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The Development of Engineering and Technical Education in India

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India has made remarkable progress in engineering and technical education over the last two decades. This paper discusses the current development of undergraduate and postgraduate engineering education in India, and presents two case studies detailing the engineering education programmes of two nationally and internationally leading institutions: the Indian Institute of Technology (IIT), New Delhi, and Birla Institute of Technology and Science (BITS), Pilani. The case studies focus on several important aspects, such as the administrative structures, departments and centres, admission procedures, course structures, scholarships, methods of teaching, evaluation of performances, research, practical training, industry links, continuing education and the resources available at these institutions. A unique and innovative industry-linked engineering education and training system recently adopted at BITS is also presented. The Indian Institute of Science (IISc), Bangalore, a leading postgraduate institution, and the Regional College of Engineering (REC), Nagpur, one of seven National Institutes of Technology (NIT) recently chosen by the Government of India for providing the best engineering education, are briefly discussed. Strategic plans, policies and programmes that have been adopted for implementation as the ninth five year plan of the All India Council for Technical Education (AICTE) to meet future technological global challenges are also outlined.

INTRODUCTION

Since the early eighties, due to rapid industrialisation and economic growth, engineering and technical education in India have been developing faster than anywhere else in the world, and India now has the second largest number of engineering students in the world [1][2]. India also has the second largest population, with more than nine hundred and forty million people, fourteen officially recognised regional languages, twenty five states and seven union territories. English is taught at every school and is the only medium of instruction at all engineering institutions. In a recent assessment by the United Nations, the Indian economy was rated as the sixth largest in the world and is expected to move into the fourth place by the end of this century [3]. India, the largest democracy in the world, is very much proud of her rich traditional cultural heritage and technically skilled manpower. Recent Indian scientific, industrial and technological development, particularly in space, nuclear and missile technology, computer engineering and information science have earned India world recognition as an emerging global power.

This paper describes technological development and the engineering and vocational education systems in India. Two world-leading institutions are chosen as case studies and their administrative structures, admission procedures, curriculum development, teaching and research areas and facilities, and other professional activities are studied. The paper also includes strategic plans, policies and programmes adopted for implementation as the ninth five year plan by the All India Council for Technical Education (AICTE) to meet future technological global challenges.

TECHNICAL EDUCATION

Since technical education determines the development and socio-economic condition of a nation, there is a greater need for high quality technical education to produce technically skilled manpower in India. A high

Table 1: Regional distributions of AICTE approved engineering colleges and polytechnic institutions in India (1997).

Region	States/Union Territories	Number of Engineering Colleges	Total sanctioned intake	Number of Polytechnics	Total sanctioned intake
Central	Madhya Pradesh, Orissa	46	8,315	74	11,124
East	Meghalaya, Arunachal Pradesh, Andaman and Nicobar, West Bengal, Assam, Manipur, Mizoram, Nagaland, Tripura, Sikkim	22	3,862	61	7,660
North	Bihar and Uttar Pradesh	52	8,597	136	15,250
North-West	Chandigarh, Haryana, Jammu-Kashmir, New Delhi, Punjab, Rajasthan, Himachal Pradesh	65	11,294	145	20,160
South	Andhra Pradesh, Pondicherry, Tamil Nadu	166	40,884	261	50,461
South-West	Karnataka and Kerala	87	28,869	243	39,920
West	Gujrat, Maharashtra, Goa,Daman & Diu	133	33,074	214	39,660
GRAND	**TOTAL**	**571**	**134,795**	**1,134**	**186,235**

quality engineer or technician can obviously be created only through high quality engineering and vocational teaching and training. Technical education is imparted at three different levels in India:

- Industrial Training Institutes (ITI), which conduct trade courses for skilled workers.
- Polytechnic Institutes, which conduct diplomas to produce middle level technicians.
- Engineering Colleges, which conduct undergraduate and postgraduate degree courses in engineering and technology.

