R.M.K GROUP OF ENGINEERING INSTITUTIONS

R.M.K
GROUP OF
INSTITUTIONS

R.M.K
GROUP OF INSTITUTIONS

GE8076 Professional Ethics in Engineering

Department: IT
Batch/Year:2019-2023/IV
2020-2024/III

Created by:
Dr.K.Balasubadra
Dr.V.Prasanna Srinivasan

Date:15/02/2023

R.M.K GROUP OF INSTITUTIONS

1. CONTENTS

R.M.K GROUP OF INSTITUTIONS

2. COURSE OBJECTIVES

- To enable the students to create an awareness on Engineering Ethics and Human Values
- To instill Moral and Social Values and Loyalty and to appreciate the rights of others.

3. PRE REQUISITES

- **Ethics in engineering practice is about professional responsibilities of engineers.**
- **Professional ethics have been recognized as an important foundation in the practice of engineering for several decades in many industrialized countries.**

4. SYLLABUS

GE8076 PROFESSIONAL ETHICS IN ENGINEERING

LT P C

3 0 0 3

OBJECTIVES

- To enable the students to create an awareness on Engineering Ethics and Human Values,
- to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 10

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.

UNIT II ENGINEERING ETHICS 9

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.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

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

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

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.

UNIT V GLOBAL ISSUES 8

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.

OUTCOMES

At the end of the course, the student should be able to:

Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

5. COURSE OUTCOMES

CO	Course outcome(CO) – Statements
CO1	Create awareness on human values and apply ethics in society.
CO2	Identify an ethical issue and assess variety of moral issues using ethical theories in engineering.
CO3	Analyze engineering, social experimentation and engineers as responsible experimenters
CO4	Realize engineers' safety and their responsibilities, professional rights, employee rights, and intellectual property rights.
CO5	Interpret various types of ethics like business ethics, environmental ethics and computer ethics.
CO6	Take part an engineers as managers, consulting engineers, engineers as expert witness and advisors.

R.M.K GROUP OF INSTITUTIONS

6. CO- PO/PSO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
1	-	-	-	-	-	3	3	3	3	3	-	3
2	-	-	-	-	-	3	3	3	3	3	-	3
3	-	-	-	-	-	3	3	3	3	3	-	3
4	-	-	-	-	-	3	3	3	3	3	-	3
5	-	-	-	-	-	3	3	3	3	3	-	3
6	-	-	-	-	-	3	3	3	3	3	-	3

	PSO1	PSO2	PSO3
CO1	-	-	-
CO2	-	-	-
CO3	-	-	-
CO4	-	-	-
CO5	-	-	-
CO6	-	-	-

7. LECTURE PLAN : UNIT – III

ENGINEERING AS SOCIAL EXPERIMENTATION

S. No	Proposed Lecture Date	Topic	Actual Lecture Date	CO	Highest Cognitive Level	Mode of Delivery	Delivery Resources	LU Outcomes	Remark
1	27.01.2023	Engineering as Experimentation		CO3	K2	MD1 & MD5	T1	Understanding Engineering as social experimentation and codes of ethics.	
2	28.01.2023	Comparisons with standard Experiments		CO3	K2	MD1 & MD5	T1	Compare the standard experiments with industrial experiments	
3	30.01.2023	Engineers as responsible Experiments		CO3	K2	MD1 & MD5	T1	Explain the concept of engineering as responsible experimentation	
4	31.01.2023	Accountability - Engineers as responsible Experiments		CO3	K2	MD1 & MD5	T1	Apply the concept of accountability	
5	01.02.2023	Codes of Ethics		CO3	K2	MD1 & MD5	T1	Explain Codes of ethics	
6	02.02.2023	Limitations of Codes		CO3	K2	MD1 & MD5	T1	Analyze the limitations of codes of ethics	
7	03.02.2023	A Balanced Outlook on Law- Babylon's Building Code		CO3	K2	MD1 & MD5	T1	Study Babylon's building Code	
8	04.02.2023	A Balanced Outlook on Law- The United State Steam Boat Code		CO3	K2	MD1 & MD5	T1	Study The united State Steam Boat code	
9	06.02.2023	Challenger Case Study		CO3	K3	MD1 & MD5		The challenger Case Study	

ASSESSMENT COMPONENTS

- AC 1. Unit Test
- AC 2. Assignment
- AC 3. Course Seminar
- AC 4. Course Quiz
- AC 5. Case Study
- AC 6. Record Work
- AC 7. Lab / Mini Project
- AC 8. Lab Model Exam
- AC 9. Project Review

MODE OF DELEIVERY

MD 1. Oral presentation
MD 2. Tutorial
MD 3. Seminar
MD 4 Hands On
MD 5. Videos
MD 6. Field Visit

8. ACTIVITY BASED LEARNING : UNIT – III

UNIT – III

8 Activity based learning

- **Case study**

Case studies (from students) for Engineering as Social Experimentation Software...

- **Student: "I was involved in designing and testing network communication software. Some tests were still being run when clients requested the software. We were unable to finish the tests, and gave the product to the customer knowing that the system caused lock-ups and loss of data. We then used the feedback from these clients to debug the software, and repeated the process." What to do?**

- **Similar student case: "In software engineering I have encountered problems in that the time required for testing the product and the deadline for testing may conflict, and some parts of the testing may have to be compromised to meet those deadlines."**

- **Environment...**
- **Student: "A turbidity meter was used to monitor if contaminants were getting into the water that goes into the river. When those meters failed to alarm us, and a white pigment went into the river, my project that focused on redesigning the monitoring station was given support."**
- **Can/should the engineer do anything?**
- **Creative solutions?**

8. ACTIVITY BASED LEARNING : UNIT – III

UNIT – III

Activity based learning

❁ Case study

Student: "In wastewater treatment plants, control systems are tested in the field. The control systems are designed according to specifications and ISA/IEEE rules, but the testing of how the systems will operate under real life situations is done after installing them.

Two questions arise, then: first, can the plant design withstand additional rain, population increases, weather problems, etc? Second, can the control system adequately analyze these new factors and operate the plant successfully?

