

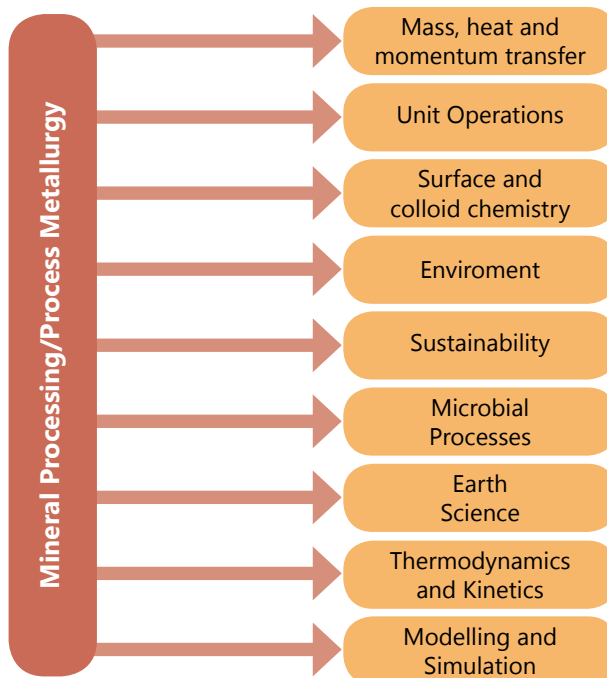
Mineral Engineering Education in India – Current Status and Challenges

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Introduction

Mineral processing is a multidisciplinary subject, and a graduate needs to acquire the broad range of skills shown in this diagram, from both the arts and the sciences. The list is aspirational, as not all programs cover all these topics.



This paper provides an overview of the programs on offer in India and some recommendations to ensure success of the Mineral Processing discipline in the future.

Mineral Processing and Extractive Metallurgy Programs offered in India

Mineral engineering in India was traditionally associated with geology, rather than geology, and does not tend to be part of engineering programs as it is in many other countries. Programs are offered at different academic levels. At the highest academic level, the degree of Bachelor of Technology (BTech) or Masters in Technology (MTech) is only offered in 2 institutions:

- Indian School of Mines, Dhanbad (BTech, MTech and PhD)
- PG Centre, Sandur, Karnataka (MTech and PhD)

Many other institutions who previously ran high calibre academic programs in mineral processing and extractive metallurgy programs have dropped the programs to concentrate on programs such as nanotechnology and materials science. Some mineral processing research continues in some of these institutions.

There are additional degree programs available at the National Institute of Technology level, with faculty mainly from Chemical Engineering, Metallurgical & Materials Engineering, Earth Science. These include:

- Indian Institute of Science, Bangalore
- Indian Institutes of Technology-Kanpur, Kharagpur, Bombay, Madras, Bhubaneshwar, Hyderabad, Guwahati, Gandhinagar, Roorkee, (BHU, Varanasi)
- National Institutes of Technology – Nagpur, Trichy, Surathkal, Warangal, Rourkela, Jaipur, Durgapur, Jamshedpur
- Institute of Chemical Technology, Mumbai (Formerly UDCT)
- Andhra University, Vishakapatnam

There are also a number of established R and D institutes. Many of the people working in these areas are specialists in other disciplines such as Chemical or Materials engineering.

Research and Development Programs

Mineral processing groups have been developed by many large R and D organisations to meet the needs of industry where the existing infrastructure does not provide specialist minerals processing and extractive metallurgy hubs – these institutions are all contributing to research in the discipline and in several cases also working in partnership with the Universities mentioned above.

- Tata Research Design Development Center (TRDDC, TCS)
- National Metallurgical Laboratory, Jamshedpur (CSIR)
- Institute of Minerals and Materials Technology, Bhubaneswar (CSIR) – Offers a PG Diploma Course in Mineral Engineering (1 year duration)
- Central Institute of Mining and Fuel Research, Dhanbad (CSIR)
- North East Institute of Science and Technology, Guwahati (CSIR)
- Indian Bureau of Mines
- Bhabha Atomic Research Center
- Atomic Minerals Directorate
- Indian Rare Earths Ltd.
- National Mineral Development Corporation, Hyderabad
- Geological Survey of India
- Aditya Birla Science & Technology Company Pvt. Ltd., Talaja, Mumbai
- National Institute of Rock Mechanics, Kolar
- Jawarharlal Nehru Aluminium Research Development and Design Center Nagpur
- Research & Development Center for Iron and Steel (RDCIS), Ranchi

The Major Indian Mineral Processing Schools

Indian School of Mines (ISM), Dhanbad

ISM was established in 1926 on the pattern of the Royal School of Mines, England to cater to the demand of mining and hydrocarbon professionals in India.

