CHAPTER – III

THEORETICAL FRAMEWORK

3.1 BRIEF HISTORICAL DEVELOPMENT OF ENGINEERING EDUCATION

Although the engineering profession can be traced back into earliest times, the records of history do not appear to contain any mention of the formal education of engineers until 1747, when the French engineer Jean Rodolphe Perronet was given the task of instructing designers in the sciences and practices needful to fulfilling with competency the different occupations relating to bridges and highways. The corps des Ponts et Chaussees, which he headed, had been established in 1716 and the school established in 1747 for the workers in the organization became the Ecole Nationale des Ponts et Chaussees, the first engineering school. It has been said that the French were the leaders in engineering in the 17th and 18th centuries; they were not only the leaders but also the pioneers in engineering education. In 1778 they founded the school that later became the Ecole Nationale Superieure des Mines, in 1794 the Ecole des Travaux Publics, which became the Ecole Polytechnique; and in 1788 the Ecole d’ Arts et Metiers. The Ecole Centrale des Arts et Manufactures was established in 1829.

The Industrial Revolution with the advent of the Industrial Age, which was ushered in by the discovery of the steam engine by James Watt about 1780, and the ability to, generate and to handle
large amounts of power rendered possible by the invention of the steam engine, men passed from dependence on human labour and hand tools to large and complicated machinery: production of commodities passed from cottage workshops to factories. Transportation by bullock-carts horse-driven carriages, and wind or man driven boats, gave way to railroads and steamships. All this necessitated the construction of large machines, engines, ships and carriages and gave rise to problem of industrial finance and labour.

While inventive genius was called upon to devise new kinds of machines and to handle new types of processes, the craftsmen and artisans were called upon to put these designs into actual practice. They were asked to test and handle these machines and to repair them whenever necessary. The engineer was thus evolved from two different streams-first from the artisans and craftsmen on one side, who belonged to the lower orders of the less specialized society of the last century, and on the other side from the genteel class who had knowledge of sciences, and had acquired habits of disciplined and organized thinking. Sometimes the two types merged in the same person i.e. the craftsman taught himself science, and learnt to think and invent, (e.g. James Watt); or the man with scientific definite objective (e.g. Sadi Carnot).

It was soon found that it was not possible to depend upon unlettered mechanics and crafts men to manufacture, according to designs given to them, the new types of machines which were
constantly coming into use, or upon apprentices to handle these machines properly, unless they were instructed in their use. Schools for general education of craftsmen and artisans, and for teaching apprentices the use of machines were founded by John Anderson at Glasgow about 1790, and Dr. Birkbeck in London in 1823. Anderson’s university ultimately became The Royal Technical College, Glasgow. Amongst the universities, Cambridge took the lead in admitting engineering to the rank of university education. In the U.S.A. the first technical school was founded at Bowdoin College, Maine in 1823, but this did not live long. The oldest surviving technical institute in the U.S.A. is the Rensselaer Polytechnic Institute at Troy (New York State), which was founded in 1823, and started giving degrees in civil engineering in 1835. The early development of engineering education in America was greatly influenced by the French Models. The curriculum of 1849 of the Rensselaer Polytechnical Institute, Troy, N.Y. which became an almost universal prototype in the United States, was largely adapted from the course of study in the *Ecole Centrale*.

In Germany, the polytechnic school at Karlsruhe was created in 1825 from two older institutions; it was the first of its kind in that country. Its curriculum was changed in 1833 to emphasize a “high scientific discipline” and the school became essentially professional.

Germany started late, but it built up, after the Franco-Prussian was a chain of technological institutes (culminating in the
Technische Hochschules) which provided for the teaching of all grades of men from craftsmen to researchers and this was mainly responsible for the great technical and industrial superiority of Germany which was noticed during the First World War. The great Technische Hochschule at Charlottenburg, Berlin was founded in 1879, as part of the university, but was later separated from it for the sake of administrative convenience. The success of this institution led to the foundation of the Imperial college of science and technology in London by the amalgamation of a number of smaller institutes in 1907. By the terms of its charter the imperial college stands alone in being specially charged to develop postgraduate studies in their application to industries.

It can be concluded that after 1871 technical schools developed rapidly in Europe and United States to serve the needs of the growing industries that burst into activity at this time.

3.2 HISTORY OF DEVELOPMENT OF ENGINEERING AND TECHNOLOGICAL EDUCATION IN INDIA BEFORE INDEPENDENCE

The impulse for creation of centres of technical training came from the British rulers of India, and it arose out of the necessity for the training of overseers for construction and maintenance of public buildings, roads, canals, and ports, and for the training of artisans and craftsmen for the use of instruments, and apparatus needed for the army, the navy, and the survey department. The superintending engineers were mostly recruited from Britain from the Cooper's Hill
College, and this applied as well to foremen and artificers; but this could not be done in the case of lower grades—craftsmen, artisans and sub-overseers who were recruited locally. As they were mostly illiterate, efficiency was low. The necessity to make them more efficient by giving them elementary lessons in reading, writing, arithmetic, geometry, and mechanics, led to the establishment of industrial schools attached to Ordinance Factories and other engineering establishments.

While it is stated that such schools existed in Calcutta and Bombay as early as 1825, the first authentic account we have is that of an industrial school established at Guindy, Madras, in 1842, attached to the Gun Carriage Factory there. A school for the training of overseers was known to exist in Poona in 1854.

Meanwhile in Europe and America, Colleges of Engineering were growing up, which drew to them men having good education, and special proficiency in mathematical subjects. This led to discussions in Government circles in India, and similar institutions were sought to be established in the Presidency Towns.

The first engineering college was established in U.P. in 1847 for the training of Civil Engineers at Roorkee, which made use of the large workshops and public buildings there that were erected for the Upper Ganges Canal. The Roorkee College (or to give it its official name, the Thomson Engineering College) was never affiliated to any university, but had been giving diplomas which were considered to
be equivalent to degrees. In pursuance of the Government policy, three Engineering Colleges were opened by about 1856 in the three Presidencies. In Bengal, a College called the Calcutta College of Civil Engineering was opened at the Writers' Buildings in November 1856; the name was changed to Bengal Engineering College in 1857, and it, was affiliated to the Calcutta University. It gave a licentiate course in Civil Engineering. In 1865 it was amalgamated with the Presidency College. Later, in 1880, it was detached from the Presidency College and shifted to its present quarters at Sibpur, occupy in the premises and buildings belonging to the Bishop's College.

Proposals for having an Engineering College at Bombay city having failed for some reasons, the overseers' school at Poona eventually became the Poona College of Engineering and affiliated to the Bombay University in 1858. For a long time, this was the only College of Engineering in the Western Presidency.

In the Madras Presidency, the industrial school attached to the Gun Carriage Factory became ultimately the Guindy College of Engineering and affiliated to the Madras University (1858).

The educational work in the three Colleges of Sibpur, Poona, and Guindy has been more or less similar. They all had licentiate courses in civil engineering up to 1880, when they organised degree classes in this branch alone. After 1880, the demand for mechanical and electrical engineering was felt, but the three Engineering
Colleges started only apprenticeship classes in these subjects. The Victoria Jubilee Technical Institute, which was started at Bombay in 1887, had as its objective the training of licentiates in Electrical, Mechanical and Textile Engineering.

