gives us this. Air travel is fairly safe with less number of accidents. But this is highly safe if there were no accident in the past year. Hence the perception safe is based only on past experience and data.



Safety for engineers means safety operation of system and the prevention of either human caused or process caused disasters.

Product Safety:

Engineers will have to design the product to reduce accidents and ease of operation for the consumers.

Ex: The electrical appliances should be inter locked,

Ex: isolator with earth switch. Products should be tested before marketing, If marketed with out proper testing for safety cause accidents. No compromise in safety quality standard.

Services:

Engineers to educate and train the consumers of handling of the product including pre sales and post sales services. During repair, original spares to be used and avoid spurious spares.

Process at work place:

Shop floors are to be kept clean and not oily and slippery. The process should be designed in such a way that mal-functions are avoided; short term and long term safety should be considered.

Disasters: Engineers should plan for disaster management. Proper training and education to users in the event of disaster is a must. In the Titanic disaster there were insufficient boats to save all. The captain was not been trained to handle the disaster management.

4.1.2 Risks:

Absolute safety is what every one wants. But it is neither attainable nor affordable. A thing is safe if its risks are judged to be acceptable. Risk is key element in engineering design. Risk is said to be the potential that some thing unwanted and harmful may occur. Bodily harm, loss of property , environmental degradation are side effects of risks. Risk can be viewed as danger. Hence safety means free from injury, damage or risk.

Safety and risk are subjective. It depends on many factors. Risks can be classified as personal risk and public risk.

Personal risk is the risk taken by individuals.

Public risk is the risk to the society.

Ex: Nuclear disasters.

Personal risk can be classified into voluntary and involuntary risk.

Voluntary risk is knowingly taking a risk.

Ex: purchasing a plot near a factory which is emitting toxic wastes. If a person is living near an industry prior to industry may not accept the level of pollution. This is involuntary risk.

A risk is acceptable when those affected are generally no longer apprehensive about it.

Doubtfulness depends mainly on how people take the risk or how people perceive it. Some feel pride in taking risk. Ex: Car race, driving motor at neck brake speed. They know fully well the risk. Such thing may cause short term and long term disabilities.

Short term and long term Consequences:

Some feel that short lived illness or disability seems safer than the result in permanent disability. Ex: Fracture of leg compared with break in spinal cord.

Expected probability:

Many feel that one in hundred thousand chances of a severe injury to be acceptable risk whereas fifty : fifty chances of fairly minor injury as not acceptable.

Ex: Swimming in beach, where there are lot of jelly fish would be unacceptable to many whereas, the risk of shark attack is low enough that it does not deter anyone from swimming.

Reversible effect:

Something will be seeing less risky if the bad effects are reversible. This is similar to short term and long term risk.

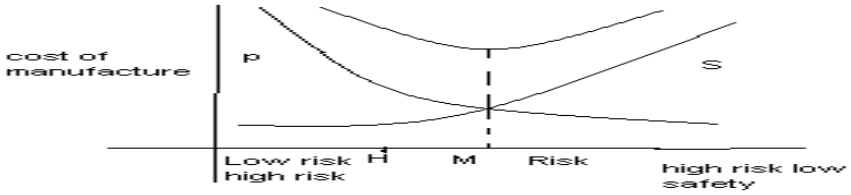
Threshold level of risk:

Something that is risky only at fairly high exposure will seen safer than something with a uniform exposure to risk. Low levels of nuclear radiations have beneficial effects on human health. Only at high levels, severe health problems occur.

Delayed and Immediate Risk:

An activity which considered as risky, whose harm is delayed for very many years may seems to be less risky. Eating high fat foods would lead to heart problem; people ignored it and finally were victims of the disease after many years. The reason is the risk is not immediate and taken lightly.

4.2 Assessment of safety and risk: Absolute safety is not attainable and any improvement in safety in analyzing product is by an increase in the cost of that product



P = Primary cost of product including safety measures
S= Secondary cost including warranty, loss of customer goodwill, litigation costs, cost of downtimes.
T= Total cost.

Minimum cost occurs at 'M' after which incremental saving in primary cost is offset by an equal increment in secondary cost. Hence highest acceptable risk (H) may fall below risk at low cost 'M'. This must be selected as design or operation point.

Uncertainties in design : Regarding application, designs that do quite well under static loads may fail under dynamic loading

Ex. Napoleon's army marching on a bridge with uniform steps shook the bridge violently.

Uncertainties regarding materials: They may not perform as expected so engineers use factor of safety in the design.

Engineer and safety:

As safety is the prime consideration of engineer , criteria to be followed by engineers for safe design are

How to ensure safety in design?

1. Design must comply with applicable law, legal standards for safety to be followed.
2. Design product must meet the standard of accepted engineering practice.
3. You cannot create a design that is less safe than what every one else in the profession understands to be acceptable.
4. Alternative designs that are potentially safer must be explored. This requires fair amount of creativity in seeking alternative solutions.
5. Foresee potential misuse of the product by the customers and design to avoid them.
6. The product must, while prototype and finished shall be rigorously tested. Testing is not for checking the specification but to meet whether the product is safe.

In short Steps involved in safe design:

1. Define the problem. (Determine the needs and requirements)
2. Generate several solutions
3. Analyze each solution to determine pros and cons of each
4. Test the solution
5. Select the best.
6. Implement the chosen solution.

4.3 RISK BENEFIT ANALYSIS AND REDUCING RISK

Risk-benefit analysis is the comparison of the risk of a situation to its related benefits. For research that involves more than minimal risk of harm to the subjects, the investigator must assure that the amount of benefit clearly outweighs the amount of risk. Only if there is favorable risk benefit ratio, a study may be considered ethical.

Risk Benefit Analysis Example

Exposure to personal risk is recognized as a normal aspect of everyday life. We accept a certain level of risk in our lives as necessary to achieve certain benefits. In most of these risks we feel as though we have some sort of control over the situation. For example, driving an automobile is a risk most people take daily. "The controlling factor appears to be their perception of their individual ability to manage the risk-creating situation." Analyzing the risk of a situation is, however, very dependent on the individual doing the analysis. When individuals are exposed to involuntary risk, risk which they have no control, they make risk aversion their primary goal. Under these circumstances individuals require the probabilty of risk to be as much as one thousand times smaller then for the same situation under their perceived control.

Evaluations of future risk:

- Real future risk as disclosed by the fully matured future circumstances when they develop.
- Statistical risk, as determined by currently available data, as measured actuarially for insurance premiums.
- Projected risk, as analytically based on system models structured from historical studies.
- Perceived risk, as intuitively seen by individuals.

Air transportation as an example:

- Flight insurance company - statistical risk.
- Passenger - percieved risk.
- Federal Aviation Administration(FAA) - projected risks.

How to Reduce Risk?

1.Define the Problem
2.Generate Several Solutions
3. Analyse each solution to determine the pros and cons of each
4. Test the solutions
5.Select the best solution
6. Implement the chosen solution
7. Analyse the risk in the chosen solution
8. Try to solve it. Or move to next solution.

4.4 Respect for Authority:

Employed engineers have obligations to respect the authority of their employers. Authority is required to run any organization smoothly and to achieve the set goal. But salaried engineers think what is the nature of this authority and how for should it be recognized. Authority is a way to identify the areas of personal responsibility and accountability so far as the salaried engineers are concerned.

Institutional Authority:

This is the Authority with in the organization. It is the right of the employers & managers to exercise power on their subordinate employees to achieve the institutional goals. Institutional right is acquired, exercised & defined within institutions. It may be defined as right given to a person to exercise power based on the resources of the institutions.

Managerial tasks are to allocate money or other resources, to make policy decisions or the recommendations or to oversee projects and issue directions to sub-ordinates on a particular topic. In order to meet those duties, the organization assigns requisite authority to the managers.

Institutional rights (authorities) and duties are two sides of the same coin. They deal with the same activity & functions.

Projects engineers have the institutional duties to ensure that the projects are successfully completed & they are given the institutional rights (authority) necessary to carry out the duty.

But in practice there is not always a perfect match between the authority granted and the qualifications needed to exercise it. In -competence is found in all large institutions. To avoid such institutional problem expert authority comes in. The expert authority signifies the possession of special knowledge, skill or competence to carry out the given job.

Ex: Doctors are authorities on health.

The Civil Engineers are authorities on structures /transportation.

One of the key competences for management is leadership ability. It is possible for engineers to have expert authority in matters in which they have little or no institutional authority to make decisions.

Ex. The engineers can design or give suggestions on the construction of nuclear plants but hey can not decide where the plant can be installed. It is to be decided by the elected representative of the people. Hence the engineers may have expert authority but they can not decide in matters where they do not have institutional authority.

In large companies the staff engineers, advisors and consultants carry expert authority while institutional authority is vested in line managers.

Institutional authority and power are to be clearly understood. Ex. A manager who lacks the skills of leadership may be unable to inspire encourage employees to produce the result. People who are effective acquire power-power goes beyond the authority attached to the positions they hold. Ex. Charismatic leaders have influence outside their domains of authority. Highly respected engineers of proven integrity may have power within an organization exceeding their explicit institutional rights.

An employer has the institutional authority to direct the engineers to do a thing which is not morally justifiable. The Engineers may have the duty institutionally to obey the order of the employer. In such cases, institutional rights and duties can not be and should not be applied in the same sense with rights and duties that are morally justified.

Institutional authority is morally justified only when the institutional goals are morally justified and acceptable and the authority does not transgress into the domain of the moral and ethical duties of engineers.

Zone of Acceptance: When the employees obey the rules and regulations framed by the employer, they accept the authority of their employer with in the frame work of institutional authority. When the employees simply accept and obey the orders of the boss without analyzing is not totally acceptable. The subordinate should also analyze the instructions so as to verify whether it is morally acceptable. This analysis would help them to find out what is their zone of acceptance of the authority of the employer.

Paramount obligations of engineers:

Code of ethics clearly indicates that an engineer's paramount obligation is to protect the public health, safety and welfare. This takes priority over their obligations of loyalty and faithful and sincere service to their employers. But is it feasible in the professional life? Employers have high powers to hire or fire engineers who do not meet their expectations. Moral dilemma occurs to engineers whether to which obligation i.e., whether the obligation to the public or to employer is to be given precedence over the others. The obligation to the public is the priority naturally.

4.5 Collective Bargaining.

This is a process which is used by companies to solve inter personal problems between them and the employees. It adopts a negotiation process. The guide lines of negotiations are:

1. Attack problems and not people.
2. Build trust.
3. Begin with interest, not positions.
4. Listen.
5. Brainstorm develope multiple options.
6. Agree on how something will be measured.

Collective bargaining means we think about union. Can a professional engineer become a member in a union?

To answer this we must know what kind of union and union activities are at issue. Often employees feel that employers are exploiting and cheating them. Unions are formed to take care of the interests of the employees. Unionism and professionalism are incompetent. Professionalism holds the interest of the society and of employer. Unionism is a collective bargaining agent that places economic interest of members. Unions should be viewed as conduits for expressions of collective will. They have lot of bargaining power due to size. Unions can often prevent unethical acts of employers. They give job security and protection against ill treatment.

Whether unions and collective bargaining practices are ethical or unethical ?

Ex, A small scale company have 120 persons and growth rate was more than 100%. As the eyes of the management were on growth rate they missed the feelings of the pulse of the dissatisfaction of employees. The employees thought that the growth was in the interest of all. Diploma engineers formed a union and external leader came in. They demanded a lot of amenities that the company could ill afford.

Lot of time was expended on bargaining. The employees went on go slow strike production suffered, and the company performance went down. The company had to be sold and the new buyer closed the factory. All of them lost their jobs and livelihood. The union did not realize that what they were doing was against their own interest. By the time they realized it was too late. For seeking short term gains, they lost long term benefits.

Codes of the professional societies specify engineers shall not actively participate in strikes, pickets or other collective coercive actions. Most employers are allergic with the word 'union'. They feel unionism is an impediment to the smooth functioning of industry.

When collective bargaining exists, loyalty to employers and public cannot exist. Engineers view that unions are the limited institutions performing limited functions. The effects of collective bargaining whether it is good or bad can be assessed on issue basis only and not as general rule. Unions have misused their power and acted with public in an irresponsible manner. In those cases, the sympathy from public had been lost.