The Department of Fuel and Mineral Engineering was founded in the year 1976 to address the processing issues of the minerals (metallic, non-metallic and fuel).

The B Tech program (4 years) in Mineral Processing was launched in 1984 by Professor TC Rao. The admission to the program is through the national Joint Entrance Examination along with IITs.

The admission to the M Tech program is through the Graduate Aptitude Test In Engineering (GATE) exam, which is very difficult and attracts very high caliber students. Mineral processing is not necessarily the first choice of these students but nevertheless provides a supply of high quality students.

ISM Course Structure

For the 4-Year B Tech Mineral Engineering ISM-IIT Dhanbad, I & II Semesters are common with the other branches in the school.

III Semester - B.Tech

Subject Code	Subject Name	L-T-P=CH (Hours per week)
Theory		
FM D-13101	Sec-A: Introduction to Mineral Engineering	2-2-0=04
GL D-13171	Sec-B: Economic Geology	2-0-0=04
FM C-13102	Particle Technology	3-0-0=06
GL R-13101	Geology - Mineralogy, Petrology & Stratigraphy	3-0-0=06
AM R-13101	Method of Applied Mathematics - 1	4-1-10=9
MM R-13101	Mechanical Engineering - 1	3-1-0=07
HSS Elective (Any One)		
HS E-13302	i) Philosophy of Science	3-0-0=06
HS E-13303	ii) Gandhian Studies	
HS E-13304	iii) Oral Communication Skills	
HS E-13305	iv) Oral Presentation Skills	
Total		20-2-0=42

Subject Code	Subject Name	L-T-P=CH (Hours per week)
Practicals		
FM C-13201	Introduction to Mineral Engineering	0-0-0=0
GL R-13201	Geology - 1: Mineralogy Petrology & Stratigraphy	0-0-0=03
	Total	0-0-6=06
Total		20-2-6=48

L-Lecture, T-Tutorial, P-Practical, CH-Credit Hours, R-Code for Capsule Course

IV Semester - B.Tech

Subject Code	Subject Name	L-T-P=CH (Hours per week)
Theory		
FM C-14101	Comminution & Classification	3-1-0=07
ME R-22132	Mining Methods & Unit Operations	3-0-0=06
AM R-14101	Numerical & Statistical Methods	4-0-0=08
MMR-14101	Mechanical Engineering – II	3-1-0=07
HS R -14306	English for Professional Communication	3-0-0=06
	Total	16-2-0=34
Practicals		
FM C-14201	Comminution & Classification	0-0-3=03
AM R-14201	Numerical & Statistical Methods	0-0-3=03
Others		
FM C-14505	Composite Viva-voce	0-0-0=(04)
SW C-14701	Co-Curricular activity	0-0-0=(03)
	4-week Vocational Training	0-0-0=06
	Total	0-0-3=03
Total		16-2-6=40

* Vocational training taken at the end of IV Semester is credited for marks in V Semester

V Semester - B.Tech

Subject Code	Subject Name	L-T-P=CH (Hours per week)
	Theory	
FM C-15101	Physical Separation Processes	3-0-0=06
FM C-15102	Fuel Technology	3-0-0=06
FM C-15103	Non Ferrous Extractive Metallurgy	3-0-0=06
MM C-15111	Bulk Solid Handling Equipments	3-1-0=07
M S R-15153	Managerial Economics	3-0-0=06
	Total	15-1-0=31
	Practicals	
FM C-15201	Physical Separation Processes	0-0-3=03
FM C-15202	Fuel Technology	0-0-3=03
	Others	
FM C-15601	Plant Visits	0-0-0=(02)
FM C-15001	Vocational Training*	0-0-0=(06)
	Total	0-0-6=06
Total		15-1-6=37

VI Semester - B.Tech

Subject Code	Subject Name	L-T-P=CH (Hours per week)
	Theory	
FM C-16101	Coal Preparation	3-0-0 = 06
FM C-16102	Ferrous Extractive Metallurgy	3-0-0 = 06
FM C-16103	Surface Phenomenon & Froth Flotation	3-0-0 = 06
EE R -16101	Applied Electrical Engineering	3-1-0 = 07
ES C- 16106	Pollution Control & Environmental Management	3-0-0 = 06
	Total	15-1-0=31