In 1915, the Indian Institute of Science, Bangalore, opened Electrical Engineering classes under Dr. Alfred Hay, and began to give certificates and associateships, the latter being regarded equivalent to a degree.

In Bengal, the leaders of the Swadeshi Movement organised in 1907 a National Council of Education which tried to organise a truly National University. Out of the many institutions it started, only the College of Engineering and Technology at Jadavpur had survived. It started granting diplomas in a mechanical and engineering course in 1908, and in chemical engineering in 1921.

The Calcutta University Commission, debated the pros and cons for the introduction of degree courses in mechanical and electrical engineering. One of the reasons cited, form the recommendations of the Indian Industrial Commission [1915, under the Chairmanship of Sir Thomas (Holland)] against the introduction of electrical engineering courses is given in the following quotation from the report: "We have not specifically referred to the training of electrical engineers, because electrical manufactures have not yet been started in India, and there is only scope for the employment of men to do simple repair work, to take charge of the running of
electrical machinery, and to manage and control hydroelectric and steam-operated stations. The men required for these three classes of work will be provided by the foregoing proposals for the training of the various grades required in mechanical engineering. They will have to acquire in addition, special experience in electrical matters, but, till this branch of engineering is developed on the constructional side, and the manufacture of electrical machinery taken in hand, the managers of electrical undertakings must train their own men, making such use as they can of the special facilities offered for instruction at the engineering colleges and the Indian Institute of Science”.

The credit of first starting degree classes in mechanical and electrical engineering and in metallurgy belong to the University of Banaras, as foreseen by its great founder, Pt. Madan Mohan Malaviya (1917).

About fifteen years later, in 1931-32, the Bengal Engineering College at Sibpur started mechanical engineering courses, electrical engineering courses in 1935-36, and courses in metallurgy in 1939-40. Courses in these subjects were also introduced at Guindy and Poona about the same time.

Quite a number of engineering colleges have been started since August 15, 1947. It is due to the realisation that India has to become a great industrial country, and would require a far larger number of engineers than could be supplied by the older
institutions. In some cases, existing lower type institutions have been raised to the status of degree-giving colleges.

3.3 MEANING OF ENGINEERING

The application of scientific and mathematical principles to practical ends such as the design, manufacture and operation of efficient and economical structures, machines, processes & systems is called Engineering. The word “Engineering” is used to mean three things:

1. The practical application of science to industry.
2. The discipline dealing with the art or science of applying scientific knowledge to practical problems.
3. A room in which the engine is located.

It also involves design, production and operation of useful objects. It is a myth that the word “engineer” originated to describe those who built ‘engines’. In fact, the words ‘engine’ and ‘engineer’ as well as ‘ingenious’ were developed in parallel from the Latin root ‘ingenious’ meaning ‘skilled’. The spellings of engineer were later influenced by back-formation from engine. The term later evolved to include all fields where the skills of application of the scientific method were used. In other words ‘Engineering’ is concerned with the design of a solution to a practical problem.

A famous dictum goes as under “A scientist builds in order to learn but an engineer learns in order to build.”
3.4 DEVELOPMENT OF ENGINEERING SCIENCES

The nineteenth century has witnessed the birth of many branches of engineering and technology in addition to the classical ones of civil and mechanical.

The range of development in engineering and technology is illustrated by the following list of separate engineering fields which are recognized and in which four or five years of under-graduate courses leading to a degree are offered in universities and colleges throughout the world. Within each one of the fields, there are further sub-divisions and specializations, each being the subject of special postgraduate study and research.

Technology and engineering are products of fundamental discoveries in basic sciences, and as is well known, these began to accumulate in the late nineteenth and in the twentieth centuries and in greater variety than in all the previous 50 centuries of civilized life. Inventive genius in Europe and America tried to utilize this science for new industries, and for other human needs. Thus new branches of engineering began to grow.

Electrical engineering which now claims as many as, or more professionals and students than the older branches of civil or mechanical, started actually from the year 1882, when Edison built the first central electric power house to supply electrical power to factories, and light and power for domestic use to dwellers of a city. The discovery of the law of electromagnetic induction was made by
Faraday in 1831, but it required work of half a century to put the discovery to practical use.

With the multiplication of the number of electrical power houses, and with the long distance transmission of power, the demand for men trained in the use of electrical machinery and acquainted with the fundamentals of the science began to grow, and the universities and technical colleges began to introduce course in electrical engineering. But only one or two colleges are known to have introduced electrical engineering courses earlier than 1880. So rapid has been the progress in this field that the number of electrical engineers, technicians and craftsmen in the U.S.A. is now estimated to be nearing the million mark. The same is trite of automotive engineering which dates from the time of the discovery of the internal combustion engine by Otto in 1970. Rudiments of chemical engineering were known in earlier metallurgical practices, but the great discoveries in organic, physical and inorganic chemistry subsequent to 1880, led to more and more large scale chemical industries. Chemical engineering courses began to be introduced about 1890, almost simultaneously in the German Technische Hoshschules and in great American technical colleges like the Massachusetts Institute of Technology (M.I.T.). The first courses were introduced in England in the Imperial College of Science and Technology in 1911.
Electrical Engineering is a typical example of this change. For about 20 years it dealt mainly with electrical power generation, transmission and utilization. With Marconi’s discovery of wireless telegraphy (1898), electrical engineers began to study and watch the progress of Radio Communication. In some, university and technical colleges, the new science began to be pursued as a subject for postgraduate study and research. Then came the discovery of the use of triode valves in 1914 which revolutionized radio communication, and made broad-casting possible. This led to the need for a large number of engineers trained in the fundamentals of radio communications, and in the use of the necessary appliances. So universities and technical colleges were called upon to undergraduate classes for the training of radio engineers.

Many developments of electrical engineering have emerged, such as power plant and transmission engineering, radio-communication, telephone communication, electronics, electrical calculating machines, electric railway engineering, electrical recording apparatus, electricity and electronics in medicine, and surgery, electrical control apparatus, servo-mechanisms and many others.

These subdivisions of the engineering field illustrate how a mature economy develops a great variety of ways for controlling and using the processes and resources of nature. The great productiveness of a country like America is due less to possession of
natural resources than to the development of a wide range of skills. Thus three basic types of engineering have developed into numerous new technologies, which have tended to become independent fields.

The engineer should be alert for any fundamental discovery which may be, turned to practical use and for betterment of the processes he is using. The structure of engineering education should be such that when opportunities occur it will be possible for the country or the industries to collect requisite personnel, from technicians to executive engineers, to turn the discovery to use within as short a period as possible. Such a set-up of engineering existed in Germany, and exists in the U.S.A., but not in the United Kingdom, of which the Indian System was for long a bad and obsolete copy. Thus though many of the great and fundamental discoveries which led to Radar and Atomic Energy utilization were made by British Physicists, their large scale utilization was for war purpose was possible only in America, where the requisite personnel of all types could be assembled and set to work. The British recognized this defect in their structure of Engineering and Technological Education during the course of the last way. Their Ministry of Education set up a committee under Lord Eustace Percy to advise the Ministry on the needs of higher technical education in England and Wales, with particular attention to the means required for maintaining appropriate co-operation between universities and technical colleges.
3.5 ALL INDIA COUNCIL FOR TECHNICAL EDUCATION (AICTE)

In order to facilitate technical and engineering education in India and to regulate it the government of India setup AICTE in 1945. It was an advisory body established by the Indian Government for the establishment of Engineering Institutions throughout the country. It made certain rules and regulations to control the institutions in that, the standards of engineering education may remain intact. The following were the main objectives to be achieved in a planned and rational manner with the passage of time.