There are engineering institutes and colleges that are supported by the state and central governments, and also a large number of private engineering colleges and institutes that provide technical education in India. The number of private institutions is increasing rapidly. Table 1 shows the rapid growth of engineering institutions in India [3][4]. Government expenditure in technical education has increased by almost 400 times from the first five year plan to the eighth. Some of the industrially developed states, such as Maharastra, Karnataka, Tamilnadu and Andra Pradesh (see Table 1), have experienced phenomenal growth both in numbers of students and engineering and technical institutions over the last two decades.

ALL INDIA COUNCIL FOR TECHNICAL EDUCATION (AICTE)

The All India Council for Technical Education (AICTE) is an apex organisation charged with the responsibility for planning and co-ordinated development of technical education in India. The AICTE is responsible for the accreditation of both state and private engineering colleges. AICTE monitors the qualitative growth of technical education in relation to planned quantitative growth and proper maintenance of norms and standards. The National Board of Accreditation of AICTE aims to bring standards of some of the programmes offered in technical institutions on par with programmes offered in institutions in the USA and Europe by introducing a quality auditing system and establishing a datum for measuring the quality and excellence in engineering education. The accreditation exercise is very rigorous and has several inputs, such as quality of teaching, level of research, faculty expertise, evaluation of teachers, and standard of infrastructure and resources available at the institution. There are seven Statutory Regional Committees across the country for assisting the Council in planning and development of technical education, monitoring and periodic evaluation of the approved institutions in the region. The

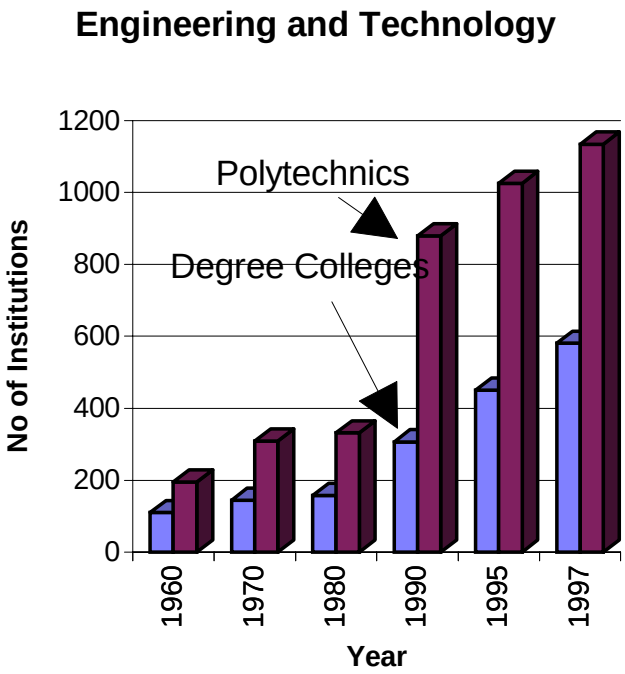


Figure 1: Growth of engineering and polytechnic institutions in India.

main approved tasks for the ninth five year plan are as follows [4]:

- Planning growth and regulation of technical education
- Human resource development
- Quality assurance and excellence
- Promotion of R&D, linkage with industries, national labs, centres and institutions
- Institutional thrust and upgrading
- Rural development programmes
- Mission-oriented programmes
- Strengthening management and governance structure
- Resource mobilisation

The number of engineering colleges and polytechnics is increasing rapidly to cope with the growing demand for technically skilled people due to rapid industrialisation and infrastructure development in the country. Table 1 shows the latest (1997) number of AICTE approved engineering colleges and polytechnics that offer vocational diplomas and engineering degrees. The unprecedented growth in engineering and technical education in India is shown in Figure 1.

Curricula

The general consensus in India is that the distribution of subjects as a percentage of total loads in a four year undergraduate engineering degree should be:

Basic Science and Mathematics	20%
Humanities and Social Sciences	10%
General Engineering	20%
Departmental Core Subjects	30%
Engineering Specialisation (Electives)	20%

Nowadays, computer-aided engineering and technical education have also become standard at all leading institutions and universities [6][7].

