

The Development of Engineering Education in Haryana

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Abstract: - Haryana is one of the constituent states of Indian republic which came into existence in 1966. The state has made remarkable progress in engineering education over the last two decades. Engineering education is adapted to the general needs of modern economy and society, dominated by globalization aimed to meet the growing demand for technical manpower in several technological areas. The present paper discusses chronological developments in the engineering education system including the various milestones, academic programme overview, courses offered & enrolment, state initiatives, issues & challenges and the future prospects. The paper specifically addresses a case study in the development of engineering education in Haryana. The paper may be useful for policy planners, academicians, researchers and people who are involved in the issues of engineering education.

Key-Words: - Engineering Education, Haryana, Undergraduate, Postgraduate, Doctoral Studies, Initiatives, Issues.

1. Introduction

The 21st century is a knowledge-based society and India has the potential to become one of the leaders in such a society. There is no doubt that the knowledge-based economy will be founded to a considerable degree upon creation of clusters, which are networks of technological and knowledge producing institutions like Universities, colleges, research institutes and technology providing firms. The later part of the last century saw the emergence of information era where connectivity and software products were driving the economy. However, in the 21st century, a new society is emerging where knowledge is the primary production resource instead of capital and labour. The last decade has witnessed an assorted increase in professional education. Engineering being a liberal education, serves the need of the society and individuals, providing a major contribution in employment, production, economy, health, and in the enhancement of the quality of human life throughout the world. India follows 10+2+4 models of education and most students move directly from one level to another across 16 years of education [1-4].

Looking at the state of Haryana, it is one of the constituent states of the Indian republic. It came into existence on 1st November, 1966 as a breakaway from the imposing Punjab. Starting off as a relatively backward region, Haryana took giant strides to establish itself as a prosperous entity

within a couple of decades. Infact, Haryana not only has a vibrant agricultural sector but also has a fast growing industrial and educational sector. The economic strength of Haryana is certainly on the rise due to achievements in the fields of information technology, software exports, health sector, telecommunication, petro-chemical production and power generating capacity. Besides industrial growth, the state also has a sound network of technological knowledge producing institutions like central, state, private, deemed Universities, autonomous and self financing institutes. In addition, the state has a diverse type of professional institutions such as engineering, ayurvedic, dental, hotel management, law, nursing, pharmacy and physiotherapy colleges [5-7]. In the present paper, efforts have been made to highlight the development of engineering education in Haryana. Similar studies regarding development of engineering education in different countries has been reported by several authors [8-10].

The present paper is organized as follows: Firstly the various milestones in the engineering education have been discussed in section 2. This is followed by the academic programme overview in section 3. Section 4 summarizes the various courses offered and mode of enrolment in engineering education. The sections 5 and 6 of the paper are devoted to a brief description of the state initiatives, challenges and issues. Finally the paper has been concluding by listing a few recommendations.

2. Milestones in the Development of Engineering Education

Engineering education in Haryana has witnessed a vast increase in institutional capacity since the last two decades. At present, the state has a sound network of technological knowledge producing institutions like central, state, private, deemed, technological Universities, autonomous and self financing institutes. Table 1 depicts various types of institutions established in the state. During the oriental period of institution building, two institutions stood out prominently as far as engineering education was concerned. The first and foremost engineering college, The Technological Institute of Textiles and Sciences was established as

self funded institute in 1943 for imparting engineering education in the field of textiles [11]. National Dairy Research Institute (NDRI) formerly Imperial Dairy Institute was established in Central Cattle Breeding Farm, Karnal in 1955 [12]. This was followed by the Regional Engineering College (REC), Kurukshetra in 1963 as a joint and cooperative enterprise of govt. of India and the state govt. of Haryana [13]. After this, the next important landmark was the evolution of Chhotu Ram State College of Engineering (CRSCE), Murthal in 1987 [14]. Until 1990, there were only four technological institutes to impart UG/PG/Doctoral studies in engineering in the state.