Subject Code	Subject Name	L-T-P=CH (Hours per week)
Practicals		
FM C-16201	Coal Preparation	0-0-3/2=3/2
FM C-16202	Analytical Techniques in Mineral Engg.	0-0-3/2=3/2
FM C-16203	Surface Phenomenon & Froth Flotation	0-0-3/2=3/2
ES C-16206	Pollution Control & Environmental Management	0-0-3/2=3/2
Others		
FM C-16501	Comprehensive Viva-voice	0-0-0=(04)
FM C-16601	Plant Visits	0-0-0=(02)
	Total	0-0-6 =06
Total		15-1-6=37

VII Semester - B.Tech

Subject Code	Subject Name	L-T-P=CH (Hours per week)
Theory		
FM C-17101	Computational Techniques in Mineral Engineering	3-0-0=06
FM C-17102	Process Equipment Selection	3-0-0=06
FM C-17103	Dewatering & Drying	3-0-0=06
FM C-17104	Beneficiation Process Control	3-0-0=06
MS R-17152	Industrial Engineering & Management	3-0-0=06
	Total	15-0-0=30
Practicals		
FM C-17801	Project Work	0-0-6=06
Others		
FM C-17601	Plant visits	0-0-0=(05)
FM C-17001	Vocational Training*	0-0-0=(05)
	Total	0-0-6=06
Total		15-0-6=36

* Vocational training taken at the end of VI Semester is credited for marks in VII Semester

VIII Semester - B.Tech

Subject Code	Subject Name	L-T-P=CH (Hours per week)
	Theory	
FM C-18101	Modeling and Simulation	3-2-0=08
FM C-18102	Flow Sheet Design	3-2-0=08
FM C-18103	Agglomeration Technology	3-0-0=06
MMC-18102	Maintenance Engineering	3-0-0=06
	Electives (Any one)	
FM E-18101	Clean Coal Technology	3-0-0=06
FM E-18102	Bio-Mineral Processing	
FM E-18103	Power Plant Engineering	
FM E-18104	Research Methodology and Techniques	
FM E-18105	Elements of materials Engineering	
As per choice*	Open Elective of Students Choice*	
	Total	15-4-0=34
	Practicals	
FM C-18203	Agglomeration Technology	0-0-3=06
FM C-18801	Dissertation	0-0-6=06
OTHERS		
FM C-18401	Term paper & Seminar	0-0-0=(03)
FM C-18501	Comprehensive Viva-voice	0-0-0=(04)
FM C-18601	Industrial Tour	0-0-0=(05)
	Total	0-0-6=06
Total		15-4-12=46

* open elective: Under this subject the student can select from the capsule courses of any of the other departments, which is of relevance and can help in carrying out the dissertation/project work.

Laboratory courses are becoming more and more difficult to sustain because of large student numbers and diminishing numbers of available staff.

Post Graduate (PG) Center, Sandur, Karnataka

This is dedicated masters program in mineral processing which began in the 1990s. It is called "Masters of Science and Minerals Processing". Features of the program include:

- The Department was established in the year 1975 by the Karnataka University, Dharwad offering job oriented 6 semester (3 Years) Master's degree course [M.A.Sc] in Mineral Processing.
- In the year 1980, The department of mineral processing came under the jurisdiction of Gulbarga University, Gulbarga. The degree was renamed as M.Tech degree course in Mineral Processing in 1990.
- In the year 2010 the department came under the jurisdiction of Vijayanagara Srikrishnadevaraya University Bellary.
- It is an unique institute, first of its kind in South India, offering job oriented M.Tech degree course in Mineral Processing.

Course Structure and Syllabus of M.Tech (Mineral Processing) P G Center

1. A candidate with B.Sc or B.E. degree is eligible for admission to I year M.Tech Degree Course.
2. Hard Core Subjects are Compulsory. Candidate can select any two soft-core subjects.
3. One Open Elective subject shall be chosen by the students of other Departments during II & III semester respectively.
4. For practical examinations a batch shall consists of not more than five students. Students are not permitted to take the practical examination without submission of the certified Laboratory records. 30% of practical marks are allotted to Viva-Voce and laboratory records.
5. After II & IV Semester students shall be sent for Plant visit and Industrial Training respectively. Industrial Training report has 2 credits. One or two staff members may visit the work place at least once during the training period for supervision. TA/DA may be paid for the staff members as per university rules.