Engineering students wishing to pursue postgraduate study take an examination known as the Graduate Aptitude Test in Engineering (GATE). This has one common subject for all engineers and advanced subjects in the area of specialisation. Undergraduate curricula in India are designed to enable students to take this test.

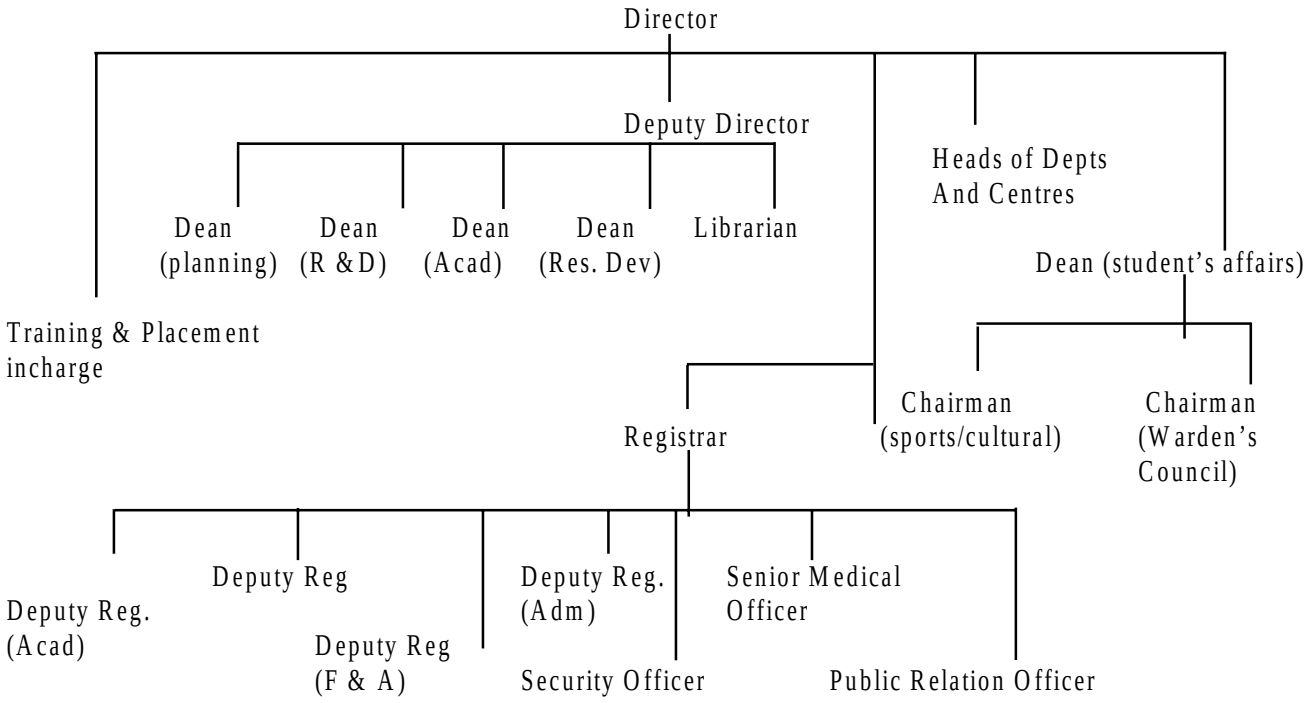
INDIAN INSTITUTE OF TECHNOLOGY

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. The six IITs are located at Kharagpur (near Calcutta), Madras, Bombay, Kanpur, Delhi and Guwahati. Entrance to the undergraduate programmes at these institutions is extremely competitive and is based strictly on students' results in the nationwide Joint Entrance Examination (JEE). The Ministry of Human Resource Development funds a large number of engineering and technical institutions, including IITs [4][5]. 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 shown in Table 2.

CASE STUDY 1: THE INDIAN INSTITUTE OF TECHNOLOGY (IIT), NEW DELHI

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 organisations. 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

Table 2: Structure of administration.



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.