(a) To facilitate collaboration and partnerships between Indian and Foreign Universities in the field of technical education

(b) To systematize the operation of foreign universities / institutions already providing training and other educational services including that of coaching of students in India leading to award of degree in technical education.

(c) To safeguard the interests of student’s community in India and ensure uniform maintenance of norms and standards.

This body was given statutory status by an act of parliament in 1987. This act made the body more powerful and it was able to control, regulate, standardize all the institutions related to technical, engineering and management. The institutions setup under its guidance are of three types: - Government Institutions, Government Aided Institutions and Private Institutions. The rules and regulations made by the AICTE were applicable to all the institutions though in
practice it is found that many institutions do not follow them properly thereby making the education substandard. It also constituted national board of accreditation (NBA) in 1994 to evaluate the institutions according to the norms and standards fixed by this body. This body in a way played a positive role to facilitate technical and engineering education throughout India.

3.6 THE POST INDEPENDENCE SCENARIO

The last half of twentieth century has transformed our environment, perhaps radically, and brought more changes in socio economic structure of Indian society than in any other modern period in history. These are the consequences of discoveries of science and applications of technology.

After, Independence frontiers of knowledge have themselves expanded rapidly making it possible to device newer and more efficient methods of solving problems of the society. Education has made efforts for securing knowledge and mastering modern skills and methods than merely storing and distributing the traditional ones. For this purpose of training of mind and mastering of skills and for harnessing science and technology to profitable and productive processes of economic growth and social well-being, the technological education system has contributed a lot.

This has indeed been the basis of our efforts after independence during the last six decades, the result is that there is a well-organised structure and a wide network of technical
institutions offering different types of programmes: craftsman courses, technician (diploma) courses, graduate and post-graduate courses, research degrees, etc., catering to the various levels of knowledge, skills and competencies required by the economy.

3.7 INSTITUTIONAL FRAMEWORK OF ENGINEERING EDUCATION IN INDIA

Degree and Post-Graduate courses are offered in colleges affiliated to the various Universities, certain University Departments, and institutions declared as of national importance or as deemed Universities. The development of technical education has been one of the major achievements of the post-independence period. The creation of the All-India Council of Technical Education in 1945, and the Report of the Scientific Manpower Committee (1947) has a far reaching influence in this development.

3.7.1 Indian Institute of Science (IISc)

It is an institution for post graduate and research study especially in science and engineering established at Bangalore. The institute's constitution was approved by vicray Lord Minto in 1909. After 1914-15 the institutions has produced leading engineers and scientists this is and institution of the country which introduced innovative integrated Ph.D. programmes in chemical and physical sciences. It has also a center for scientific and industrial consultancy through which the know-how generated at the institute percolates to industries via industry sponsored projects.
3.7.2 Indian Institutes of Technology (IITs)

Internationally renowned engineering institutions, known as Indian institutes of Technology (IITs), were created in the early fifties with the vision of providing excellence in science and engineering education.

These are Apex Indian Institutions for engineering education and research. Each Institute conducts a Graduate Degree course and Master's Degree course in a wide range of subject fields, and also offers facilities for Research and Doctoral work. The main emphasis at these Institutes is on the Post-Graduate studies and Research with an inter-disciplinary approach. To this end each Institute has developed good departments of Physics, Chemistry, Mathematics, and Social Sciences which inter-act with the departments of Engineering and Technology. The student enrolment at the Institutes at the Undergraduate level is limited and admission at the Post-Graduate level is designedly kept at about the same order as in the under-graduate courses. The Institutes are in various stages of consolidation and development. As part of the national plan of science and technology, five Centres of Advanced Study and Research have been set up in the Indian Institutes of Technology in Energy Studies (Delhi), Material Science (Kanpur), Cryogenic Engineering (Kharagpur), Ocean Engineering (Madras) and Resource Engineering (Bombay).

IIT Mumbai, IIT New Delhi and IIT Chennai offer integrated M.Tech courses of five year duration. IIT Chennai, IIT New Delhi and IIT Mumbai also offer duel degree programmes of 5 year duration in several branches.
Like any township, an IIT campus is self-sufficient as far as day-to-day activities are concerned. Most of the facilities, such as convocation hall, auditoriums, lecture theatres, libraries, post-office, banks, printing press, central school, hospital, shopping complex, temple, parking, gymkhana, community hall, children’s park, staff club, student activity centre and student hostels, are available on all of the campuses. All IITs have the same structure of administration as shown in Fig. 3.1

Fig 3.1: Structure of Administration in the Indian Institutes of Technology (IITs)
(Source: Palit 1997)
The IITs have had an enviable reputation for providing the best undergraduate and postgraduate engineering education in India. The IITs and a few other leading engineering institutions formulate their own curriculum with faculty committees and through formal consultation with professional organizations. The IITs and a number of universities have a semester system, with each semester lasting for sixteen weeks. An academic year has two semesters. Short courses and project work are undertaken in the summer months. The following sections present details common to all IITs, as well as specific information relating to the engineering curriculum at the Indian Institute of Technology, New Delhi, which is one of the best engineering institutions in India.

3.7.2.1 Undergraduate Admission

Admission to the first year of the undergraduate programmes leading to the degrees of B.Tech. and the five year integrated M.Tech is made through the Joint Entrance Examination (JEE) and is common to all IITs. Every year the JEE is coordinated by a different IIT. Admission for foreign nationals wishing to study at an IIT requires successful completion of a Higher Secondary Certificate (HSC) or equivalent tertiary entrance examination with at least 80% marks in chemistry, physics and mathematics. The applicant must also pass a public examination in English languages, securing at least a 60% mark.
3.7.2.2 Postgraduate Admission

Admission to the M.Tech/M.Sc. programmes is determined on the basis of the Graduate Aptitude Test in Engineering (70% weightage) and performance in the test/interview (30% weightage). Candidates are sought by advertising the programmes in the leading newspapers in April each year. Foreign nationals, selected under various scholarships schemes of the Ministries of External Affairs and Human Resources Development, are considered for admission on the recommendation or sponsorship of the respective Ministry. Such candidates should route their application through the Ministry concerned. Applications for self-financing foreign students are considered directly by the institute.

Admission to the PhD programmes is determined by a department or centre on the basis of a candidate’s written test/interview. The minimum qualification for admission is a Master’s degree in engineering/technology with a minimum Cumulative Grade Point Average (CGPA) of 7 on a 10 point scale (Rajaraman 1993 : 1). In exceptional cases, candidates with an excellent record in their B.Tech degree (minimum 7.5 on a 10 point scale) may be considered eligible for admission, provided that they have passed either the GATE or any other national level examination. PhD programmes are advertised in the leading newspapers in April for the first semester and in October for the
second semester each year (the institutes’ academic year consists of two semesters, the first starting in July and the second in January).