Ex. 1) Transport union strike.
2) Secretariat staff strike.

Arguments in favor of UNIONS:

a. Unions play a leading role in getting higher salaries to the workers; thereby their standard of living is increased. Non- member of a particular union also gets the increased salary and benefits.
b. Unions help in creation of greater sense of participation among the employees in the affairs of the company like decision-making
c. Unions give job security and protection against unreasonable treatment to employees.
d. Unions can resist obeying unethical orders to perform Unethical acts.
e. Unions help to provide a grievance procedure for the complaints of the employees and thereby a stable environment is maintained.
f. Unions help to avoid extreme political interference which exploits the employees in many a times.

Arguments against Union:

1. Unions are the main cause for inflationary condition of a country.
2. Unions can cause destruction to the economy of a nation by placing misrepresenting influences on the efficient uses of labor force.
3. Unions encourage an opponent decision-making rather than co- operating decision-making.
4. Unions remove the individual negotiations between employer and employee as part of the collective bargaining group.
5. Unions discourage initiative among workers by stressing job
   a. security and making promotion by mere seniority only.
6. Unions prevent the management to reward an individual worker
   a. for his personal achievement because they insist on salary
   b. negotiation only according to job description and seniority.
7. Unions encourage a dissatisfied and tensed relationship between
   a. employer and workers.

The external responsibilities of professional engineers i.e. to the society are **confidentiality, conflict of interest & occupational crime.**

4.6 CONFIDENTIALITY:

Confidential information is information deemed desirable to keep secret. This implies that a communication is kept secret and will remain private. Codes of ethics require their members to maintain total confidentiality of any privileged information they are in possession. A piece of information /communication that is conveyed to some one else with the expectancy that it will remain private is privileged. This type of information has no access to all and only to some who are on special assignments. In case of engineers, design and drawings, process charts etc are to be kept confidence. Also the information about yet to be released products, design of such products are confidential information.

One may ask keep secret with whom? In Govt. agencies and private companies, engineers and other employees are expected to withhold confidential information from **unauthorized people both inside and outside the organization**.

A doctor has to keep the patients personal data as confidential information. Lawyers should keep their client's information as confidential likewise engineers shall keep their companies information as confidential.

Proprietary information: It is the information that a company owns or is the proprietary of. This can be taken as 'Trade Secret' i.e. any information not made known to the public. It is the information the employer prefers to keep as secret.

Trade Secret: It is a type of secret given a limited legal protection against employee or contractor abuse or misuse. An employer can sue an employee for divulging the trade secrets or even planning to do so.

These secrets may be about designs, list of clients, process methods, facilities available, and quality control methods.

Patents: This is different from trade secrets. Patents legally protects some specific products from being manufactured by other companies without proper permission of the patent holder. The patent holder possesses legally protected monopoly power under GATT 1995 agreement (General Agreement on Tariffs and Trade). The period of patent right is 20 years.

Justification and limit of confidentiality:

What are the moral limits or restrictions on the confidentiality obligations of employees? The obligation of confidentiality can be justified at two levels.

The obligation to hold the confidential information is focused first on the moral considerations. This is first level of confidentiality-obligation which is to appeal the three ordinary moral consideration. They are

a. Respect for autonomy
b. Respect for promises
c. Respect for public well being.

Respect for autonomy means respect the freedom and self determination of individuals and institutions to exercise control over private information about their companies.

Just as patients should be allowed to maintain substantial control over personal information, the employers should have some control over the private information about their companies.

Respect for promises:

Promises are given to others only to respect and carried out. They are not to be flouted. Employees should not disclose the promises made with their employer.

Employees often make promises in the form of signing contracts not to divulge certain information considered sensitive by the employers. These promises should be respected.

Regard for social wellbeing:

This is essential in identifying confidentiality relationships with in the professional areas. A patient gets confidence in a doctor if the doctor does not disclose the personal information to others. This will enable patient to discuss freely with the doctor on their personal problems. Clients feel free to talk when there is a trust of confidentiality is created. This is analogy to the economic benefits of competitiveness with in a free market are promoted when companies can maintain some degree of confidentiality concerning their products.

Ex: Developing new products requires investing resources in acquiring new knowledge. The motivation to make those investments might diminish if that knowledge were immediately dispersed to competitors, who could then quickly make better products at lesser cost, since they did not have to make comparable investment in R& D.

The **second level of confidentiality** obligation- will be to appeal to major **ethical theories**. Advocate of every theory would probably agree that employers have some moral & institutional rights to decide what information about their organization can be released publicly.

Different ethical theory will justify the rights differently & will also differ in the limits they place on them.

These can be broadly stated as

a. Right based theories
b. Duty based theories
c. Utilitarian theories

Right based theory simply **justifies employee's confidentiality obligations** by appealing to basic human rights. NO employer has a right to safe guard proprietary information by preventing engineers from whistle blowing in cases were public knowledge of such information (Say the composition of toxic wastes indicative of a products ingredients) would save human lives & there by protect the rights of people to live.

Duty based theories insists to the employers & employees to keep up the trust placed in them, in case of an agreement between them. These theories may also appeal to general duties not to abuse the property of others.

Utilitarian theories justify the rules of confidentiality only when such **rule benefits the public**.

The stress is on how the investors get profit & how the society is benefited. The theory focuses on each & every situation when an employer decides on some matters to be treated as confidential information.

Changing of Jobs:

Employees when switchover to the other job, they sell the information they had relating to the erstwhile employer for a price. In some cases the employees are placed in the same type of job in which they were with the previous employer. This puts them in dilemma. In the sense, that they have to use the knowledge gained by them earlier, but the new employer is happier. To restrict future employment, certain employers provide positive benefits

Ex. Companies offer pension plan to employees in exchange for an agreement not to work for a competitor on certain kinds of projects for a certain member of years after leaving the company. Some other companies offer a special post employment annual consulting fees for several years on the conditions that he or she not work for a direct competitor during that period.

The relationship between employer and employee in regard to confidentiality continues beyond the formal period of employment. Unless employer gives consent, former employees are barred indefinitely from revealing trade secrets. This provides the way in which the professional integrity of engineers involves much more than mere loyalty to one's employer.

4.7 Conflict of Interest:

Conflict of interest occur when employees have interests that, if pursued could keep them away from meeting their obligations to serve the interests of the employer or client for whom they work , such conflicts are to be avoided so as to prevent one from fully meeting these obligations. Professional conflicts of interest occur to an engineer in a situation in which he works in a company and also acts as consultant to the competitor's firm. If he continuous the same, he may not be in a position to meet the obligation to his employers or client. He would be more loyal to the competitor's firm if he invests in that company. So the threats posed by such acts by engineers led to giving prominence in the code of ethics, in management policy statements and in the law.

There are three types of conflicts of interest.

a. Actual conflict of interest
b. Potential conflict of interest
c. Apparent conflict of interest.

Actual conflict of interest is based on weak judgment and service. Conflicting interest means a person has two or more desires that can not all be satisfied in the given circumstances.

Ex:A student may have interest in excelling on four final exams. She knows however that there is time to study adequately for only three of them and so she must choose which interest not to pursue.

Conflicting interest means a person has two or more desires that cannot all be satisfied given the circumstances.

Potential conflicts of interest are based on the difference between gifts and bribes. In the event of a friend of the engineer turning as a supplier to his firm, the judgment might becomes conflicted in order to maintain his friendship. This type of conflicts arises when the engineer accept large gifts from suppliers.

Bribe is a large amount of money or substantial amount of goods offered with the aim of gaining the contract. Kickback is another word for bribe. Pre arranged payment done in exchange for contracts actually granted later are termed as kickbacks. Bribes are illegal and immoral.

Gift is a small amount of money given for the services rendered in the normal conduct of business.

Gift is a bribe if you cannot eat, drink or smoke it in a day. If you think that your acceptance of a particular gift would have grave or a merely embarrassing consequences for your company if made public, then the gift should be considered as bribe.

Engineers' code of ethics is clear on accepting gifts/bribes.

Engineers shall not accept gratitude's directly or individually from contractors, their agents or other parties dealing with clients or employers in connection with works for which they are responsible.

Apparent conflict of interest: This happens when the engineer is **paid based on the cost** of the design and there is no incentive offered to him if he cuts down the cost. Naturally the engineer would try to inflate the cost to get more commission. The engineer will be branded as distrustful, though he could have reduced the cost using his professional capability and judgment.

Conflicts of interest arises due to

1. Financial investment
2. Insider Trading
3. Bribe
4. Gifts
5. Kickbacks.

Conflicts of interest will arise because of financial investment in a competitors' business.

Ex: If you are an engineer and CEO of firm and another firm which had bid for a large project of your company. You have financial stake in that company which has bid for it. The tendency will be to award the bid to the company when you have stakes. This will be regarded as unethical decision.

Insider Trading: This involves using privileged information unfairly when you are working for a company. You could have access to the confidential information which other would not be ale to get it. If such information relates to the financial performance of the company and you use it to trade in the shares of the company, this would be considered as insider trading.

MOONLIGHTING:

Working in one firm and in spare time working for another company is called moonlighting. This violates the right to pursue onc's legitimate self interest. This type of work makes one exhausted and the result is his inability to meet his professional obligation at both places. It also ends up with poor job performance.

Resolving conflict problems:

S is working in a chemical factory. A compound emitted from the stack of the plant has been linked by several side effects to respiratory problems that can be severe in a small percentage of the population. The Pollution control board, has not banned the compound Its elimination will be expensive and it may force the elimination of the product line. This will lead to loss of a number of jobs in the community i.e., heavily dependent on the plant for employment.

An added dimension is that the product line could become very successful in future, thus adding jobs in the community. S's supervisor instructs him not to bring up the issue in hearing of the Pollution board officials, because the supervisor felt that by the time the PCB takes the final decision, they can modify the process and eliminate the emission itself. The health problem is not fatal in any case. How should S respond? S is now in a dilemma of conflict problem. First code of ethics say that engineer should hold paramount safety and health and welfare of the public in the performance of their professional carrier. On the other hand it also tells engineers shall act in professional matters for each employer as faithful agents or trustees. Further to the obligation to the public also puts S, in two different directions. One obligation, to protect the physical health of the community and the second obligation, to be concerned with economic health of the community.If public were enquired, they will support management since it gives many employment. Conflicts between competing obligations both of which appear to be valued are common features of life.

How to approach to such conflicts, which are not between good and bad but between good and good. ??

Creative midway should be adopted. The engineer should respect corporate hierarchy and protest in a private and a non confrontal way. The engineer should do every thing possible to avoid embarrassing their employer and give the employer an opportunity to correct the problem, in so far as

consideration of the well being of the public permits. Another limitation is the employee is not to protest about minor risks to the health and safety of the public. If there is a mechanism where by the employees could register ethical concerns this could be eliminated.

Avoiding conflicts of interest:

The following ways can help in avoiding conflicts of interest.

1. Follow the guidance from the company's policy.
2. Consult colleagues /sub ordinates or manager for a second opinion. This creates an opinion of being frank.
3. Use ethical problem solving technique.
4. Take refuge in code of ethics.

4.8 Occupational Crimes:

These are illegal acts made possible thro one's lawful employment. It can be treated as secretive violation of laws regulating work activities. If the occupational crimes are committed by office workers, professionals and managers, they are called white collar crimes.

Most of the occupational crimes are special instant of conflict of interest. It leads to the failure of meeting the professional obligations. The white collar crime meets with **less severe penalty**. There are ***three types*** of occupational crimes.

a. Industrial espionage,
b. Price fixing
c. Endangering of lives

Industrial espionage: Espionage is secret gathering of information, in other words spying. Keeping something secret is a right but acquisition of others secret to your advantage is espionage which is not right and unethical. Espionage is made in a covert manner. The espionage agent is called spy. There is large extent of industrial espionage thro out the world. Ex: Santa Clara in California is known as silicon valley. Lot of young and enterprising engineers work there. Due to competitions among various manufacturers of computer parts, high industrial espionage is there. The reason is

1.The development of computer chip is a competitive area and also is fast moving one. Within two years, the product get outdated, due to continuous development of technology. Profitable technology suddenly becomes a loss proposition with the introduction of modified version of various parts. Ex: VCD player, DVD player and now Blue Ray players

2.Computer chips are expensive. Large savings can be made by adopting **"reverse Engineering**". This means breaking the competitor's device physically, mentally or by tests and re constructing to produce an identical or better device that can be offered at a lower price because of low development cost. By obtaining thro illegal ways the competitors design drawings, large savings are achieved.