Undergraduate admission

Admission to the first year of the undergraduate programmes leading to the degrees of BTech and the five year integrated MTech is made through the Joint Entrance Examination (JEE) and is common to all six IITs. Every year the JEE is co-ordinated 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 language, securing at least a 60% mark.

Postgraduate admission

Admission to the MTech/MSc 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 [8]. In exceptional cases, candidates with an excellent record in their BTech 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).

Scholarships

The IIT, New Delhi, offers *merit-cum-means* scholarships to 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 a 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 postgraduate 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 CGPA at the end of the semester falls below 6.75 is not renewed for the subsequent semester.

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 [8]:

$$GPA = \frac{\sum (Credits\ X\ Grade\ point)}{\sum (Credits\ Registered)}$$

An example of SGPA and CGPA is shown in Table 3. Each course has a certain number of credits, which reflect its weightage. A one hour lecture per week is treated as one credit point. Every laboratory/tutorial hour per week per semester is assigned half a credit point. The mini, minor and major projects can have three to six credit points per semester. If a first year student at the end of the second semester is not able to complete twenty earned credit points (Table 3), his/her registration would be terminated. At the end of fourth semester, a student under general category must complete sixty earned credits, failing which his/her registration is terminated.

Table 3: SGPA and CGPA.

Semester 1

Course	Credits Registers	Grade Awarded	Points Secured	Earned Credits
HUxxx	4	C (6 points)	24	4
PHxxx	5	C⁻ (5 points)	25	5
MAxxx	5	E (2 points)	10	0
MExxx	4	A⁻ (9 points)	36	4
MExxx	5	B (8 points)	40	5
Total	23		135	18

SGPA = (Total Points Secured)/(Total Credit Registered) = 135/23 = 5.87 = CGPA.

Semester 2

Course	Credits Registers	Grade Awarded	Points Secured	Earned Credits
CSxxx	4	F (0 point)	0	0
MAxxx	4	C (6 points)	24	4
MExxx	4	B⁻ (7 points)	28	4
AMxxx	5	A (10 points)	50	5
MExxx	4	C⁻ (5 points)	20	4
CYxxx	5	B (8 points)	40	5
Total	26		162	22

SGPA = (Total Points Secured)/(Total Credit Registered) = 162/26 = 6.23.

At the end of the second semester the total earned credits = 18+22 = 40

GPA = (135 + 162)/(23 + 26) = 6.06

ENGINEERING DEPARTMENTS

The Faculty of Engineering has the following departments to meet the growing demands of professional engineers in the country. These departments run four year BTech and five year integrated MTech programmes as shown below:

Four year BTech programmes

- Electrical Engineering
- Computer Science and Engineering
- Chemical Engineering
- Civil Engineering
- Manufacturing Science and Engineering
- Mechanical Engineering
- Textile Technology

Five year integrated programmes

- Master of Technology in Biochemical Engineering and Biotechnology

Postgraduate and research programmes

- Postgraduate Diploma (DIIT)
- Master of Technology (MTech)
- Master of Design (MDes)
- Master of Science by Research (MS)
- Doctor of Philosophy (PhD)

In addition to the above programmes, the Institute has interdisciplinary MTech programmes as listed

below:

- Computer Applications
- Energy Studies
- Industrial Tribology and Maintenance Engineering
- Instrument Technology
- Opto-electronics and Optical Communications
- Polymer Science and Technology

The following section describes the teaching, research, academic activities and facilities available in the Department of Electrical Engineering at the IIT, New Delhi.

DEPARTMENT OF ELECTRICAL ENGINEERING

This section of the paper concerns the electrical and electronics engineering study programme currently offered at the Indian Institute of Technology, Delhi [8][9]. The courses are tailored to the anticipated needs of professional engineers in the rapidly expanding fields of computers, telecommunications, electronics, instrumentation, control and power systems.

There are a number of interdisciplinary centres with a significant contribution from the Department, at the Institute, such as the Centre for Applied Research in Electronics, the Applied System Research Programme, the Microprocessor Applications Programme and the Telematics Programme. Under the IMPACT project, for example, a project funded by the Department of Electronics and the World Bank, the Department is collaborating with the Instrument Design and Development Centre on a programme for the development of courses in the area of electronics for engineering colleges and polytechnics. Emphasis in the Department is placed on the use of microprocessors and computational techniques in all fields of electrical engineering. The Department has built up a local network integrated with its computational resources.

