Que-1: Discuss- History and development of Engineering Ethics

As engineering rose as a distinct profession during the 19th century, engineers saw themselves as either independent professional practitioners or technical employees of large enterprises. There was considerable tension between the two sides as large industrial employers fought to maintain control of their employees.

In the United States growing professionalism gave rise to the development of four founding engineering societies: The American Society of Civil Engineers (ASCE) (1851), the American Institute of Electrical Engineers (AIEE) (1884), the American Society of Mechanical Engineers (ASME) (1880), and the American Institute of Mining Engineers (AIME) (1871). ASCE and AIEE were more closely identified with the engineer as learned professional, where ASME, to an extent, and AIME almost entirely, identified with the view that the engineer is a technical employee.

Even so, at that time ethics was viewed as a personal rather than a broad professional concern.

Turn of the 20th century and turning point:

When the 19th century drew to a close and the 20th century began, there had been series of significant structural failures, including some spectacular bridge failures, notably the Ashtabula River Railroad Disaster (1876), Tay Bridge Disaster (1879), and the Quebec Bridge collapse (1907). These had a profound effect on engineers and forced the profession to confront shortcomings in technical and construction practice, as well as ethical standards.

One response was the development of formal codes of ethics by three of the four founding engineering societies. AIEE adopted theirs in 1912. ASCE and ASME did so in 1914.[8] AIME did not adopt a code of ethics in its history.

Concerns for professional practice and protecting the public highlighted by these bridge failures, as well as the Boston molasses disaster (1919), provided impetus for another movement that had been underway for some time: to require formal credentials (Professional Engineering licensure in the US) as a requirement to practice. This involves meeting some combination of educational, experience, and testing requirements.

In 1950, the Association of German Engineers developed an oath for all its members titled 'The Confession of the Engineers', directly hinting at the role of engineers in the atrocities committed during World War II.

Over the following decades most American states and Canadian provinces either required engineers to be licensed, or passed special legislation reserving title rights to organization of professional engineers. The Canadian model is to require all persons working in fields of

engineering that posed a risk to life, health, property, the public welfare and the environment to be licensed, and all provinces required licensing by the 1950s.

The US model has generally been only to require the practicing engineers offering engineering services that impact the public welfare, safety, safeguarding of life, health, or property to be licensed, while engineers working in private industry without a direct offering of engineering services to the public or other businesses, education, and government need not be licensed. This has perpetuated the split between professional engineers and those in private industry. Professional societies have adopted generally uniform codes of ethics.

Development of Engineering Ethics:

Criterion three of ABET's Engineering Criteria 2000 requires engineering programs to demonstrate that their graduates have “an understanding of professional and ethical responsibility” 1 . The field of engineering ethics examines and sets standards for engineers’ obligations to the public, their clients, employees and the profession.2 In the course of practicing engineering, an engineer solves problems. The engineering decisions are generally guided by the project management variables of cost, schedule and quality. But engineering decisions are also guided by moral values; concern and respect for others. Gaul Baura in “Engineering Ethics” states: “The corporate culture is very powerful and can sway a young engineer’s thinking”.3 As Baura continues: “In preparation for being involved in unethical situations you cannot control, it is important to know your limits. Know your personal engineering ethics threshold for action.”3 This paper proposes an engineering ethics course that will help students develop these personal engineering ethics and presents the outline of the content, assessment, and pedagogy for teaching the Engineering Ethics course. As part of the course modules for ethics communications and group work projects have been developed. The paper starts with a background outlining the context of the Engineering Ethics course, mentions some particular so called “best practices” to present such a course, explores assumptions about the course audience and raises some possible bottlenecks in teaching engineering ethics. It then continues with an overview of the content, assessment, and pedagogy, including my pedagogical approach to teaching this course. Finally, the alignment of these three areas closes out the document. For a better understanding of the course design, supportive materials such as the course syllabus, assessment worksheet, assessment triangle for resolution of ethical dilemmas, and a course schedule are integrated into the text.

The motivation to create this course comes from years of personal experience practicing engineering and encountering issues of unethical practice that often arose in the workplace. These experiences have led to my belief that students graduating from engineering programs must have an understanding of how ethics work in the real world and how ethical problems can

affect an engineer's entire professional career. This course will focus on the ethics of engineering practice. As part of the course students will be expected to consider the effects of their actions (and failure to act) including the economic, environmental, political, societal, health and safety consequences of their work, while also keeping in mind the manufacturability and sustainability of their structures and products. This course was originally developed in the context of a curriculum design course. It was created with the intention of further development using the results of a program of rigorous research to evaluate the assessment tool and understand how engineering students acquire moral reasoning. A further effort was intended to identify ways through which the course could easily be incorporated into the wider curriculum. This paper includes my personal pedagogical philosophy, in addition to discussions of course content and other course details, in order to help the reader understand the approach taken to teaching engineering ethics and how it differs from traditional methods. This paper has been shared with experts in the engineering ethics field for review and feedback on the course content and assessment tool and this feedback will be presented at the ASEE conference in June 2011 and published in a future paper.