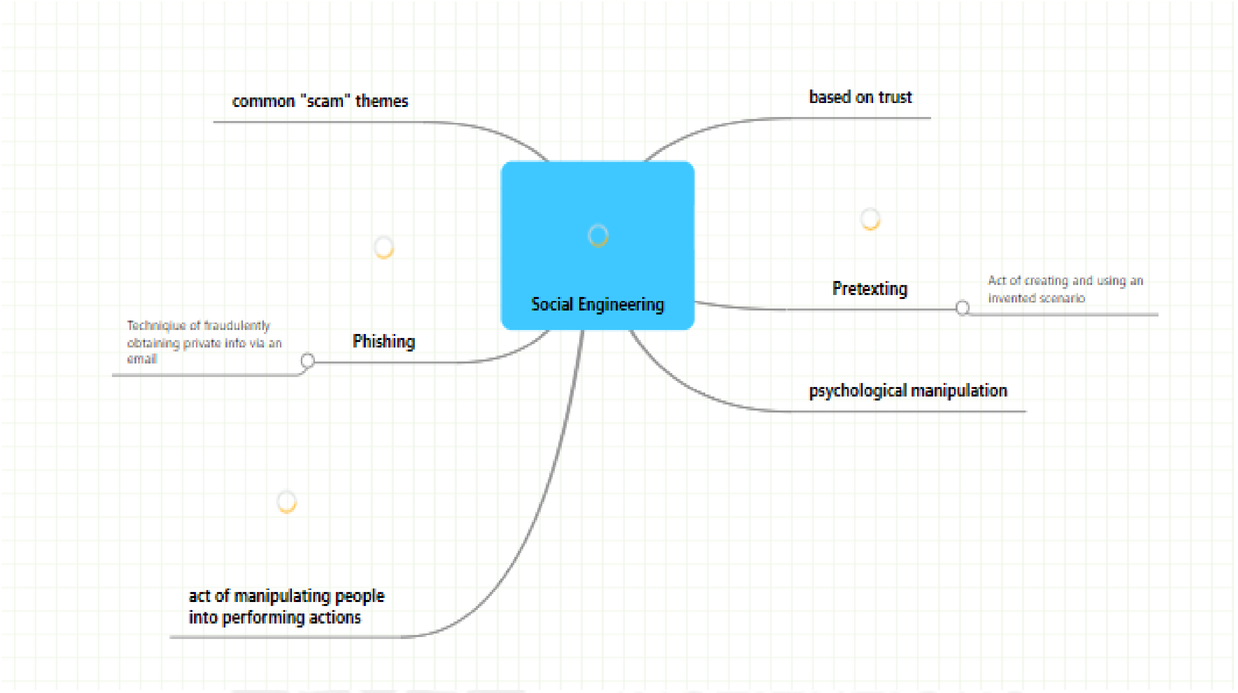
If anything fails, the great danger is the release of raw sewage/sludge and bacteria onto land and into the water supply." What can the engineer do? Will competence solve the problem?

R.M.K GROUP OF INSTITUTIONS

8. ACTIVITY BASED LEARNING : UNIT – III

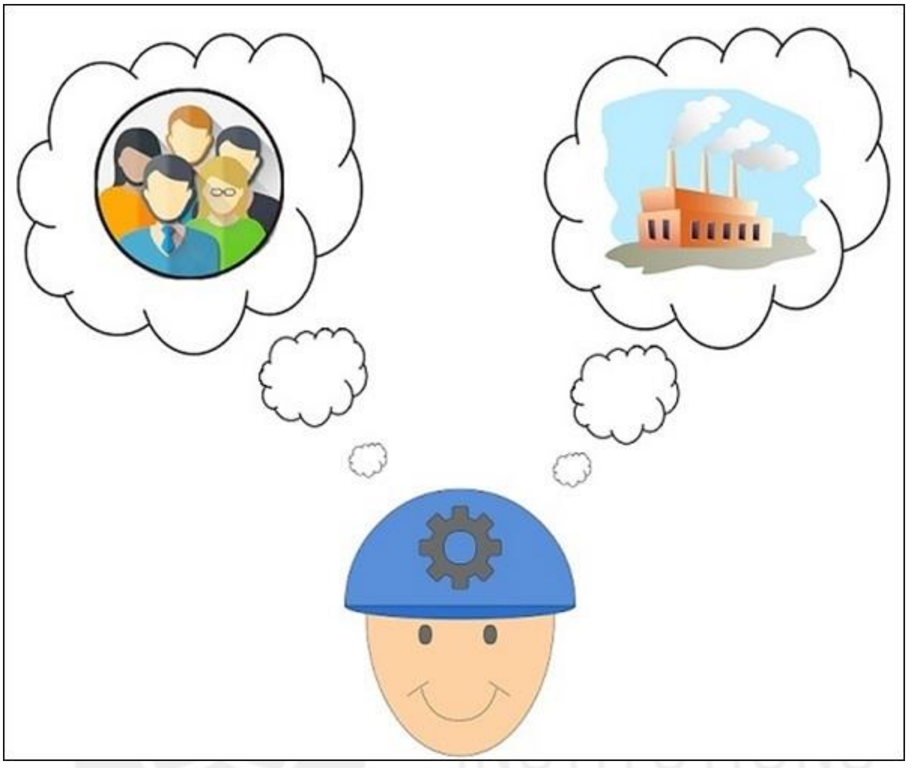
UNIT – III

❁ MIND MAP FOR ENGINEERING AS SOCIAL EXPERIMENTATION



8. ACTIVITY BASED LEARNING : UNIT – III

STORY TELLING



Classroom Activities for this Lesson

9. LECTURE NOTES : UNIT – III

ENGINEERING AS EXPERIMENTATION

3.0 ENGINEERING AS EXPERIMENTATION

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.

Before manufacturing a product or providing a project, we make several assumptions and trials, design and redesign and test several times till the product is observed to be functioning satisfactorily. We try different materials and experiments. From the test data obtained we make detailed design and retests. Thus, design as well as engineering is iterative process as illustrated in Fig. 3.1.

