INTERNAL REVIEW REPORT

(2009-2014)

Industrial Tribology, Machine Dynamics and Maintenance Engineering Centre (ITMMEC)

INDIAN INSTITUTE OF TECHNOLOGY DELHI

March 2014

1. Curriculum

1.1 List of degree programmes offered – PG and enrollment.

i) M.Tech. - Interdisciplinary M. Tech. Program in 'Industrial Tribology and Maintenance Engineering

The Centre is authorized to enroll 15 students against the institute fellowship. In addition to these, sponsored candidates from defense and industries are also admitted each year. However, enrollment of self-financing students is stopped due to shortage of hostels.

ii) ***Ph.D. Program***

Candidates in the program are admitted in July and January each year; as full-time, with institute teaching assistantship / sponsored or part-time, as sponsored.

No. of PhD Students at present: 14

No. of PhD Students defended their thesis (last 5 years): 10

1.2 Consistency of curricula with academic vision of the department –

The curriculum is consistent with the vision of achieving world class excellence in academic Research and Teaching.

1.3 Quality of programmes:

(a) Last curriculum review PG – at the institute level; As per the Institute.

(b) Mechanism for review at UG and PG level –

By a committee as per the institute norms; and its recommendations deliberated first at departments/centres level in the institute, followed by BPGS and finally, approved by the Senate.

(c) Coursework for PG and PhD programmes (Core / Elective)

For PG: Total credits = 60,

(Core – 42, Electives – Programme: 12, and Outside: 6)

For Ph. D.; 6 credits for candidates with PG degree, and 24 credits for candidates with UG degree.

(d) Pre PhD courses offered (*in last 5 yrs*) –

All courses at 700 level are offered as pre-PhD courses for students from different departments/centres.

(e) New advanced Masters / Pre-PhD courses introduced in last 5 yrs - Nil.

(f) Overlap between courses (c) and (d) & (e), including opening latter to UG - NA.

(g) Seminar series (weekly/regular) held each semester –

Part of regular course work every semester

(g) Placement details – Refer *Annexure-1*.

Relevance of PG programmes to recruiters, potential and on-campus recruiters –

After completion of degrees students are acceptable to the industry, R&D laboratories, International Educational/Research Institutes/ Universities for Jobs, or PhD/Postdoc fellowships.

(h) Benchmarking of curriculum – Refer *Annexure-2*.

2. Teaching environment

2.1. Student-Teacher ratio separately and total for PG, PhD

Ph.D. – 3.5:1

M.Tech. – 3.8:1

Total- 7.3:1

2.2. No. of students graduated in each programme, incl. Ph.D.

Program	2009	2010	2011	2012	2013	Total
Ph.D.	-	2	3	3	2	10
M.Tech.	11	6	14	9	11	61

2.3. Student-T.A. ratio

M.Tech.: 23/20

PhD.: 14/8

2.4. No. of skilled technical staff – 4 (excluding 3 under transfer)

2.5. Gross laboratory space; break-up of lab space for core PG teaching –

Gross laboratory space available is 7145 Sq.ft; (excluding 1112 Sq ft already surrendered to institute). The same labs are utilized for teaching the PG courses and research work of PG and PhD students.

2.6. Laboratory modernization performed in last 5 years –

Following new facilities have been installed:

i) Friction and Wear Laboratory:
   a. Tribometer
   b. Micro-Raman spectroscope
   c. Thermal conductivity analyzer
   d. Brake dynamometer
   e. Compression moulding machine

ii) Lubrication and oil monitoring laboratory
   a. Piston ring Test Rig
   b. EHD Rig

iii) SEM Laboratory
   a. SEM and EDX facility

iv) Machine Dynamics Laboratory
   a. Acoustic Emission System
   b. Thermography System

v) Lubricant Laboratory
   a. Viscometers (Kinematic and Dynamic)
   b. Flash point Measurement Apparatus

2.7. Course files for each course for last 5 years – Not maintained

2.8. Study materials (monographs, notes, books, videos, web-based materials, etc.) prepared, course-wise,

Course	Course Coordinator	Notes/Book, etc.
ITL 752	Prof. V.K. Agarwal	Pneumatic Conveying Systems: Design, Selection and Troubleshooting With particular reference to Pulverised Fuel Ash, Vogel Buchverlag, Germany, 2009, First Reference, ISBN0-87849-126-0, (Co-author: David Mills).

2.9. Research and Innovations in teaching-learning processes -

2.10. No. of students (UG and PG separately) who have spent at least a semester at another university/institute (overseas or Indian) –

- Two M.Tech. students to University of Newcastle, Australia Feb-March 2013.
- Three M.Tech. students under DAAD Programme in Germany, Sept. 2012, and Sept. 2013.
- One PhD Student to University of Newcastle, Australia in July-Dec 2009.
- One PhD Student to IVW Germany in 2013 for 3 months.

2.11. No. of students from overseas universities who have taken classes, done project work or internship, UG & PG separately, in the department.

Fun Jun Wei, Second Semester 2011-2012, Course ITL740.