In the 1920s, less than a third of engineering educators considered the study of differential equations to be necessary for an engineer's education, now such study is integral to the engineering curriculum. In the engineering world of the future, a sound understanding of the theoretical and practical sides of engineering ethics will be as necessary to the proper education of engineers as a knowledge of differential equations is today, if not more so". 4 Robin Tatu in her article "Knowledge Isn't Enough" takes the famous quote from the Greek inventor Archimedes "Give me a place to stand and I will move the Earth" and argues that "the potential to wield such power is accompanied by equally weighty social responsibility, however; and today, that obligation is becoming ever more pressing and complex". 5 As Tatu continues in discussing the new book written by Douglas, Papadopoulos, and Boutelle "Citizen Engineer" : "A successful 21st century engineer must become "part environmentalist, part intellectual property attorney, part MBA, and part diplomat – not to mention an expert in an engineering discipline, a great teammate, and a skilled communicator". 5 This view is supported by the National Academy of Engineering as suggested in Educating the Engineer of 2020: "Within the context of the changing national and global landscape, The US National Academy of Engineers enunciated a set of aspirations for engineers in 2020. The future engineers have to be technically proficient engineers who are broadly educated, see themselves as global citizens, can be leaders in business and public service, and who are ethically grounded. The committee set targeting attributes needed for the graduates of 2020. These include such traits as strong analytical skills, creativity, ingenuity, professionalism, and leadership". 6 As of today, even though Criterion three of ABET's Engineering Criteria 2000 requires engineering programs to demonstrate that their graduates have an understanding of professional and ethical

responsibility, the teaching of engineering ethics is still not a high priority in U.S. engineering education. This is partly because engineering faculty do not accept enough responsibility for the teaching of engineering ethics.7 Engineering ethics courses are not mandatory and when offered through engineering schools are integrated through the curriculum in a variety of different forms. While the methods of ethics instruction and assessment are often left to the discretion of the instructor, methods of curricular incorporation are mostly established at the institutional level.

The predominant methods of curriculum incorporation include: required courses within the discipline, elective courses outside the discipline, across-the-curriculum, and the linking of ethics with society. 8 As Ohland and Barry state: “applied ethics plays a critical role in engineering, health, business, and law. Applied ethics is currently a required component of the pre-practice education for these professions, yet the literature suggests that challenges remain in how we define, instruct, and assess professions-based ethics education.”11 “Without clear evidence, the debate over curriculum methods will continue, and the engineering community cannot advance its approach to this important subject”.

Que-2: Definition and Scopes of Ethics:

The English word *ethics* is derived from the Ancient Greek word ***ēthikós*** (ἠθικός), meaning "relating to one's character", which itself comes from the root word *êthos* (ἦθος) meaning "character, moral nature".This word was transferred into Latin as *ethica* and then into French as *éthique*, from which it was transferred into English.

Rushworth Kidder states that "standard definitions of *ethics* have typically included such phrases as 'the science of the ideal human character' or 'the science of moral duty'".Richard William Paul and Linda Elder define ethics as "a set of concepts and principles that guide us in determining what behavior helps or harms sentient creatures".The *Cambridge Dictionary of Philosophy* states that the word "ethics" is "commonly used interchangeably with 'morality' ... and sometimes it is used more narrowly to mean the moral principles of a particular tradition, group or individual." Paul and Elder state that most people confuse ethics with behaving in accordance with social conventions, religious beliefs, the law, and don't treat ethics as a stand-alone concept.

The word *ethics* in English refers to several things. It can refer to philosophical ethics or moral philosophy—a project that attempts to use reason to answer various kinds of ethical questions. As the English moral philosopher Bernard Williams writes, attempting to explain moral philosophy: "What makes an inquiry a philosophical one is reflective generality and a style of argument that claims to be rationally persuasive." Williams describes the content of this area of inquiry as addressing the very broad question, "how one should live". Ethics can also refer to a common human ability to think about ethical problems that is not particular to philosophy. As bioethicist Larry Churchill has written: "Ethics, understood as the capacity to think critically about moral values and direct our actions in terms of such values, is a generic human capacity." Ethics can also be used to describe a particular person's own idiosyncratic principles or habits. For example: "Joe has strange ethics."

The scope of ethics indicates its subject matter. Ethics as normative science deals with moral ideal or the good in order to enquire the nature of our conduct. It enquires into the nature of the springs of actions, motives, intentions, voluntary actions and so on. It determines rightness or wrongness of human actions.

Hence the study of Engineering ethics, where such ethics are implemented in engineering by the engineers, is necessary for the good of the society. Engineering Ethics is the study of decisions, policies and values that are morally desirable in engineering practice and research.

Ethics in Engineering:

Ethics are principles followed depending upon the moral responsibility that a person feels. The study of related questions about moral ideals, character, policies and relationships of people and organizations involved in technological activity, can be termed as Engineering ethics.

An engineer whether he works individually or works for a company, has to go through some ethical issues, mostly under the conditions such as, conceptualization of a product, issues arising in design and testing departments, or may be on the issues involving the manufacturing, sales and services. Questions related to morality also arise during supervision and team works.

The ethical decisions and moral values of an engineer need to be considered because the decisions of an engineer have an impact the products and services - how safe they are to use, the company and its shareholders who believe in the goodwill of the company, the public and the society who trusts the company regarding the benefits of the people, the law which cares about how legislation affects the profession and industry, the job and his moral responsibilities and about how the environment gets affected, etc.

Not only an engineer, but everyone has to follow a set of morals in order to keep away from getting morally degraded. Our behavior should include the following −

- Respecting others and ourselves.
- Respecting the rights of others.
- Keeping promises.
- Avoiding unnecessary problems to others.
- Avoiding cheating and dishonesty.
- Showing gratitude towards others and encourage them to work.

Morality commands respect for persons, both others and ourselves. It involves being fair and just, meeting obligations and respecting rights and not causing unnecessary harm by dishonesty and cruelty or by hubris.

Que-3: Different Branches of Ethics:

Four Branches of Ethics:

- Descriptive Ethics.
- Normative Ethics.
- Meta Ethics.
- Applied Ethics.

Descriptive Ethics:

Descriptive ethics deals with what people actually believe (or made to believe) to be right or wrong, and accordingly holds up the human actions acceptable or not acceptable or punishable under a custom or law.