3. Computer chips being small in size can be easily taken away secretly and chances of being caught are little.

4. Some agents buy secrets and sell them to competitions. They get the products from employee themselves.

Case study:

Peter was an expert in semiconductor application. He worked for a number of computer chip companies, before he started his own consulting company. He had a lot of acquaintance and contacts. Hence he was able to buy and sell the secrets of the company.

James, a skilled electronics technician worked for Peter under 'moon lighting' method. He worked in a company called National Semi Conductor corporation (NSC).Peter financed James to build a house . Peter asked James that he need not repay the finance, but wanted him to steal some documents from NSC. James gladly agreed and did so.

Peter sold this document to Intel Co-operation. As Peter got contacts with Intel he managed to steel some documents from them and sold it to NSC. By this exchange of documents, employees were in high demand and employee cost was high.

After some time NSC and Intel spread the "drag net", and finally Peter was trapped and punished in an court of law. But the penalty was only a fine of a small amount which he could easily part with.

While collar crimes meet with less sever penalties.

Prices Fixing: This is known as "Cartelizing". Competitors come together and decide on the prices to be charged. The price fixation leads to restraint of free competetion and trade. It leads to unfair practices. To grab high valued order, major companies form a cartel and fix with in themselves the proposed price to be quoted. They would also preplan the share of the order to be executed by them individually between them, in the name of the successful bidder.

In US there is a law called Sherman Anti Trust Act 1980 which for bids companies jointly setting price. But by companies violate these laws.

Top managers of Westinghouse and G.E. joined together and allotted with in themselves, the share of the order. They also decided to quote a particular price and grab the order and share the same accordingly to the agreed plan. They called thus plan as **'Phase of the moon'**. But they were caught and sued. But being a 'white callar crime', they were only fined and let off.

Their agreement in the court was that they helped the public by stabilizing the prices and hence theirs was not unlawful. They argued that criminal action meant damaging some one and they did not do it. They were working on a survival basis in order to try to make enough to keep their plant and employers with job.

Endangering of lives: Employers expose their employees to safety hazards. They escape criminal penalties, Victims sue them for damages under civil law and get compensations. Companies very well aware of this and hence they resort to payments of compensation, not to take preventive measures which are expensive. They disregard the value of individual's life.

In U.S. millions of asbestos workers were affected with a type of lung cancer called asbestosis and more than one million workers lost their lives. The victims were asking the companies for monetary benefits as compensation and no one preferred for asking criminal justice. Companies make use of this attitude and close the cases by paying compensation amount. Some company went to declare them as insolvent and get immunity from making payment. In the court the companies argue when asked why they have not got informed consent they said 'as long as they feel well, happy at home and at work and his physical conditions remains good, nothing should be said.

Another case: Film Recovery System was a small corporation that recycles silver from used photo graphic and x-ray plates. Used plates were soaked in a cyanide solution to leach out their silver content. Other companies use this process safely by protecting workers against inhaling cyanide gas and against making skin contact with liquid; they provided them rubber gloves, boots and apron as well as respirators and proper ventilation. None of these precautions were taken by Silver Recovery System Company. Workers were given paper masks, cloth gloves and ventilation was terrible and respirators were not provided. Workers were not complaining but in one incident autopsy of an employee revealed cyanide poisoning. Charges were brought against the executive of the company. During the trial, it was

proved that the president, the plant manager, plant foreman all knew of the dangers of cyanide. They also knew the hazards conditions on their plant. Each was fined dollar ten thousand and jail term pf 25 years.

4.9 Professional rights:

Engineers have several types of moral rights which some times overlap.

Categories are

a. Human rights
b. Employee rights
c. Contractual rights
d. Professional rights

Engineers possess the fundamental rights to live in a state of freeness to pursue freely their legitimate interest. They have human rights to pursue their work and not to be unfairly discriminative. Professional rights are vested to the engineers by virtue of their being professionals.

Fundamental professional rights are

- ✓ Right to form a professional judgment and to express it freely.
- ✓ Right to refuse and refrain from participating in unethical activities.
- ✓ Right to disagree on issues relating to the profession
- ✓ Right to warn and caution the public about dangers
- ✓ Right to obtain a fair remuneration for the professional services
- ✓ Right to talk on the job he holds.
- ✓ Right to engage in the activities of professional society.

Basic right of professional consciences: Engineers, using professional responsibility involves in exercising both technical judgment and reasoned moral convictions. This basic right is referred as the right of professional conscience. In practice the duties of engineers are not clearly defined. In engineering profession decisions to be taken by engineers are morally complex in nature. The basic professional right of the engineer is termed as 'Negative' Right, as it asks other to stay away without interference.

But engineers while taking a decision on a project they need an atmosphere of trust and the management has to ensure this. In such situation the basic right of the engineer is considered as 'Positive right'.

Institutional recognition of rights: Moral rights of engineers have to be recognized and respected by the organization to which they belong.

Specific rights: In some specific instance it is difficult to apply professional rights.

Right of conscientious refusal: This is to refuse to engage in unethical behavior and to refuse to do so, solely because of one views it as unethical. This situation arises when a discussion being held among a group of engineers and there exists a chance to disagree on the nature of action to be taken in an issue by a member of group.

As per this right no employee can be forced to do something by his employer, which is unethical in the opinion of the employee. To correct the data already existing, forging the document, altering test results, taking bribes, telling lies intentionally fall under this category.

In case an engineer has to work in an environmentally unfriendly & dangerous situation, he has the right to refuse, which is in all most all cases the employer does not understand.

Engineers have a right to professional recognition for their work & accomplishments. Part of this involves fair monetary remuneration & part non monetary forms of recognition.

If a patent leads to millions of dollars of revenue for a company, it is unfair to give the discoverer a nominal bonus & a thank you letter. It is not possible to pin point what a reasonable salary is or what a fair remuneration for patent discovering, because it depends on both the resources of a company & the bargaining position of engineers. Non monetary forms of recognition are also important.

Foundation of professional rights:

The principles of professional rights can be **justified as rights ethics, duty ethics & utilitarianism.**

Right ethics: It insists the moral rights as of the fundamental grounds of morality. The public have human rights to be warned of any safety hazards due to technology improvement. Public right recognizes of engineers in an indirect way.

Duty ethics: This view, rights are not the ultimate moral appeal instead they are mirror-image correlates of more basic. If an engineer has the right to do his work, it is because others have obligations to permit him to carryout his work without any interference. There by the engineer may not be able to meet their obligation to the public.

No employer has the right to threaten are engineer under him with loss of job, if he refuses to work on projects causing dangers to public.

Utilitarianism :This suggests that we should produce the good things for the general or more people being given equal opportunity to every one. This theory has ***two parts***

- ✓ **Act utilitarian**: This says that we have to focus only on individual actions and not on general rules. We have to see that we do not break the promises, do not deceive others and do not give or get bribes.
- ✓ **Rule utilitarian** (BRANDT) takes efforts to setup the **best rule** or policy to follow their obligations to public at large.

Individuals actions are considered right only when they conform to moral rules. These moral rules, like refusing bribes etc., are termed as moral codes, according to Brandt.

4.10 Employee rights:

By being an employee, he has got certain rights, of either moral or legal in nature. This right is called employee right. He has right to disobey his employer in the event of forcing him to do unethical activities that would endanger the safety of public.

Another right, is the right of not to be discriminated against social causes. Another employee right called contracted employee rights, which ensures the right to receive salary & right to receive company's benefits as eligible like increments etc.

Another form of employee right is 'Non-contractual employee rights' which exist even if they are not recognized by the existing practices of the company.

Choice of outside activity:

Employees have right of engaging in outside activity of their choice. This will not attract any punishment from the employers. This is a part of human rights to pursue the legitimate interests without any interference.

But the employee should not damage the interest of their employer outside the office hours. Outside activities should not spoil the normal duties or pose any impediment to their normal obligations to their employer.

Privacy:

Right to have outside activity is a matter of right to the employees. This right is also termed as 'Privacy'. This right is a **limited** one. Ex. Prospective employees will be asked to undergo some tests that include questions on their criminal records, or a lie detector test, before hiring them. These tests are prone to be misused by certain employers.

This act of misuse is termed as unwanted **transgression into the domain of privacy of job seekers.** In the interest of the organization conducting and collecting such data by employer can not be totally denied.

Fixing surveillance camera in the factory, shops is the right of the employer. Frisking the employees at the entrance by the watch and ward staff can not be considered as an encroachment into the privacy of the employees.

Right to due process:

With out institutional recognition, the moral rights of conscience, free speech, out side activity and privacy would be of little help to employees. Institutional recognition includes formal encouragement of the rights, company policy statement, or employment contracts. It also requires creation of an institutional procedure for protecting those who exercise the rights.A right to fair procedures, safeguarding the exercise of other rights is the right to due process.

The **right to due process** extends to fair procedures in firing, demotion and disciplinary actions.

Implementing the right to due process involves two general procedures.

First written explanation are owed to employees who are discharged, demoted or transferred to less enriching workings or in other ways penalized.

Second an appeal procedure should be established that is available to all employees who believe their rights have been violated. The procedures shall be part of organizations, effective, equitable and efficient. It must be easy to use and work quickly. For Govt. already a set procedure is available. But private companies, each has got its own procedures.

4.11 Intellectual Property Rights:

Intellectual property is a class of property created out of human intellect. Any property whether it is movable or immovable has legal protection to prevent it from being stolen. Intellectual property also means anything that results due to intellectual activity of an individual or a group of individuals. The creations of the brain are the intellectual property.

These could be novel working ideas, and skills, improvements and unique solutions to problems in any aspect of human efforts.

IPR rights are the legal and statutory provisions available to individuals to protect the ownership of their creations and the resulting, commercial benefits. IPR has got wide range of social and economical impacts.

There are various forms of IPR. Trade related intellectual property rights are often called as TRIPS.

WTO recognizes **seven** forms of IPR. They are

1. Patents,
2. Trade mark,
3. Geographical indications,
4. Industrial design,
5. Copy rights,
6. Integrated Circuits,
7. Trade secrets.

1. **Patent:** These are legal rights **granted for new inventions** using scientific and technical knowledge. The period is 20 years. It gives exclusives privilege of making, selling and using the invention and also authorizing others to do so thro' out the country.

Ex: A new drug for the treatment of AIDS , A new cellular phone

CONDITIOS FOR PATENTING:

Any creation becomes eligible for a patent if the following conditions are satisfied.

1. It must be inventive and unique. Inventive means that it makes a feature that is not obvious to a person skilled in the art. An invention can be an unforeseen technical effect produced by a new combination of known elements.

2. It must be Novel- (Fresh, different, Original, Unsusal, imaginative, inventive, un conventional, innovative, ground-breaking)

3. It must have a commercial value

For applying patent, the following **document**s are needed.

-Problem of invention
-Current report of the problem to address
-Solution or procedure to the problem
-Extent of novelty or inventive
-Application or uses
-Details of inventor
-Resources of funding

Types of patent:

Three types are there. 1. Utility patents 2. Design patent 3. Plant patents

- ✓ **Utility patents** can be granted to any one who discovers/invents any new and useful **process,** machines, **manufacture or composition** of matter. The utility duration will be 20 years. **Process** refers to industrial and manufacturing methods.
Manufacture refers to the articles or goods manufactured

Composition of matter relates to chemical composition and includes mixture of ingredients as well as new chemical compounds.

- ✓ **Design patents** can be granted to anyone who invents a new and original ornamental pattern for an article of manufacture. It protects the ornamental design or appearance of the article. This has validity 14 years from the date of applying for the patent with complete documents.

- ✓ **Plant Patent**: can be granted to any one who invents or discovers and reproduces a variety of plant. Validity period is 20 years. Patents law varies from country to country. International or world patent are yet to come.