6. During V Semester, the students shall be taken for Industrial Tour for a period of 15 days and has 2 credits.
7. The candidates have to take a Project Work in the Department or in any well established mineral based organization / laboratory for 3 -4 months and submit the dissertation report. The Project Report has 8 credits and Viva-Voce has 4 credits.
8. Plant visits, Industrial training and Tour are compulsory. Candidate should present the dissertation work before the Viva-Voce Committee consisting of BOE, Chairman of the Department and concerned guide.
9. Theory Question paper format for CBCS Semester examinations consists of 3 questions,
 - Question 1. consists of 20 Marks for short 10 Questions covering all the units. [2 × 10 = 20]
 - Question 2. consists of 20 Marks for 4 Questions with choice covering all the units. [5 × 4 = 20]
 - Question 3. consists of 30 Marks for Essay type Questions with choice covering all the units [3 × 10 = 30]
10. All other conditions are as per the university rules and regulations.

First Semester

Total marks for first semester = 650

Sl. No.	Subject Code	Title of The Paper	No. of Credits		Exam Hours	Marks	
			L-T-P	Total		IA	Theory/ Lab
Hard Core Papers - Theory							
1	MP C-1.1	Mineralogy	3-0-0	3	3	30	70
2	MP C-1.2	Petrology and Elements of Mining	2-1-0	3	3	30	70
3	MP C-1.3	Elements of Mechanical Engineering	3-0-0	3	3	30	70
Soft core papers – Theory (Select any two)							
4	MP C-1.4	Elements of Electrical Engineering	3-0-0	3	3	30	70
5	MP C-1.5	Applied Mathematics and Applied Statistics	3-0-0	3	3	30	70
6	MPC- 1.6	Mining Geology	3-0-0	3	3	30	70
Hard Core Papers-Practical							
7	MPL C-1.7	Mineralogy and Petrology Lab	0-0-2	2	4		50
8	MPL C-1.8	Mechanical Engineering Lab	0-0-2	2	4		50
9	MPL C-1.9	Electrical Engineering Lab	0-0-2	2	4		50
Total				21		150	500

Second Semester

Total marks for second semester = 700

Sl. No.	Subject Code	Title of The Paper	No. of Credits		Exam Hours	Marks	
			L-T-P	Total		IA	Theory/ Lab
Hard Core Papers - Theory							
1	MP C-2.1	Economic Geology	2-1-0	3	3	30	70
2	MP C-2.2	Analytical Chemistry	3-0-0	3	3	30	70
3	MP C-2.3	Mineral Processing – I	3-0-0	3	3	30	70
Soft Core papers – Theory (Select any two)							
4	MP C-2.4	Testing of Materials & Transport Phenomenon	3-0-0	3	3	30	70
5	MP C-2.5	Computer Programming in C & C+	3-0-0	3	3	30	70
6	MP C-2.6	Heat and Mass Transfer	3-0-0	3	3	30	70
Hard Core Papers - Practical							
7	MPL C-2.7	Analytical Chemistry Lab – I	0-0-2	2	4		50
8	MPL C-2.8	Mineral Processing Lab – I	0-0-2	2	4		50
9	MPL C-2.9	Computer Programming in C & C+ Lab	0-0-2	2	4		50
Elective paper (Select any one)							
1	OE 2.1	Study of Minerals and Rocks	2-0-0	2		15	35
2	OE 2.2	Mineral Resources of India	2-0-0	2		15	35
Total				23		165	535

Third Semester

Total marks for third semester = 700

Sl. No.	Subject Code	Title of The Paper	No. of Credits		Exam Hours	Marks	
			L-T-P	Total		IA	Theory/ Lab
Hard Core Papers - Theory							
1	MP C-3.1	Ore Microscopy & Research Methodology	2-1-0	3	3	30	70
2	MP C-3.2	Mineral Processing - II	3-0-0	3	3	30	70
3	MP C-3.3	Coal Preparation & Fuel Technology	3-0-0	3	3	30	70
Soft Core papers – Theory (Select any two)							
4	MP C-3.4	Surface Chemistry	3-0-0	3	3	30	70
5	MP C-3.5	Indian Mineral Resources & Processing Plant Flow Sheets	2-1-0	3	3	30	70
6	MP C-3.6	Bio Processing	3-0-0	3	3	30	70
Hard Core Papers - Practicals							
7	MPL C-3.7	Study of Ores and Ore Microscopy Lab	0-0-2	2	4		50
8	MPL C-3.8	Mineral Processing Lab – II	0-0-2	2	4		50
9	MPL C-3.9	Analytical Chemistry Lab – II	0-0-2	2	4		50
Elective paper							
1.	OE 3.1	Introduction to Mineral Processing	2-0-0	2		15	35
2.	OE 3.2	Iron Ore Processing and Steel Making	2-0-0	2		15	35
Total				23		165	535