However, customs and laws keep changing from time to time and from society to society. The societies have structured their moral principles as per changing time and have expected people to behave accordingly. Due to this, descriptive ethics is also called comparative ethics because it compares the ethics or past and present; ethics of one society and other. It also takes inputs from other disciplines such as anthropology, psychology, sociology and history to explain the moral right or wrong.

Normative Ethics:

Normative Ethics deals with “norms” or set of considerations how one should act. Thus, it’s a study of “ethical action” and sets out the rightness or wrongness of the actions. It is also called prescriptive ethics because it rests on the principles which determine whether an action is right or wrong. The Golden rule of normative ethics is “doing to other as we want them to do to us“. Since we don’t want our neighbours to throw stones through our glass window, then it will not be wise to first throw stone through a neighbour’s window. Based on this reasoning, anything such as harassing, victimising, abusing or assaulting someone is wrong. Normative ethics also provides justification for punishing a person who disturbs social and moral order.

Aristotle’s virtue ethics, Kant’s deontological ethics, Mill’s consequentialism (Utilitarianism) and the Bhagwad Gita’s Nishkam Karmayoga are some of the theories in Normative Ethics.

Virtue ethics

Virtue ethics focuses on one’s character and the virtues for determining or evaluating ethical behaviour. Plato, Aristotle and Thomas Aquinas were major advocates of Virtue ethics. Plato gave a scheme of four cardinal virtues viz. prudence, justice, temperance and fortitude (courage). His disciple Aristotle categorized the virtues as moral and intellectual. He identified some of the moral virtues including “wisdom”.

Deontological ethics

Deontological ethics or duty ethics focuses on the rightness and wrongness of the actions rather than the consequences of those actions. There are different deontological theories such as categorical imperative, moral absolutism, divine command theory etc.

First famous deontological theory is Immanuel Kant's Categorical Imperative or Kantianism. Kant said that the human beings occupy special place in creation and there is an ultimate commandment from which all duties and obligations derive. The moral rules, as per Kant, should follow two principles viz. universality and principle of reciprocity. By universality, he meant that a moral action must be possible to apply it to all people. By principle of reciprocity, he meant said "do as you would be done by. Such premise of morality is found in all religious systems, including Hinduism, Islam, Christianity, Judaism, Buddhism etc.

Second famous deontological theory is Moral absolutism. It believes that there are absolute standards against which moral questions can be judged. Against these standards, certain actions are right while others are wrong regardless of the context of the act. For example, theft is wrong, regardless of context in which theft was carried out. It ignores that sometimes wrong act is done to reach out to right consequence.

Third deontological theory is Divine command theory. It says that an action is right if God has decreed it to be right. As per this theory, the rightness of any action depends upon that action being performed because it is a duty, not because of any good consequences arising from that action.

Consequentialism (Teleology)

Consequentialism or teleological ethics says that the morality of an action is contingent with the outcome of that action. So, the morally right action would produce good outcome while morally wrong action would produce bad outcome. Based on the outcome, there are several theories such as Utilitarianism {right action leads to most happiness of greatest number of people}, Hedonism {anything that maximizes pleasure is right}, Egoism {anything that maximizes the good for self is right}, Asceticism {abstinence from egoistic pleasures to achieve spiritual goals is right action}, Altruism {to live for others and not caring for self is right action}.

The core idea of consequentialism is that “the ends justify the means“. An action that might not be right in the light of moral absolutism may be a right action under teleology.

Meta Ethics:

Meta Ethics or “analytical ethics” deals with the origin of the ethical concepts themselves. It does not consider whether an action is good or bad, right or wrong. Rather, it questions – what goodness or rightness or morality itself is? It is basically a highly abstract way of thinking about ethics. The key theories in meta-ethics include naturalism, non-naturalism, emotivism and prescriptivism.

Naturalists and non-naturalists believe that moral language is cognitive and can be known to be true or false. Emotivists deny that moral utterances are cognitive, holding that they consist of emotional expressions of approval or disapproval and that the nature of moral reasoning and justification must be reinterpreted to take this essential characteristic of moral utterances into account. Prescriptivists take a somewhat similar approach, arguing that moral judgments are prescriptions or prohibitions of action, rather than statements of fact about the world.

Applied Ethics:

Applied ethics deals with the philosophical examination, from a moral standpoint, of particular issues in private and public life which are matters of moral judgment. This branch of ethics is most important for professionals in different walks of life including doctors, teachers, administrators, rulers and so on. There are six key domains of applied ethics viz. Decision ethics {ethical decision making process}, Professional ethics {for good professionalism}, Clinical Ethics {good clinical practices}, Business Ethics {good business practices}, Organizational ethics {ethics within and among organizations} and social ethics.

It deals with the rightness or wrongness of social, economical, cultural, religious issues also. For example, euthanasia, child labour, abortion etc.

Que-4: Social Change and the Emergence of New Technologies.

Technology and Social Change:

Technology is the application of scientific knowledge to the making of tools to solve specific problems. Technological advances such as automobiles, airplanes, radio, television, cellular phones, computers, modems, and fax machines have brought major advances and changes to the world. Indeed, 20th century technology has completely—and irreversibly—changed the way people meet, interact, learn, work, play, travel, worship, and do business.

Technological information increases exponentially: The entire database of scientific knowledge doubles every several years. This “technological explosion” is due in part to an “Information explosion,” as well as to advances in storage, retrieval, and communication of data. In other words, a cycle occurs: Improvements in technology lead to increases in knowledge and information and, thus, to uncovering the means to create better technology. Consequently, sociologists are concerned with how technological societies will be forced to adapt to the social changes that improvements in technology will continue to bring.

Computer technology

In the 1990s, people witnessed an explosion of computer technology—both in America and around the globe, which has in turn led to a change in how and where people work. Telecommuters are employees of agencies or business firms who work full-time or part-time at home instead of in the office. They connect to their offices via electronic networking: phone,

computer, e-mail, and fax. Telecommuting allows employees to work under supervisors in another state or country. This form of employment especially helps disabled individuals who are unable to leave home or travel to an office, as well as working parents of young children.