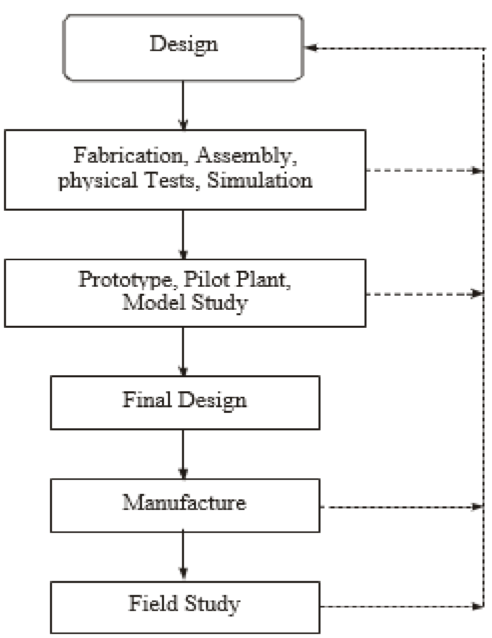


Fig. 3.1 Design as an interactive process

9. LECTURE NOTES : UNIT – III

Several redesigns are made upon the feedback information on the performance or failure in the field or in the factory. Besides the tests, each engineering project is modified during execution, based on the periodical feedback on the progress and the lessons from other sources. Hence, the development of a product or a project as a whole may be considered as an experiment.

3.0.1 Engineering Projects VS. Standard Experiments

We shall now compare the two activities, and identify the similarities and contrasts.

A. Similarities

1. Partial ignorance: The project is usually executed in partial ignorance. Uncertainties exist in the model assumed. The behavior of materials purchased is uncertain and not constant (that is certain!). They may vary with the suppliers, processed lot, time, and the process used in shaping the materials (e.g., sheet or plate, rod or wire, forged or cast or welded). There may be variations in the grain structure and its resulting failure stress. It is not possible to collect data on all variations. In some cases, extrapolation, interpolation, assumptions of linear behavior over the range of parameters, accelerated testing, simulations, and virtual testing are resorted.

2. **Uncertainty:**

The final outcomes of projects are also uncertain, as in experiments. Some times unintended results, side effects (bye-roducts), and unsafe operation have also occurred. Unexpected risks, such as undue seepage in a storage dam, leakage of nuclear radiation from an atomic power plant, presence of pesticides in food or soft drink bottle, an new irrigation canal spreading water-borne diseases, and an unsuspecting hair dryer causing lung cancer on the user from the asbestos gasket used in the product have been reported.

3. **Continuous monitoring:**

Monitoring continually the progress and gaining new knowledge are needed before, during, and after execution of project as in the case of experimentation. The performance is to be monitored even during the use (or wrong use!) of the product by the end user/beneficiary.

4. **Learning from the past:**

Engineers normally learn from their own prior designs and infer from the analysis of operation and results, and sometimes from the reports of other engineers. But this does not happen frequently. The absence of interest and channels of communication, ego in not seeking information, guilty upon the failure, fear of legal actions, and mere negligence have caused many a failure, e.g., the Titanic lacked sufficient number of life boats—it had only 825 boats for the actual passengers of 2227, the capacity of the ship being 3547! In the emergent situation, all the existing life boats could not be launched. Forty years back, another steamship Arctic met with same tragedy due to the same problem in the same region. But the lesson was learned. In most of the hydraulic systems, valves had been the critical components that are least reliable. The confusion on knowing whether the valve was open or closed, was the cause of the Three-Mile Island accident in 1979. Similar malfunctioning of valves and mis-reading of gauges have been reported to have caused the accidents else where in some power plants. But we have not learnt the lesson from the past. The complacency that it will not happen again and will not happen 'to me' has lead to many disasters.

B. Contrasts

The scientific experiments in the laboratory and the engineering experiments in the filed exhibit several contrasts as listed below:

1. Experimental control:

In standard experiments, members for study are selected into two groups namely A and B at random. Group A are given special treatment. The group B is given no treatment and is called the 'controlled group'. But they are placed in the same environment as the other group A.This process is called the experimental control. This practice is adopted in the field of medicine. In engineering, this does not happen, except when the project is confined to laboratory experiments. This is because it is the clients or consumers who choose the product, exercise the control. It is not possible to make a random selection of participants from various groups. In engineering, through random sampling, the survey is made from among the users, to assess the results on the product..

2. Humane touch:

Engineering experiments involve human souls, their needs, views, expectations, and creative use as in case of social experimentation. This point of view is not agreed by many of the engineers. But now the quality engineers and managers have fully realized this humane aspect.

3. Informed consent:

Engineering experimentation is viewed as Societal Experiment since the subject and the beneficiary are human beings. In this respect, it is similar to medical experimentation on human beings. In the case of medical practice, moral and legal rights have been recognized while planning for experimentation. Informed consent is practiced in medical experimentation. Such a practice is not there in scientific laboratory experiments.

9. LECTURE NOTES : UNIT – III

Informed consent has two basic elements:

1. **Knowledge:** The subject should be given all relevant information needed to make the decision to participate.
2. **Voluntariness:** Subject should take part without force, fraud or deception. Respect for rights of minorities to dissent and compensation for harmful effect are assumed here.

For a valid consent, the following conditions are to be fulfilled:

1. Consent must be voluntary
2. All relevant information shall be presented/stated in a clearly understandable form
3. Consenter shall be capable of processing the information and make rational decisions.
4. The subject's consent may be offered in proxy by a group that represents many subjects of like-interests

Informed consent when bringing an engineering product to market, implies letting the customer know the following: (a) the knowledge about the product (b) risks and benefits of using the product and (c) all relevant information on the product, such as how to use and how not to use (do's and don'ts). The relevant factual information implies, that the engineers are obliged to obtain and assess all the available information related to the fulfillment of one's moral obligations (i.e., wrong or immoral use of a product one designs), including the intended and unintended impacts of the product, on the society. Still there exists a possibility of a large gap of understanding between the experimenter and the subjects (public). Sometimes, the managements have not been willing to disseminate the full information about the project or product beyond the legal requirements, because of the fear of potential competitions and likely exposure to potential litigation.