3.7.2.3 Scholarships

The IIT’s offer merit-cum-means scholarships to the undergraduate students in engineering and technology. The recipient is exempted from payment of tuition fee. The criterion of merit for the first year is the candidate’s all India rank in the JEE. The scholarships are renewed on yearly basis subject to the satisfactory performance of scholarship holders. The criterion of means is determined by the income of the candidate’s parents. The institute has no scholarship scheme for postgraduate programmes in engineering.

A scheme for the purpose of providing financial assistance to post-graduate students offers half-time research/teaching assistantships. Those who obtain assistantships work for eight hours per week outside of their normal academic work. Assistantship for students whose Cumulative Grade Point Average (CGPA) at the end of the semester falls below 6.75 is not renewed for the subsequent semester.

3.7.2.4 Evaluation of Performance

A student’s performance is evaluated in terms of two indices, the Semester Grade Point Average (SGPA), the grade point average per semester, and the Cumulative Grade Point Average
(CGPA), the grade point average of all completed semesters. The GPA is calculated as (Rajaraman 1993:1)

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GPA = \frac{\sum (Credits \times Gradepoint)}{\sum (Credits \text{ Registered})}
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### 3.7.3 Indian Institutes of Science Education and Research (IISERs)

In order to strengthen science education & research in the country, the Government has setup three IISERs. Two IISERs at Pune and Kolkata commenced their academic session in 2006 while the third one at Mohali started its session in August, 2007. The vision of these institutes encompasses creation of research universities of the highest caliber in which teaching and education in basic sciences will be totally integrated with state-of-art research. The Institutes offer Integrated Master's Programmes (5 Years) (after 10+2) and when fully established will also offer Integrated Doctoral Programmes (after B.Sc) (5 Years plus) and Conventional Doctoral and Post-Doctoral Programmes in the areas of Physical Science, Chemical Science, Mathematics, Material Science, Environment & Earth Science and Computer Science. Admission into IISERs are based on IIT-JEE merit list.

### 3.7.4 National Institutes of Technology

Seventeen Regional Engineering Colleges (REC's) were established in various States as a joint and co-operative enterprise of the Central and the State Governments concerned. Each REC was to
function as an all-india institution admitting students and recruiting faculty from all parts of the country. Fifty percent of the admissions of these institutions (each of which was meant to be equipped for a total annual student intake of 250) was reserved for students from States other than the one in which they are located. In addition to under-graduate courses, these Colleges also offered Post-graduate courses in various fields.

In 2002, the Seventeen erstwhile Regional Engineering Colleges (RECs) were rechristened as National Institute of Technology (NITs) were taken over as fully funded institutes of the Central Government and granted deemed university status. In addition, Central Government has also taken over 3 other Institutes namely Bihar Engineering College, Patna, Government Engineering College, Raipur, and Tripura Engineering College, Agartala, and converted them into National Institute of Technology (NITs) on 28th January 2004, 1st December 2005 and 1st April 2006 respectively. Thus the total number of NITs has gone up to 20. These institutes are expected to be at par with other national level technical institutes and be able to fulfill the demand of high quality undergraduate and postgraduate level of education in engineering and technology. An Act, namely the National Institute of Technology Act, 2007, has since been enacted by Parliament. So as to provide a common statutory framework for all NITs.
The total budget allocation for all NITs for the year 2006-2007 was increased to Rs. 110.00 crore under Plan and Rs. 200.00 crore under Non-Plan, from about 70.00 crores under Plan and 118.00 crores under Non-Plan at the time of conversion.

3.7.5 State Colleges and University Departments

In addition to the above institutions offering courses at degree and post-graduate level, there is a wide net work of engineering colleges established and administered by the State Governments, Universities and private agencies; they are also affiliated to the respective Universities, and offer degree courses in a variety of subject fields. Some of them are more than a century old and have been pioneers in engineering education in the country. Many of these State colleges and University Departments are making significant contribution in the field of technical education.

3.7.6 Special Institutions

In additions to the above institutions there are certain specialised institutions which offer education/training in specific fields:

3.7.6.1 National Institute for Training in Industrial Engineering, Bombay

Offers a two years post-graduate programme in Industrial Engineering as also a number of Executive Development Programmes and Unit based programmes in various areas of specific interest to specific employing agencies. National Institute of Foundry and Forge Technology, Ranchi - Offers a special post-graduate
training programme of 12-18 months duration in Advanced Foundry and Forge techniques for personnel from the industry.

3.7.6.2 Indian School of Mines, Dhanbad

Which has been declared a deemed University is a specialised Centre for Undergraduate and Post-graduate studies and research in Mining, Applied Geology, Petroleum Technology and Geo-Physics.

3.7.6.3 National Institute of Technical Teachers' Training & Research

At Bhopal, Calcutta, Chandigarh and Madras offer special ‘training’ to serving teachers of polytechnics. Sant Longowal Institute of Engineering & Technology (SLIET), Longowal, Punjab -The institute was established by the Govt. of India in 1989 in the memory of Late Sant Harchand Singhji Longowal with an objective to provide technical education in emerging areas of Engineering and Technology. SLIET offers 12 certificate, 10 diploma, 8 degree and 3 PG Courses. The affiliation of this institute is with the Punjab Technical University, Jalandhar. The annual intake of students is 1025.

3.7.6.4 School of Planning & Architecture (SPA), New Delhi

The School was established by the Government of India in 1955 in the name of School of Town and Country Planning, to provide facilities in education and training in the fields of rural planning, urban planning and human settlement. The School was renamed as the School of Planning and Architecture (SPA), New Delhi in 1959 after the Department of Architecture was included in
it. The School was conferred the status of ‘Deemed University’ in 1979. SPA provides undergraduate and post-graduate education and training in the fields of architecture, planning, design and management of different aspects of human habitat and environment. During the academic session 2006-07, 99 students were enrolled in undergraduate courses and 122 students in post-graduate programmes. The School is also conducting research in areas of Town Planning & Architecture. A Centre for Excellence has been inaugurated in the Department of Architecture of the School in collaboration with Autodesk Inc. during the year 2006. A Memorandum of Understanding has also been signed between Guru Gobind Singh Indraprastha University and School of Planning & Architecture, New Delhi. The objective is to collaborate with each other in areas of mutual academic interests and further to disseminate knowledge jointly through teaching, research programmes and consultancy work. Besides this, Master's Degree Course in Building Engineering & Management and Doctoral programmes are also offered leading to Ph.D. degree in disciplines available at the School. The faculty of the School also undertook seven professional/institutional consultancy projects entrusted by the various government departments.

3.7.7 Private Institutions of Technology and Science

There are some private institutions of engineering and technology also which are renowned and recognized nationally and
internationally. One of such institutions is Birla Institute of Technology and Science (BITS).

