Summary Report

About Department/Center/School:

On the recommendation of *Nayudamma Committee* for the advancement of low temperature research in science and engineering in India, Cryogenic Engineering Centre was established in the year 1976 at the Indian Institute of Technology, Kharagpur. Cryogenic engineering is an interdisciplinary subject comprising three major disciplines, namely, Physics, Mechanical Engineering and Chemical Engineering. As per the Institute charter, the Centre offers M. Tech. and Ph.D. courses in cryogenic engineering. In addition, the Centre also offers several electives related to cryogenic engineering at the undergraduate level. Apart from creating human resources, the Centre is actively engaged in serving the country by executing projects. Keeping in view the need of interdisciplinary research in cryogenic engineering in the country, the Centre is constantly upgrading its infrastructure and academic programme.

1. Academic Programs (Range of Degrees and Disciplines):

M.Tech., M.S. and Ph.D. in Cryogenic Engineering. The Centre is also contributing to the B.Tech. programs of the Institute by conducting several inter-disciplinary breadth electives.

2. **Major 4-5 Thrust Areas of Research:**

Cryogenic Process and Equipments, Applied Magnetism and Superconductivity, Liquefied Natural Gas, Safety with Cryogenic Fluids, Advanced Materials and Composites.

3. Curriculum and Courses & Teaching Environment

Items	**Ratio/ Number**	**Items**	**Number/%**
Teacher-student Ratio	1:4.5 excluding the UG load	Average No. of students motivated (%) to opt of careers Eng/ Tech. Sectors UG/PG/PhD	**NA/85/90**
No. of Faculty members as on today	10 (1 on lien, 1 visiting professor)	Average No. of students motivated (%) to opt of careers in Science sectors UG/PG/PhD	**NA/80/85**
Average No. of Tutorial Assistants	None. All PhD scholars are helping.	No. of teaching labs	**3**
No. of UG/DD students	300 (3 UG electives)	Average No. of students per experiments in core courses	**10**
No. of PG students/PhD students	45/12	No. of Students' workshops/``Tinkering'' Labs	**1**
Average no. of tutors with more than 100 students	NIL	No. of new courses introduced	**4**
Average Students placements (%) (UG/DD/PG)	NA/NA/50	No. of New program introduced	**NIL**
No of major curriculum review in both UG & PG level	NIL	Undergraduate Vs PhD strength expressed as Percentage	**NA**

No of UG lab (teaching labs) developed/set-ups	NA	No of PG/research labs developed/new set up	**1/4/10**
No of E class rooms	NIL	No. of lab classes per week	**6 hours**
Average No. of Course done per student for B. Tech/DD/M. Tech/Ph.D	NA/NA/16/6	No. of core/elective/seminar/projects subjects taken for B. Tech, DD, and M. Tech respectively	**5/14/2/1** For M.Tech only

4. Research and Development & its Environment

Items	**Number**	**Items**	**Number**	**Items**	**No.**
Total No. of Publications in Journals (2008-13)	140	Average no. of citation per paper	**14**	No of large interdisciplinary research projects	**NIL**
Total No. of Publications in Conference & Symposium	67	Average Journal publication per year	**30**	Number of Int. conf./workshops attended by students	**12**
Total No of Books & e-books published	NIL	h-Index of the department since 2008/overall h-index in Scopus	**21**	No. of PDF hired in the Institute	**1**
Total No of Edited Conference Proceedings/book chapters	NIL	Number of papers with citation more that the average no. of citation of the Journals		No. of international Students as PhDs/PDFs	**NIL/NIL**
Total No. of Technology Developed/transferred	**0/0**	No. of recognitions & Awards, fellows etc to faculty/students (provide break up if necessary)	10 Given just below the table	No. of International visiting researchers/adjunct faculty stayed here for at least a week	**NIL**
Total No. of Patents Filed/Obtained	1/0	Average Retention(%) of Young faculty for at least 10 years	100%	No. of short courses/workshops /conf. organized with international participations	6
Total No. of Copyright Filed/Obtained	*0/0*	No. of Sponsored research Project /fund(lakh) generated from non-internal source	**29/739**	Average No. of PhD granted per year	2
No. of Publications per Faculty/Masters/PhD students	**15/0.7/5**	No. of Consultancy /fund (lakh) generated from non-internal source	**13/146**	Average No. of PhD Granted per year per faculty	0.2
No. of Publications per Faculty/Masters/PhD students in Top Ten Journals as Identified by the department	**12/0.5/4**	No of Internal and external Collaborations research papers/research projects/PhD students	30/8/10	Patent granted per faculty	0
Average No. of Citation per faculty per	**45**	No of M. Tech students motivated into pursuing	10/10	Number of articles in collaborations	10

year		PhD/PhD graduates motivated to pursue career in Academics(abroad or IIT etc)		with Ten countries*	
Ranking of the department in terms of average citations per paper within the Institute	**2**	Ranking of the department in terms of total number of Journal publications within the Institute/publications per faculty	19/14	No of articles of the dept. contributing towards h-index of the Institute since 2008	7