Fourth Semester

Total marks for fourth semester = 650

Sl. No.	Subject Code	Title of the Paper	No. of Credits		Exam Hours	Marks		
			L-T-P	Total		IA	Theory/ Lab	
Hard Core Papers - Theory								
1	MP C-4.1	Mineral Processing – III	3-0-0	3	3	30	70	
2	MP C-4.2	Non Ferrous Extractive Metallurgy	3-0-0	3	3	30	70	
3	MP C-4.3	Flow Sheet Development & Evaluation	2-1-0	3	3	30	70	
Soft Core papers – Theory (Select any two)								
4	MP C-4.4	Agglomeration MPD (Auxillaryopn)	3-0-0	3	3	30	70	
5	MP C-4.5	Process Control & Automation	3-0-0	3	3	30	70	
6	MP C-4.6	Industrial Management	3-0-0	3	3	30	70	
Hard Core Papers - Practical								
7	MPL C 4.7	Mineral Processing Lab – III	0-0-2	2	4		50	
8	MPL C-4.8	Agglomeration & Study of Flow sheets	0-0-2	2	4		50	
9	MPL C-4.9	Coal Preparation Lab	0-0-2	2	4		50	
				Total	21		150	500

Fifth Semester

Total marks for fifth semester = 650

Sl. No.	Subject Code	Title of the Paper	No. of Credits		Exam Hours	Marks	
			L-T-P	Total		IA	Theory/ Lab
Hard Core Papers - Theory							
1	MP C-5.1	Mineral Processing – IV	3-0-0	3	3	30	70
2	MP C-5.2	Mineral Processing Plant Design [Comm-Concen]	3-0-0	3	3	30	70
3	MP C-5.3	Ferrous extractive metallurgy	2-1-0	3	3	30	70
Soft Core papers – Theory (Select any two)							
4	MP C-5.4	Simulation & Modeling	3-0-0	3	3	30	70
5	MP C-5.5	Environmental Management & Mineral Processing Economics	3-0-0	3	3	30	70
6	MP C-5.6	Waste Recycling	3-0-0	3	3	30	70
Hard Core Papers - Practical							
7	MPL C-5.7	Mineral Processing Lab – IV	0-0-2	2	4		50
8	MPL C-5.8	Metallurgy Lab	0-0-2	2	4		50
9	MPL C-5.9	Simulation & Modeling Lab	0-0-2	2	4		50
Total				21		150	500

Sixth Semester

Total marks for sixth semester = 250

Sl. No.	Subject Code	Title of the Paper	No. of Credits		Exam Hours	Marks	
			L-T-P	Total		IA	Theory/ Lab
Project Work							
1	MP C-6.1	Dissertation	0-2-6	8	-	-	100
2	MP C-6.2	Viva Voce on Dissertation	0-0-4	4	-	-	100
3	MP C-6.3	Industrial Training	0-0-2	2	-	5	
4	MP C-6.4	Industrial Tour Report	0-0-2	2	-	5	
Total				16	-	0	200

The pattern of matrix for M.Tech Mineral Processing (Six Semesters)

No	Courses	I SEM			II SEM			III SEM			IV SEM			V SEM			VI SEM	
		C	P	M	C	P	M	C	P	M	C	P	M	C	P	M	C	P
1	Hard Core	15	5	450	15	5	450	15	5	450	15	5	450	15	5	450	16	Project Work
2	Soft Core	6	2	200	6	2	200	6	2	200	6	2	200	6	2	200		
3	Open Elective	-	-	-	2	1	50	2	1	50	-	-	-	-	-	-		
Total		21	7	650	23	8	700	23	8	700	21	7	650	21	7	650	16	