Courses offered

The Department offers an undergraduate course of four years duration, covering eight semesters of teaching. The course leads to the award of a BTech in Electrical Engineering and offers specialisation in the fields of electronics, computer technology, control, instrumentation and power systems. In order to broaden students' knowledge in the fields closely allied to electrical engineering, they take a variety of subjects in the first two semesters in basic sciences, engineering arts and science. During the next four semesters the students take a set of departmental core subjects in circuits, devices, systems, electromagnetics, power instruments and systems, communications, control, microprocessors and computers, etc, subjects that are common to all electrical engineering students. From the fifth semester, students have the opportunity to take some elective subjects.

All subjects in the final year are electives. Students choose a combination of them, thus obtaining specialisation in a chosen field. Each student is required to work on a project under the supervision of a faculty member. The students also undergo practical training in industrial establishments as part of their engineering training and education.

Postgraduate programme

The Department has a strong postgraduate programme, offering MTech, MS by research and PhD programmes in electrical engineering with specialisation in communications, computers, control, instrumentation, integrated electronics and circuits, power systems and power electronics. The research activities in the Department can be classified into the following groups:

- Communications Group
  - Communications and Signal Processing
  - Electromagnetics
- Computer Technology Group
- Control and Systems Group
  - Modelling, Identification and Control
  - Systems
- Integrated Electronics and Circuits Group
  - Integrated Electronics
  - Integrated Circuits and Systems
- Power Apparatus and Systems Group
  - Power Systems
  - Power Electronics, Electrical Machines and Drives
  - Energy conversions and systems

The Department has laboratories in basic electrical engineering, measurements, communications, microwaves, signal and information processing, optical communications and optical signal processing, computer technology, computation, microprocessor development systems, microprocessor applications, control engineering, systems engineering simulation, process control, physical electronics, electronic circuits and networks, integrated circuits, electrical machines and

drives, power systems and power electronics.

Centre for Applied Research in Electronics (CARE)

The Centre has three strong research areas, namely:

- Microelectronics technology
- Microwave and millimetre wave components and techniques
- Digital systems and signal processing techniques

The main feature of the Centre is its emphasis on object-oriented research and industry interface. The Centre has major projects with the Ministry of Defence, Defence Organisations, R&D laboratories and Industries, and many of the projects are collaborative in nature, which enables a horizontal transfer of technology to the industries.

In collaboration with the Department of Electrical Engineering, the Centre also offers an MTech programme in communications and radar engineering. The Centre has its own PhD programme in the three main areas of signal processing, microwave technology and microelectronics. Its labs are fully equipped with modern equipment to undertake research; for example, the Microwave and Millimetre Wave Testing Laboratory has two automatic network analysers, one up to 20 GHz and the second covering 0-40 GHz, a spectrum analyser, a scalar network analyser, a TDR set-up and a complete millimetre wave test bench. The microwave group has a Sun IPX workstation system for developing CAD of microwave and millimetre wave integrated circuits. The group also has commercially available state-of-the-art software, HP EESOF and HP MDS, for the simulation and design of microwave devices and circuits.

Centre for Biomedical Engineering

The Biomedical Engineering Centre at IIT Delhi is a postgraduate research and training centre, offering the PhD degree in biomedical engineering. This programme is jointly supported by the IIT Delhi and the All India Institute of Medical Sciences (AIIMS), New Delhi. In addition, the Centre has collaborative projects with major hospitals in India, and is recognised as a World Health Organisation (WHO) collaborative centre for research and training in safety technology.

The Centre's areas of research and development include: medical electronics, biomechanics, bio-materials, computers in medicine, rehabilitation engineering, technology in mass health care, bioengineering in reproductive medicine, physiological system analysis and modelling, and prevention and control of injuries.