R.M.K GROUP OF INSTITUTIONS

People object to *involuntary risks* wherein the affected individual is neither a direct participant nor a decision maker. In short, we prefer to be the subjects of our own experiments rather than those of somebody else. If it is an asbestos plant or nuclear plant to be approved, affected parties expect their consent to be obtained. But they are ready to accept *voluntary* risks as in the case of stunts and amazing races. In case of Koodangulam power project as well as the Sethusamudram Canal Project, Tamil Nadu, several citizen groups including Fishermen Forums have responded. The Central government was able contain many harsh apprehensions and protracted legal and political battles, by providing all relevant information.

4. Knowledge gained:

Not much of new knowledge is developed in engineering experiments as in the case of scientific experiments in the laboratory. Engineering experiments at the most help us to (*a*) verify the adequacy of the design, (*b*) to check the stability of the design parameters, and (*c*) prepare for the unexpected outcomes, in the actual field environments. From the models tested in the laboratory to the pilot plant tested in the field, there are differences in performance as well as other outcomes.

R.M.K GROUP OF INSTITUTIONS

9. LECTURE NOTES : UNIT – III

3.1 ENGINEERS AS RESPONSIBLE EXPERIMENTERS

Although the engineers facilitate experiments, they are not alone in the field. Their responsibility is shared with the organizations, people, government, and others. No doubt the engineers share a greater responsibility while monitoring the projects, identifying the risks, and informing the clients and the public with facts. Based on this, they can take decisions to participate or protest or promote.

The engineer, as an experimenter, owe several responsibilities to the society, namely,

1. Aconscientious commitment to live by moral values.
2. A comprehensive perspective on relevant information. It includes constant awareness of the progress of the experiment and readiness to monitor the side effects, if any.
3. Unrestricted free-personal involvement in all steps of the project/product development (autonomy).
4. Be accountable for the results of the project (accountability).

3.1.1. Conscientiousness

Conscientious moral commitment means: (*a*) Being sensitive to full range of moral values and responsibilities relevant to the prevailing situation and (*b*) the willingness to develop the skill and put efforts needed to reach the best balance possible among those considerations. In short, engineers must possess open eyes, open ears, and an open mind (i.e., moral vision, moral listening, and moral reasoning).

This makes the engineers as social experimenters, respect foremost the safety and health of the affected, while they seek to enrich their knowledge, rush for the profit, follow the rules, or care for only the beneficiary. The human rights of the participant should be protected through voluntary and informed consent.

9. LECTURE NOTES : UNIT – III

3.1.2 Comprehensive Perspective

The engineer should grasp the context of his work and ensure that the work involved results in only moral ends. One should not ignore his conscience, if the product or project that he is involved will result in damaging the nervous system of the people (or even the enemy, in case of weapon development)

A product has a built-in obsolete or redundant component to boost sales with a false claim. In possessing of the perspective of factual information, the engineer should exhibit a moral concern and not agree for this design. Sometimes, the guilt is transferred to the government or the competitors. Some organizations think that they will let the government find the fault or let the fraudulent competitor be caught first. Finally, a full-scale environmental or social impact study of the product or project by individual engineers is useful but not possible, in practice.

3.1.3 Moral Autonomy

A detailed discussion is available in # 2.5. Viewing engineering as social experimentation, and anticipating unknown consequences should promote an attitude of questioning about the adequacy of the existing economic and safety standards. This proves a greater sense of personal involvement in one's work.

3.1.4 Accountability

The term Accountability means:

1. The capacity to understand and act on moral reasons
2. Willingness to submit one's actions to moral scrutiny and be responsive to the assessment of others. It includes being answerable for meeting specific obligations, i.e., liable to justify (or give reasonable excuses) the decisions, actions or means, and outcomes (sometimes unexpected), when required by the stakeholders or by law.

The tug-of-war between of causal influence by the employer and moral responsibility of the employee is quite common in professions. In the engineering practice, the problems are:

1. The fragmentation of work in a project inevitably makes the final products lie away from the immediate work place, and lessens the personal responsibility of the employee.
2. Further the responsibilities diffuse into various hierarchies and to various people. Nobody gets the real feel of personal responsibility.
3. Often projects are executed one after another. An employee is more interested in adherence of tight schedules rather than giving personal care for the current project.
4. More litigation is to be faced by the engineers (as in the case of medical practitioners). This makes them wary of showing moral concerns beyond what is prescribed by the institutions. In spite of all these shortcomings, engineers are expected to face the risk and show up personal responsibility as the profession demands.

3.2 CODES OF ETHICS

The 'codes of ethics' exhibit, rights, duties, and obligations of the members of a profession and a professional society. The codes exhibit the following essential roles:

1. **Inspiration and guidance** The codes express the collective commitment of the profession to ethical conduct and public good and thus inspire the individuals. They identify primary responsibilities and provide statements and guidelines on interpretations for the professionals and the professional societies.

R.M.K
GROUP OF
INSTITUTIONS

1. Support to engineers. The codes give positive support to professionals for taking stands on moral issues. Further they serve as potential legal support to discharge professional obligations.
2. **Deterrence** (discourage to act immorally) and discipline (regulate to act morally). The codes serve as the basis for investigating unethical actions. The professional societies sometimes revoke membership or suspend/expel the members, when proved to have acted unethical. This sanction along with loss of respect from the colleagues and the society are bound to act as deterrent.
3. **Education and mutual understanding** Codes are used to prompt discussion and reflection on moral issues. They develop a shared understanding by the professionals, public, and the government on the moral responsibilities of the engineers. The Board of Review of the professional societies encourages moral discussion for educational purposes.
4. **Create good public image** The codes present positive image of the committed profession to the public, help the engineers to serve the public effectively. They promote more of self regulation and lessen the government regulations. This is bound to raise the reputation of the profession and the organization, in establishing the trust of the public.
5. **Protect the status quo** They create minimum level of ethical conduct and promotes agreement within the profession. Primary obligation namely the safety, health, and welfare of the public, declared by the codes serves and protects the public.
6. **Promotes business interests** The codes offer inspiration to the entrepreneurs, establish shared standards, healthy competition, and maximize profit to investors, employees, and consumers.