Table 1 Different Type of Institutions in State

S.No	Institutions	Number of Institutions
1	Central University, Mahendragarh	1
2	State Universities: (1) Maharishi Dayanand University (MDU), Rohtak (2) Kurukshetra University (KU), Kurukshetra (3) Chaudhary Devi Lal University (CDLU), Sirsa and (4) Bhagat Phool Singh Mahila Vishwavidyalaya (BPSMV), Khanpur-Kalan	4
3	State Agricultural University: Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hisar	1
4	Health University: Pandit Bhagwat Dayal Sharma University of Health & Science, Rohtak	1
5	Technological State Universities: (1) GJUS&T, Hisar (2) DCRUS&T, Murthal and (3) YMCAUS&T, Faridabad	3
6	Private Universities: (1) O.P. Jindal Global University, Jagdishpur (2) Appejay Stya University, Faridabad and (3) ITM University, Gurgaon	3
7	Govt Engineering College: CDLMGEC, Panniwala Mota, Sirsa	1
8	Dairy Research Institute: National Dairy Research Institute (NDRI), Karnal	1
9	Deemed to be Private Universities: (1) MMU Mullana (2) Manav Rachna International University and (3) Lingyas University, Faridabad	3
10	Institute of National Repute: National Institute of Technology (NIT), Kurukshetra	1
11	Autonomous Institutes: Nemi Chand College of Engineering (NCCE), Israna & Al Falah School of Engineering, Dhauj	2
12	Self financing institutes	125
Total		146

During the epoch of 1990's, multinational companies started coming up in emerging areas like communication & signal processing, VLSI design, software sector, automation, real estate etc. Thus, there was a sudden increase in the demand for technical trained professionals; but with its existing engineering institutes, the state was unable to keep pace with the demand for engineering graduates. Therefore, in the mid 1990's, the private sector started taking a keen interest by initiating self funding institutes. In 1995, three self financing

institutes named Seth Jai Parkash Mukand Lal Institute of Engineering and Technology (JMIT), Radaur; Vaish College of Engineering (VCE) Rohtak, and Maharishi Markandeshwar Engineering College (MMEC), Mullana were evolved [15-17]. Later, in 1995, Guru Jambheshwar University, Hisar was also established to emphasize on technical education in the state [18]. Further in late 1990's, launching of UG course in Information Technology (IT) took place with the development of new employment opportunities. During the span of 1999-

2000, there were a total of 23 engineering colleges, out of which 20 were self financing which showed the mass gathered by the private sector in engineering education.

In the era of 2000, the state established Chaudhary Devi Lal Memorial Government Engineering College (CDLMGEC), Panniwala Mota in societal mode in 2003 [19]. This was followed by the setting up of University Institute of Engineering and Technology (UIET) at KUK and MDU in 2004 and 2005, respectively [20-21]. After mid 2000, the state further strengthened the network of higher learning by upgrading three institutes into Universities with a vision to introduce more innovative and research-oriented engineering and technology programmes. In 2006, CRSCE, Murthal was upgraded to Deenbandhu Chhotu Ram University of Science and Technology (DCRUS&T), Murthal [14]. Moreover, GJU Hisar was renamed as Guru Jambheshwar University of Science & Technology, Hisar in 2006 [18]. Special emphasis was also given by Haryana state to empower and to promote the cause of girl's education in northern India. Keeping in view the same, the state upgraded Girls Gurukul Khanpur-Kalan into the first state women University of north India, naming Bhagat Phool Singh Mahila Vishwavidyalaya, Khanpur- Kalan, Sonipat in 2006 [22].

Apart from the above mentioned institutes, three major private players were conferred the status of deemed Universities in 2008, viz. Maharishi Markandeshwar University, Mullana; Manav Rachna International and Lingayas University, Faridabad [17, 23-24]. To pioneer further innovation in the academic programmes of engineering to meet the need of the industry, in 2008 the state granted academic autonomy to three promising engineering colleges in the state viz. NCCE Israna; Institute of Technology and Management (ITM), Gurgaon and Al Falah School of Engineering, Faridabad [25-27]. During the end of this decade, YMCA institute of engineering, Faridabad was also upgraded to YMCA University of Science and Technology in 2009 [28]. Besides, two most promising self financing engineering institutes named ITM, Gurgaon and Appejay College of Engineering, Sohna, Faridabad were conferred the status of ITM University, Gurgaon and Appejay Stya University, Faridabad recently in 2010 through state private University act [26, 29]. In addition, the Central Institute of Plastic Engineering & Technology (CIPET) is also being established under the department of chemicals and petrochemicals, Ministry of chemicals and fertilizers at the campus of DCRUS&T, Murthal [30].

In a nutshell, at present the state has a cluster of technological institutes including central, state, technical, deemed Universities and several self financing engineering institutes. Most of these institutes are offering various UG/PG programmes in several disciplines of engineering and technology [31-32]. Table 2 summarizes the time line for growth and development of engineering education in the state.