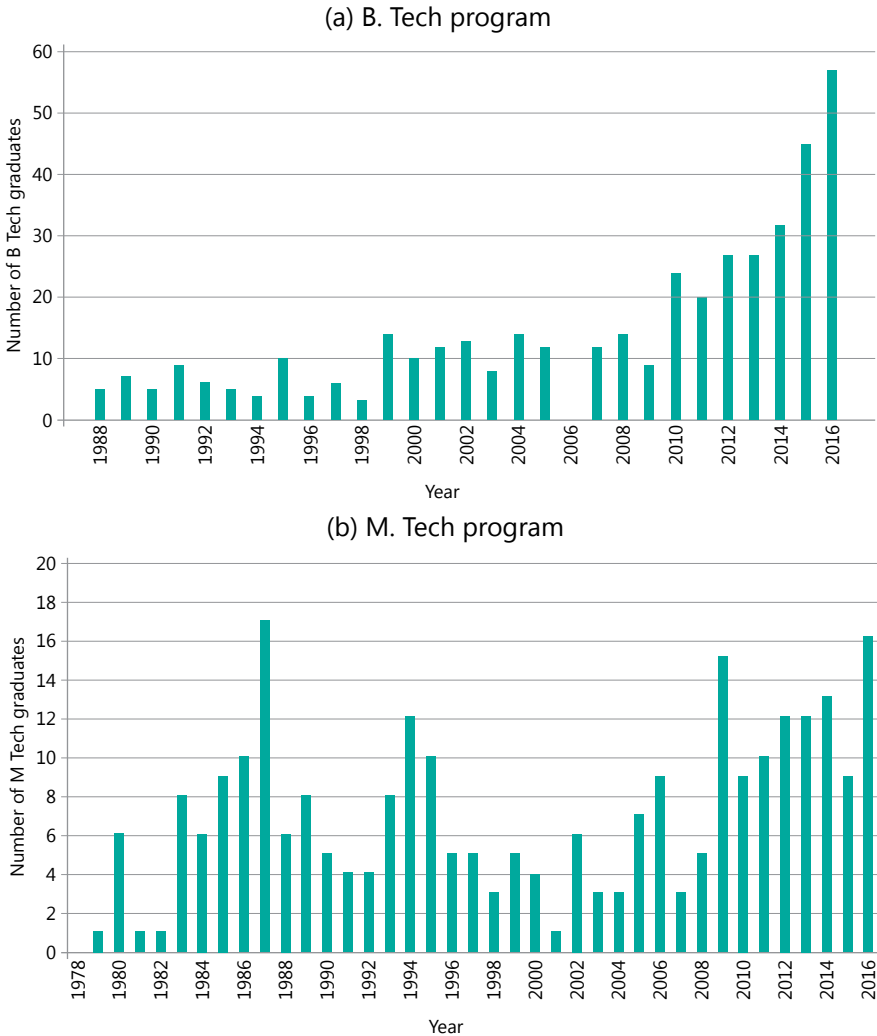
Total

	C	P	M
Hard Core	91	25	2250
Soft Core	30	10	1000
Open Elective	04	02	100
Total	125	37	3350

Next – how are the courses doing?

Degree conferments 1988 to 2016 are presented in figures and below. Total degree conferments during this period are 414 for the Bachelors degree (B.Tech), and 271 students graduated from the Masters (MTech) program.