Copy right:

Copy right law prevents others from
-Copying the work,
-Publishing and selling copies commercially
-Renting and demonstrating the work in public.

Trade Mark: is a visual symbol in the form of a word or label applied to the product. This gives details to the buyer on the origin of manufacture of goods. Ex: Philips in electronic goods, Sony, Pioneer.

Geographical indications:

These indications identify the origin of the goods with respect to the country where they are manufactured ex: Kancheepuram silk, Dindigul lock.

Trade secrets:

Any trade information kept confidential can be said to be Trade secret. In engineering profession, certain formulae programming, processing and data collection can be treated as trade secret. Trade secrets are not registered. Protection for such trade secrets cannot be given on a time frame because at any point of time the secrecy is liable to be lost.

Engineers have responsibility to use the trade secrets without disclosing to others. If the information is intentionally or un intentionally leaked out, the rights owner can sue in a court for remedy.

Need for protection of IPR:

When IPR is protected, we can expect technology development and creativity. It will give stimuli to research.

IPR protection is based on the following needs.

- To prevent plagiarism (i.e., using the original work as his own
-To prevent others to use it.
-To prevent using it for financial gains.
-To support income generation
-To fulfill as an obligation to the sponsor

IPR is considered **important** because it gives

-The inventors' exclusive rights of dealing
-Permit avoidance of competitors
-Permit entry to technical market
-Generate a steady income by issuing license.

IPR protection gives protection against piracy.

In India we have the following act to IPR

-The Patents Act 1970
-The copy rights act 1957
-Trade and Merchandise Mart Act 1958
-The Design Act 1911.

4.12 Discrimination

This is to make unfair difference in one's treatment. Giving preference to gender, race, religion falls under this. **Morally unjustified** treatment to people can be called as discrimination.

Ex: 1)Vacancy exists for a very high post in a private company. Just because the best suitable person does not belong to the majority community of people working there he was denied promotion to that post.

The reason put forth is that if that person is posted, the other sub-ordinate world not extend co-operation to him and in the process the company would suffer. So the management promoted a person of lesser capability, just because he belongs to the majority community working there.

2) More number of woman engineers are appointed in the sales division of a company but they were **paid lesser** than male engineers.

In India we have laws to prevent such discrimination. i.e., Factories Act, Labor Act, Wages Act.

The equal employment opportunity act in USA protects the weaker, minorities and woman from discrimination by gender, race, color or religion

Preferential treatment:

Weak preferential treatment gives benefit or preference to the members of traditionally discriminated against groups over equally qualified applicants who are the members of the other group

Ex: Hiring a woman or a member of minority over an equally qualified white male people.

Strong preferential treatment by contrast exist in giving preference to woman or minorities over better qualified white males.

CHERNOBYL CASE STUDIES

What Happened?

At 1:24 AM on April 26, 1986, there was an explosion at the Soviet nuclear power plant at Chernobyl. One of the reactors overheated, igniting a pocket of hydrogen gas. The explosion blew the top off the containment building, and exposed the molten reactor to the air. Thirty-one power plant workers were killed in the initial explosion, and radioactive dust and debris spewed into the air.

It took several days to put out the fire. Helicopters dropped sand and chemicals on the reactor rubble, finally extinguishing the blaze. Then the Soviets hastily buried the reactor in a sarcophagus of concrete. Estimates of deaths among the clean-up workers vary widely. Four thousand clean-up workers may have died in the following weeks from the radiation.

The countries now known as Belarus and Ukraine were hit the hardest by the radioactive fallout. Winds quickly blew the toxic cloud from Eastern Europe into Sweden and Norway. Within a week, radioactive levels had jumped over all of Europe, Asia, and Canada. It is estimated that seventy-thousand Ukrainians have been disabled, and five million people were exposed to radiation. Estimates of total deaths due to radioactive contamination range from 15,000 to 45,000 or more.

To give you an idea of the amount of radioactive material that escaped, the atomic bomb dropped on Hiroshima had a radioactive mass of four and a half tons. The exposed radioactive mass at Chernobyl was fifty tons.

In the months and years following, birth defects were common for animals and humans. Even the leaves on the trees became deformed.

Today, in Belarus and Ukraine, thyroid cancer and leukemia are still higher than normal. The towns of Pripyat and Chernobyl in the Ukraine are ghost towns. They will be uninhabitable due to radioactive contamination for several hundred years. The worst of the contaminated area is called "The Zone," and it is fenced off. Plants, meat, milk, and water in the area are still unsafe. Despite the contamination, millions of people live in and near The Zone, too poor to move to safer surroundings.

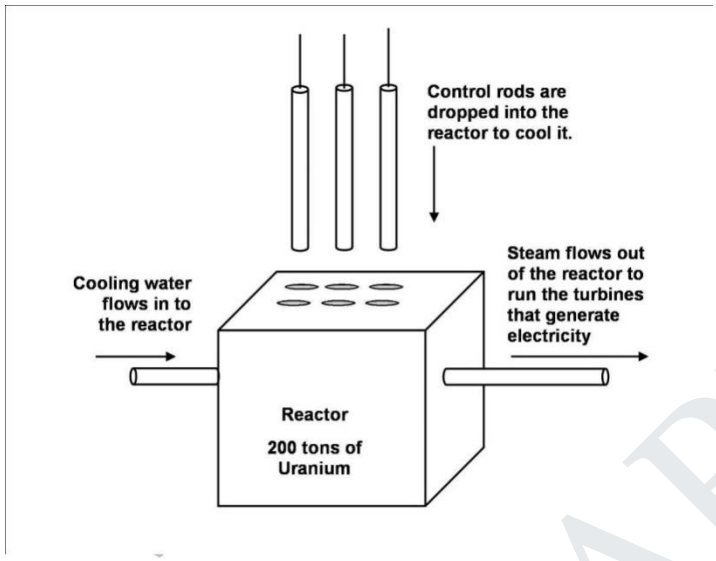
Further, human genetic mutations created by the radiation exposure have been found in children who have only recently been born. This suggests that there may be another whole generation of Chernobyl victims.

Recent reports say that there are some indications that the concrete sarcophagus at Chernobyl is breaking down.

How a Nuclear Power Plant Works

The reactor at Chernobyl was composed of almost 200 tons of uranium. This giant block of uranium generated heat and radiation. Water ran through the hot reactor, turning to steam. The steam ran the turbines, thereby generating electricity. The hotter the reactor, the more electricity would be generated. Left to itself, the reactor would become too *reactive*—it would become hotter and hotter and more and more radioactive. If the reactor had nothing to cool it down, it would quickly *meltdown*—a process where the reactor gets so hot that it melts—melting through the floor. So, engineers needed a way to control the temperature of the reactor, to keep it from the catastrophic meltdown. Further, the engineers needed to be able to regulate the temperature of the reactor—so that it ran hotter when more electricity was needed, and could run colder when less electricity was desired. The method they used to regulate the temperature of the reactor was to insert heat-absorbing rods, called *control rods*. These control rods absorb heat and radiation. The rods hang above the reactor, and can be lowered into the reactor, which will cool the reactor. When more electricity is needed, the rods can be removed from the reactor, which will allow the reactor to heat up. The reactor has hollow tubes, and the control rods are lowered into these reactor tubes, or raised up out of the reactor tubes. At the Chernobyl-type reactors, there are 211 control rods. The more control rods that are inserted, the colder the reactor runs. The more control rods that are removed, the hotter the reactor becomes.

How a Nuclear Power Plant Works



Soviet safety procedures demanded that at least 28 rods were inserted into the Chernobyl reactor at all times. This was a way to make sure that the reactor wouldn't overheat.Water was another method to moderate the temperature of the reactor.When more water ran through the reactor, the reactor cooled faster.When less water ran through the reactor, the reactor stayed hot.

Chernobyl Background

The list of senior engineers at Chernobyl was as follows: Viktor Bryukhanov, the plant director, was a pure physicist, with no nuclear experience. Anatoly Dyatlov, the deputy chief engineer, served as the day-to-day supervisor. He had worked with reactor cores but had never before worked in a nuclear power plant. When he accepted the job as deputy chief engineer, he exclaimed, "you don't have to be a genius to figure out a nuclear reactor." The engineers were Aleksandr Akimov, serving his first position in this role; Nikolai Fomin, an electrical engineer with little nuclear experience; Gennady Metlenko, an electrical engineer; and Leonid Toptunov, a 26 year-old reactor control engineer. The engineers were heavy in their experience of electric technology, but had less experience with the uniqueness of neutron physics.The confidence of these engineers was exaggerated. They believed they had decades of problem-free nuclear work, so they believed that nuclear power was very safe. The engineers believed that they could figure out any problem. In reality, there had been many problems in the Soviet nuclear power industry. The Soviet state tried to keep problems a secret because problems are bad PR. The Soviets had a number of nuclear accidents (this is a partial list of Soviet accidents before Chernobyl). In 1957 in Chelyabinsk, there was a substantial release of radioactivity caused by a spontaneous reaction in spent fuel; in 1966 in Melekess the nuclear power plant experienced a spontaneous surge in power, releasing radiation; In1974, there was an explosion at the nuclear power plant in Leningrad; Later in 1974, at the same nuclear power plant, three people were killed and radiation was released into the environment; in 1977, there was a partial meltdown of nuclear fuel at Byeloyarsk; in 1978 at Byeloyarsk, the reactor went out of control after a roof panel fell onto it; In 1982 at Chernobyl, radioactivity was released into the environment; In 1982, there was there was a fire at Armyanskaya; In 1985, fourteen people were killed when a relief valve burst in Balakovo. Had the engineers at Chernobyl had the information of the previous nuclear accidents, perhaps they would have known to be more careful. It is often from mistakes that we learn, and the engineers at Chernobyl had no opportunity to learn. As a footnote, don't think that the problems were just those mistake-laden Soviets. Here is a partial list of American accidents before

Chernobyl: In 1951, the Detroit reactor overheated, and air was contaminated with radioactive gasses; In 1959, there was a partial meltdown in Santa Susanna, California; In 1961, three people were killed in an explosion at the nuclear power plant at Idaho Falls, Idaho; In 1966, there was a partial meltdown at a reactor near Detroit; In 1971, 53,000 gallons of radioactive water were released into the Mississippi River from the Monticello plant in Minnesota; In 1979, there was population evacuation and a discharge of radioactive gas and water in a partial meltdown at Three Mile Island; in 1979 there was a discharge of radiation in Irving Tennessee; In 1982, there was a release of radioactive gas into the environment in Rochester, New York; In 1982, there was a leak of radioactive gasses into the atmosphere at Ontario, New York; In 1985, there was a leak of radioactive water near New York City; In 1986, one person was killed in an explosion of a tank of radioactive gas in Webbers Falls, Oklahoma. The engineers at Chernobyl didn't know about these nuclear accidents. These were secrets that the Soviets kept from the nuclear engineers. Consequently, no one was able to learn from the mistakes of the past. The nuclear plant staff believed that their experience with nuclear power was pretty much error-free, so they developed an overconfidence about their working style.

So, according to Gregori Medvedev (the Soviet investigator of Chernobyl), their practice became lazy and their safety practices slipshod. Further, the heavy bureaucracy and hierarchy of the Soviet system created an atmosphere where every decision had to be approved at a variety of higher levels. Consequently, the hierarchical system had quelled the operators' creativity and motivation for problem-solving.

April 25th, 1:00 PM

The engineers at Chernobyl had volunteered to do a safety test proposed by the Soviet government. In the event of a reactor shutdown, a back-up system of diesel generators would crank up, taking over the electricity generation. However, the diesel engines took a few minutes to start producing electricity. The reactor had a turbine that was meant to generate electricity for a minute or two until the diesel generators would start operating. The experiment at Chernobyl was meant to see exactly how long that turbine would generate the electricity. The experiment required that the reactor be operating at 50% of capacity. On April 25th, 1986, at 1:00 PM, the engineers began to reduce the operating power of the reactor, by inserting the control rods into the reactor. This had the effect, you may recall, of cooling off the reactor—making it less reactive.They also shut down the emergency cooling system. They were afraid that the cooling system might kick in during the test, thereby interfering with the experiment. They had no authorization to deactivate the cooling system, but they went ahead and deactivated it. The experiment called for running the reactor at 50% capacity, thereby generating only half the electricity. At 2:00 PM, a dispatcher at Kiev called and asked them to delay the test because of the higher-than-expected energy usage. They delayed the test, but did not reactivate the emergency cooling system.