The Internet—the world's largest computer network—has revolutionized electronic networking. The number of people using the Internet continues to double annually, with at least 50 percent of all Americans “online” in 2000.

The Internet originally developed from a system built by the U.S. Defense Department to permit governmental work in the aftermath of a nuclear attack. Although originally only those with governmental or university positions could access the Internet, now virtually any home can purchase World Wide Web service. Net-surfers can telecommute, read articles, check stock prices, conduct research, comparison price, shop from home, meet others in chat rooms or on bulletin boards, take college courses, and even earn an accredited degree.

The Internet has certainly provided exciting new possibilities for electronic communication, yet critics argue that a dark side exists to this informational tool. One area of special concern, especially for families with young children, is the ability to access and download pornographic materials. Internet users can download pornographic photos, trade sexual messages on a bulletin board, have overtly sexual conversations with a distant “playmate,” play erotic games, or purchase tickets for a singles cruise. In recent years, sexual predators have also used the Internet to identify potential victims. Other areas of concern include potential social isolation, random and reckless dissemination of nonverifiable or inaccurate information, plagiarism, and family estrangement.

Biotechnology

Recent decades have produced dramatic—though controversial—scientific advances in biotechnology (the application of technology to the practice of medicine). Advances in such areas as reproductive technologies, surrogate parenthood, sex preselection, and genetic engineering have raised difficult political, ethical, and moral questions.

Reproductive technologies and sex preselection

Not every couple wanting to conceive can do so. If they fail to conceive after one year or more of trying, the couple is considered infertile. At any one time, up to 20 percent of couples in the United States may be infertile.

In many cases, doctors can successfully treat infertility:

• Fertility drugs (ovulation-stimulating hormones) can help when the woman's inability to ovulate causes the infertility.

• Artificial insemination, which involves collecting and introducing sperm into the vagina using a syringe, proves particularly useful when the man possesses a below-normal sperm count.

• In vitro fertilization, or the “test-tube baby” method, involves fertilizing an egg outside the woman's body and implanting it into the uterus. This procedure is useful when the woman has blocked fallopian tubes.

• Gamete intrafallopian transfer (“GIFT”) involves taking eggs from the woman's ovaries, mixing them with the man's sperm, and then inserting them into the fallopian tube. In this procedure, fertilization takes place inside the woman's body rather than outside. To date, couples in the United States have produced over 20,000 babies using alternatives such as these.

Some couples or individuals decide that adopting a child represents the best way of dealing with infertility. Others elect to utilize the services of a surrogate mother—a woman who contracts with a couple to carry their fetus to full term, deliver it, and adopt it to the couple. A physician may artificially inseminate the surrogate with the man's sperm or implant an in vitro fertilized egg into her uterus. Either way, the procedure remains controversial, given the many potential ethical, legal, and moral issues it raises. For example, questions of legal, moral, and biological parenthood can give rise to long and complicated custody proceedings.

Similar to surrogate motherhood, and also controversial, is carrier implantation. The procedure involves implanting a fertilized egg into a relative's uterus. Because a relative carries the fetus to term, the woman or couple avoids the expense and hassle of hiring a surrogate mother.

Physicians have now successfully implanted embryos into women in their 50s, following hormone therapy to reverse the effects of menopause.

Sex preselection techniques designed to help a couple choose the gender of their unborn child have also proven controversial. Because sperm bearing the Y chromosome produce males, couples wanting a male baby attempt to increase the chances of a Y-bearing sperm fusing with the X-ovum. A number of sperm-separating techniques supposedly accomplish this. For example, doctors can impregnate the mother-to-be via artificial insemination of primarily Y-bearing sperm, which they have separated in a test tube. Success rates of sperm-separating techniques are questionable, with reported figures approaching 85 percent. Critics note that society cannot know the effects of gender imbalances created through sex preselection. Will people prefer more girls than boys? What happens to the future of marriage and family?

Genetic engineering

Perhaps even more presumptuous (or alarming, according to some critics) than reproductive technologies and sex preselection is altering human behavior through genetic engineering. Cloning, or the creation of exact replicas from a single genetic ancestor, represents the most extreme form of genetic engineering. Geneticists have cloned animals for years, but may soon focus their efforts on human beings.

One of the latest advances in genetic engineering is gene therapy, in which genetic engineers, in limited cases, can disable genes carrying undesirable traits and replace them with genes carrying desirable traits. While these sorts of developments pose many possibilities for altering various organisms and eradicating certain diseases and disabilities, gene therapy remains experimental.

For obvious reasons, certain groups, such as the National Multiple Sclerosis Society and the Cystic Fibrosis Foundation, support genetic engineering in the hopes of dramatic cures being developed. Still others, like certain religious groups, oppose genetic engineering.