3. Engineering Academic Programmes Overview

At present, the various engineering institutions in the state are offering undergraduate B.E./B.Tech, postgraduate M.E./M.Tech and doctoral studies in various disciplines of engineering and technology. In this section, a brief academic overview of these programmes is presented.

3.1 Under Graduate (UG) Programmes

The B.E./B.Tech academic programme is divided into 8-semesters with a load of 4-5 subjects per semester supplemented by 3-4 laboratories in each semester. First two semesters of the programme focus on the fundamentals of basic science, engineering science & humanities with a broad coverage of associated subjects. The course curriculum in first two semesters is common in all the disciplines of engineering. Semesters 3&4 cover broad discipline-wise orientation course. During semester 5-6, students focus on branch-wise orientation in the related areas. In the final year of the course, students are required to work on small independent/group projects to sharpen their scientific acumen and knowledge. Graded seminars are also conducted. In addition, each student also undertakes training in various industrial or govt organizations as per the curricula of the concerned Universities [2].

Admission to B.E./B.Tech courses in different institutes in the state is based on All India Engineering Entrance Examination (AIEEE) conducted by Central Board of Secondary Education (CBSE). Further, the admission to architectural programme is made on the basis of valid National Aptitude Test in Architecture (NATA) score conducted by Council of Architecture. The admission to All India category seats of B.Tech (Agriculture Engineering) are filled by Indian Council of Agricultural Research (ICAR) [33-36]. Besides, after completion of a 3 year diploma

candidates can also get direct admission to the 2nd year of B.Tech programme through lateral entry.

Table 2 Time Scale in the Development of Engineering Education

S.No	Year	State Institutions
1	1943	Evolution of Technological Institute of Textiles and Sciences, Bhiwani to offer diploma courses in textile and in 1953 upgraded as B.Tech imparting institute.
2	1955	Establishment of NDRI formerly Imperial Dairy Institute in Central Cattle Breeding Farm, Karnal.
3	1963	Regional Engineering College (REC), Kurukshetra was established.
4	1969	Establishment of YMCA, Faridabad to impart specialized courses on German pattern.
5	1987	Establishment of Chhotu Ram State College of Engineering, Murthal by state Act.
6	1989	NDRI, Karnal conferred the status of Deemed University.
7	1992	Evolution of College of Agriculture Engineering & Technology; CCSHAU, Hisar.
8	1995	Establishment of Institute of Instrumentation Engineering at KU, Kurukshetra.
9	1995	Guru Jambheshwar University, Hisar was established by state legislation.
10	1995	Evolution of three self financing engineering institutes named JMIT, Radaur; VCE, Rohtak and MMCE, Mullana.
11	1997	State took over the control of YMCA, Faridabad and upgraded into UG offering institute.
12	1995-2000	Establishment of 20 major self financing engineering institutions.
13	2002	Upgradation of REC to National Institute of Technology (NIT), Kurukshetra.
14	2003	Evolution of CDLMGEC, Panniwala Mota under societal mode by state.
15	2004	Establishment of University Institute of Engineering & Technology (UIET), KUK.
16	2005	University Institute of Engineering & Technology (UIET), MDU Rohtak was setup.
17	2006	Upgradation of Chhotu Ram State College of Engineering into DCRUS&T, Murthal.
18	2006	Renaming of GJU, Hisar to GJUS&T, Hisar through state legislative Act
19	2006	Evolution of Institute of Mass Communication and Media Technology at KUK.
20	2006	Upgradation of Girls Gurukul Khanpur Kalan to 1 st state women University, Bhagat Phool Singh Mahila Vishwavidyalaya, Khanpur Kalan, Sonapat by the state Legislature.
21	2008	Evolution of School of Engineering and Sciences at BPSMV, Khanpur-Kalan.
22	2008	Evolution of 11 women self financing engineering institutes in state.
23	2008	Academic autonomy to Institute of Technology and Management, Gurgaon; Al Falah School of Engineering, Faridabad and NC college of Engineering, Israna.
24	2008	Evolution of 42 self financing engineering institutes.
25	2008	Evolution of 3 private deemed Universities, Maharishi Markandeswar University, Mullana; Manav Rachna International and Lingayas University, Faridabad.
26	2009	Upgradation of YMCA Institute of Engineering to YMCA University of Science and Technology, Faridabad.
27	2009	Establishment of Central University at Mahendragarh.
28	2010	Evolution of CIPET at the campus of DCRUS&T, Murthal.
29	2010	ITM University, Gurgaon and Appejay Stya University, Faridabad established through state private University Act.