April 25th, 11:00 PM

At 11:00 PM, they began the test again. Toptunov, the senior reactor control engineer, began to manually lower the reactor to 50% of its capacity so that they could begin the turbine safety experiment.Lowering the power generation of a nuclear reactor is a tricky thing. It is not like lowering the thermostat in a house. When you lower the thermostat in the house from 72 to 68 degrees, the temperature in the house will drop to 68 degrees and stay there. But in a nuclear reactor, the dropping of the temperature is not only the *result* of lowering the reactivity, but it is also a *cause* of lowering the reactivity. In other words, the coldness of the reactor will make the reactor colder. This is called the *self-damping effect*. Conversely, when the reactor heats up, the heat of the reactor will make itself hotter (the self-amplifying effect). So, when the control rods are dropped into the reactor, the reactivity goes down. And the water running through the reactor also lessens reactivity. But the lower reactivity also makes the reactor itself

less reactive. So, the Chernobyl reactor damped itself, even as the water and the control rods damped its reactivity.It is typically hard for people to think in terms of exponential reduction or exponential increase. We naturally think of a linear (straight-line) reduction or a linear increase. We have trouble with self-damping and self-amplifying effects, because they are nonlinear by definition.So, the engineers oversteered the process, and hit the 50% mark, but they were unable to keep it there. By 12:30 AM, the power generation had dropped to 1% of capacity.Chernobyl-type reactors are not meant to drop that low in their capacity. There are two problems with the nuclear reactor running at 1% of capacity. When reactivity drops that low, the reactor runs unevenly and unstably, like a bad diesel engine. Small pockets of reactivity can begin that can spread hot reactivity through the reactor. Secondly, the low running of the reactor creates unwanted gasses and byproducts (xenon and iodine) that poison the reactor. Because of this, they were strictly forbidden to run the reactor below 20% of capacity.

Further, safety rules are not designed so that people are killed instantly when the safety standard is broken. On a 55-mile per hour limit on a highway, cars do not suddenly burst into flames at 56 miles per hour. In fact, there is an advantage to going 56 miles an hour as opposed to 55 (you get to your destination faster). In the same way, engineers frequently view safety rules as troublesome, and there is an advantage to have the freedom to disregard them. In fact, we experience this psychologic every day, usually without thinking about it. When you come toward an intersection, and the light turns yellow, you reach a point where you either have to go through on a yellow light, or come to a stop. Many people go through on the yellow, even though there is a greater risk. So, in a split second, we decide between the surety of sitting at a red light or the possibility, albeit slight, of a safety problem to go through the yellow light. There is a clear advantage to take the risk (as long as you aren't in an accident). While the stakes were higher at Chernobyl, the same psychologic applies. At this point in the Chernobyl process, there were 28 control rods in the reactor—the minimum required. Increasing power would mean that even more control rods would have to be removed from the reactor. This would be a breach of protocol--the minimum number of rods was 28. Dyatlov gave the order to remove more control rods. Toptunov, the reactor control engineer, refused to remove any more rods. He believed it would be unsafe to increase the power. With the reactor operating at 1%, and the minimum number of control rods in the reactor, he believed it would be unsafe to remove more rods

April 26th, 1:00 AM

By 1:00 AM, the power of the reactor was stable at 7% of capacity. Only 18 control rods were in the reactor (safety protocols demanded that no less than 28 control rods should always be in the reactor). At 1:07 AM, the engineers wanted to make sure the reactor wouldn't overheat, so they turned on more water to ensure proper cooling (they were now pumping five times the normal rate of water through the reactor). The extra water cooled the reactor, and the power dropped again. The engineers responded by withdrawing even more control rods. Now, only 3 control rods were inserted in the reactor. The reactor stabilized again. The engineers, satisfied with the amount of steam they were getting (they needed steam for their experiment) shut off the pumps for the extra water. They shut off the water, apparently only considering the effect that the water would have on the experiment—and did not consider the effect that the water was having on the reactor. At this point, with only 3 control rods in the reactor, the water was only thing keeping the reactor cool. Without the extra cool water, the reactor began to get hot. Power increased slowly at first. As the reactor got hotter, the reactor itself made the reactor hotter—the self-amplifying effect. The heat and reactivity of the reactor increased exponentially.

The engineers were trying to watch multiple variables simultaneously.

The water, the steam, the control rods, and the current temperature of the reactor all were intertwined to affect the reactivity of the reactor. People can easily think in cause and effect terms. Had their only been one variable that controlled the reactivity, the results would probably have been different. However, people have difficulty thinking through the process when there are a multitude of variables, all interacting in different ways.People are not processors of unlimited information. There is a limited amount of information with which a person can work. With the safety of hindsight, we can sit back and make a judgment saying, "they didn't think through all their information." However, this kind of linear judgment does not tell us *why* they didn't see what is obvious to our hindsight.

At 1:22 AM (90 seconds before the explosion), the engineers were still relaxed and confident. Dyatlov, in fact, was seeing his turbine safety experiment coming to a successful conclusion. In what turned out to be a tragic irony, he encouraged his engineers by suggesting, “in two or three minutes it will all be over.”

Thirty seconds before the explosion, the engineers realized the reactor was heating up too fast. With only 3 control rods in the reactor, and then shutting off the water, the reactor was superheating. In a panic, they desperately tried to drop control rods into the reactor, but the heat of the reactor had already melted the tubes into which the control rods slid.

The floor of the building began to shake, and loud banging started to echo through the control room. The coolant water began to boil violently, causing the pipes to burst. The super-heating reactor was creating hydrogen and oxygen gasses. This explosive mixture of gasses accumulated above the reactor. The heat of the reactor was building fast,and the temperature of the flammable gasses was rising.

April 26th, 1:24 AM

Finally, the gasses detonated, destroying the reactor and the protective containment building. The control room was far enough away from the containment building to escape destruction, but the explosion shook the entire plant. Debris caved in around the control room members, and Dyatlov, Akimov, Toptunov, and the others were knocked to the floor. Dust and chalk filled the air. While they knew there had been an explosion, they hoped and prayed the explosion had not come from the reactor. Toptunov and Akimov ran over the broken glass and ceiling debris to the open door, and ran across the compound toward the containment building. There, they saw the horrifying, unspeakable sight. There was rubble where the reactor had been. They saw flames shooting up 40 feet high, burning oil squirting from pipes onto the ground, black ash falling to the ground, and a bright purple light emanating from the rubble.

Within a few minutes, fire fighters had arrived. The fire fighters, most with no protective equipment, heroically worked to extinguish the fire, hoping to prevent further damage to the three other reactors at the plant. Most of the fire fighters died from the radiation exposure.flight," where people retreat from the worst-case scenario, convincing themselves to believe the best-case scenario. Bryukhanov had convinced himself that the reactor was not in danger. And after all, someone from the plant had called and given an ambiguous message. Surely they would have known if the reactor had been destroyed.

April 26th, 4:00 AM

At 4:00 AM, the command from Moscow came back: *Keep the reactor cool*. The authorities in Moscow had no idea that the damage was so catastrophic. Akimov, Dyatlov, and Toptunov, their skin brown from the radiation, and their bodies wrenched from internal damage, had already been taken away to the medical center.

At 10:00 AM, Bryukhanov, the plant director, was informed that the reactor had been destroyed. Bryukhanov rejected the information, preferring to believe that the reactor was still intact. He informed Moscow that the reactor was intact and radiation was within normal limits.

Later that day, experts from around the Soviet Union came to Chernobyl, and found the horrifying truth. The reactor had indeed been destroyed, and fifty tons of radioactive fuel had instantly evaporated. The wind blew the radioactive plume in a northwesterly direction. Belarus and Finland were going to be in the path of the radioactive cloud.

The Days Afterward

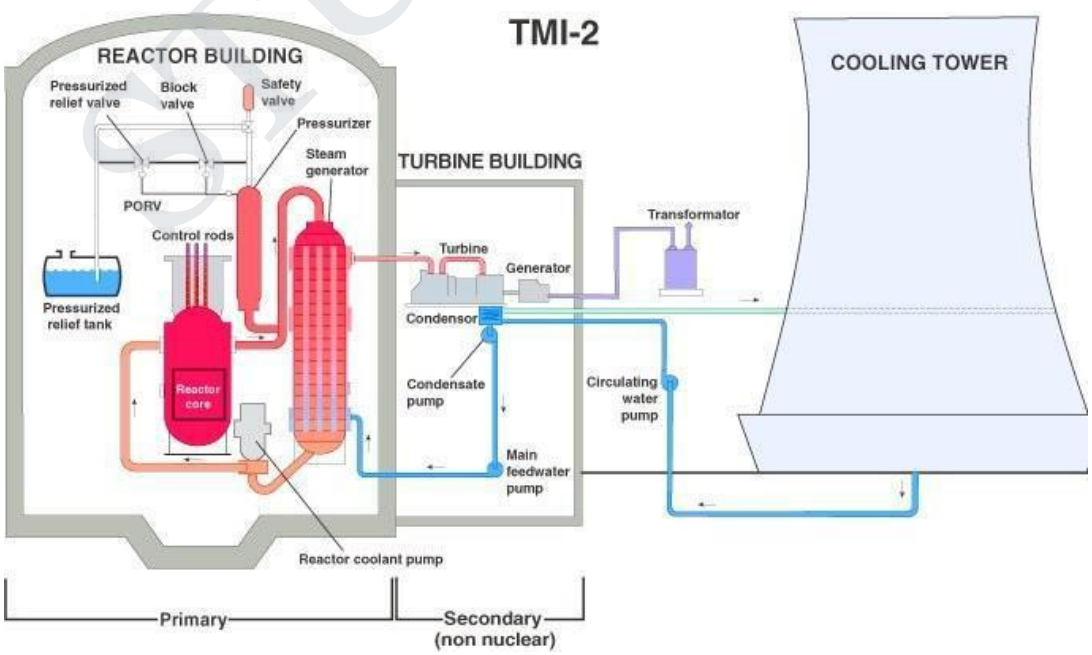
The secretive Soviet state was slow to act. Soviet bureaucracy debated whether to evacuate nearby cities, and how much land should be evacuated. They were slow in their response, slow to evacuate, and slow to inform the world of the disaster. It took over 36 hours before authorities began to evacuate nearby residents. Two days later, the nightly news (the fourth story) reported that one of the reactors was "damaged."Within a few days, radiation detectors were going off all over the world. The Soviets continued to try to hide the issue from the world and their own residents.

Several months later, Bryukhanov was arrested, still believing that he did everything right. Dyatlov survived the radiation sickness, and was arrested in December of that year. He believed he was a scapegoat for the accident. Akimov died a few weeks after the disaster, but till the very end continued to say, "I did everything right. I don't know how it happened."

THREE MILE ISLAND ACCIDENT

In 1979 at Three Mile Island nuclear power plant in USA a cooling malfunction caused part of the core to melt in the # 2 reactor. The TMI-2 reactor was destroyed. Some radioactive gas was released a couple of days after the accident, but not enough to cause any dose above background levels to local residents. There were no injuries or adverse health effects from the Three Mile Island accident.

The Three Mile Island power station is near Harrisburg, Pennsylvania in USA. It had two pressurized water reactors. One PWR was of 800 MWe (775 MWe net) and entered service in 1974. It remains one of the best-performing units in USA. Unit 2 was of 906 MWe (880 MWe net) and almost brand new.