The emergence of new technologies:

The ICT sector represents a key industry in the economy and a crucial source of technical change. Its growing importance is reflected in the increasing number of patent applications as well as in its rising share in total patents. A recent bulletin by Eurostat (2003) shows that, in 2001, the share of the Information and Communication Technology (ICT) sector in the total number of patent applications to the European Patent Office (EPO) was 2.3 times larger than that of 1991. This ratio was 1.3 and 2.0 times larger for Japan and the United States respectively. ICT patent applications to the EPO accounted for 15.5% of the total for the EU in 2001, 18.7% for Japan and 24.6% for the United States. In terms of annual average growth rates, ratios for applications in the ICT sector are well above those of total patents not only for the EU (23.4% vs. 11.0%), but also for the United States (22.0% vs. 10.9%) and Japan (17.7% vs. 11.9%). For patents data the study uses the International Patent Classification (IPC) classes and, following the indication by the OECD, defines as ICT the following classes: Computing, Calculating, Counting (G06); Basic electric circuitry (H03); Electric communication technique (H04). This paper claims that the use IPC classes to describe technological fields in ICT (and to single out the emerging ones) is subject to some major drawbacks. First, technological progress in this sector proceeds at a very high speed and in many different directions, making it difficult to encompass all the innovations within the existing technological classes. Second, the general purpose character of ICT and the combination/fusion of ICT with other technologies, which has recently been responsible for the emergence of innovations in different sector, make it difficult to assign a patent to a specific class, which is exogenously defined. This paper examines the emergence of new technologies, applications and platforms in the area of ICT, using patents' data. The main objectives of the research are: 1) to use patents abstract for the identification of relevant ICT-related technologies, products, applications; 2) to show that relevant technologies/applications/products spread across a many IPC classes (also at a 4-digit level of disaggregation). Moreover the set of relevant IPC classes is wider that the one commonly used (e.g. in Eurostat, 2003) 3) to identify among the relevant technologies/applications/products, the emerging ones; 4) to compare the characteristics of the emerging and non-emerging technologies, by looking at the degree of technological hybridisation of the technologies, at the sources of the innovation, in terms of firms, research centres, universities, at the geographical distribution of the innovation. In particular we are interested in the role of big firms and concentration at the firm level to

promote or hinder the emergence of new technologies/applications/products in ICT. The paper is structured as follows. In the first part (Section 2), we discuss the general issue of the emergence of new technologies and industrial activities, introducing the concept of hybridisation. In Section 3 we describe the methodology used to identify 3 ICT-related technologies. The methodology involves the selection of relevant triples of words from patents' abstracts, which allow to detect, without a subjective bias, existing and important applications in the ICT area, which extend over different technological classes. The methodology draws its theoretical background from the existing works on keyword and co-word analysis (Courtial, Callon and Sigogneau, 1993; Van Raan and Tijssen, 1993; Noyons and van Raan, 1998; Ding et al., 2000) and aims at overcoming the existing classification system (IPC), which does not properly capture the continuous and complex technical progress in the area and the general-purpose nature of some ICTbased platforms and applications. This paper focuses on the nature of the emerging technologies in terms of the characteristics of their knowledge sources and of the actors who bring them about. As far as knowledge sources are concerned, the main issue is related to whether new technologies stem from a single idea within a selected and homogeneous set of technological principles, or instead are the result of the convergence of different ideas from different technological fields. Furthermore, we are interested in understanding which of these technologies serve as a source of innovation in different areas. Regarding the actors involved in the innovation process, three issues are addressed in this paper. First, we enquire the role of industrial concentration of innovative activities in the promotion of new technologies. Secondly, we analyse whether there is a distinct pattern in the creation of new technologies at a country level. Finally, we investigate the role of different institutions - universities and public research centres - in the development of new technologies. The work of Pavitt has emphasized that emergent technological paradigms spread across different industries (such as the digital technology one). Moreover, he has underlined that increased technological complexity - arising within the high tech sectors - generates innovations that are more and more developed across industrial boundaries (Koumpis and Pavitt, 1999; Mahdi and Pavitt, 1997). In particular, there is a growing tendency towards the fusion of existing technologies and towards the emergence of applications that spread across different technological areas (Kodama, 1992; Miyazaki, 1994; Koumpis and Pavitt, 1999; Fujimoto et al., 2000). This is particularly true for the socalled general purpose technologies (Bresnahan and

Trajtenberg, 1995; Helpman, 1998), which are characterised by pervasiveness of use and inherent potential for 4 technological improvement and dynamism. In this sense, technologies such as ICT play the role of enabling technologies, opening up new opportunities in different fields. A useful starting point is to consider that new technologies and applications undergo life cycles processes. They emerge out of the knowledge and capabilities related to existing technologies and are initially aligned to the problems of the old regimes. In the first stages, the domain of application of the new technology is quite limited and public demand often provides the initial niche market for it, since in that area performance is more important than costs and considerable financial resources may be available (Rip, 1995). This has been evident in the case of the development of the digital computer regime and of the Internet, whereby the requirements of the US Defence Department have strongly stimulated technological advances in the area. The first commercial domains are crucial for the take off of a new technology: they initiate learning processes at the supply and user side and foster institutional support from investors, customers and other actors. At the very beginning, the existing technologies may benefit from dynamic learning effects related to the new technologies, and their trajectories are often sustained by the interests of different parts in their continuation - e.g., incumbent firms that have invested in infrastructure based upon one specific technology (Ehrnberg and Jacobsson, 1997). However, once the new technologies become more robust and are accepted in the market, they start benefiting from dynamic scale and learning economies, from the development of complementary innovations and from institutional adaptations, so that irreversibilities emerge (Van den Ende and Kemp, 1999).

We examine the emergence of new technologies, products and technological applications related to ICT by adopting an innovative approach, which is based upon the identification of relevant triples of words from patents' abstracts. The literature on keywords has shown that there are two main ways to extract words from a journal article, a paper, and abstracts. The first one consists of extracting words from keyword lists, titles, and sometimes even classification codes. Coulter et al. (1998) for example select descriptors chosen by professional indexers, considering that their experience guarantees a correct procedure of keyword selection. Similarly, Noyons and van Raan (1998) utilise the co-occurrence of classification codes. This methodology has a main

shortcoming, in that indexing might reflect the preconceptions and points of view developed by indexers during the course of their training and the probable inconsistencies in keyword selection by professional indexers working for different databases. The second way of finding words involves extracting words directly from.

Q-5.Law Necessity and application in Engineering

Engineering is a profession in which scientific knowledge and mathematics is used and experimented with to develop ways that benefit mankind, making it extremely important to society for several reasons.