Infact, 10% seats of sanction intake in each discipline of UG are reserved for diploma holders [37]. All the admissions in UG courses are followed by on line off campus counseling conducted by Haryana State Counselling Society [38-41].

3.2 Postgraduate (PG) Programmes

Though B.E./B.Tech programmes provide a broad coverage of a particular discipline, one can opt for specialization in engineering & technology only at

the PG level and thereafter during doctoral/post-doctoral studies. The master's programmes in different fields are oriented towards imparting an in-depth knowledge of the specialized field together with a firm understanding of the subject. The first three semesters of the programme focus on the recent developments in the course and also on special topics relevant to the specialization in emerging areas. In the last semester, the students have to undertake a thesis/dissertation according to their area of interest. The students thus dedicate their

whole semester to a particular topic to sharpen their scientific and technical knowledge. This provides an exposure to the students in the area of research & development [2, 42].

The admission to PG programme M.E./M.Tech in the state is made on the basis of either entrance test conducted by the institutes at individual level or on merit bases of the qualifying examination. However, those who are in prefinal, final year or one who has completed B.E./B.Tech programme can apply for the entrance test called Graduate Aptitude Test for Engineers (GATE). The GATE score candidates are given preference in the PG admission and offered scholarship of an amount of Rs. 8000/- per month [43].

3.3 Doctoral Studies

After completion of PG, one can also pursue doctoral studies in any discipline of engineering & technology from different Universities in the state. At present, as per the minimum standards and procedure for the award of Ph.D. degree, regulations 2009 from UGC, the admissions to all state Universities are made through an entrance test conducted at the individual level of the University followed by course work. Candidates having valid

Graduate Aptitude Test for Engineers (GATE) score are exempted from entrance test and get the benefit of scholarship during their course of study [43-45]. The Ph.D. students undertake a course work of minimum 18 credits and maximum of 36 credits in two semesters depending upon the nature of the topic/subject. The course work consists of four-five subjects in relevant discipline of engineering and technology supplemented by research methodology and computer knowledge. Registered candidates can complete Ph.D. programme in a duration of 2-5 years.

Thus, it can be seen that the state offers ample opportunities for pursuing UG/PG/doctoral studies in the field of engineering. Besides aforementioned academic programmes, one can also go for short-duration courses in various specialized fields of engineering & technology. These courses are unique programmes aimed at imparting dedicated training in thrust areas of engineering and technology. These short term courses are beneficial for continuous upgradation of knowledge and skills that become a necessity due to rapid advancements in technologies. Various institutions in the state offer these certificate courses. The eligibility qualifications and mode of admissions are depicted in table 3.

Table 3 Eligibility condition of UG/PG/Doctoral Studies

S.No.	Entity	Under Graduate Course	Post Graduate Course	Doctoral Studies
1	Duration	4 years –B.E./B.Tech; 5 years- B.Arch	2 years–M.E./M.Tech	2-5 years
2	Qualification Required	Should have passed 10+2 system of Indian education with Physics & Mathematics as compulsory subjects along with one of the subjects: Chemistry, Bio-Technology, Computer Science or Biology Or Direct admission in 2 nd year of B.E./B.Tech after 3 year diploma course. A relaxation of 5% in aggregate marks to SC/ST students.	Pass in appropriate UG course of engineering & technology with minimum 50% aggregate marks.	Pass in appropriate PG course of engineering & technology with minimum 55% aggregate marks.
3	Mode of admission	Online off campus counselling through HSCS in July-August	Physical counselling at institute level in the month of July-August	University level physical counselling in the month of July-August
4	Basis of admission	AIEEE/NATA/ICAR or LEET	Through GATE or University/institution level test/ qualifying percentage	University level entrance test (GATE qualified candidates are exempted from entrance test)