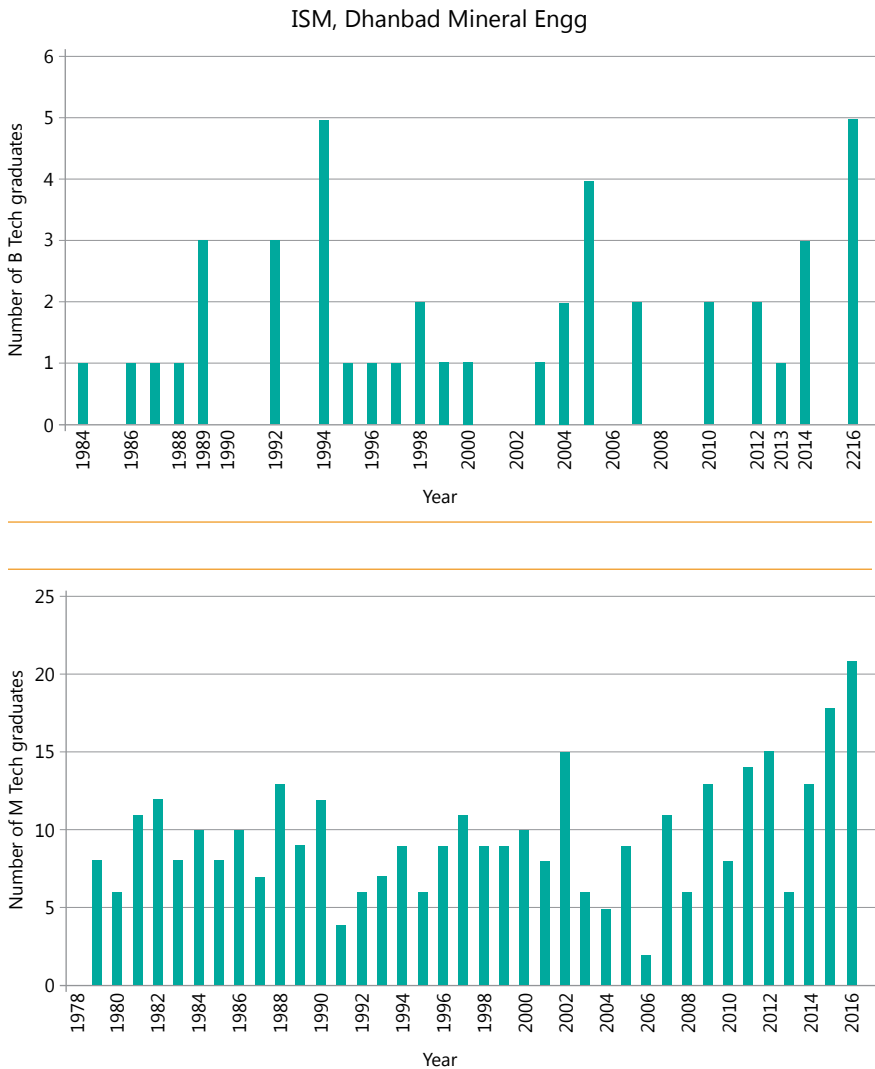
Figure 1: Graduates from 1978-2016 from Indian School of Mines

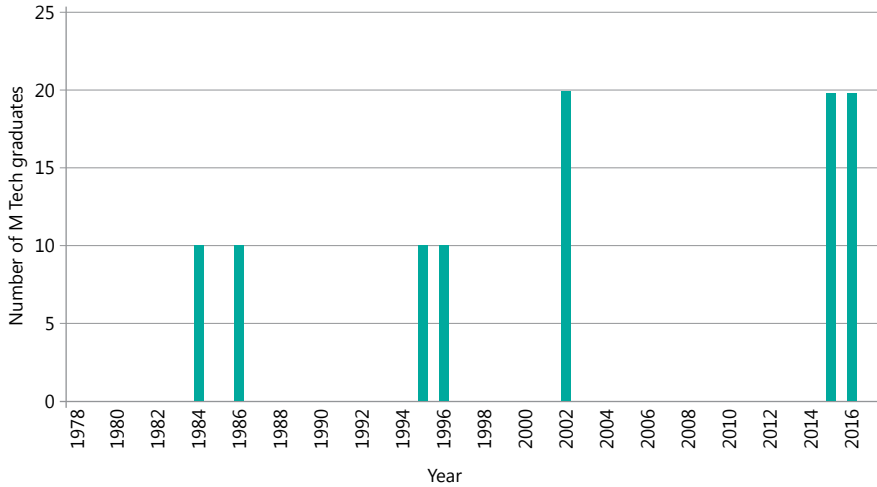


Note the cyclic nature of the programs, reflecting changing nature of industry, as students are attracted to promising jobs at times of high demand.

414 PhD degrees have been awarded over the same time period (Figure ??).

Figure 2: PhD Graduates from 1978-2016 from Indian school of mines





Numbers of graduates from the PG Center are also shown. There were a total of 374 graduates from the M Tech program and 10 PhD graduates.

Graduate Placements

Graduates from these institutions are placed at most of the minerals companies in India.