Birla Institute of Technology and Science (BITS), Pilani, is an All India Institute for Higher Education deemed to be a university by the Government of India. BITS is recognized nationally and internationally as a leading private institute, which symbolizes the maturing of Indian technical ability and her can do entrepreneurial spirit, especially as derived from the private sector. For over 25 years, BITS has been providing one of the best engineering and technical education programmes to students admitted on the basis of merit. Students in BITS come from all parts of the country and broad and are of different cultural and social backgrounds. The important programmes at BITS, which provide the university-industry linkages at the first-degree level, are Practice School (PC), Technology Innovation Centre (TIC) and Project Oriented subjects. (Maheshwari, 1991 : 4)

3.8 CURRICULUM OF ENGINEERING EDUCATION

The education of an engineer extends over a wide range of knowledge; from pure science, and especially what is known as engineering science, to technology. The major portion of the field is covered by the following branches: aeronautical, agricultural, chemical, civil, electrical, industrial, mechanical, metallurgical, mining, geological, and nuclear engineering. There is a great variety and a good deal of specialization in the above branches. A civil
engineer may aim at highway engineering, structural engineering or some other branch, and his education will be influenced to some extent by his choice. Similarly a mechanical engineer may aim at automatic, machine-tools, aeronautical or general production engineering; and an electrical engineer at heavy current work such as power supply, at light current work such as telephone communications or at work in the field of electronics.

Modern engineering demands a sound training in general science, particularly in physics, mathematics and chemistry. For certain industries a basic knowledge of biology is also essential. The relative importance of the fundamental sciences depends on the branch of engineering for example, an electronics engineer who wishes to specialize in communication or electronics needs an extensive knowledge of physics and mathematics, where as for an agricultural engineer, training in chemistry and the biological science is more important.

Views on engineering education in the later half of the 20th century emphasized the need for a broadening of the curriculum and for an understanding by engineers of the social implications of their work. It was recognized that—especially in management posts—the ability to deal skillfully with problems of human relations was sometimes as important as technical knowledge.
3.9 NATIONAL BOARD OF ACCREDITATION

The usefulness of NBA lies with concern of developing quality education in the globalized world. In other words, it is a process of quality assurance. This body demonstrates the strategies of various activities of technical institutes. As a result NBA was constituted by the AICTE, as an Autonomous Body, under section 10(4) of the AICTE Act, 1987 in order to periodically evaluate institutes or function of various programmes on the basis of guidelines issued by the body. Those institute can apply for accreditation whose program are approved by AICTE and they must have completed atleast two batshes of the students.

3.10 NATIONAL TECHNICAL MANPOWER INFORMATION SYSTEM (NTMIS)

In order to ensure planned growth of technical education the council has introduced scheme ‘National Technical Manpower Information System’ to generate a database to monitor demand and supply of engineering manpower and to ensure planned development of education. The council has also launched an Early Faculty Induction Program to attract bright engineering students towards the teaching profession while providing them best training.

3.11 COURSES IN ENGINEERING EDUCATION

3.11.1 Courses offered at Under Graduate Level

(1) Civil Engineering, (2) Mechanical Engineering, (3) Electrical Engineering, (4) Chemical Engineering, (5) Textile

3.11.2 Courses offered at Post Graduate Level:


3.11.3 Courses offered in Indian Institutes of Technology at Under Graduate Level

3.11.4 Courses offered in Indian Institutes of Technology at Post Graduate Level


3.11.5 Courses offered in Regional Engineering Colleges at Under Graduate Level

(1) Civil Engineering (2) Mechanical Engineering (3) Electrical Engineering (4) Electronics and Communication (5) Metallurgy (6) Architecture (7) Chemical Engineering

3.11.6 Courses offered in Regional Engineering Colleges at Post Graduate Level

(1) Civil Engineering (2) Electrical Engineering (3) Mechanical Engineering (4) Metallurgical Engineering (5) Public Health Engineering (6) Structural Engineering

3.11.7 M.Tech. Industry-oriented Courses in National Institutes of Technology

Resources Engineering (8) Design & Production - Power Plant
Machinery Hydro-Electric. (9) Design & Production - Power Plant
Machinery-Thermal (10) Design & Production - Power Plant
Machinery-Heavy Electrical Equipment. (11) Foundation Engineering
& Production Engineering Medium Duty Machines (14) Mechanical
Shaping of Metals (Rolling, Forging and Heat Treatment) (15)
Extractive Metallurgy and Foundry with emphasis on Alloy Steel
Production (16) Production of Fertilizers. (17) Extractive Metallurgy
(18) Foundry Technology (19) Public Health Engineering (20)
Integrated Power System and Diploma course in Metallurgy Ferro
Alloys Production (21) Marine Structure (22) Industrial Structures
(23) Industrial Physics (24) Analysis and Design of Process
Equipment (25) Production of Process Machines and Equipment (26)
Design of Process Machines (27) Design & Production - High
Pressure Boilers and Accessories (28) Design & Production - Heavy
Machines with emphasis on mechanical equipment for steel plants
(29) Technology of Metallurgical Furn.

3.12 EQUALITY OF OPPORTUNITY IN ENGINEERING EDUCATION

Before independence the days of British rule in India
were the dark days. The Britishers did not take any steps for the
development of the Indian economy. Their main aim was to exploit
the country for their own interests. The Indian society had been
suffering from a large number of inequalities and differences based
on caste, creed, gender and many other discriminations. It was strongly felt that unless an egalitarian society is reorganized the desired national unity, integrity and solidarity can not be brought about in the country.

When India attained freedom on August 15, 1947 the main goal was to rehabilitate the country on the eve of independence. Pandit Jawaharlal Nehru, the first Prime Minister of India, in his historic address, said “long years ago we made a tryst with destiny and now the time comes when we shall redeem our pledge, not wholly or in full measure but very substantially. At the stroke of midnight hour, while the world sleeps, India will awake to life and freedom”. Before these statements the government of India act 1935 had already laid foundation of democratic setup in the country. The nationalist leaders of India emphasized radical changes in all spheres of national activity. They wanted to establish democratic setup. Pandit Nehru also expressed very succinctly, “we stand for democracy”. Accordingly, the preamble of the Indian constitution has been enunciated,

“We, the people of India having solemnly resolved to constitute India into a Sovereign, Democratic, Socialist, Republic And Secure to all its citizens :

- Justice, social, economic and political
- Liberty of thought, expression, belief, faith and worship
• Equality of status and opportunity and to promote among them all

• Fraternity assuring the dignity of the individual and the unity of the nation”

In this historic declaration, super structure of democracy has been raised on the four pillars of justice, liberty, fraternity and equality. Etymologically the term, ‘democracy’ is derived from two Greek words ‘demos’ and ‘kratia’ that means ‘power of the people’. Democracy has been synonymous with the emancipation of men from the bondage of superstitions, wrong belief, inequalities, tyranny and oppressions. It seeks to set upon egalitarian society. It affirms the worth and dignity of the individual and declares that every human being is to be regarded as an end never as a mere means.

Democracy thus denotes not merely political concept but a way of life in a society in which each individual is believed to be entitled to an equality of concern as regards the changes of his participating freely in the values of that society. Besides this our constitution has clearly recognized the role of modern education in the social and economic development.