1) Gold Medal for Best Oral Presentation in NCTP-09, Boroda (Oct 09) by Madhusree Kole (Ph.D)
2) Gold Medal for Best Oral Presentation in NCTP-11, BHU (Oct 11) by Madhusree Kole (Ph.D)
3) Gold Medal for Best Oral Presentation in NCTP-13, Kanpur (Oct 2013) by P. Rajaswari (Ph.D)
4) Best Poster Award for Mr. Krishna Murthy, PhD student, at DAE Symposium held in SRM Engineering College, Chennai, 2011
5) Nandi, Tapas Kumar (2008) *Awarded* - Institution of Engineers (India)
6) Indian Cryogenics Council- Prof. T.K. Nandi
7) Indian Society for Technical Education (ISTE) – Prof. T. K. Nandi
8) Bandyopadhyay, Syamalendu Sekhar (2012) *Member, Programme Advisory and Monitoring Committee (PAMC) of NPCSR of DST*
9) Kar Soumen, is the first Indian student to receive IEEE Graduate Fellowship Award for the year 2013, for his work on Applied Superconductivity. The award includes a US$ 5000 cash, one year free IEEE student membership and one year free IEEE society membership.
10) Gold Medal for Best Oral Presentation in NCTP-13, CSJM Univ, Kanpur (Oct 13) by P. Rajeshwar (Ph.D)

5.External Stakeholder Engagement and others

Items	**Number**	**Amount Lakh**
No. of PhD/Master students' thesis funded by Industries	NIL	
Total number of Industry sponsored projects and its income (Lakh)	NIL	
No. of Curriculum Development Initiative for Industries	NIL	
No of Technology transfer/adopted by Industry/Labs	NIL	
No. of Nationally relevant research projects	NIL	
No of Policy inputs/consultancies provided	NIL/18	
No. of Research grant and seed money from internal savings of the Institute per young faculty of the department and its total fund	4	20.0 (approx)
No. of Community Relevant projects	1	

6. Vision for the Future (in brief):

(a) Departments/centers/schools should spell out its Mission and Vision Statements, (b) Plans for future to achieve the projected goals and (c) measures adopted towards above.

1. Establishment of world class milli-Kelvin, liquid hydrogen and liquid helium facilities.
2. Participation in Nation's mission programs on nuclear fusion, superconducting power applications, cryogenic rocket propulsion and non-conventional energy.
3. Dissemination of knowledge in the field of cryogenic engineering through workshops, short term courses etc.
4. Initiate international collaborations by holding International Conferences, collaborative research with foreign/multinational institutes/R&D laboratories/industries.
5. Creation of Centres of Excellence in collaboration with various R&D laboratories like ISRO, DRDO, BHEL, Power Grid, DAE etc.

7. External peer review of the Dept./centre/schools (in brief):

(a) Date of the peer review: MAY 06, 2010

(b) Name of the Experts involved and their affiliations in short:

Prof. N. K. Gupta, ISRO, Thiruvananthapuram

Prof. Y. C. Saxena, IPR Gandhinagar

Prof. A. K. Majumdar, S.N.Bose National Centre, Kolkata

(d) Measures adopted/action taken at the department level to address the recommendations of the peer review report:

In progress

8. **Strengths, Weaknesses, Opportunities & Threats (SWOT) Analysis of the Department**

STRENGTHS 1. The only department of the country offering degree (M. Tech.) in cryogenic engineering. Four to five other institutes offer cryogenics along with other subjects such as refrigeration, vacuum etc. 2. Faculty has good interaction with cryogenic industry of the country among private and government sector. 3. Inter-disciplinary research is pursued **WEAKNESSES** 1. Any reasonable cryogenic technology development needs trained technical manpower apart from substantial funding. 2. Narrow domain of the technology makes the opportunity for students somewhat restricted. Limited job opportunities in the private sectors 3. Absence of cryogenic awareness at UG level 4. Industries are just realizing the importance of cryogenics	**OPPORTUNITIES** 1. There is growing demand of cryogenic technologies in the various strategic sectors such as space, industrial gases, defence, energy, power, medical, advanced nano materials, etc. 2. More manpower can be placed in the Indian industry in coming years. 3. More consultancy/ sponsored projects can be done in the future. **THREATS** 1. Number of motivated students may dwindle because of the limited job opportunity 2. Faculty trained in cryogenic technology is difficult to get for fresh recruitment. 3. Non-availability of trained technical manpower to support cryogenic experiments may make it difficult for the faculty and student to produce quality research output.