Limitations:

The codes are not remedy for all evils. They have many limitations, namely:

1. General and vague wordings. Many statements are general in nature and hence unable to solve all problems.
2. Not applicable to all situations. Codes are not sacred, and need not be accepted without criticism. Tolerance for criticisms of the codes themselves should be allowed.
3. Often have internal conflicts. Many times, the priorities are clearly spelt out, e.g., codes forbid public remarks critical of colleagues (engineers), but they actually discovered a major bribery, which might have caused a huge loss to the exchequer.
4. They can not be treated as final moral authority for professional conduct. Codes have flaws by commission and omission. There are still some grey areas undefined by codes. They can not be equated to laws. After all, even laws have loopholes and they invoke creativity in the legal practitioners.
5. Only a few enroll as members in professional society and non-members can not be compelled.
6. Even as members of the professional society, many are unaware of the codes
7. Different societies have different codes. The codes can not be uniform or same! Unifying the codes may not necessarily solve the problems prevailing various professions, but attempts are still made towards this unified codes.
8. Codes are said to be coercive. They are sometimes claimed to be threatening and forceful.

R.M.K GROUP OF INSTITUTIONS

3.3 INDUSTRIAL STANDARDS

Industrial standards are important for any industry. Specification helps in achieving interchangeability. Standardization reduces the production costs and at the same time, the quality is achieved easily. It helps the manufacturer, customers and the public, in keeping competitiveness and ensuring quality simultaneously. Industrial standards are established by the Bureau of Indian Standards, in our country in consultation with leading industries and services.International standards have become relevant with the development of the world trade. The International Standards Organization has now detailed specifications for generic products/services with procedures that the manufacturers or service providers should follow to assure the quality of their products or service. ISO 9000-2000 series are typical examples in this direction.

Table 3.1 gives a list of some types of standards with a few examples.

Table. 3.1 Industrial standards

Aspects	*Purpose*	*Examples*
1. Quality	Value appropriate to price	Surface finish of a plate, life of a motor
2. Quality of service	Assurance of product to ISO procedures	Quality of degrees according institutions by educational institutions
3. Safety	To safeguard against injury or damage to property	Methods of waste disposal
4. Uniformity of physical properties and functions	Interchangeability, ease of assembly	Standard bolts and nuts, standard time

R.M.K GROUP OF INSTITUTIONS

9. LECTURE NOTES : UNIT – III

3.4 A BALANCED OUTLOOK ON LAW

The 'balanced outlook on law' in engineering practice stresses the necessity of laws and regulations and also their limitations in directing and controlling the engineering practice. Laws are necessary because, people are not fully responsible by themselves and because of the competitive nature of the free enterprise, which does not encourage moral initiatives. Laws are needed to provide a minimum level of compliance.

The following codes are typical examples of how they were enforced in the past:

3.4.1 Code for Builders by Hammurabi

Hummurabi the king of Babylon in 1758 framed the following code for the builders:

"If a builder has built a house for a man and has not made his work sound and the house which he has built has fallen down and caused the death of the householder, that builder shall be put to death. If it causes the death of the householder's son, they shall put that builder's son to death. If it causes the death of the householder's slave, he shall give slave for 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 sound condition at his own cost"

This code was expected to put in self-regulation seriously in those years.

9. LECTURE NOTES : UNIT – III

3.4.2 Steam Boat Code in USA

Whenever there is crisis we claim that there ought to be law to control this. Whenever there is a fire accident in a factory or fire cracker's store house or boat capsize we make this claim, and soon forget. Laws are meant to be interpreted for minimal compliance. On the other hand, laws when amended or updated continuously, would be counter productive. Laws will always lag behind the technological development. The regulatory or inspection agencies such as Environmental authority of India can play a major role by framing rules and enforcing compliance.

In the early 19th century, a law was passed in USA to provide for inspection of the safety of boilers and engines in ships. It was amended many times and now the standards formulated by the American Society of Mechanical Engineers are followed.

3.4.3 Proper Role of Laws

Good laws when enforced effectively produce benefits. They establish minimal standards of professional conduct and provide a motivation to people. Further they serve as moral support and defense for the people who are willing to act ethically.

Thus, it is concluded that:

R.M.K GROUP OF INSTITUTIONS

1. The rules which govern engineering practice should be construed as of responsible experimentation rather than rules of a game. This makes the engineer responsible for the safe conduct of the experiment.
2. Precise rules and sanctions are suitable in case of ethical misconduct that involves the violation of established engineering procedures, which are aimed at the safety and the welfare of the public.
3. In situations where the experimentation is large and time consuming, the rules must not try to cover all possible outcomes, and they should not compel the engineers to follow rigid courses of action.
4. The regulation should be broad, but make engineers accountable for their decisions, and
5. Through their professional societies, the engineers can facilitate framing the rules, amend wherever necessary, and enforce them, but without giving-in for conflicts of interest.

R.M.K GROUP OF INSTITUTIONS

3.5 CASE STUDY: THE CHALLENGER

3.5.1 What happened?

The orbiter of the Challenger had three main engines fuelled by liquid hydrogen. The fuel was carried in an external fuel tank which was jettisoned when empty. During lift-off, the main engines fire for about nine minutes, although initially the thrust was provided by the two booster rockets. These booster rockets are of the solid fuel type, each burning a million pound load of aluminum, potassium chloride, and iron oxide.

The casing of each booster rocket is about 150 feet long and 12 feet in diameter. This consists of cylindrical segments that are assembled at the launch site. There are four-field joints and they use seals

consisting of pairs of O-rings made of vulcanized rubber. The O-rings work with a putty barrier made of zinc chromate.

The engineers were employed with Rockwell International (manufacturers for the orbiter and main rocket), **Morton-Thiokol** (maker of booster rockets), and they worked for NASA. After many postponements, the launch of Challenger was set for morning of Jan 28, 1986. **Allan J. McDonald** was an engineer from Morton-Thiokol and the director of the Solid Rocket Booster Project. He was skeptic about the freezing temperature conditions forecast for that morning, which was lower than the previous launch conditions. A teleconference between NASA engineers and MT engineers was arranged by Allan.

Arnold Thompson and **Roger Boisjoly**, the seal experts at MT explained to the other engineers how the booster rocket walls would bulge upon launch and combustion gases can blow past the O-rings of the field joints (Fig. 3.2).