Article 13(1) of the International covenant on economic, social and cultural rights (1966) provides, “the state parties to the present covenant recognize the right of everyone to education”. They agreed that education “shall be directed to the fullest development of the human personality and shall strengthen the respect for human
rights and fundamental freedoms”. Clause (2) of Article 13 of the covenant further provides, “the state parties to the present covenant recognize that with a view to achieving the full realization of these rights secondary education in its different forms, including technical & vocational education shall be made generally available & accessible to all by every appropriate means & in particular by the progressive introduction of free education. Higher education shall be made equally accessible to all, on the basis of capacity, by every appropriate means particularly by the progressive introduction of free education”.

Article 26(1) of the Universal Declaration of Human Rights (1948) also states, “Everyone has right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit”. Clause (2) of article 26 of the Declaration further provides “Education shall be directed to the full development of the human personality and shall strengthen the respect for human rights and fundamental freedom”. Moreover, the Indian constitution contains following provisions in this regard:

1. Article 38 of the constitution provides, “the state shall strive to promote the welfare of the people by securing and protecting as effectively as it may a social order in
which justice, social, economic and political shall inform all the institutions of the national life.”

2. According to Article 41 of the constitution, “The state shall with in the limits of its economic capacity and development, make effective provision for securing the right to education.”

3. Article 46 of the Indian constitution provides, “The state shall promote with special care the educational and economic interests of the weaker sections of the people and in particular of the Schedule Caste and the Schedule Tribe and shall protect them from social injustice and other forms of exploitation.”

4. The 44th Amendment act (1978) provides, “The state shall in particular strive to minimize the inequalities in income and endeavour to eliminate inequalities in status, facilities and opportunities not only amongst individuals but also amongst groups of people, residing in different areas and engaged in different vocations”.

The Kothari Commission (1964-66) is of the view that one of the important social objectives of education is to equalize opportunity, enabling the backward or under privileged classes and individuals to use education as a lever for the improvement of their condition. Every society that values social justice and is anxious to improve the lot of the common man and cultivate all available talent,
must ensure progressive equality of opportunity to all sections of the population. This is the only guarantee for the building up of an egalitarian and humane society in which the exploitation of the weak will be minimized.

The National Policy on Education (1986) also lays stress on the removal of disparities and to equalize educational opportunities for women, Schedule Caste, Schedule Tribe, Backward Class and handicapped etc. Special attention will be paid to the education of minority groups by providing constitutional guarantees to establish and administer their own educational institutions.

The Ramamurti Review Committee (1990) lays emphasis on equality of educational opportunities for the citizen related to rural areas and tribal areas. These areas suffer due to scarcity of resources and infrastructure facilities. It was also recommended that financial institutions should take steps to increase loans and scholarships facilities for the backward sections of society.

The problem of inequalities in the field of education is mainly due to the following factors:

i. Uneven distribution of educational institutions in the country

ii. Poverty and educational backwardness among the masses.

iii. Difference in the standards of various educational institutions.
iv. Problems of handicaps.

Various education commissions and committees, social reformers, thinkers, intellectuals have stressed to solve this problem. To build a strong democratic set up in the country it is essential to give proper facilities to all.

In the Indian constitution the term equality of opportunity has been used in the sense that every citizen of free India should be provided with equal choices of obtaining higher and professional education with no discrimination of class, caste, creed, gender or habitat.

To bring the potential talent in the sphere of engineering education the state must realize its responsibility of providing equal opportunities to all.

3.13 QUALITY OF ENGINEERING EDUCATION

The quality of engineering education today has become a very important issue the world over. India has also to shift the focus from quantitative expansion to qualitative emphasis in engineering education. Feigenbaum (1969) has used the term ‘quality’ in relation to wider issues such as planning, organization, management, responsibility etc. It is a general perception that in the globalised world those institutions will survive which will offer quality education. Moreover the role of services sector is continuously increasing. The economy is triggered by advances and applications of new information, communication technologies (ICT). The new ICT
and its application across the disciplines has brought about a new set of skills. There is need for adding more liberal courses in engineering curriculum and increasing emphasis on interpersonal skills to enable them to deal with diversified work environment. Australia (1995), Denmark (1992), Germany (1992), Hong Kong (1992) also laid stress on the quality issue. These nations had considered outcomes assessment and benchmarking as alternatives to criteria specification as a means of measuring quality. To improve the quality of institutions the National Academy of Engineers awards the Charles Stark Draper prize and the B. M. Gurdon prize to outstanding contribution. In India in 1994 the National Board of Accreditation was formed, modeling its procedures after the US Accreditation Board for Engineering and Technology (ABET). When we look at engineering education ten countries Australia, Canada, Denmark, Germany, Hong Kong, India, Jordan, Mexico, UK, USA are paying more attention towards this issue. It is interesting to note that despite wide differences in their circumstances, the response of the engineering education community to the trends listed above has been similar in many respects. Engineering educators around the world are looking to accreditation as a means of quality assurance. In India even before independence, in 1917, the Calcutta University Commission has recommended various steps to improve the quality of different types of engineering and technology.
3.13.1 Meaning of Quality

Following are some of the parameters on which quality of any engineering institution can be evaluated:

i. Do the institutions fulfill the objectives of engineering education which means to give education in what the society needs?

ii. Are the teaching materials available in a proper quantity?

iii. What is the position of faculty in an institution? It includes teachers students ratio, qualifications and experience of the staff, innovative nature of faculty, communicative skills etc.

iv. Criteria of students intake in the institutions.

v. Proper financial resources to meet the expenditure of the institution.

vi. The quality of student support services available.

Normally the term ‘Quality’ means of excellent product or services that fulfills or exceeds expectations. It has three dimensions i.e. quality for design, quality for conformity and quality for performance.

When we talk of the quality of engineering institutions it indicates cent percent examination results of the students, ratio of employment opportunities to the students i.e. placement of the students and reputation of the institution at national and international level.
In the recent past there has been an unprecedented mushroom growth of engineering institutions in the country. These institutions are generally criticized on account that they have been established with the motive of churning out money. It is also said that they do not follow the standards and norms prescribed by AICTE, National Assessment & Accreditation Council (NAAC), National Board of Accreditation (NBA), University Grant Commission (UGC), etc. It has negative impact on the quality of these privately managed institutions whereas there is a hard competition among the students to get admission in IIT’s, NIT and other public institutions which are known to their quality of engineering education.

There is no doubt that we have several high quality institutions comparable to the best in the world but for a country of our size and to convert human resources into working capital and optimum utilization of human potential the number is too small. A number of institutions are hovering at the threshold.

It is a challenge for the country that the health of today’s engineering education especially in the light of the concept of knowledge based education. Tinkering with the present system with incremental charges will not do. Major inventions are required to redefine and implement benchmarks for the students, faculty, academic program, infrastructure, ambience and system management.
Various authors and researchers have given contrasting views on this issue. Rao (2005) and Prakash (2005) take this matter seriously. They suggest that it is a very important issue. According to them, more stress should be laid on research activities, otherwise we shall not have the brightest people entering our Research & Development sector, in national laboratories and in the industry. Navaratnam (1997) is of the opinion that quality education is managed education. Boyer (1996) emphasized on the good performance of an institution. Banerjee and Banyopadhyay (2004) have also given more stress on the issue of quality in the competitive age. Nirjar’s (2005) view about quality is that syllabus should conform to the needs of society. After fourth five year plan quality improvement and standards have started getting priority.