A) Indian Organizations

- Sandur Manganese & Iron Ore Co Ltd
- Tata Iron & Steels Col. TISCO
- Steel Authority of India Ltd (SAIL)
- Hospet Steels, Hospet
- Kirloskar Ferrous Industries Ltd., Hospet
- SISCAL, SALEM
- MSPL Baldota, Hospet
- Bharath Coking Coal Ltd (BCCL), Dhanbad
- Rassi Steels Ltd., West Bengal
- Indian School of Mines, Dhanbad,
- JSW Steel Limited, Torangallu
- Manganese Ore India Ltd (MOIL), Nagpur
- Hindustan Copper Co. Ltd.
- Neyveli Lignite Corporation, Neyveli
- Kudremukh Iron Ore Company Ltd.
- Fomento Mining Industries Ltd., Goa
- Chowgule Mining Corporation Ltd., Goa

- Dempo Mining Corporation, Goa
- Bateman Co.Ltd. Bengaluru
- Delkor Co. Ltd. Bengaluru
- Thriveni Earth Movers, Salem
- Eriez India Ltd.
- Weir Minerals, Bengaluru
- Insmart Systems, Hyderabad
- Tega Industries, Kolkata
- MacNally Bharath Sayaji Ltd
- Indian Institute of Science
- Indian Bureau of Mines
- Usha Martin Ltd.
- Sesa Goa Ltd.
- Bhजारंग Ispat Ltd., Raipur
- Uttar Pradesh Mineral Development Co Ltd.
- Department of Atomic Energy
- National Mineral Development Corporation, Regional Research Laboratories (CSIR)
- National Metallurgical Laboratories (CSIR)
- Central Fuel Research Lab, Dhanbad
- Indian Rare Earths Ltd.
- Uranium Corporation of India Ltd.
- CDE Asia
- Rungta Co Ltd., West Bengal
- Salgaocar Co Ltd., Goa
- Jayalakshmi Minerals Ltd., Hospet
- VSL Co Ltd.
- TAMIN, Tamil Nadu
- BMM Ispat Ltd., Bellary, Karnataka
- Ingwaenia Min Tech Ltd.
- Grindwell Norton Ltd., Mumbai
- Ashapura Mine Chem Ltd.
- Coal India Ltd.
- Thakur Industries Ltd., Hospet, Karnataka
- Geomin Ltd., Jabalpur, Madhya Pradesh

A number of graduates also travel overseas for work and have been placed at the following institutions:

B) Overseas Organizations

- Trimex Co Ltd., U.A.E.
- Mineral Technologies Inc., USA
- LONGi Ltd., China
- Oman Phosphates P. Ltd.
- CSIRO, Australia
- Jordan Phosphates, Jordan
- Mintek, South Africa
- Outotec, Canada

- Creative Engineers Ltd., Dhaka, Bangladesh
- Swaziland Iron ore P. Ltd.
- Wharton Phosphates Ltd., Oman
- Bumege Inc., Canada
- Julius Kruttschnitt Mineral Research Centre (JKMRC), The University of Queensland, Australia
- Metso Minerals
- Barrick Gold Corporation, Canada

Challenges & Opportunities for Indian Mineral Processing Education

The most serious problem is difficulties in faculty recruitment with Mineral Engineering specialization. There is little in the way of incentives for students to embark on PhD studies and therefore not many potential faculty for Indian Universities. Many universities are unable to find suitable faculty to teach mineral processing.

There is also a need for alignment of skills demanded by the industry and the training provided by the universities, despite many efforts to set up industry advisory boards and established linkages with industry, there is a need for better engagement between university departments and industry.

Academics tend to underestimate the importance of a number of aspects of minerals processing education including:

- Design of reactors, process engineering, mass, heat and momentum balance, flowsheet development.
- Provision for industrial personnel to participate as adjunct faculty in student training programs in universities.
- Summer training internship programs for students in industry
- Faculty secondment to industries to assimilate recent innovations in machinery and operations in industry.
- Strengthening of computational/modeling skills for scale up of bench scale experiments (ICT).
- Techno-economic feasibility reports

Closer interaction with the industry to design courses and impart necessary skills to tackle industrial problems-is recommended to promote better outcomes.

Involvement of professional societies (IIME, IIM) in developing professional development/training programs for industrial personnel in collaboration with universities would also be of benefit. This is ongoing and supported by industry.

The way forward

The following are recommended to ensure a successful future for the mineral processing and extractive metallurgy disciplines in India:

- To sustain student interest in Mineral Engineering, the program needs to be integrated with the Chemical Engineering discipline for a comprehensive training in 'particulate processing' encompassing not only the mineral and coal preparation industries but also paint, pigment and dyes, pharmaceutical, ceramics, cement, textile, petroleum, bio-medical engineering, polymer science, nanoscience and engineering.
- Enhancing PhD Enrollment is important to ensure availability of faculty
- Student internships in overseas industries for gaining first-hand experience in modern mineral processing plants as part of international student exchange fellowship programs.