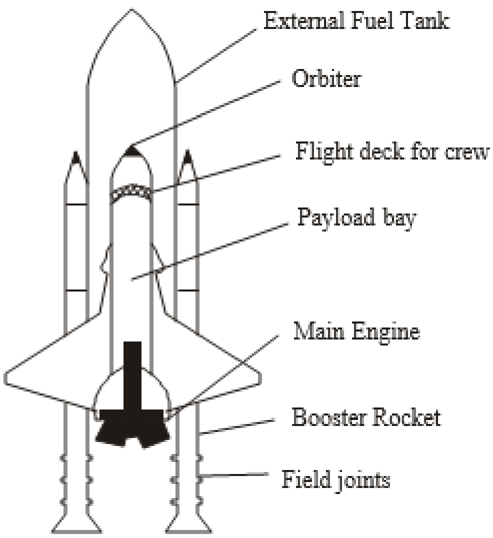
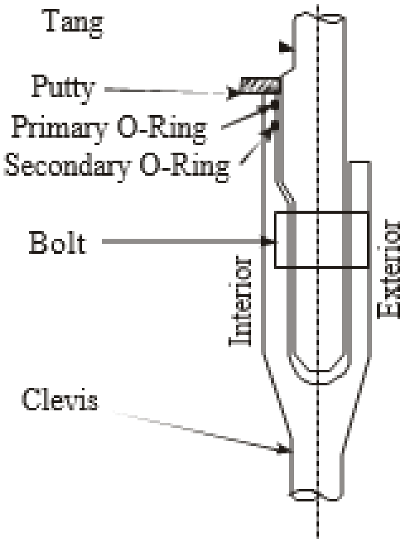


Fig. 3.2 a Challenger



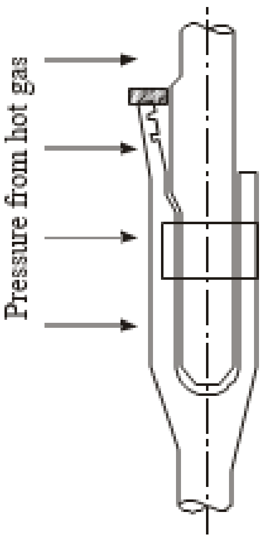


Fig. 3.2 b Field joint before ignition

Fig. 3.2 c Field joint after ignition

9. LECTURE NOTES : UNIT – III

On many of the previous flights the rings have been found to have charred and eroded. In freezing temperature, the rings and the putty packing are less pliable. From the past data gathered, at temperature less than 65 °F the O-rings failure was certain. But these data were not deliberated at that conference as the launch time was fast approaching.

The engineering managers **Bob Lund** and **Joe Kilminster** agreed that there was a safety problem. Boisjoly testified and recommended that no launch should be attempted with temperature less than 53 °F. These managers were annoyed to postpone the launch yet again. The top management of MT was planning for the renewal of contract with NASA, for making booster rocket. The managers told Bob Lund "to take-off the engineering hat and put on your management hat". The judgment of the engineers was not given weightage. The inability of these engineers to substantiate that the launch would be unsafe was taken by NASA as an approval by Rockwell to launch.

At 11.38 a.m. the rockets along with Challenger rose up the sky. The cameras recorded smoke coming out of one of the filed joints on the right booster rocket. Soon there was a flame that hit the external fuel tank. At 76 seconds into the flight, the Challenger at a height of 10 miles was totally engulfed in a fireball. The crew cabin fell into the ocean killing all the seven aboard.

Some of the factual issues, conceptual issues and moral/normative issues in the space shuttle challenger incident, are highlighted hereunder for further study.

3.5.2 Moral/Normative Issues

1. The crew had no escape mechanism. Douglas, the engineer, designed an abort module to allow the separation of the orbiter, triggered by a field-joint leak. But such a 'safe exit' was rejected as too expensive, and because of an accompanying reduction in payload.
2. The crew were not informed of the problems existing in the field joints. The principle of informed consent was not followed.
3. Engineers gave warning signals on safety. But the management group prevailed over and ignored the warning.

3.5.3 Conceptual Issues

1. NASA counted that the probability of failure of the craft was one in one lakh launches. But it was expected that only the 100000th launch will fail.
2. There were 700 criticality-1 items, which included the field joints. A failure in any one of them would have caused the tragedy. No back-up or stand-bye had been provided for these criticality-1 components.

R.M.K
GROUP OF
INSTITUTIONS

3.5.4 Factual/Descriptive Issues

1. Field joints gave way in earlier flights. But the authorities felt the risk is not high.
2. NASA has disregarded warnings about the bad weather, at the time of launch, because they wanted to complete the project, prove their supremacy, get the funding from Government continued and get an applaud from the President of USA.
3. The inability of the Rockwell Engineers (manufacturer) to prove that the lift-off was unsafe. This was interpreted by the NASA, as an approval by Rockwell to launch.

9. LECTURE NOTES : UNIT – III

ONLINE LEARNING

Sl. No	Topic	Link
1	THE CHALLENGER CASE STUDY - VIDEO	https://www.youtube.com/watch?v=mG8BPB_oPlg
2	THE CHALLENGER CASE STUDY - PDF	https://ocw.mit.edu/courses/engineering-systems-division/esd-10-introduction-to-technology-and-policy-fall-2006/readings/challenger.pdf

R.M.K GROUP OF INSTITUTIONS

10. ASSIGNMENT : UNIT – III

(CO1, K4)

1. Challenges facing by nurses in Australian health care system.
2. Titanic disaster case study under the concept of learning from the past.