3.14 FINANCING OF ENGINEERING EDUCATION

Increasing costs bring us to the issue of financing of the technical education system as such. By and large, the efforts at building up and development of the system has so far been under official auspices - either Central and/or States. However, looking into the enormous costs involved, the maintenance of these courses/institutions and the increasing prices around of men and material, it would not be difficult to envisage a situation where let alone the sponsored agencies, but even the Government agencies, would find it difficult to adequately meet the rising cost of technical education. This is a matter of serious concern and has to be faced
squarely before it is too late when this system which has been built with so much of care might crumble because of lack of adequate attention.

It is true that considerable efforts have to be made by the institutions themselves for augmenting their resources, by way of various measures for resource generation such as consultancy practice, servicing and testing, production, etc. However, as was pointed out earlier in connection with the involvement of the system in community services, here again one should not lose sight of the primary objective of the system as such. Any attempt at raising the resources should have only a secondary role that too complimentary to the academic culture of the system and not for its own sake. If this obvious principle is accepted then the limitations on the institutions raising their own resources will become evident. So, we are left with the major issue again of the provision of adequate funds for the technical education system. It is here, perhaps, one should consider the ways and means by which large users of the products of the system also share the responsibility adequately for the cost of production. There have been suggestions over the years in this direction for motivation by way of incentives, or raising of resources by levying a technical education cess on the users etc. Certain incentives, of course, have been offered by giving to an extent exemption for industry in Income Tax, towards contribution to educational programmes and for a cess in the research and
development establishment for R & D purposes. But, however, this has not resulted in a large shift and on the whole most of the burden has been solely on that of the Government. This has been because technical education has been considered as part of social service and governmental responsibility for the social welfare programmes has had to take care of such programmes. It is now necessary for us to have a detailed and fresh look at this issue.

In the emerging 21st century contexts, several factors constrain the capacity of India's education system in order to meet the needs of a liberalized, economy. One of the serious implications in this regard relates to the availability and optimal use of financial resources.

The questions of fundamental importance are: what should be the total level of financial support for education at all levels to ensure achievement of national goals and rapid advancement of national economy, cohesion and security? What judgement and guidelines can be formulated and with what degree of reliability and confidence in respect of the distribution of funds between different levels or stages of education (including research) and different sectors within a level? Although quality and quantity are inseparable, yet what proportions of the total resources should be broadly devoted to the improvement of quality and consolidation and to the expansion of education? It may be noted that these questions, by their very nature, do not permit precise answers
because they are not questions of arithmetic or production engineering but of human dynamics involving complex sociological considerations.

Education is said to be a merit good. The potentiality of education to accelerate the pace of socio-economic development has been recognized by the various commissions and committees appointed by the government of India from time to time. The Education Commission (1964-66) chose to caption its report as Education and National Development and expressed the view that education system has to be used as a powerful instrument of social, economic and political change and will, therefore, have to be related to the long term national aspirations, and the programmes of national development on which the country is engaged and the difficult short term problems it is called upon to face.

It may be noted that with the onset of planning as a means of socio-economic development in India, the role of education exercising a determining influence on the rate of economic growth and its distributive effect has been re-emphasized. The successive plans have underlined the importance of education, as a contributory factor to economic and social development. In the light of these assumptions financing in education has assumed a new significance. What is meant by financing of education then? It implies the flow of funds to various levels of education- primary, secondary, tertiary and technical. The point to be understood
mainly is that flow of funds may be from the public or private sector or both depending upon the constitutional obligations for education.

It may be remembered that public finance is the main instrument for implementing, public priorities, and there is a strong rationale for public intervention in the financing of education. In general, public investment accounts for about two-thirds of all education spending, although the-share varies from as much as 93 percent in Hungary to below 50 percent in Uganda. Public spending on education is often insufficient, however, when it is misallocated across levels and within levels, and it is inequitable when qualified potential students are unable to enroll in institutions because there are no educational opportunities available or because they are unable to pay or to obtain financing.

The high private rates of returns to investment at all levels of education justify large investments by individuals. They also justify self-financing by families or students, through immediate or deferred cost-sharing. Despite these high private returns and the justification for private finance, there is also a strong, case for public intervention, for reasons of income distribution, capital market imperfections, information asymmetries, and externalities. In fact, most governments are heavily involved in all levels of education, an activity which in many cases takes up a significant portion of public expenditure.
Education can reduce income inequality by promoting productivity gains in agriculture and the modern industrial sector. Equality of distribution of education results in equality of income.

In case of higher and technical education it is rightly believed to be as the instrument of socio-economic transformation of both individuals and the nation. Consequently, there has been greater interest and investment in higher and technical education now than in the past. In the knowledge driven economy, there is a demand for a large number of knowledge workers with a variety of skills for which higher and technical education is the only source. Understandably, the demand for higher and technical education is also on the increase. Even in cases where the demand does not increase significantly in terms of percentage of the relevant age, group, in absolute numbers it is increasing due to the growing population. When technical and university education is focused on academic and intellectual pursuits and when a small fraction of the population indulges in leisurely learning, it is not difficult to maintain a small higher education system. But now, when higher education has become the interest and destination of the relevant age group of the masses, finding the resources for developing and, sustaining a large educational infrastructure has become a formidable task, particularly for third world countries. India is no exception.
There are only two sources of support for higher & technical education as in any economic or social activity. It has to come either from the government or from private contributions, which in turn depends on the perception about the benefits of higher education and the affordability of either the government or the population. One perception about Higher education is that the primary beneficiaries are individuals as they gain by their education both economic and social status immediately. This is the view held by USA and some other developed countries and consequently their higher education system is left to be sustained largely by the direct beneficiaries and other private contributions, of course balanced with enough student aid funds. The other view is that any expenditure on higher education is a national investment and the outcome in terms of trained manpower is crucial for national development and therefore for the public good. This perception is the basis for public spending for higher education in most of the European countries, particularly in Germany.

The developing countries including India have, however, difficulties in adopting either of the two perceptions that determine the source of funding for higher and technical education. Neither the state nor any significant section of the population are willing to afford the-cost of fully supported higher education. This is in spite of their realization that mass higher education is essential for both national and individual welfare. The Gross National Product of third
world countries is so low and the size of the population is so high that public funding for providing access to even a small proportion of the population is almost impossible. Also, the majority of their population cannot afford higher education; as their per capita income is very low. It is in this context one should look at the scope, feasibility, inevitability and the usefulness of Private Higher Education.