The accident to unit 2 happened at 4 am on 28 March 1979 when the reactor was operating at 97% power. It involved a relatively minor malfunction in the secondary cooling circuit which caused the temperature in the primary coolant to rise. This in turn caused the reactor to shut down automatically. Shut down took about one second. At this point a relief valve failed to close, but instrumentation did not reveal the fact, and so much of the primary coolant drained away that the residual decay heat in the reactor core was not removed. The core suffered severe damage as a result. The operators were unable to diagnose or respond properly to the unplanned automatic shutdown of the reactor. Deficient control room instrumentation and inadequate emergency response training proved to be root causes of the accident

The chain of events during the Three Mile Island Accident

Within seconds of the shutdown, the pilot-operated relief valve (PORV) on the reactor cooling system opened, as it was supposed to. About 10 seconds later it should have closed. But it remained open, leaking vital reactor coolant water to the reactor coolant drain tank. The operators believed the relief valve had shut because instruments showed them that a "close" signal was sent to the valve. However, they did not have an instrument indicating the valve's actual position.

Responding to the loss of cooling water, high-pressure injection pumps automatically pushed replacement water into the reactor system. As water and steam escaped through the relief valve, cooling water surged into the pressuriser, raising the water level in it. (The pressuriser is a tank which is part of the primary reactor cooling system, maintaining proper pressure in the system. The relief valve is located on the pressuriser. In a PWR like TMI-2, water in the primary cooling system around the core is kept under very high pressure to keep it from boiling.)

Operators responded by reducing the flow of replacement water. Their training told them that the pressuriser water level was the only dependable indication of the amount of cooling water in the system. Because the pressuriser level was increasing, they thought the reactor system was too full of water. Their training told them to do all they could to keep the pressuriser from filling with water. If it filled, they could not control pressure in the cooling system and it might rupture.

Steam then formed in the reactor primary cooling system. Pumping a mixture of steam and water caused the reactor cooling pumps to vibrate. Because the severe vibrations could have damaged the pumps and made them unusable, operators shut down the pumps. This ended forced cooling of the reactor core. (The operators still believed the system was nearly full of water because the pressuriser level remained high.) However, as reactor coolant water boiled away, the reactor?s fuel core was uncovered and became even hotter. The fuel rods were damaged and released radioactive material into the cooling water.

At 6:22 am operators closed a block valve between the relief valve and the pressuriser. This action stopped the loss of coolant water through the relief valve. However, superheated steam and gases blocked the flow of water through the core cooling system.

Throughout the morning, operators attempted to force more water into the reactor system to condense steam bubbles that they believed were blocking the flow of cooling water. During the afternoon, operators attempted to decrease the pressure in the reactor system to allow a low pressure cooling system to be used and emergency water supplies to be put into the system.

Cooling Restored

By late afternoon, operators began high-pressure injection of water into the reactor cooling system to increase pressure and to collapse steam bubbles. By 7:50 pm on 28 March, they restored forced cooling of the reactor core when they were able to restart one reactor coolant pump. They had condensed steam so that the pump could run without severe vibrations.

Radioactive gases from the reactor cooling system built up in the makeup tank in the auxiliary building. During March 29 and 30, operators used a system of pipes and compressors to move the gas to waste gas decay tanks. The compressors leaked, and some radioactive gas was released to the environment.

The Hydrogen Bubble

When the reactor's core was uncovered, on the morning of 28 March, high-temperature chemical reaction between water and the zircaloy metal tubes holding the nuclear fuel pellets had created hydrogen gas. In the afternoon of 28 March, a sudden rise in reactor building pressure shown by the control room instruments indicated a hydrogen burn had occurred. Hydrogen gas also gathered at the top of the reactor vessel.

From 30 March through 1 April operators removed this hydrogen gas "bubble" by periodically opening the vent valve on the reactor cooling system pressuriser. For a time, regulatory (NRC) officials believed the hydrogen bubble could explode, though such an explosion was never possible since there was not enough oxygen in the system.

Cold Shutdown

After an anxious month, on 27 April operators established natural convection circulation of coolant. The reactor core was being cooled by the natural movement of water rather than by mechanical pumping. The plant was in "cold shutdown".

Public concern and confusion

When the TMI-2 accident is recalled, it is often in the context of what happened on Friday and Saturday, March 30-31. The drama of the TMI-2 accident-induced fear, stress and confusion on those two days. The atmosphere then, and the reasons for it, are described well in the book "*Crisis Contained, The Department of Energy at Three Mile Island*," by Philip L Cantelon and Robert C. Williams, 1982. This is an official history of the Department of Energy's role during the accident.

"Friday appears to have become a turning point in the history of the accident because of two events: the sudden rise in reactor pressure shown by control room instruments on Wednesday afternoon (the "hydrogen burn") which suggested a hydrogen explosion? became known to the Nuclear Regulatory Commission [that day]; and the deliberate venting of radioactive gases from the plant Friday morning which produced a reading of 1,200 millirems (12 mSv) directly above the stack of the auxiliary building.

No Radiological Health Effects

The Three Mile Island accident caused concerns about the possibility of radiation-induced health effects, principally cancer, in the area surrounding the plant. Because of those concerns, the Pennsylvania Department of Health for 18 years maintained a registry of more than 30,000 people who lived within five miles of Three Mile Island at the time of the accident. The state's registry was discontinued in mid 1997, without any evidence of unusual health trends in the area.

Indeed, more than a dozen major, independent health studies of the accident showed no evidence of any abnormal number of cancers around TMI years after the accident. The only detectable effect was psychological stress during and shortly after the accident.

The studies found that the radiation releases during the accident were minimal, well below any levels that have been associated with health effects from radiation exposure. The average radiation dose to people living within 10 miles of the plant was 0.08 millisieverts, with no more than 1 millisievert to any single individual. The level of 0.08 mSv is about equal to a chest X-ray, and 1 mSv is about a third of the average background level of radiation received by U.S. residents in a year.

UNIT V
GLOBAL ISSUES

Syllabus: Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE),India, etc.

5.1 MULTINATIONAL CORPORTIONS

A multinational corporation (MNC), also called a transnational corporation (TNC), or multinational enterprise (MNE), is a corporation or an enterprise that manages production or delivers services in more than one country. It can also be referred to as an international corporation. The International Labour Organization (ILO) has defined[citation needed] an MNC as a corporation that has its management headquarters in one country, known as the home country, and operates in several other countries, known as host countries.

The Dutch East India Company was the first multinational corporation in the world and the first company to issue stock. It was also arguably the world's first megacorporation, possessing quasi-governmental powers, including the ability to wage war, negotiate treaties, coin money, and establish colonies.

The first modern multinational corporation is generally thought to be the East India Company. Many corporations have offices, branches or manufacturing plants in different countries from where their original and main headquarters is located.

Some multinational corporations are very big, with budgets that exceed some nations' GDPs. Multinational corporations can have a powerful influence in local economies, and even the world economy, and play an important role in international relations and globalization

Multinational corporations have played an important role in globalization. Countries and sometimes subnational regions must compete against one another for the establishment of MNC facilities, and the subsequent tax revenue, employment, and economic activity. To compete, countries and regional political districts sometimes offer incentives to MNCs such as tax breaks, pledges of governmental assistance or improved infrastructure, or lax environmental and labor standards enforcement. This process of becoming more attractive to foreign investment can be characterized as a race to the bottom, a push towards greater autonomy for corporate bodies, or both.

However, some scholars for instance the Columbia economist Jagdish Bhagwati, have argued that multinationals are engaged in a 'race to the top.' While multinationals certainly regard a low tax burden or low labor costs as an element of comparative advantage, there is no evidence to suggest that MNCs deliberately avail themselves of lax environmental regulation or poor labour standards. As Bhagwati has pointed out, MNC profits are tied to operational efficiency, which includes a high degree of standardisation. Thus, MNCs are likely to tailor production processes in all of their operations in conformity to those jurisdictions where they operate (which will almost always include one or more of the US, Japan or EU) that has the most rigorous standards. As for labor costs, while MNCs clearly pay workers in, e.g. Vietnam, much less than they would in the US (though it is worth noting that higher American productivity—linked **to** technology—means that any comparison is tricky, since in America the same company would probably hire far fewer people and automate whatever process they performed in Vietnam with manual labour), it is also the case that they tend to pay a premium of between 10% and 100% on local labor rates.[10] Finally, depending on the nature of

the MNC, investment in any country reflects a desire for a long- term return. Costs associated with establishing plant, training workers, etc., can be very high; once established in a jurisdiction, therefore, many MNCs are quite vulnerable to predatory practices such as, e.g., expropriation, sudden contract renegotiation, the arbitrary withdrawal or compulsory purchase of unnecessary 'licenses,' etc.

Market withdrawal

Because of their size, multinationals can have a significant impact on government policy, primarily through the threat of market withdrawal. For example, in an effort to reduce health care costs, some countries have tried to force pharmaceutical companies to license

their patented drugs to local competitors for a very low fee, thereby artificially lowering the price. When faced with that threat, multinational pharmaceutical firms have simply withdrawn from the market, which often leads to limited availability of advanced drugs. In these cases, governments have been forced to back down from their efforts. Similar corporate and government confrontations have occurred when governments tried to force MNCs to make their intellectual property public in an effort to gain technology for local entrepreneurs. When companies are faced with the option of losing a core competitive technological advantage or withdrawing from a national market, they may choose the latter. This withdrawal often causes governments to change policy. Countries that have been the most successful in this type of confrontation with multinational corporations are large countries such as United States and Brazil which have viable indigenous market competitors.

Lobbying

Multinational corporate lobbying is directed at a range of business concerns, from tariff structures to environmental regulations. There is no unified multinational perspective on any of these issues. Companies that have invested heavily in pollution control mechanisms may lobby for very tough environmental standards in an effort to force non-compliant competitors into a weaker position. Corporations lobby tariffs to restrict competition of foreign industries. For every tariff category that one multinational wants to have reduced, there is another multinational that wants the tariff raised. Even within the U.S. auto industry, the fraction of a company's imported components will vary, so some firms favor tighter import restrictions, while others favor looser ones. Says Ely Oliveira, Manager Director of the MCT/IR: This is very serious and is very hard and takes a lot of work for the owner.pk

Multinational corporations such as Wal-mart and McDonald's benefit from government zoning laws, to create barriers to entry.

Patents

Many multinational corporations hold patents to prevent competitors from arising. For example, Adidas holds patents on shoe designs, Siemens A.G. holds many patents on equipment and infrastructure and Microsoft benefits from software patents. The pharmaceutical companies lobby international agreements to enforce patent laws on others.

Government power

In addition to efforts by multinational corporations to affect governments, there is much government action intended to affect corporate behavior. The threat of nationalization (forcing a company to sell its local assets to the government or to other local nationals) or changes in local business laws and regulations can limit a multinational's power. These issues become of increasing importance because of the emergence of MNCs in developing countries.

Micro-multinationals

Enabled by Internet based communication tools, a new breed of multinational companies is growing in numbers.(Copeland, Michael V. (2006-06-29). "How startups go global".CNN.http://money.cnn.com/2006/06/28/magazines/business2/startupsgoglobal.biz2/index.htm. Retrieved 2010-05-13.) These multinationals start operating in different countries from the very early stages. These companies are being called micro-multinationals. (Varian, Hal R. (2005-08-25). "Technology Levels the Business Playing Field". The New York Times.

http://www.nytimes.com/2005/08/25/business/25scene.html. Retrieved 2010-05-13.) What differentiates micro-multinationals from the large MNCs is the fact that they are small businesses.

Some of these micro-multinationals, particularly software development companies, have been hiring employees in multiple countries from the beginning of the Internet era. But more and more micro-multinationals are actively starting to market their products and services in various countries. Internet tools like Google, Yahoo, MSN, Ebay and Amazon make it easier for the micro-multinationals to reach potential customers in other countries.

Service sector micro-multinationals, like Facebook, Alibaba etc. started as dispersed virtual businesses with employees, clients and resources located in various countries. Their rapid growth is a direct result of being able to use the internet, cheaper telephony and lower traveling costs to create unique business opportunities.

Low cost SaaS (Software As A Service) suites make it easier for these companies to operate without a physical office.

Hal Varian, Chief Economist at Google and a professor of information economics at U.C. Berkeley, said in April 2010, "Immigration today, thanks to the Web, means something very different than it used to mean. There's no longer a brain drain but brain circulation. People now doing startups understand what opportunities are available to them around the world and work to harness it from a distance rather than move people from one place to another."