R.M.K GROUP OF INSTITUTIONS

11. PART A : Q & A : UNIT – III

SNo	Questions and Answers	CO	K
1	What are the aspects of engineering that make it appropriate to view engineering as experiments? Engineering projects, like the standard experiments, are carried out in partial uncertainties, the final outcomes of engineering projects are also generally uncertain like those of other experiments, similar to standard experiments; engineering experiments also require thorough knowledge about the products at the pre production and post production stages.	CO3	K1
2	In what ways engineering experiments differ from standard experiments? The engineering experiments involve human beings as experimental subjects. In fact clients and customers have more control, as they own the authority of that project, so here the experimental subjects say clients or end user are out of the engineering experimenter's control, unlike standard experiments.		K2
3	What is meant by conscientious in terms of engineers as responsible experimenters? Conscientiousness means commitment to live according to certain values. It implies consciousness. Engineers have to be sensitive to a range of moral values and responsibilities, which are relevant in a given situation.		K1
4	What is the role played by experimentation in the design process? During the design process, engineers need to apply various experimentations. Preliminary tests or simulations are conducted to convert a new engineering concept into its first rough design. Then many		K1

R.M.K GROUP OF INSTITUTIONS

11. PART A : Q & A : UNIT – III

SNo	Questions and Answers	CO	K
	formal experimental techniques are employed to try out different materials and processes. Since design process is iterative in nature, therefore many trial design experiments are carried out before the final tests.	CO3	K1
5	What does control group mean? In standard experiments, experimental control involves selecting members for two different groups randomly. The first group members are given the special, experimental treatment, whereas the members of other group are not given that special treatment. Even both the groups are subjected to the same environment; the group that was not given the special treatment is called as the control group.		K1
6	What are the elements of informed consent? Knowledge, voluntariness		K1
7	What are the characteristics of valid consent? The consent should be given voluntarily and not by any force, the consent should be based on all the information needed for a rational person to make a reasonable decision. Moreover the information should be presented in a clear and easily understandable manner; the consenter should be competent enough to process the information and to make rational decisions.		K1

R.M.K GROUP OF INSTITUTIONS

11. PART A : Q & A : UNIT – III

SNo	Questions and Answers	CO	K
8	What are the general responsibilities of engineers to society? Engineers are considered as social enablers rather than being sole experimenters, their responsibility is shared with management, the public and others, while excising duties, the engineers should display the virtue of being morally responsible persons.	CO3	K1
9	What are the requirements for the engineers to act as responsible agents? The responsible agents require • Imaginative forecasting of possible bad side effects. • The development of an attitude of 'defensive engineering' and 'preventive technology'. • Careful monitoring of projects • Respect for people's right to give informed consent.		K1
10	What are the general features of morally responsible engineers? A Conscientious commitment to live by moral values, a comprehensive perspective, autonomy, accountability.		K1
11	What is code of ethics? The primary aspect of code of ethics is to provide the basic framework for ethical judgment for a professional, the code of ethics, also referred as code of conduct, express the commitment to the ethical conduct shared by members of a profession. In other words, these codes furnish common, agreed upon standards for professional conduct.		K1

11. PART A : Q & A : UNIT – III

SNo	Questions and Answers	CO	K
12	What are the different roles and functions of codes of ethics? Inspiration, guidance, support for responsible conduct, deterring and discipline unethical professional conduct, education and promotion of mutual understanding, contributing to a positive public image of the profession, protecting the status quo and suppressing dissent within the profession, and promoting business interests through restraint of trades.	CO3	K1
13	What are the limitations of code of ethics? Code of ethics is broad guidelines, restricted to general and vague wordings/phrases. The codes cannot be applied directly to all situations; engineering codes often have internal conflicts, which may result in moral dilemmas. The codes cannot serve as the final moral authority for professional conduct, the proliferation of codes of ethics for different branches of engineering gives a feeling that ethical codes are relative.		K1
14	List some of the engineering societies that have published codes of ethics? CO2 (Analyzing) American Society of Mechanical Engineers (ASME) American Society of Civil Engineers (ASCE) Institute of Electrical and Electronics Engineers (IEEE) The Institution of Engineers (India)		K2
15	What are industrial standards? Standards frame by companies for their in house use, sometimes standards are also prescribed as parts of laws and official regulation.		K1

R.M.K GROUP OF INSTITUTIONS

11. PART A : Q & A : UNIT – III

SNo	Questions and Answers	CO	K
16	Give a brief account of learning from the past, mentioning an example. Engineers should learn not only from their own earlier design and operating results, but also from those of other engineers. Engineers cannot rely on engineering handbooks. They demand updated detailed information at every stage of a projects history. Example: The titanic lacked a sufficient number of life boats. After many years because of the same problem the steamship arctic had suffered.	CO3	K2
17	List out some of the positive roles of Code of Ethics. CO2 (Analyzing) Inspiration, guidance, support for responsible conduct, deterring and discipline unethical professional conduct, education and promotion of mutual understanding, contributing to a positive public image of the profession, protecting the status quo and suppressing dissent within the profession, and promoting business interests through restraint of trades.		K2
18	Summarize about accountability. Responsible people accept moral responsibility for their action. It refers to the general disposition of being willing to submit ones actions to moral scrutinee and be open and responsive to assessments of others.		K2
19	What is meant by standardization? Standardization setting a standards are measuring sticks by which extend, quality, quantity, value performance are service may be gauged are determined		K1

11. PART A : Q & A : UNIT – III

SNo	Questions and Answers	CO	K
20	What are the features of engineering experimentation? Engineering projects like the standard experiments are carried out in partial uncertainties. The final outcome of engineering projects is also generally uncertain. Engineering experiment also require thorough knowledge about the product at the pre-production and post-production stage.	CO3	K1
21	What do you understand by 'A balanced outlook on Law'? It emphasizes the necessity of laws and regulations and their limitations in governing engineering practice.		K1

12. PART B QUESTIONS : UNIT – III

(CO3, K1,K2)

1. What are the moral and ethical lessons learnt from the space shuttle challenger study.
2. Explain the role of engineering projects as the experiments.
3. What is code of ethics? What are the positive roles of code of ethics and specify its limitation.
4. Compare and contrast engineering experiments with standard experiments.
5. Discuss engineers as responsible experimenters.
6. Explain how moral leadership and ethical work culture influence the ethical behavior of commercial organizations
7. Explain as to how far there is congruence between the professional and environmental ethics.
8. Describe the internal and external responsibility of engineers.
9. Discuss the limitations of codes from engineering experimentation point of view.

PART C QUESTIONS
(CO3, K1,K2,K3)

1. Compare and contrast moral values. What are the three types of values? State and explain the various attempts to reduce morality to those types of values with examples.
2. What are the greater details applied to engineer project as conceived as social experiment? Given the codes play all the roles which function are the most valuable and which should be emphasized and encouraged. Why?
3. Given an account of the challenger disaster and examine how the principal actors in this tragedy behaved as responsible experimenters within the framework of the engineering as experimentation model.
4. Write on industrial standards.
5. "The moral responsibility of engineers should go beyond merely following the laws". Discuss.
6. Discuss on the roles played by the codes of ethics set by professional societies.
7. Explain some universally accepted ethical principles?