After 1980s the decreasing government support for higher and technical education has resulted in private initiatives being encouraged in higher education. It is assumed that private initiative would contribute to the basic infrastructure, lands and buildings and the recurring expenditures like the salary of the employees would be met by the income generated by tuition and other fees as well as from the contributions of society as donations and endowments. However, in practice, private providers have been looking for resources even for the basic infrastructure. For much sought after professional programs, there are one time capitation fee running into hundreds of thousands of rupees, development fee, library and computer fees, and above all the tuition fee that the students have to pay. Though private providers can get loans from financial institutions, they have to be repaid. The maintenance of the infrastructure is also costly. All this should be met out of the funds collected one way or the other from the students.
In a third world country like India, there are not many philanthropists who could contribute substantial donations. By and large, most of the Private Higher Education, institutions are dependent on the parents and the students for their contributions and there appears to be no other resources forthcoming from any sector. This leads to higher financial implications to those who opt for the benefits of the educational services of these institutions. However, one should remember that the beneficiaries of these private initiatives critically evaluate the quality and worth of educational services and only those institutions that pass this test of social accreditation are able to survive.

Even in states where Private Higher Education thrives, less than 20% of students are enrolled into the self financing, high fee structure institutions in spite of the fact that these private higher education institutions outnumber the public-funded colleges by about 60%. This is largely because the cost of education is Phenomenally high in Private Higher Education while it costs virtually nothing in the public institutions. As the number and diversity of Private Higher Education institutions mushroomed rapidly without any market survey, there is a glut of approved seats with no takers even in professional colleges. Consequently the Private Higher Education institutions either extend concessions in the fee levels or lower the entry level achievement of aspiring students. Through legal intervention the affiliated self-financing
institutions are made to provide access to the meritorious and the disadvantaged students by a set quota (reservation) system and these institutions have accepted the norms and other fee structures evolved by the government. Both the government and the judiciary are conscious of the real cost of education that is taken into account while fixing the fee structure. The other category of stand-alone private institutions has no such obligations. So the major issues in educational financing are:

i. How much has to be invested in education in general?

ii. What should be the, guiding principles of allocating the educational budget to the various types and levels of education?

iii. How to mobilize the financial resources for the quantitative and qualitative expansion of technical education in India?

The first two types of questions are related to the field of planning for education. In the Indian context, the third question appears to be far more important than the first two i.e. the issue of mobilization of financial resources for educational expansion according to V. N. Kothari and P. R. Panchamukhi (1980:2001) should be tackled from three points of view:

i. The economy as a whole

ii. The institutions supplying education

iii. The individuals demanding education.
3.15 PRIVATIZATION OF EDUCATION

The role of the private sector in the field of education in general and technical education in particular is growing. The high fee rates donations and capitation fee, for financing adopted by the private education institutions have raised the social desirability of such methods of financing education. Therefore the private engineering colleges in urban areas have emerged as "elite–centres" and thus, are catering to the educational needs of the upper strata of Indian society. Because of these reasons, private educational institutions are widely criticized and their mode of financing has become highly controversial.

The protagonists of private educational institutions make the following claims on their legacy to the field of engineering education:

i. Private educational institutions are known for the students discipline, personality development, good teaching, promotion of extra curricular and sport activities, etc. Thus there is more demand for the educational output supplied by the private institutions.

ii. These institutions are better equipped with teachers, libraries, laboratories, playgrounds, etc. They offer a larger number of facilities parents seeking admissions for their wards.
iii. Private institutions are, sometimes, established by the minority communities. To protect the educational and cultural interests of the linguistic, ethnic and religions minorities, separate educational institutions are allowed in India under minority rights. Thus private educational institutions of minorities have come to stay and are increasing in number since 1951.

iv. Private educational institutions are generally financed by grants from the government and donations received from the philanthropic general public. The share of government grant and charities as donations in the overall finances of private educational institutions is, greater than other receipts.

v. Most private educational institutions, it is argued, collect donations and capitation fees at discriminatory rates. Therefore there would be greater financial burden on the fixed income groups of the urban areas.

vi. Private educational institutions have come up in India in response to the growing educational requirements of the people, expressed in terms of the desire for good quality education, non availability of seats in government institutions and the Phenomenal rise in the students enrolment at different levels of education.
Private educational institutions exist since the government has not been able to expand the educational network as required and desired by the emerging modern society and economy of the country. Thus the state, itself, has promoted the growth of private educational institutions in free India to share the responsibility of the state in the field of education. The antagonists argue:

i. Private and minority-oriented educational institutions have led to separatism and consequently, act as a barrier to bringing the minority population into the mainstream of national life in India. They perpetuate the existing social and cultural separatism and segregation

ii. Private educational institutions, both in general education and technical education, further widen the rich-poor gap and urban-rural disparities by catering only to the upper income groups and urban middle class. In fact, it is argued that the capitation fees collected by colleges of engineering have become a source of huge capital accumulation. Thus the capitation fee is causing more social and economic inequalities.

iii. Private educational institutions have not been fully using the capital collected by them through charities, donations and capitation fees for improving the
education facilities in their institutions. They also suffer from the same infrastructural inadequacies as the government institutions do. Therefore, the private educational institutions are indulging in money-making rather than in educational development.

iv. Since private educational institutions make admission on the basis of donations & capitation fees, they neglect the educational merits of the students from rural areas and urban, lower and middle income groups. This is particularly true of admissions to the professional courses like engineering thus the student with low educational abilities enter the most important educational courses which require high academic excellence. The result is the supply of poor quality engineering graduates.

v. As a large amount of money is involved in admission to the private engineering colleges, their working and managements have become increasingly politicized. The increasing politicization of technical colleges has encouraged corruption, malfunctioning and inefficiency in turn.

vi. The opponents of the private colleges argue that these colleges have led to social demoralization and ethical lowering in education. In fact the private colleges
created an "Elite Island" within our educational system. Thus, they argue that all types of private educational institutions must be immediately nationalized.

In the mutually conflicting arguments advanced both by the protagonists and antagonists of private educational institutions, there is an element of truth.

The protagonists of private educational institutions include politicians and educationists as well as minority and religious leaders. These people argue that without donations and capitation fees, they cannot setup and efficiently run their educational institutions, because technical education is highly capital intensive. But the antagonists of private institutions argue that the capitation fees and donations collected from students are prohibitively high and hence exploitative as a result of which a large section of the common people cannot send their wards to these institutions.

3.16. DEMAND AND SUPPLY OF ENGINEERING GRADUATES

It is the human resources of any country which make the nation strong, healthy and prosperous. But even after training, if our engineering graduates and post graduates do not get suitable placements, our efforts go in vain. The issue of suitable placement is a very crucial aspect. The engineering graduates who get employment in some companies and institutions at domestic level as well as foreign level contribute a lot in the development of the
country. But unemployed persons become parasites on the sources of the country. They feel frustrated and depressed which further leads to many socio-economic problems.

At the time of independence there was no proper growth and development of engineering education in the country. We were fully dependent on other countries. We had shortage of technical manpower for building the infrastructure. The Indian government thought seriously in this context by opening new institutions with the help of other countries. The population growth was very meagre as compared to present situation. The liberalization and globalization process was slow. The intake capacity and student’s response towards technical line was slow. So the employment opportunities for engineering graduates were enough to cope with the supply. But these days rapid growth of graduate engineering education has raised the question of unemployment. Besides opening new institutions in the country by the government and private sector many foreign educational institutions are also contributing towards the engineering education a lot. As a result, an imbalance between the demand and supply of engineering graduates has been established.