4. Courses Offered and Enrolment

The engineering faculties of various Universities and self funded institutes offer a large choice of disciplines in engineering and technology at UG and PG level. At UG level, one can choose a wide range of programmes from conventional engineering disciplines to emerging areas of technology including hi-tech frontier areas. At present, the state offers UG engineering programmes in almost all disciplines of engineering as stated in table 4. The institutes offer PG course in various specializations of engineering and technology such as electronics and communication engineering, biotechnology, computer science, agriculture, civil, chemical, electrical, information technology, instrumentation & control, mechanical, printing and food engineering etc. However, there is a need to focus on other courses such as medical nanotechnology, mechatronics & automation, information & communication technology, communication & signal processing, information security,

computational linguistics, bioelectronics, biomedical instrumentation etc. In addition, the dual degree 5 year integrated programme in engineering and technology supplemented by management or specialized areas of relevant discipline leading to a dual degree viz. B.Tech-MBA or B.Tech-M.Tech with a choice for an exit policy after four years is an added advantage. Moreover, the state is also ahead in the field of research and imparts doctoral studies in various specializations including computer science and engineering, information technology, nanotechnology, bioinformatics, food technology, electronics and communication engineering, electrical engineering, instrumentation and control, mechanical engineering, civil engineering, biotechnology, printing technology, instrumentation engineering, agricultural engineering, dairy engineering and others too [38]. Table 4 indicates the disciplines offered and the status of UG/PG enrolment in the state during session 2009-10.

Table 4 UG/PG disciplines offered and enrolment in session 2009-10 (*University Teaching Departments)

S.No	Discipline	Students intake at UG level		Students intake at PG
		*UTD/ Govt Aided	Self Financing	
1	Agriculture Engineering	45	-	04
2	Architecture Engineering	40	280	18
3	Automobile Engineering	-	90	-
4	Aeronautical Engineering	-	60	-
5	Bio-Technology	150	300	122
6	Biomedical Engineering	90	90	-
7	Chemical Engineering	60	60	18
8	Civil Engineering	210	2010	78
9	Computer Science & Engineering	620	10800	458
10	Dairy Technology	47	-	09
11	Electronics Engineering	660	12120	490
12	Electrical Engineering	210	1410	177
13	Fashion & Apparel Engineering	-	30	-
14	Fashion Technology	60	-	-
15	Food Engineering	60	-	20
16	Food Technology	60	30	-
17	Industrial Engineering & Management	60	-	-
18	Instrumentation Engineering	60	-	20
19	Information Technology	180	6660	66
20	Instrumentation and Control	-	150	48
21	Mechanical Engineering	480	7350	296
22	Plastic Technology	60	-	-
23	Printing Technology	60	30	20
24	Packaging Technology	60	-	-
25	Printing Graphics & Packaging	30	-	-
26	Textile Engineering and Technology	-	130	-
27	Textile Chemistry	-	10	-
Total		3302	41610	1862

A comparative study indicates that in 1995 there were 8 institutes offering 10 UG and 5 PG disciplines with an intake of 1632 and 90 students respectively. However, in 2005 it increased to 41 institutes having 18 UG disciplines with an intake of approximately 7452 students and PG in 8 areas with an intake of approximately 130 students. In the session 2009-10, the state offered 27 different UG disciplines with an enrolment of 44912 students and PG in 15 areas with an intake of 1862 students. This study clearly indicates that there has been many-fold increase in institutional capacity, disciplines offered and enrolment which will strengthen the youth of state.

5. State Level Initiatives

The state is also taking initiatives to further strengthen UG/PG/Ph.D. in engineering and technology. In this section, a brief overview of the various state initiatives has been presented.

5.1 Emphasis on Enrolment of Girl Students

The low visibility of girl students in engineering education was addressed in 2008 to overcome the existing gender gap in information age. Keeping in view, the women empowerment through technical education, the state upgraded girls gurukul Khanpur-Kalan to 1st state women University, namely, Bhagat Phool Singh Mahila Vishwavidyalaya, Khanpur Kalan, Sonapat and also established School of Engineering and Sciences there. In addition, 11 other self financing women engineering institutes were also established in the state [22, 46].

Moreover, Haryana state launched a new education loan scheme in April 2007 for female students of the state with a view to encourage them to pursue higher professional education in the country and abroad. In order to avail the scheme, no preconditions of income/caste/religion were set. The Haryana women development corporation contributes Rs 5% per annum per beneficiary on behalf of the student availing the loan. One can exercise the option of repayment from 1st year onwards or at the end of the course.

Furthermore, the state technical education department has also provided few scholarships to the amount of tuition fees for only girl child in the state. Also, there is 10% tuition fess waiver scheme of AICTE wherein, economically backward and physically handicapped meritorious women students are exempted from paying tuition fees. The institute in term shall be allowed to admit 10% additional

intake in the same discipline/ branch of study. Also 50 scholarships for B.Tech students have been fixed for Haryana state residents having only two girl children [38].