2.12. Course feedback – For each course; at mid and end semester - Online submission

Semester	Number of PG Courses	Average Class Size	Max. Score	Min. Score	Average Score
1301	6	20.50	4.64	4.16	4.32
1202	4	26.0	4.37	3.94	4.04
1201	7	21.57	4.65	3.94	4.17
026	5	16.40	4.72	4.41	4.62
023	6	7.00	4.66	3.04	3.63
022	8	16.12	4.44	3.93	4.17

2.13. Industry experts who have delivered lecture(s), seminars, discussions as part of a core/elective course –

2.14. Industry exposure to PG students – course-related visits to factories, sites, industry exhibitions, field trips, etc.

– Field visits arranged by course coordinators to industries such as Badarpur thermal power plant, NTPC Dadri, IUAC, etc.

3. Research

3.1. No. of Masters and Ph.D. students supported:

M. Tech.:

i) Institute Assistantship - average 14 per year

ii) on sponsored projects/consultancies -

iii) others sources and –

iv) sponsored by external organizations, including QIP - 12

Ph.D.:

i) Institute Assistantship – 10,

ii) Sponsored by external organizations, including QIP – 5.

3.2. No. of Ph.D.s enrolled, graduated per faculty for last 5 years –

Enrolled: 16

Graduated: 10/4

3.3. Areas of research (e.g. areas listed in Prospectus, and others) by (i) Volume (quantifiable parameters), (ii) Breadth, and (iii) Years these have been research areas – Refer *Annexure-3*.

3.4. Publications per faculty (average per year for last five years) in academic journals: 3.52

3.5. Publications (journal and conference) total and per (a) Ph.D. student, (b) Masters student, (c) UG student.

Total Publications: 137 (*Appendix- I*)

PhD Students: 130

MTech Students: 7

3.6. Best papers in last 5 years: (i) Individual best 3, (ii) department/centre best 10; and brief justifications.

Individual best 3

1. Prof. J. Bijwe

i) Sini N K; Bijwe J and Varma I K "Renewable benzoxazine monomer from vanillin: synthesis, characterization and studies on curing behaviour" J. of Polymer Science Part A: Polymer Chemistry Volume 52, Issue 1, pages 7–11, 1 January 2014 (IF: 3.54).

ii) Mukesh Kumar Dubey, Jayashree Bijwe, SSV Ramkumar PTFE based nano-lubricants, Wear, 30 August (2013), 80–88

iii) Jayashree Bijwe N. Aranganathan, Sanjeev Sharma, Nidhi Dureja and Ram Kumar, Nano-abrasives in friction materials-Influence on tribological properties, Wear 2961–2, 30 August (2012), 693-701- One of the top 25 most downloaded articles in Wear in 2012

2. Prof. N. Tandon

i) Patel, V.N., Tandon, N. and Pandey, R.K., A dynamic model for vibration studies of deep groove ball bearings considering single and multiple defects in races, *Journal of Tribology*, *Trans. ASME*, 132, 2010, pp 041101-10.

ii) Babu, C.K., Tandon, N. and Pandey, R.K., Vibration modelling of a rigid rotor supported on the lubricated angular contact ball bearings considering six degrees of freedom and waviness on balls and races, *Journal of Vibration and Acoustics, Trans. ASME*, 134, 2012, pp 011006-1-12.

iii) Patel, V.N., Tandon, N. and Pandey, R.K., Improved defect detection of rolling element bearings in the presence of external vibrations using adaptive noise cancellation and multiscale morphology, *Proc. IMechE, Part J: J. Engineering Tribology*, 226, 2012, pp 150-162.

3. Prof. O.P. Gandhi

i) Aju Kumar, V.N. and Gandhi, O.P., “Quantification of human error in maintenance using graph theory and matrix approach”, Quality and Reliability Engineering Int., Vol. 27 (8), 2011, 1145-1172.

ii) Aju Kumar, V.N. and Gandhi, O.P., “Evaluation of green maintenance initiatives in design and development of mechanical systems using an integrated approach”, Journal of Cleaner Production, Vol. 51, 2013, 34-46.

iii) Gupta Piyush, Gupta Shashank and Gandhi O.P., “Modeling and evaluation of MTTR at product design stage based on contextual criteria”, J. Engg. Design, Vol. 24 (7), 2013; 499-523.

4. Prof. V.K. Agarwal

i) S.K. Gupta, V.K.Agarwal, V. Seshadri, S.N. Singh and David Mills, Parameters affecting fluidized motion conveying of flyash, *Particulate Science and Technology,* Vol. 27, pp. 469-487, 2009

ii) Behera N., Agarwal V.K., Jones M.G. and Williams K.C. (2013), "Modeling and analysis for fluidized dense phase conveying including particle size distribution", *Powder Technology*, Vol. 235 pp 386-394.

iii) Behera N., Agarwal V.K., Jones M.G. and Williams K.C. (2012), "Transient parameter analysis of fluidized dense phase conveying", Powder Technology, Vol. 217 pp 261-268.