Other centres, such as the Centre for Energy Studies and the Instrument Design and Development Centre, are also pursuing research and development work and offer interdisciplinary MTech programmes at the Institute.

Industry-institute interaction

IIT, Delhi, has a memorandum of understanding to facilitate and co-ordinate institution-industry collaboration. Industries provide certain physical and training facilities to the institution, and in return the Institute offers continuing education to their working professionals. Industry expert and technical staff work as a team with the Institute's staff and participate in workshops, conferences and short courses. Industry managers, supervisors and executives, who are able to share practical experiences with the students, are invited as guest lecturers. Students' vacations are effectively utilised by working in the industries with a small incentive in the form of scholarships or wages. Every department of the institution, including Electrical Engineering, has an R&D section partly funded by industry, with one staff member being its co-ordinator. The involvement of students under the guidance of a supervisor for undertaking industry-oriented projects is not only useful to the students and the academic staff, but also promotes interactive networking between the institution and the involved industries.

REGIONAL ENGINEERING COLLEGES (RECS)

In terms of quality education and prestige, the Regional Engineering Colleges (RECs) are second only to the IITs. The Government of India has created 17 RECs throughout the country to be centres of excellence for the promotion of basic and advanced research and technological education at a higher level. The student body of an REC is determined by a 50% quota going to the home state, with the remaining 50% shared by the other states. Each state has its own selection criteria to determine which students will be admitted to the RECs. Some states base their criteria on rankings obtained by students in common entrance examinations and/or performance in the standard twelve Board examinations. Based on their rankings in the entrance examinations, students can choose the REC and the programme they wish to join.

As an example, the REC, Nagpur, officially called the Visvesvaraya Regional College of Engineering, commenced operation in 1960 and established itself as one of the premier educational institutions in the country. The College offers degrees at the undergradu-

ate and postgraduate levels in various disciplines in engineering and architecture. It is one of seven regional engineering colleges selected by the Indian Government as a National Institute of Technology (NIT), which became operational this year (1998). They are being equipped with the latest technological and research facilities to provide the best education in engineering in India. A common entrance exam for admission to the NITs is held on a nationwide basis, with students from all over India. Depending on their scores and subsequent ranks in the entrance exam, students can choose the NIT and the programme that they wish to join. A large number of foreign students join each year to study engineering at the Regional Engineering Colleges.

INDIAN INSTITUTE OF SCIENCE (IISC)

The Indian Institute of Science is a postgraduate institution that offers opportunities for higher studies in science and engineering. In 1898, while India was under British rule, the Royal Society of London, at the request of the Secretary of the Sate of India, employed the talents of William Ramsey, Nobel Laureate, to establish an institution for the promotion of original research in science and engineering in India. Ramsey undertook a quick tour of the country and judged Bangalore to be a suitable place for such an institution. The Institute's constitution was approved by Viceroy Lord Minto in 1909, and the Maharaja of Mysore laid the foundation stone of the Institute; the first batch of students was admitted to the Departments of General and Applied Chemistry and Electrotechnology in July 1911. With the establishment of the University Grants Commission in 1956, the Institute came under its purview as a deemed university.

The IISc has produced many national and international leading scientists and engineers, such as C.V. Raman, H.J. Bhabha, Vikram S. Sarabhai, J.C. Ghose, S. Dhawan, C.N.R. Rao and scores of others who have played key roles in the scientific and technological progress of the country. Some of the departments and centres at the Institute, considered to be India's best, are:

- Departments
  - Aerospace Engineering
  - Biochemistry
  - Computer Science and automation
  - Electrical Communications Engineering
  - High Voltage engineering
  - Electrical Engineering
  - Mechanical Engineering
  - Microbiology and Cell Biology
  - Physics
- Centres
  - Atmospheric and Oceanic Sciences
  - Electronic Design and Technology (CEDT)
  - Reproductive Biology and Molecular Endocrinology

Research students constitute more than 50% of the total student body and each year the Institute produces more than 200 PhD and MSc (Eng) degrees, probably the largest number of any institution in India. This is also the first institute in India to introduce innovative integrated PhD programmes in biology, and chemical and physical sciences for science graduates. The continuing education programme is one of the best in the country and covers a wide range of topics, with over 1,500 scientists and professional engineers passing through its courses every year. In keeping with its aims and objectives, the Institute has a Centre for Scientific and Industrial Consultancy through which the know-how generated at the Institute percolates to industries via industry-sponsored projects.