5.2 Educational Scholarships

Apart from above mentioned schemes, from 2009 onwards the state has launched a cash prize of Rs 1 lac to Haryana domicile candidate who ranks first at the all India level in various technical examinations such as AIEEE, IIT, GATE and CAT. Besides, the government is also giving Rs 51000/- to the candidates of Haryana securing top 10 positions in similar examinations. The government is also giving Sir M. Vishvesvariya scholarship to meritorious candidates to encourage them for technical education (B.E./B.Tech./B.Arch. courses) amounting to Rs. 20000/- per student per year or actual tuition fee whichever is less to the toppers of online counseling in each branch in each institute admitted through central counseling. Haryana state counseling society (HSCS) has also launched half tuition fee scholarship of a total amount of Rs. 50 lacs for candidates belonging to Kashmiri migrant's category in the diploma level/B.E./B.Tech./B.Arch. courses. The state has also made a provision of scholarship of Rs. 20000/- to Rs.40000/- for the above said courses to the girl toppers of online counseling in each branch in each institute admitted through central counseling.

Scholarships of Rs. 40000/- shall be given to first 50 Haryana govt. senior secondary school girl toppers admitted to B.E./B.Tech./B.Arch. through central counseling society. Further, from session 2010-2011 onwards, scholarships of Rs. 40000/- at B.E./B.Tech level will also be given to Haryana govt. school toppers candidates admitted through central counseling only. Besides, the state provides 60 Arya Bhatt Research scholarship amounting to Rs. 40000/- per annum or actual tuition fee whichever is less plus Rs. 5000/- per month for contingency, boarding & lodging to the topper of regular M.Tech having a valid GATE score in each branch of each institute. In case, if sufficient number of candidates with valid GATE score is not available the same is offered to others as per the prescribed academic weightage of HSCS. Moreover, to encourage the students to pursue research and doctoral studies, the state provides 30 Sir C.V.Raman scholarships of an amount of Rs. 18000/- per month per candidate plus Rs. 5000/- contingency per month which is highest among all other Ph.D. courses in the state [31, 38, 43-44].

5.3 Rural Youth Empowerment

Besides the above initiatives, the state has also reserved one seat in each discipline of engineering in every institute for the toppers of government senior secondary schools of Haryana. Moreover, 4% seats are also reserved in School of Engineering and Sciences for the resident of village Khanpur-Kalan and Bhiswal in the state university BPSMV Khanpur-Kalan. Further, 10 seats are also reserved for the bonafide residents of Murthal in the state technological university DCRUS&T Murthal (Sonipat) and 10 seats in Govt. Engineering College CDLMGEC, Panniwala Mota, Sirsa for residents of village Panniwala Mota. Also 8 seats (2 seats in each branch) are also reserved in Matu Ram Institute of Engineering and Management, Rohtak for the residents of Bohar/ Garhi and migrated residents of these villages to Kutana/Majra in B.E./B.Tech courses [14, 22, 38].

5.4 Post Matric Scholarship

The objective of the scheme is to provide financial assistance to meritorious students belonging to economically weaker section of minority community. The scholarships are open to scheduled tribes nationals of India for studying at post matriculation or post secondary stage to enable them to complete their education. These scholarships are awarded by government of the state /union territory administration to which the applicant actually belong. The purpose of the scheme is to provide enhanced participation of SC population of the state in technical education, so that they can reap the benefits of technology advancement and growth. This scheme is applicable for SC students admitted in full time regular programmes at pre engineering/diploma/UG/PG engineering & technology, architecture & town planning. SC students whose parents/guardian income is less than one lac shall be entitled for post matric scholarship scheme of govt. of India [47].

In a nutshell, the state is strengthening the UG/PG/doctoral programmes by taking various state initiatives as elaborated above. Moreover, to strengthen the technical education in the state, budget for the same has been set at Rs. 157.9 crore in the fiscal 2009-10 in comparison to Rs. 29 crore in 2004-05.

6. Challenges and Issues

Inspite of the above mentioned state initiatives, there are some challenges and issues regarding

engineering education which still need to be addressed. In this section, a brief overview of the various challenges has been presented [48].