Engineering encompasses a whole range of industries that could include on-site, practical construction work as well as evaluating safety systems from an office. They use the knowledge they have within a specific industry in order to make things work and solve problems, whether this be with transport, medicine, entertainment, space or the environment. In fact, engineering is behind everything. Mobile phones? They're down to engineers. Make-up? Also, down to engineers. Cars, computers, shoes and even cutlery? It's all down to engineers.

The environment that engineers work in ranges from offices to studios and laboratories to the outdoors and even underground. Engineering is very closely linked to technology, and the rise of it, which is why it has played a huge part in technological advances including computers, hospital machines, the internet and more.

Healthcare has also improved dramatically thanks to advancements in medical technology thanks to engineers. The improvement of medical technology has meant that the discovery of illnesses and treatment has helped to save and improve the lives of many people.Credible engineers that have changed society include Alan Turing, who invented the Enigma machine that helped to bring an end to World War II, the engineers behind high speed flight that helped to send man to space and the engineers behind advancements in communication- who'd of thought we could see and talk to someone on a screen from anywhere in the world.

New developments are taking place every single day. Have you heard of the Crossrail in London? It will increase the transport capacity in London

and the South East by 10%, contributing to shorter journey times and easier, quicker connections.

No one knows exactly how engineers could make a difference to society in the future, but it is guaranteed that they will. New engineering jobs are constantly appearing alongside new and innovative technologies. Though it's easy to overlook the sheer amount of work that engineers do, it is inevitable to understand that there is more to engineering that is first thought.

If being at the forefront of technology in the future and helping to make a difference to lives is something that interests you, an engineering career could be the perfect choice. At GET, we have been designing and delivering engineering training programmes since 1977.

Applications engineering is a hot trend in the current IT market. An applications engineer is responsible for designing and application of technology products relating to various aspects of computing. To accomplish this, he/she has to work collaboratively with the company s manufacturing, marketing, sales, and customer service departments.

Those who are fascinated towards exploring various facets associated with creating and designing computer software programs can consider becoming an Application Engineer. The specific role of a Computer Applications Engineer is to **create, design and test computer software programs.**

Importance of an Application Engineer

An applications engineer has to prepare a model for application performance and then test, evaluate and adjust the **application performance** throughout the application life cycle. The importance of the application engineer varies as per the niche segment of the industry they choose to make their career in.

- An applications engineer working with an industry is required to plan, design and deploy **heavy machinery**.
- Applications Engineer in the computing domain is required to apply knowledge of programming and software to develop specific computing systems and software applications.

Tasks and Responsibilities of an Application Engineer

An application manager is expected to carry out various kinds of tasks and responsibilities varying from most basic computing responsibilities to **advanced computing operations**. The specific tasks and responsibilities of an application manager can be listed as:

- The most basic task of an application manager is to check if enough computers are available in the office.
- Installation and maintenance of routers, maintaining backups and keeping a check on overall working ambience of the computing unit is another task of an application engineer.
- Product registration, SSL certification and maintenance of documents pertaining to service contracts also need to be looked into by the application engineer.
- An application manager is expected to carry out technology orientation sessions for the staff wherein they are provided with knowhow related to various technical aspects of computing.
- Designing and development of web applications as needed by the company or organization is a key responsibility of the application manager.
- Coding and implementing the Software.
- The application manager is expected to develop technology policies, manuals and standard procedures as framed by the company or organization.

Que-01: Discuss the Ethical Expectations

Ethical expectations are a vital part of the business environment. The public expects business to be **ethical** and wants corporate managers to apply **ethical** principles—in other words, guidelines about what is right and wrong, fair and unfair, and morally correct—when they make business decisions**.**

Ethical expectations are a vital part of the business environment. The public expects business to be ethical and wants corporate managers to apply ethical principles—in other words, guidelines about what is right and wrong, fair and unfair, and morally correct—when they make business decisions.

In the global arena, ethical standards—and even what is meant by ethics—can vary from one society to another. In spite of differences in ethical meanings, cultural variation does not automatically rule out common ethical agreement being reached among people of different societies.

Human rights issues have become more prominent and important for business. For many years that pressure was exerted on South Africa's political leaders to halt racially discriminatory practices of apartheid and its business leaders to challenge the South African government's enforcement of the policy.

Society wants business to be both at the same time. Ethical behavior is a key aspect of corporate social performance. To maintain public support and credibility—that is, business legitimacy—businesses must find ways to balance and integrate these two social demands: high economic performance and high ethical standards. When a company and its employees act ethically in dealings with other stakeholders, they are improving the organization's contribution as a social actor. When they fail to act ethically, there is the risk of losing the public support an organization needs to be credible and successful.

Business leaders are faced with the continuing challenge of meeting public expectations that are, themselves, always changing. Yesterday's acceptable behavior may not be tolerated today. Many forms of harassment and discrimination were once common. Today, however, social standards make such actions unacceptable. Public expectations of service and ethical behavior are as relevant to a business as customer expectations regarding products such as automobiles and computers.

Organizational ethics is the ethics of an organization, and it is how an organization responds to an internal or external stimulus. Organizational ethics is interdependent with the organizational culture. Although it is to both organizational behavior and industrial and organizational psychology as well as business ethics on the micro and macro levels, organizational ethics is neither organizational behavior nor industrial and organizational psychology, nor is it solely business ethics (which includes corporate

governance and corporate ethics). Organizational ethics express the values of an organization to its employees and/or other entities irrespective of governmental and/or regulatory laws.

Ethics are the principles and values used by an individual to govern his or her actions and decisions.An organization forms when individuals with varied interests and different backgrounds unite on a common platform and work together towards predefined goals and objectives.[1] A code of ethics within an organization is a set of principles that is used to guide the organization in its decisions, programs, and policies. An ethical organizational culture consists of leaders and employees adhering to a code of ethics.