5.2 ENVIRONMENTAL ETHICS

Environmental ethics believes in the ethical relationship between human beings and the natural environment. Human beings are a part of the society and so are the other living beings. When we talk about the philosophical principle that guides our life, we often ignore the fact that even plants and animals are a part of our lives. They are an integral part of the environment and hence have a right to be considered a part of the human life. On these lines, it is clear that they should also be associated with our guiding principles as well as our moral and ethical values.

What is Environmental Ethics?

We are cutting down forests for making our homes. We are continuing with an excessive consumption of natural resources. Their excessive use is resulting in their depletion, risking the life of our future generations. Is this ethical? This is the issue that environmental ethics takes up. Scientists like Rachel Carson and the environmentalists who led philosophers to consider the philosophical aspect of environmental problems, pioneered in the development of environmental ethics as a branch of environmental philosophy.

The Earth Day celebration of 1970 was also one of the factors, which led to the development of environmental ethics as a separate field of study. This field received impetus when it was first discussed in the academic journals in North America and Canada. Around the same time, this field also emerged in Australia and Norway. Today, environmental ethics is one of the major concerns of mankind.

When industrial processes lead to destruction of resources, is it not the industry's responsibility to restore the depleted resources? Moreover, can a restored environment make up for the originally natural one? Mining processes hamper the ecology of certain areas; they may result in the disruption of plant and animal life in those areas. Slash and burn techniques are used for clearing the land for agriculture.

Most of the human activities lead to environmental pollution. The overly increasing human population is increasing the human demand for resources like food and shelter. As the population is

exceeding the carrying capacity of our planet, natural environments are being used for human inhabitation.

Thus human beings are disturbing the balance in the nature. The harm we, as human beings, are causing to the nature, is coming back to us by resulting in a polluted environment. The depletion of natural resources is endangering our future generations. The imbalance in nature that we have caused is going to disrupt our life as well. But environmental ethics brings about the fact that all the life forms on Earth have a right to live. By destroying the nature, we are depriving these life forms of their right to live. We are going against the true ethical and moral values by disturbing the balance in nature. We are being unethical in treating the plant and animal life forms, which coexist in society.

Human beings have certain duties towards their fellow beings. On similar lines, we have a set of duties towards our environment. Environmental ethics says that we should base our behavior on a set of ethical values that guide our approach towards the other living beings in nature.

Environmental ethics is about including the rights of non-human animals in our ethical and moral values. Even if the human race is considered the primary concern of society, animals and plants are in no way less important. They have a right to get their fair share of existence.

We, the human beings, along with the other forms of life make up our society. We all are a part of the food chain and thus closely associated with each other. We, together form our environment. The conservation of natural resources is not only the need of the day but also our prime duty.

5.3 COMPUTER ETHICS

Ethics is a set of moral principles that govern the behavior of a group or individual. Therefore, computer ethics is set of moral principles that regulate the use of computers. Some common issues of computer ethics include intellectual property rights (such as copyrighted electronic content), privacy concerns, and how computers affect society. For example, while it is easy to duplicate copyrighted electronic (or digital) content, computer ethics would suggest that it is wrong to do so without the author's approval. And while it may be possible to access someone's personal information on a computer system, computer ethics would advise that such an action is unethical.

As technology advances, computers continue to have a greater impact on society. Therefore, computer ethics promotes the discussion of how much influence computers should have in areas such as artificial intelligence and human communication. As the world of computers evolves, computer ethics continues to create ethical standards that address new issues raised by new technologies.

5.4 WEAPONS DEVELOPMENT

A weapon is an instrument used for the purpose of causing harm or damage to people, animals or structures. Weapons are used in hunting, attack, self-defense, or defense in combat and range from simple implements like clubs and spears to complicated modern machines such as intercontinental ballistic missiles. One who possesses or carries a weapon is said to be armed.

In a broader context weapons include anything used to gain an advantage over an adversary or to place them at a disadvantage. Examples include the use of sieges, tactics, and psychological weapons which reduce the morale of an enemy

Classification By user - *what person or unit uses the weapon*

- Personal weapons (or small arms) - designed to be used by a single person.
- Hunting weapon - primarily for hunting game animals for food or sport
- Infantry support weapons - larger than personal weapons, requiring two or more to operate correctly.
- Fortification weapons - mounted in a permanent installation, or used primarily within a fortification.

- Mountain weapons - for use by mountain forces or those operating in difficult terrain.
- Vehicle weapons - to be mounted on any type of military vehicle.
- Railway weapons - designed to be mounted on railway cars, including armored trains.
- Aircraft weapons - carried on and used by some type of aircraft, helicopter
- Naval weapons - mounted on ships and submarines.
- Space weapons - are designed to be used in or launched from pace.

- *the construction of the weapon and principle of operation*

- Antimatter weapons (theoretical) would combine matter and antimatter to cause a powerful explosion.
- Archery weapons operate by using a tensioned string to launch a projectile.
- Artillery are capable of launching heavy projectiles over long distances.
- Biological weapons spread biological agents, causing disease or infection.
- Chemical weapons, poisoning and causing reactions.
- Energy weapons rely on concentrating forms of energy to attack, such as lasers or sonic attack.
- Explosive weapons use a physical explosion to create blast concussion or spread shrapnel.
- Firearms use a chemical charge to launch projectiles.
- Improvised weapons are common objects, reused as weapons.
- Incendiary weapons cause damage by fire.
- Non-lethal weapons are designed to subdue without killing.
- Magnetic weapons use magnetic fields to propel projectiles, or to focus particle
- Melee weapons operate as physical extensions of the user's body and directly impact **their** target.
- Missiles are rockets which are guided to their target after launch. (Also a general term for projectile weapons).
- Nuclear weapons use radioactive materials to create nuclear fission and/or nuclear fusion detonations.
- Primitive weapons make little or no use of technological or industrial elements.
- Ranged weapons (unlike Mêlée weapons), target a distant object or person.
- Rockets use chemical propellant to accelerate a projectile
- Suicide weapons exploit the willingness of their operator to not survive the attack.
- Trojan weapons appear on face value to be gifts, though the intent is to in some way to harm the recipient

By target - *the type of target the weapon is designed to attack*

- Anti-aircraft weapons target missiles and aerial vehicles in flight.
- Anti-fortification weapons are designed to target enemy installations.
- Anti-personnel weapons are designed to attack people, either individually or in numbers.
- Anti-radiation weapons target sources of electronic radiation, radar emitters.
- Anti-satellite weapons target orbiting satellites.
- Anti-ship weapons target ships and vessels on water.
- Anti-submarine weapons target submarines and other underwater targets.
- Anti-tank weapons are designed to defeat armored targets.
- Area denial weapons target territory, making it unsafe or unsuitable for enemy use or travel.
- Hunting weapons are civilian weapons used to hunt animals.
- Infantry support weapons are designed to attack various threats to infantry units

5.5 CONSULTING ENGINEERS

Consultants are individuals who typically work for themselves but may also be associated with a consulting firm. They, for a fee, gives advice or provides a service in a field of specialized knowledge or training. Most consultants carry their own life and health insurance, pay their own taxes, most have their own tools and equipment. The consultant can work alone or with the client's staff.

Consultants can play a multi-faceted role. They can, for example function as advisors, fixers, bosses, generalists, stabilizers, listeners, advisors, specialists, catalysts, managers or quasi-employees. The actual work that consultants perform for one company to another may vary greatly, i.e. tax account to office decoration. However, the typical underlying reasons that a consultant is hired are universal. A problem exists and the owner or manager of the company has decided to seek the help of an expert.

Bringing in an expert can save time, effort and money. It has been estimated that approximately 3/4 of all companies call upon consultants at one time or another. Many companies claim that they receive a higher return for their invested dollars by using consultants for specific tasks.

Most companies have experienced the problem of needing short-term technical expertise. Perhaps the company's existing staff is already working to capacity. In many cases, the engineering skills required for a project can be satisfied with a full time employee. When they can not fully justify bringing someone on board full time, their answer is to hire a consultant. By doing so, the businessman solves his immediate problem without permanently increasing his payroll and payroll taxes.

Consultants can be hired when the company may not have anyone on staff capable of solving the specific problem. At such times, a costly learning curve on the part of the engineering staff is associated with the project. One example is using a consultant as a viable alternative during the development stages of new products. Hiring a consultant with experience in a given area can then cut days, weeks or even months off a project schedule. In addition, he can help the staff avoid mistakes they may otherwise make. When the project reaches a certain point, the permanent staff can then take over.

Consultants can deal directly with owners and upper management. In this role , consultants can provide an objective third-party view point. Critical objectives can then be identified and advise given in confidence Consultants are a viable alternative in assisting in feasibility studies or in proposal preparation.

Perhaps the manager cannot justify shifting the duties of existing staff members.Another time that consultants become useful is when a company is just starting a business. The development of the company's new product can be begun by the consultant while a full time permanent technical staff member is being hired.

Finding the right consultant can be difficult. Managers can rely on referrals from their friends or hire the consultant who happens to call at the right time. Once the decisions is made to hire a consultant, the need is immediate and one may not have the time to shop for a consultant. As a part of planning ahead, it is wise to meet various consultants on an informal basis before the need to hire one arises. Then when the time comes, you will know exactly who to call for you have already established an informal relationship.

ETHICS IN ASCE

To preserve the high ethical standards of the civil engineering profession, the Society's ethics program includes:

- **Edict** - The Society maintains a Code of Ethics.
- **Enforcement** -The Society enforces the Code by investigating potential violations of the Code and taking disciplinary action if warranted.
- **Education -**The Society endeavors to educate its members and the public on ethics issues.

IEEE code of Ethics

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

Ethics in Indian Institute of Materials and Management

- To consider first, the TOTAL interest to one's organization in all transactions without impairing the dignity and responsibility to one's office;
- To buy without prejudice, seeking to obtain the maximum ultimate value for each Rupee of Expenditure;
- 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;
- To accord a prompt and courteous reception so far as conditions will permit, to all who call upon a legitimate business mission;

To respect one's obligations and those of one's organization, consistent with good business practice

Ethics in Institute of Engineers

1.1 Engineers serve all members of the community in enhancing their welfare, health and safety by a creative process utilising the engineers' knowledge, expertise and experience.

1.2 Pursuant to the avowed objectives of The Institution of Engineers (India) as enshrined in the presents of the Royal Charter granted to the Institution, the Council of the Institution prescribed a set of "Professional Conduct Rules" in the year 1944 replacing the same with the "Code of Ethics for Corporate Members" in the year 1954 which was revised in the year 1997.

1.3 In view of globalisation, concern for the environment and the concept of sustainable development, it has been felt that the prevailing "Code of Ethics for Corporate Members" needs review and revision in letter and spirit. The engineering organisations world over have updated their Code of Ethics.

1.4 The Council of the Institution vested with the authority in terms of the Present 2(j) of the Royal Charter adopted at its 626th meeting held on 21.12.2003 at Lucknow the "Code of Ethics for Corporate Members" as provided hereinafter.

1.5 The Code of Ethics is based on broad principles of truth, honesty, justice, trustworthiness, respect and safeguard of human life and welfare, competence and accountability which constitute the moral values every Corporate Member of the Institution must recognize, uphold and abide by.

1.6 This "Code of Ethics for Corporate Members" shall be in force till the same is revised by a decision of the Council of the Institution.

5.6 CODE OF ETHICS FOR INSTITUTE OF ENGINEERS

1.0 Preamble

1.1 The Corporate Members of The Institution of Engineers (India) are committed to promote and practice the profession of engineering for the common good of the community bearing in mind the following concerns :

1.1.1` Concern for ethical standard;
1.1.2 Concern for social justice, social order and human ights;
1.1.3 Concern for protection of the environment;
1.1.4 Concern for sustainable development;
1.1.5 Public safety and tranquility.

2.0 The Tenets of the Code of Ethics

2.1 A Corporate Member shall utilise his knowledge and expertise for the welfare, health and safety of the community without any discrimination for sectional or private interests.

2.2 A Corporate Member shall maintain the honour, integrity and dignity in all his professional actions to be worthy of the trust of the community and the profession.