6.1 Standardization & Review of Curriculum

At present, the whole global society is in the process of socio economic integration. Thus, the engineering education curricula as well as the pedagogy may need to be redesigned and developed so as to produce world-class technocrats who can take decisions in the integrated global society. The Indian industry has also become globally competitive in several sectors and can increase its global market share. It is worthwhile to improve the quality of engineering education by reconsidering the curriculum, the infrastructure, equipment & faculty and other academic input. There is a need to have proper and perfect contents, subject enrichment, better teaching technologies, personnel development, organizational culture, social ethics, employability skills and team work. The academic curriculum needs input as per industry and global scenario. Moreover, there is a need to support teaching and learning through ICT aids, e-learning, virtual simulation tools and globally used simulation tool such as MATLAB. Soft skills and advance topics should also be covered as per the requirement [49-56]. The curriculum of all Universities in various disciplines of engineering should be standardized by the policy makers and all education & training institutes should follow it. Such an approach would bring quality control in engineering education and will facilitate in building accreditation programs accordingly for quality control of educational institutes.

6.2 Adoption of Credit Base System

Almost all the Universities in the state have adopted or are under the process to implement credit base system. However, the assignment of credit and scale varies across different state Universities. Keeping in view the same, the syllabi and scheme of examination should be designed in such a manner that various Universities/institutions across the state have common credit and grade scale, syllabi and scheme of examination for better improvement in the system of examination & process of evaluation. The same will also be beneficial and easy during transfer of credits in case of migration of students. The flexibility and quality improvement of higher education can be achieved by adopting uniformity in the credit base system across the state. Moreover,

there is a need to introduce choice based credit system for technical education in the state [57-58].

6.3 Development of Professional Skills

In Haryana, 71% of the population resides in rural areas and a mere 29% of its population is urban based. At present, a major enrolment in engineering institutions is from rural background. Most of the students belonging to the rural area are very poor in communication skills. Keeping in view the above facts, the institutions of the state should take initiatives to incorporate and establish language labs in engineering curriculum as learning resource centre to develop communication & technical skills. This will also act as a platform where learners are groomed for soft & interpersonal skills [5-7].

6.4. Ensuring Employability Skills

During the last five years, the number of institutions offering engineering education has almost increased four fold in the state. The input to various academic institutions varies in view of the availability of qualified teachers, infrastructural facilities etc. The output from technical institutions in terms of education (graduates (B.Tech/B.E.), post graduates, PhDs) and research (Publications, Journals, Books, Patents) also varies a lot as per academic institution.

As far as placement is concerned, industry today is looking out for professionals who have multiple skills, domain knowledge and are capable of multitasking. The focus of higher education should not only be on preparing professionals for employment but more importantly towards developing employability skills because most of the engineering institutions in the state are running on less than 30-40% placements. Carefully structured and thoughtfully conceived employability skill development will equip the professionals of tomorrow to build up the much desired self-confidence and motivation, to meet the work challenges successfully, to survive and most importantly to flourish. A large number of studies define the skills and abilities required for engineering graduates to excel at their work place [59-62].

In addition, there is also a need to strengthen industry- institute interface. Therefore, the contents of the training programme/curriculum need to be changed in consonance with the changing needs of the industry.

6.5 Research Focus

Growth and development scenario in engineering education requires advance courses that may attract students towards research. The teaching pedagogy can help to inculcate problem solving skills that will serve in motivating students and will provide a prerequisite material for research. Indeed, the perception among Indian social fabric is such that students are interested in joining a high paying job as soon as they finish up minimum educational requirements. Among them, very few pursue post graduate & research programmes. Although, the state is moving ahead in engineering and technology education, however, one of the factors that limit the growth of engineering and technology education is non-availability of Ph.D. professionals.

Upto 2002, there were only 5-10% faculties having master's degree in engineering and technology in the institutes of the state. However, the state has been able to overcome the shortage of PG professionals during the last decade due to increase in institutional capacity and by starting of new PG courses across the state. But, as far as doctoral studies are concerned the situation is almost the same due to limited opportunities since the last decade. At present, the state is producing only 5-10 PhDs in engineering and technology every year, which is very less as the institutional capacity has grown at a very fast rate during the last ten years. Therefore, there is a need to encourage students and faculty to pursue research programmes.

In addition to the above challenges and issues, there are other issues which need to be addressed such as lack of educational infrastructure in terms of academic inputs, non effective and large class room teaching due to increasing enrolment in engineering disciplines, lack of qualified teachers, lesser inclination towards higher education & research, weak industry academia cooperation, identification & inclusion of relevant skills in the curriculum, lack of awareness of funding and fellowship opportunities for research [63-64].