Note: Ten countries: US, UK, Germany, Japan, Canada, France, Italy, Australia, Singapore, South Korea

Important Highlights

Cryogenic Engineering Centre was established in 1976 on the recommendation of Nayudumma Committee for the advancement of cryogenics and cryogenic engineering. This is the only department in India that is engaged in conducting postgraduate studies in Cryogenic Engineering through its M.Tech., M.S. and Ph.D. programme. The Cryogenic Engineering is a multi-disciplinary academic curriculum with inputs from three major disciplines, namely, Physics, Mechanical Engineering, and Chemical Engineering. The objective is to generate expert manpower in this advanced field of science and technology through teaching and research. The Centre, through interactions with industries and academia at both national and international levels, commits itself to excel in cryogenic engineering and allied areas.

Teaching, sponsored research and consultancy remain at the core of activities of the centre. The Centre offers several courses related to cryogenics and cryogenic engineering at both undergraduate and postgraduate levels. Research and development activities are carried out through its postgraduate and doctoral programmes as well as through inter-departmental undergraduate and postgraduate studies. The Centre is also active in continuing education programme of the Institute by conducting short term courses and workshops in specialised areas to train engineers from industries, faculty from academic institutions and scientists from R&D organisations.

Major research areas pursued at the Centre include superconducting magnets and applications, magnetic materials and devices, nanocomposites and nanofluids, oxygen safety, helium cryogenics, cryogenic heat exchangers, cryogenic rocket propulsion, natural gas and hydrogen energy, air separation, carbon capture and sequestration etc.

The Centre receives sponsored and consultancy projects from various government agencies and industries. Some of these include DST, BARC, ISRO, MHRD, CSIR, ONGC, BHEL etc.

Research Facilities

The Centre started its journey under the competent leadership of Professor S. K. Dutta Roy as the founder Head of the Centre. Low temperature activities of the Centre began with the production of liquid nitrogen using an old Philips Liquid Nitrogen Plant *PLN-106* which Prof. Dutta Roy had arranged from CWISS of IIT Kharagpur. Later, the liquid nitrogen production facility was augmented with *PLN-430*. Later on financial as well as technical support from Germany through a significant Indo-FRG cooperation project (1990-1999) helped a lot towards developing research facilities and modernising the cryogen-production facilities. Recently, substantial amount of

funding was received from DST to develop liquid-helium-free superconducting magnet-based research facility, vacuum hot press furnace in the Centre.

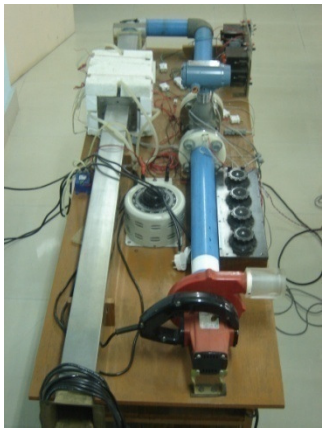
Liquid Nitrogen Facility

Cryogen free Superconducting Magnet

Short Term Courses

During the past five years, Cryogenic Engineering Centre has held about 20 short term courses for industry, research and academic institutions in the areas of cryogenic technology, air separation, vacuum technology and safety in oxygen systems.

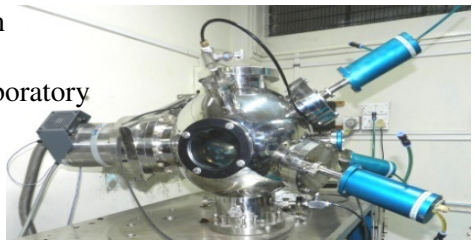
Hot Press Vacuum Furnace



New Laboratories

Two new research laboratories have been developed recently.

- Surface and interface engineering laboratory
- Transport phenomena laboratory



Publications

In the past five years, Cryogenic Engineering Centre has published more than 140 journal papers, 67 number of conference papers. Many of our students have obtained best paper award in different national and international conferences.

Students' Placements

Alumni of centre are holding positions in different national and international organisations. Several of our PhD students are working in the different national laboratories or they have joined academics in IITs or NITs.

Funded Research

During the past few years, the several research projects of national importance have been executed in the Centre. Total funding of worth 735 lakhs have been obtained by the faculty members of our centre. Another 145 lakhs have been received from different consultancy projects by our faculty members.