R.M.K GROUP OF INSTITUTIONS

13. SUPPORTIVE ONLINE CERTIFICATION COURSES

UNITS : I TO V

COURSERA

MORALITIES OF EVERYDAY LIFE

ETHICS IN THE AGE OF AI

UNETHICAL DECISION MAKING IN ORGANIZATIONS

MANAGING RESPONSIBLY: PRACTICING SUSTAINABILITY,

RESPONSIBILITY AND ETHICS

UDEMY

CORPORATE ETHICS

BUSINESS ETHICS : HOW TO CREATE AN ETHICAL ORGANIZATION

NPTEL

ETHICS IN ENGINEERING PRACTICE

14. REAL TIME APPLICATIONS : UNIT – III

CODE OF ETHICS

1. As a real estate professional, you're bound to encounter ethical dilemmas from time to time. Enter The Code of Ethics in Action:

Real-Life Applications. In this course, you'll review each Article within the NAR Code of Ethics, gain insight into recent changes, and discover important takeaways you can employ in your practice**.**

15. CONTENTS BEYOND SYLLABUS : UNIT – III

Discuss on social acceptability certification and the criteria.

- Besides ISO certification 9001and 14001, exporters are required to get social acceptability certification such SA 8000 for European countries and Worldwide Responsible Apparel Production Principles (WRAP) certificate for American brands.
- WRAP certification insists on compliance with laws and workplace regulations, Prohibition of forced labor, child labor, harassment or abuse, compensation and benefits, working hours, prohibition of discrimination, ensuring health, and safety, freedom of association and collective bargaining, environment and custom clearance, and security. By August 2005 four exporters have obtained WRAP certification in Tirupur.
- SA 8000 was developed with the participation of workers and their union, socially-responsible investors, consumer, governments, business owners and managers. An Advisory Board oversees the program, sets standards, and licenses independent auditors. SA 8000 is based on the ILO conventions and the Universal Declaration of Human Rights and the Convention of the Rights of the Child. By August 2005, 25 leading exporters got SA 8000 certification in Tirupur.
- The criteria for social acceptability are–

1. No workers under age 14 (for developing countries)
2. No forced labour
3. Safe and healthy work environment
4. Freedom to associate and collective bargaining
5. No discrimination or sexual harassment
6. No corporal punishment, coercion, or verbal abuse.
7. Comply with local law: maximum of 48 hours, six days a week, overtime
8. Legal minimum wage
9. Integration of the standards into management systems

16. ASSESSMENT SCHEDULE

Assessment Tools	Proposed Date	Actual Date
I ASSESSMENT	10.02.2023	10.02.2023
II ASSESSMENT	27.02.2023	27.02.2023
MODEL		

R.M.K GROUP OF INSTITUTIONS

17. PRESCRIBED TEXT BOOKS & REFERENCE BOOKS

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, —Ethics in Engineering‖, Tata McGraw Hill, New Delhi, 2003.

2. Govindarajan M, Natarajan S, Senthil Kumar V. S, —Engineering Ethics‖, Prentice Hall of India, New Delhi, 2004.

REFERENCE BOOKS:

1. Charles B. Fleddermann, —Engineering Ethics‖, Pearson Prentice Hall, New Jersey, 2004.

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, —Fundamentals of Ethics for Scientists and Engineers‖, Oxford University Press, Oxford, 2001.

5. Laura P. Hartman and Joe Desjardins, —Business Ethics: Decision Making for Personal Integrity and Social Responsibility‖ Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013.

6. World Community Service Centre, ‗ Value Education', Vethathiri publications, Erode, 2011.

18. MINI PROJECT SUGGESTION

❁ Objective:

1. **Discuss on the code of ethics for any industry in disaster Management.**

2. **Discuss The Code of Conduct for the International Red Cross and Red Crescent Movement (the Movement) and Non-Governmental Organizations (NGOs) in Disaster Relief is a voluntary code designed to help signatories deliver principled and effective humanitarian action.**

18. MINI PROJECT SUGGESTION

Objective:

Discuss on the responsibilities of the engineers in Ford-Pinto Car issue?

Design Engineer

1. IN assess the risk by testing the vehicle at normal speed, maximum permissible speed and also at breaking cpced.
2. To conduct the tests with different vantage locations of the gas tank.
3. To test with different *designs shapn,* materials, size and thlr-kness) pt the gas tank.
4. To identify the weakeft link or component causing of the damage (in this ease, the exposed bolts).
5. Prototype tests with dummy passengers to assess the risk ur safety.
6. To si mulate the tests wherever the tests are very costly or are destructive or time-consuming.
7. Study the long-term effects such as corrosion, fatigue, and creep of materials wherever neKessary. •
8. To study and make a realistic estimate nf the costs of improvement/modification vs. ihe benefits of implementing the re-designeil gadget.
9. To inform ihe users on the Jimitatinns on speed, and on the necessary use of safety gadgets and precau ,ions.

10. Not to fall prey to bribery or to falsify the data or methods or try short-cuts, upon the influence by the vested interests. For example, emisston tests on 1973 Ford cars were rigged by 300 actions with the mistakes loyalty to the organization to get early clearance from the Environmental Protection A;gency. But the company has to pay the fine subsequently

18. MINI PROJECT SUGGESTION

Managers

1. Give only the factual information in the brochure, catalogue or advertisement to the public Inform the customers of the risks and recommend appropnale safety gadgets and procedures for safe handling the product.
2. Educate the customers on do's, don'ts, to use the original spare parts and shun 'spurious and substandard' parts.

Thank you

Disclaimer:

This document is confidential and intended solely for the educational purpose of RMK Group of Educational Institutions. If you have received this document through email in error, please notify the system manager. This document contains proprietary information and is intended only to the respective group / learning community as intended. If you are not the addressee you should not disseminate, distribute or copy through e-mail. Please notify the sender immediately by e-mail if you have received this document by mistake and delete this document from your system. If you are not the intended recipient you are notified that disclosing, copying, distributing or taking any action in reliance on the contents of this information is strictly prohibited.