Q-02:Employers and Employees:

In commerce and entrepreneurship, the terms employee and employer are often used. Both terms are involved in 'exchange of services' and 'payment' which are crucial to business.

Difference between an Employee and an Employer

Employee

An employee is a person who works for an organization or a company on a part-time or full-time basis and receives compensation for the services rendered in form of a salary. However, not every individual who offers his or her services to an organization or company gets compensation for the rendered services can be considered an employee.

An employee is hired for a specific job or just to provide labor and does his/her work in the service of another entity, mostly the employer. The main difference between an employee and a contractor is that the employer has control over the activities of the employee, but the contractor does his or her work independently. The employee has a specified salary or wage and is bound by an employment contract, whether written, express or implied. The organization which has hired the services of the employee do control or if not, they possess the right to control the work which is done by the employee and how the work is done.

Employer

The employer is the organization or company which puts to work, employs or hires the services of the employee. The employer can also be an individual, a small business, a government entity, an agency, a

professional services firm, a store, an institution or a non-profit association. The employer has the mandate of compensating the services rendered by the employee in a way which is agreed upon by both parties in the employment contract or as per the organization's policy. These ways include a salary, an hourly, daily or weekly wage and other employment benefits as legally outlined by the local laws and provided by the employer.

In a workplace which is represented by a union, the employer bears the obligation of paying as per the union-negotiated contract. The employer has the power of terminating the employment of a worker if the employee fails to meet the standards expected at the time of employment or if he or she breaks some rules as set by the employer.

Common Features

Mutual Dependence

The employer and the employee both depend on each other for achieving a set target and therefore both mutually gain something from each other.

This is an important factor which enables sustainability. The employers depend on the employees to perform specific tasks and in so doing help them in achieving their business goals and ensure the business runs smoothly.

On the other hand, the employee depends on the employer to pay him or her the agreed salary or wages and thereby enable them to financially support themselves and possibly their families. In case one of the parties feels that they are not getting enough on their end of the bargain, the relationship is likely to be terminated if negotiations fail. The employer might decide to fire the employee if they are dissatisfied or otherwise the employee can just resign or quit their job.

Bonding

The relationship that exists between the employer and the employee is a relationship that must be developed over time. This development requires the input of both parties, that is, the employer and the employee. The employer can play their part of establishing and developing a relationship with their employees by showing interest in their life away from work, asking the employees about their families and learning about what their interests are.

Employees can contribute by being more open to their employers and talking about themselves and their lives away from work comfortably. These relationships are important to the success of the business since a strong relationship makes the workers satisfied and consequently increases productivity.

Restrictions

For a sustainable relationship, there needs to be established lines that should not be crossed and beyond which a relationship stops being beneficial to a business anymore, sometimes even toxic. These restrictions and limits exist in every company setup although the type of relationship which is considered healthy may vary from company to company.

In general, romantic relationships between the employer and the employee are unhealthy in most companies. The employee should also be careful not to develop a relationship with the employer which is closer than the relationship between the employer and the other employees as this may raise favoritism concerns and other unfairness issues in the workplace.

Both the employer and the employee share the responsibility of making sure that their relationship does not cross the restrictions of professionalism and those of the company standards.

Difference between Employee and Employer

Goal

The objectives of an employer and those of an employee are different and necessary for the existence of that relationship. The employers aim to improve their productivity be it organizational or industrial. By hiring the services of the employee and assigning them to a role which suits the employee's qualifications, the employer targets to maximize the productivity of that specific area or to eliminate errors which lag the general productivity of the organization.

The employee, on the other hand, seeks the job and renders the services required by the organization in exchange for the compensation in form of salaries and periodical wages. This gives the employee the ability to support themselves financially and also to enjoy other employment benefits as may be provided by the employer.

Cash Flow

Another difference between the employer and the employee is the direction of cash flow in the company or business. On the side of the employer, the salary is a deduction from the income of the company. This income could be from the proceeds of the business if it is an enterprise or from grants and sponsorship if it is a non-profit association. The employer gives out the cash. However, for the employee, the salary is an addition to their finances as they are the recipients of the cash given by the employer.

In terms of profits, the profits garnered by the particular enterprise eventually find their way to the employers account and the employee can only get a part of the proceeds through the salary or as a bonus if the organization has a policy of rewarding most industrious workers.

Roles and Responsibilities

The role of the employer is to protect the health, welfare, and safety of the employees and any other persons that may be affected by the activities of the business. The employer must responsibly do whatever is under their power and ability to achieve this. The employer provides other benefits for the employee besides the salary in order to take care of this. This includes providing things like health covers which extend to the employees' family if they are parents and giving them catered-for vacations to ensure they are satisfied. This also improves their productivity. They should provide a conducive and safe workplace for their employees and ensure they are paid in good time.

The employee has the responsibility, among others, of obeying a lawful and sensible order as stipulated in the contract of employment. He or she should serve the employer faithfully and uphold loyalty and diligence when carrying out his or her duties. Employees are also required not to misuse any confidential information they acquire from the employer during the time of service.

Level of Authority

The employer has more authority than the employee. In fact, the employer can and, in most cases, does monitor and control what the employee does, and sometimes even how they do it. Employees carry out roles which have been assigned by the employer and reports to the employer. However, the employee does not have authority over the employer. Their authority can only be exercised with lower level employees. The employer also has the authority of terminating the employment of the employer if justified by the company policy and the employment contract.

03. Inter-Professional Relationship:

Inter-professional collaboration is a process involving jointly advantageous active participation between independent professionals in which each member of the health care team has knowledge

and skills that underwrite to the care provided and their relationships are governed by negotiated shared norms and visions

An engineer who is a professional, has some tasks to perform by which he acts as any of the following, which can be termed as Models of Professional Engineers.