7. Future Prospects

Recently, the state has taken initiatives to set up Rajeev Gandhi Education City in Sonipat for strengthening higher education network at global level. The state's Haryana Urban Development Authority (HUDA) has offered 11 sites for setting up of multi-discipline private Universities and educational institutes in Rajeev Gandhi Education City, Sonipat. Fore School of management, Birla Institute of Management Technology, Thapar

University, Jindal Global University, MIT Group, AMITY, Apeejay Styra University, St Xavier's Education and Institute of Technology & Management are a few to set up institutions of higher education and professional courses in the Education City [65]. Besides, a School of Engineering and Technology is also proposed in Central University at Mahendergrah during the 11th five year plan [66]. Furthermore, initiatives are underway to affiliate technical institutes of the state with DCRUS&T, Murthal and GJUS&T, Hisar, thus converting them to affiliating Universities. Moreover, the state technological university DCRUS&T, Murthal has also started B.Tech weekend programme in electronics and communication engineering, computer science and engineering, electrical engineering, mechanical engineering, civil engineering and PG weekend programme in highway and safety engineering to strengthen engineering education in the state [67].

Besides above, during the 11th five year plan, the state has also made a remarkable development in health sector. In this scenario, it will be highly advantageous to take initiatives for starting UG/PG courses which integrate engineering and health sector. Therefore, courses and specializations such as biomedical engineering, biomedical signal processing, biomedical instrumentation, medical electronics, bioelectronics and other interdisciplinary engineering areas which have been started at various institute level will lead to ample opportunities in the upcoming years. apart from the existing programmes in the future, there is a need to start UG programmes in other disciplines such as environmental engineering, fire engineering, metallurgical & materials engineering, bioinformatics, production and industrial engineering, agri-informatics engineering, ceramic engineering, electronics engineering-design & manufacturing, energy engineering, engineering physics, industrial design, polymer engineering etc. to endorse engineering education in the state.

8. Recommendations

The following recommendations are suggested for further development of engineering and technology education in the state:

1. MATLAB and language lab should be introduced in engineering faculties of all state Universities as a part of engineering curriculum and made compulsory for all engineering students right from first year.
2. Engineering faculties should encourage their teaching staff to attend workshops, seminars,

conferences in various areas of engineering and technology. Moreover, there should be financial rewards for R&D projects and publications with high impact factor.

3. Engineering faculties should encourage teaching staff and students to become members of professional societies in relevant disciplines.
4. Inter-university and inter-departmental interaction among students and faculty should be encouraged to inspire interest in different areas.
5. Emphasis should be laid on six month industrial training instead of 6 weeks in engineering faculties of all state Universities.
6. The contents of the curriculum need to be changed in consonance with industry changing needs. Therefore, the people from industry and R&D exposure should be included as the members of the UG/PG board of studies and departmental research committee.
7. Implementing faculty exchange programmes among engineering faculties and R&D institutes across the country.
8. Emphasis should be laid on implementation of choice based credit system and starting of dual degree B.Tech-MBA or B.Tech-M.Tech course with an exit policy after four year.

Owing to the dynamic nature of the engineering and technology field there will always be scope for innovation and improvement. The development of engineering education in a knowledge based society requires joint efforts among various engineering faculties of various universities, state technical education department, industry and R&D institution in view of accomplishing the above recommendations.

9. Conclusion

Engineering education in Haryana has made a remarkable progress in terms of the number of institutions, UG/PG/Ph.D. student's enrolment, increase in disciplines and faculty during the last two decades to strengthen engineering education in the state. Infact, in 1995 there were only 8 engineering institutes offering 10 UG and 5 PG disciplines with an intake of 1632 and 90 students in each. However, in 2009-10 these have increased to 146 institutes offering 27 UG and 15 PG disciplines with an enrolment of 44912 and 1862 students respectively. This shows an increase of approximately four fold in case of state Universities and approximately more than twenty times rise in both student enrolment and institutional capacity as compared to the situation in 1995.

Besides, looking at the growth and development of institutes across the regions and disciplines, it seems that in spite of a large number of technical institutions imparting engineering education at UG level, there is voluminous supply of engineering qualified manpower. Still at the higher end, the state is producing only a few PhDs and M.Techs as compared to the number of UG professionals. The state is making all efforts to bridge the gap at PG and doctoral studies by upgrading and establishing academic institution of higher education.

It can thus be concluded that by the end of the first decade of the 21st century, the engineering education system in the state is undergoing a vibrant change. Sensing the potential of engineering education in state development, there is a great need to impart quality engineering and technological education in this era of automation and industrial revolution.

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