CASE STUDY 2: 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 recognised nationally and internationally as a leading private institute, which symbolises 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 abroad 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 [10].

Practice School (PS) programmes

BITS made a pioneering contribution to engineering education through evolving the practice school system of education by linking university-industry across interdisciplinary areas. PS has two components, PS-I, which is of eight weeks duration implemented during the summer term after the second year, and PS-II, a

course of five and a half months duration implemented in the final year along with part of the adjoining summer. PS-I is exposure-oriented and initiates students to the art of data acquisition, retrieval, processing, documenting and analysis of information. This course is normally implemented at large industrial and scientific complexes and is directly monitored by a BITS faculty member together with professionals from the organisation. A PS-II assignment covers a large spectrum of industrial activity, ranging from systems planning, design, implementation, computerisation, techno-economic analysis, maintenance and product development, etc.

A student may opt for a specific project offered by the industry. An eligible student's profile, outlining their achievements in various courses, personal attributes and extracurricular involvement, is prepared at the Institute and sent to the host industry. Again, students can be organised into interdisciplinary groups and each group may be allotted an assignment. One of the members of the group is appointed leader for that particular project and is entrusted with total responsibility for planning, scheduling and implementation. Professional experts and a faculty member supervise the student or group. Evaluation components in PS courses can include quiz, viva, seminar, group discussion, project report, observation and technical diary. This evaluation brings out many latent attributes of a student, such as professional judgement, teamwork, leadership, written and oral presentation abilities, etc.

Technology Innovation Centre (TIC)

TIC is a complementary activity centre to PS, where problems of industry are investigated on campus through the involvement of professionals from industry, BITS faculty and students. The students take these projects either as a full-semester thesis requirement or as one course in the form of an elective project.

Project-oriented subjects

The Institute offers various project-oriented subjects that are conducted on an unstructured basis. These are:

- Lab-oriented projects
- Study-oriented projects
- Projects on organisational aspect
- TIC projects
- CAD simulation and design

Through this programme students get proper exposure to real-life problems.

CONCLUSION

The present study on Indian engineering and technical education reveals that the leading institutions have adopted standard competitive research and object-oriented engineering study programmes. Some of the programmes are innovative in nature and offer tremendous advantages and benefits to students, universities and industries. The main benefits to the students can be summarised as: gaining confidence in decision making, relating theory with practice, increased job opportunities, realisation of responsibility, opportunities to know one's weaknesses and strengths, and opportunities to work with modern equipment and on problems of current importance. Finally, it can be concluded that other universities and institutions should adopt more job and object-oriented engineering education curricula linked with industries and research organisations to meet the present and future challenges of rapid technological changes and industrial development in India.

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BIOGRAPHY

Sajal Kumar Palit obtained his MSc in Applied Physics and Electronics Engineering from the University of Dhaka, Bangladesh in 1977 and a PhD in 1982 in Electrical Communications Engineering from the Indian Institute of Science, Bangalore, India. Before migrating to Australia in 1993, Dr Palit held several faculty positions in India, Bangladesh and Libya. Dr Palit joined the Department of Electronics Engineering and Applied Physics, University of Canberra, as a lecturer in 1994 and pursued research and teaching on electromagnetics, RF design, antennas and radio communications. Since February 1996, Dr Palit has been with the Department of Electrical and Computer Systems Engineering, Monash University, where he has been recently promoted to Senior Lecturer.

Dr Palit authored and co-authored more than 35 technical papers in refereed journals and leading international conference proceedings, including seven publications in engineering education. His research interests include wideband microstrip antennas, smart antennas for mobile and satellite communications, satellite-feed antennas, electromagnetics, RF design and computer-aided engineering education.