Savior − A person who saves someone or something from any danger is called a Savior. An engineer who saves a group of people or a company from a technical danger can also be called a Savior. The Y2K problem that created problems for computers and computer networks around the world was solved by engineers who were the saviors.

Guardian − A person who knows the direction towards a better future is known to be the Guardian for the same. An engineer who knows the direction in which there is scope for the technology to develop can also be called a Guardian. This engineer provides the organization with innovative ideas for technological development.

Bureaucratic Servant − A person who is loyal and can solve problems when they occur using his own skills, is a Bureaucratic servant. An engineer who can be a loyal person to the organization and also the one who solves the technical problems the company encounters, using his special skills can be termed as a Bureaucratic servant. The company relies on his decision-making capability for the future growth.

Social Servant − A person who works for the benefit of the society without any selfish interest and does not work on any business grounds, is called a Social servant. An engineer who receives a task as part of the government's concern for the society considering the directives laid by the society and accomplishes the assigned tasks can be termed as a Social Servant. He knows what the society needs.

Social Enabler or Catalyst − A person who makes the society understand its welfare and works towards the benefits of the people in it, is a Social Enabler. An engineer who plays a vital role in a company and helps company along with society to understand their needs and supports their decisions in work can be termed as a Social Enabler or Catalyst. This person quickens the procedure and helps maintain good environment in the company.

Game Player – A person who plays a game according to the rules given is a Game player in general. An engineer who acts as neither a servant nor a master, but provides his services and plans his works according to the economic game rules in a given time, can be termed as a Game player. He is smart enough to handle the economic conditions of the company.

Q-04: Professional Organization maintaining a commitment of ethical Standards

Organizations interested in employee ethics compliance face the problem of conflict between employee and organizational ethical standards. Socializing new employees is one way of assuring compliance. Important for longer term employees as well as new ones, however, is making those standards visible and then operable in the daily life of an organization. This study, conducted in one large organization, found that, depending on organizational level, awareness of an organization's ethical standards is predicted by managerial adherence to and organizational compliance with those standards and/or discussions with peers. Regardless of level, organizational commitment was predicted most strongly by managerial adherence to organizational standards. These findings have theoretical implications for the fields of business ethics, organizational identity and organizational socialization and practical implications for the implementation of ethics policies.

The Journal of Business Ethics publishes original articles from a wide variety of methodological and disciplinary perspectives concerning ethical issues related to business. Since its initiation in 1980, the editors have encouraged the broadest possible scope. The term 'business' is understood in a wide sense to include all systems involved in the exchange of goods and services, while 'ethics' is circumscribed as all human action aimed at securing a good life. Systems of production, consumption, marketing, advertising, social and economic accounting, labour relations, public relations and organisational behaviour are analysed from a moral viewpoint. The style and level of dialogue involve all who are interested in business ethics – the business community, universities, government agencies and consumer groups. Speculative philosophy as well as reports of empirical research are welcomed. In order to promote a dialogue between the various interested groups as much as possible, papers are presented in a style relatively free of specialist jargon.

Q-05:Important Skills for Ethical Reasoning

Let us now discuss the important skills for ethical reasoning −

- **Moral Reasonableness** − The ability and willingness to be morally reasonable that one should have while dealing such issues. Unless one is willing and improve such ability, justice cannot be done.
- **Respect for Persons** − The persons involved in the issue, should be treated with genuine concern by one. Such concern should also be there with oneself along with being there for others.
- **Tolerance of diversity** − One should have a broader perspective towards ethnic and religious differences that the people have. Every person differs with another when compared on grounds of moral reasoning. The acceptance of those differences is really important.
- **Moral hope** − The moral conflicts can be resolved by using better communication and having rational dialogue which is evident-based and open-ended which is acceptable and appreciable by both the parties.
- **Integrity** − The moral integrity has to be maintained. Being honest and having strong moral principles helps one to resolve an issue in an efficient manner. An individual also needs to consider other's professional life and personal convictions while solving a problem.

Engineering Ethics - Moral Issues

A moral issue can be understood as an issue to be resolved not only by considering the technical stuff but also by keeping moral values in mind. To be more precise, let us consider the definition in general.

Moral issue is a working definition of an issue of moral concern is presented as any issue with the potential to help or harm anyone, including oneself."

Types of Moral Issues

There are mainly two types of Moral issues that we mostly come across while keeping the ethical aspects in mind to respond. They are −

Micro-ethics

This approach stresses more on the problems that occur on a daily basis in the field of engineering and its practice by engineers.

Macro-ethics

This approach deals with social problems which are unknown. However, these problems may unexpectedly face the heat at both regional and national levels.

Examples

Let us now understand a few examples related to moral issues.

Example 1

After a recent collapse of a structure in which many people died, an Engineer came to know about a bridge which is marginally safe. He informed his superior who asked him to stay calm and not to discuss with anyone, while waiting for the next year budget sessions to get some financial help for the repair required. What should the engineer do?

Example 2

What should an Engineer who observes his colleague copying confidential information unauthorized, do immediately? If he chooses to stop his friend, what if this gets repeated without his notice? If he chooses to report the management, what if his friend loses the job? Which is morally correct?

Example 3

An engineer who develops a proto-type for the project, loses it due to a mishap exactly the day before the submission. Is it morally correct to outsource the prototype of the project and reduce the risks of job insecurity? What should he do?

These are the few examples just to understand the kind of moral dilemmas. There might be one or more correct answers at times. There can be some other way around to deal with the issue, which one can’t easily notice. However, the decisions have to be made by following a slow and clear process in order to avoid further problems and also to solve this in a manner that leads to no regrets.