2.3 A Corporate Member shall act only in the domains of his competence and with diligence, care, sincerity and honesty.

2.4 A Corporate Member 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.

2.5 A Corporate Member shall not falsify or misrepresent his own or his associates' qualifications, experience, etc.

2.6 A Corporate Member, 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.

2.7 A Corporate Member shall maintain utmost honesty and fairness in making statements or giving witness and shall do so on the basis of adequate knowledge.

2.8 A Corporate Member shall not directly or indirectly injure the professional reputation of another member.

2.9 A Corporate Member shall reject any kind of offer that may involve unfair practice or may cause avoidable damage to the ecosystem.

2.10 A Corporate Member shall be concerned about and shall act in the best of his abilities for maintenance of sustainability of the process of development.

2.11 A Corporate Member 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.

3.0 General Guidance

The Tenets of the Code of Ethics are based on the recognition that –

3.1 A common tie exists among the humanity and that The Institution of Engineers (India) derives its value from the people, so that the actions of its Corporate Members should indicate the member's highest regard for equality of opportunity, social justice and fairness;

3.2 The Corporate Members of the Institution hold a privileged position in the community so as to make it a necessity for their not using the position for personl and sectional interests.

4.0 And, as such, a Corporate Member

4.1 should keep his employer or client fully informed on all matters in respect of his assignment which are likely to lead to a conflict of interest or when, in his judgement, a project will not be viable on the basis of commercial, technical, environmental or any other risks;

4.2 should maintain confidentiality of any information with utmost sincerity unless expressly permitted to disclose such information or unless such permission, if withheld, may adversely affect the welfare, health and safety of the community;

4.3 should neither solicit nor accept financial or other considerations from anyone related to a project or assignment of which he is in the charge;

4.4 should neither pay nor offer direct or indirect inducements to secure work;

4.5 should compete on the basis of merit alone;

4.6 should refrain from inducing a client to breach a contract entered into with another duly appointed engineer;

4.7 should, if asked by employer or client, to review work of another person or organisation, discuss the review with other person or organisation to arrive at a balanced opinion;

4.8 should make statements or give evidence before a tribunal or a court of law in an objective and accurate manner and express any opinion on the basis of adequate knowledge and competence; and

4.9 should reveal the existence of any interest – pecuniary or otherwise – which may affect the judgement while giving an evidence or making a statement.

5.0 Any decision of the Council as per provisions of the relevant Bye-Laws of the Institution shall be final and binding on all Corporate Members.

ASME Code of Ethics of Engineers

ASME requires ethical practice by each of its members and has adopted the following Code of Ethics of Engineers as referenced in the ASME Constitution, Article C2.1.1.

5.7 CODE OF ETHICS OF ENGINEERS

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

I. Using their knowledge and skill for the enhancement of human welfare;
II. Being honest and impartial, and serving with fidelity the public, their employers and clients; and
III. Striving to increase the competence and prestige of the engineering profession.

The Fundamental Canons

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.
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 build their professional reputation on the merit of their services and shall not compete unfairly with others.
6. Engineers shall associate only with reputable persons or organizations.
7. Engineers shall issue public statements only in an objective & truthful manner.

8. Engineers shall consider environmental impact in the performance of their professional duties.

The ASME criteria for interpretation of the Canons are guidelines and represent the objectives toward which members of the engineering profession should strive. They are principles which an engineer can reference in specific situations. In addition, they provide interpretive guidance to the ASME Board on Professional Practice and Ethics on the Code of Ethics of Engineers.

1. Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.

a. Engineers shall recognize that the lives, safety, health and welfare of the general public are dependent upon engineering judgments, decisions and practices incorporated into structures, machines, products, processes and devices.

b. Engineers shall not approve or seal plans and/or specifications that are not of a design safe to the public health and welfare and in conformity with accepted engineering standards.

c. Whenever the Engineers' professional judgments are over ruled under circumstances where the safety, health, and welfare of the public are endangered, the Engineers shall inform their clients and/or employers of the possible consequences.

(1) Engineers shall endeavor to provide data such as published standards, test codes, and quality control procedures that will enable the users to understand safe use during life expectancy associated with the designs, products, or systems for which they are responsible.

(2) Engineers shall conduct reviews of the safety and reliability of the designs, products, or systems for which they are responsible before giving their approval to the plans for the design.

(3) Whenever Engineers observe conditions, directly related to their employment, which they believe will endanger public safety or health, they shall inform the proper authority of the situation.

d. If engineers have knowledge of or reason to believe that another person or firm may be in violation of any of the provisions of these Canons, they shall present such information to the proper authority in writing and shall cooperate with the proper authority in furnishing such further information or assistance as may be required.

2. Engineers shall perform services only in areas of their competence.

a. Engineers shall undertake to perform engineering assignments only when qualified by education and/or experience in the specific technical field of engineering involved.

b. Engineers may accept an assignment requiring education and/or experience outside of their own fields of competence, but their services shall be restricted to other phases of the project in which they are qualified. All other phases of such project shall be performed by qualified associates, consultants, or employees.

3. Engineers shall continue their professional development throughout their careers, and should 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.

a. Engineers shall avoid all known conflicts of interest with their employers or clients and shall promptly inform their employers or clients of any business association, interests, or circumstances which could influence their judgment or the quality of their services.

b. Engineers shall not undertake any assignments which would knowingly create a potential conflict of interest between themselves and their clients or their employers.

c. Engineers shall not accept compensation, financial or otherwise, from more than one party for services on the same project, or for services pertaining to the same project, unless the circumstances are fully disclosed to, and agreed to, by all interested parties.

d. Engineers shall not solicit or accept financial or other valuable considerations, for specifying products or material or equipment suppliers, without disclosure to their clients or employers

e. Engineers shall not solicit or accept gratuities, directly or indirectly, from contractors, their agents, or other parties dealing with their clients or employers in connection with work for which they are responsible. Where official public policy or employers' policies tolerate acceptance of modest gratuities or gifts, engineers shall avoid a conflict of interest by complying with appropriate policies and shall avoid the appearance of a conflict of interest.

f. When in public service as members, advisors, or employees of a governmental body or department, Engineers shall not participate in considerations or actions with respect to services provided by them or their organization(s) in private or product engineering practice.

g. Engineers shall not solicit an engineering contract from a governmental body or other entity on which a principal, officer, or employee of their organization serves as a member without disclosing their relationship and removing themselves from any activity of the body which concerns their organization.

h. Engineers working on codes, standards or governmental sanctioned rules and specifications shall exercise careful judgment in their determinations to ensure a balanced viewpoint, and avoid a conflict of interest.

i. When, as a result of their studies, Engineers believe a project(s) will not be successful, they shall so advise their employer or client.

j. Engineers shall treat information coming to them in the course of their assignments as confidential, and shall not use such information as a means of making personal profit if such action is adverse to the interests of their clients, their employers or the public.

(1) They will not disclose confidential information concerning the business affairs or technical processes of any present or former employer or client or bidder under evaluation, without his consent, unless required by law or court order.

(2) They shall not reveal confidential information or finding of any commission or board of which they are members unless required by law or court order

(3) Designs supplied to Engineers by clients shall not be duplicated by the Engineers for others without the express permission of the client(s).

k. Engineers shall act with fairness and justice to all parties when administering a construction (or other) contract.

Before undertaking work for others in which Engineers may make improvements, plans, designs, inventions, or other records which may justify seeking copyrights, patents, or proprietary rights, Engineers shall enter into positive agreements regarding the rights of respective parties.

m. Engineers shall admit their own errors when proven wrong and refrain from distorting or altering the facts to justify their mistakes or decisions.

n. Engineers shall not accept professional employment or assignments outside of their regular work without the knowledge of their employers.

o. Engineers shall not attempt to attract an employee from other employers or from the market place by false or misleading representations.

5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.

a. Engineers shall negotiate contracts for professional services on the basis of demonstrated competence and qualifications for the type of professional service required.

b. Engineers shall not request, propose, or accept professional commissions on a contingent basis if, under the circumstances, their professional judgments may be compromised.

c. Engineers shall not falsify or permit misrepresentation of their, or their associates, academic or professional qualification. They shall not misrepresent or exaggerate their degrees of responsibility in or for the subject matter of prior assignments. Brochures or other presentations used to solicit personal employment shall not misrepresent pertinent facts concerning employers, employees, associates, joint venturers, or their accomplishments.

d. Engineers shall prepare articles for the lay or technical press which are only factual. Technical Communications for publication (theses, articles, papers, reports,etc.) which are based on research involving more than one individual (including students and supervising faculty, industrial supervisor/researcher or other co-workers) must recognize all significant contributors. Plagiarism, the act of substantially using another's ideas or written materials without due credit, is unethical. (See Appendix.)

e. Engineers shall not maliciously or falsely, directly or indirectly, injure the professional reputation, prospects, practice or employment of another engineer, nor shall they indiscriminately criticize another's work.

f. Engineers shall not use equipment, supplies, laboratory or office facilities of their employers to carry on outside private practice without consent

6. Engineers shall associate only with reputable persons or organizations.

a. Engineers shall not knowingly associate with or permit the use of their names or firm names in business ventures by any person or firm which they know, or have reason to believe, are engaging in business or professional practices of a fraudulent or dishonest nature.

b. Engineers shall not use association with non-engineers, corporations, or partnerships to disguise unethical acts.

7. Engineers shall issue public statements only in an objective and truthful manner.

a. Engineers shall endeavor to extend public knowledge, and to prevent misunderstandings of the achievements of engineering.

b. Engineers shall be completely objective and truthful in all professional reports, statements or testimony. They shall include all relevant and pertinent information in such reports, statements or testimony.

c. Engineers, when serving as expert or technical witnesses before any court, commission, or other tribunal, shall express an engineering opinion only when it is founded on their adequate knowledge of the facts in issue, their background of technical competence in the subject matter, and their belief in the accuracy and propriety of their testimony.

d. Engineers shall issue no statements, criticisms, or arguments on engineering matters which are inspired or paid for by an interested party, or parties, unless they preface their comments by identifying themselves, by disclosing the identities of the party or parties on whose behalf they are speaking, and by revealing the existence of any financial interest they may have in matters under discussion.

e. Engineers shall be truthful in explaining their work and merit, and shall avoid any act tending to promote their own interest at the expense of the integrity and honor of the profession or another individual.

8. Engineers shall consider environmental impact in the performance of their professional duties.

Engineers shall concern themselves with the impact of their plans and designs on the environment. When the impact is a clear threat to health or safety of the public, then the guidelines for this Canon revert to those of Canon 1.

9. Engineers accepting membership in The American Society of Mechanical Engineers by this action agree to abide by this Society Policy on Ethics and procedures for its implementation.

5.8 MORAL LEADERSHIP

Moral Leadership brings together in one comprehensive volume essays from leading scholars in law, leadership, psychology, political science, and ethics to provide practical, theoretical policy guidance. The authors explore key questions about moral leadership such as:

- How do leaders form, sustain, and transmit moral commitments?
- Under what conditions are those processes most effective?
- What is the impact of ethics officers, codes, training programs, and similar initiatives?
- How do standards and practices vary across context and culture?
- What can we do at the individual, organizational, and societal level to foster moral leadership?

5.9 ENGINEERS AS EXPERT WITNESS AND ADVISORS

Engineering expert witnesses are highly credentialed mechanical, safety & civil, geotechnical, chemical and electrical engineers specializing in the areas of design, construction & structural engineering, failure analysis, human factors, occupational safety, metallurgy and more. They provide litigation support through review and evaluation of distressed structures for land slide and erosion cases; performance of forensic studies on hydraulics, power plants, pipelines, boiler systems, traffic, automotive, electrical fire involving electrical systems of machinery; site research and inspection, laboratory testings, report writing, depositions and court testimony.

a. Engineers shall endeavor to extend public knowledge, and to prevent misunderstandings of the achievements of engineering.
b. Engineers shall be completely objective and truthful in all professional reports, statements or testimony. They shall include all relevant and pertinent information in such reports, statements or testimony.
c. Engineers, when serving as expert or technical witnesses before any court, commission, or other tribunal, shall express an engineering opinion only when it is founded on their adequate knowledge of the facts in issue, their background of technical competence in the subject matter, and their belief in the accuracy and propriety of their testimony.