Centre's Best 10:

i) Patel, V.N., Tandon, N. and Pandey, R.K., A dynamic model for vibration studies of deep groove ball bearings considering single and multiple defects in races, *Journal of Tribology*, *Trans. ASME*, 132, 2010, pp 041101-10.

ii) Babu, C.K., Tandon, N. and Pandey, R.K., Vibration modelling of a rigid rotor supported on the lubricated angular contact ball bearings considering six degrees of freedom and waviness on balls and races, *Journal of Vibration and Acoustics, Trans. ASME*, 134, 2012, pp 011006-1-12.

iii) Patel, V.N., Tandon, N. and Pandey, R.K., Improved defect detection of rolling element bearings in the presence of external vibrations using adaptive noise cancellation and multiscale morphology, *Proc. IMechE, Part J: J. Engineering Tribology*, **226**, 2012, pp 150-162.

iv) Aju Kumar, V.N. and Gandhi, O.P., "Quantification of human error in maintenance using graph theory and matrix approach", Quality and Reliability Engineering Int., Vol. 27 (8), 2011, 1145-1172.

v) Aju Kumar, V.N. and Gandhi, O.P., "Evaluation of green maintenance initiatives in design and development of mechanical systems using an integrated approach", Journal of Cleaner Production, Vol. 51, 2013, 34-46.

vi) Sini N K; Bijwe J and Varma I K "Renewable benzoxazine monomer from vanillin: synthesis, characterization and studies on curing behaviour" J. of Polymer Science Part A: Polymer Chemistry Volume 52, Issue 1, pages 7–11, 1 January 2014 (IF: 3.54).

vii) Mukesh Kumar Dubey, Jayashree Bijwe, SSV Ramkumar PTFE based nano-lubricants, Wear, 30 August (2013), 80–88.

viii) Jayashree Bijwe, Sanjeev Sharma, Mohit Sharma, Tushar Parida, Prakash Trivedi Exploration of potential of solid lubricants and short fibers in Polyetherketone (PEK) composites; Wear 301 (2013) 810-819.

ix) S.K. Gupta, V.K.Agarwal, V. Seshadri, S.N. Singh and David Mills, Parameters affecting fluidized motion conveying of flyash, *Particulate Science and Technology,* Vol. 27, pp. 469-487, 2009

x) Behera N., Agarwal V.K., Jones M.G. and Williams K.C, "Modeling and analysis for fluidized dense phase conveying including particle size distribution", *Powder Technology*, Vol. 235 pp 386-394, 2013.

3.7. Average citation per department/center.

Average citation = 753 per faculty (since 2009)

3.8. Changes, modifications, etc. done to improve the quality of (i) M.Tech., and (ii) Ph.D. graduates – M. Tech. –

- Based on the industry feedback, course ITL730; 'Lubricants' changed from Progarmme Elective to Core, while the course ITL710; 'Design of Tribological Elements was changed from Core to Progarmme Elective.
- Ph.D. scholars were encouraged to attend International / National Conferences.

3.9. Sponsored projects - (i) individually, (ii) with another faculty of the group/section of the department, (iii) with another faculty of the department but from another group/section of the department (iv) with another faculty of another dept/center.

Sl. No	Title	Budget / Amount, (Rs)	Funding Agency	PI & Co-PI
Sponsored Projects				
1	Asbestos- Free Brake Material for Automobiles: Tailoring, characterization and evaluation- Phase II-	91 Lacs	DST	PI-J Bijwe Co-PI- NIL
2	Tailoring of High Performance Tribo-composites with Heterogeneous Surface and Bulk	19.4 l Lacs	CSIR	PI-J Bijwe Co-PI- NIL
3	Up-gradation of facilities for ongoing project "Wear Mapping of Aluminum Bronze and 17-4 Ph Stainless Steel in Dry Medium	4.00 Lacs	DGFS - BRNS	PI-J Bijwe Co-PI-V K Agarwal
4	Design and development of cushion bonded/rigid bonded organic, cerametallic, cookies & single/duel sintered buttons (copper/iron based) ceramic cookies & annular ring clutch discs and matching cover assemblies	188.5 Lacs	CSIR NMITLI	PI-J Bijwe Co-PI- NIL
5	Development of Nano-composites based on Engineering Polymers for Performance enhancement in Tribology".	19 Lacs	Fast-track Young scientist	PI- Dr Nidhi Co-PI- J Bijwe
6	Synthesis of PBZs derivatives for applications as binder in FM for brake-pads	18 Lacs	Fast-track Young scientist	PI- Dr Bimlesh Co-PI- J Bijwe
7	Exploration of Nano-Fillers for Fabric Reinforced Polymer Composites to Enhance Tribo-Performance in Various	25 Lacs	CSIR	PI-J Bijwe Co-PI- NIL

	Wear Applications			
8	Development of self-lubricated and surface engineered bush bearings with polymeric nano-composites- Approved	145 lacs	DST	PI-J Bijwe Co-PI- R K Pandey Mech Engg Dept
9	Indo – Russian Project Erosion wear of pipelines of pneumotransport installations and definition of critical velocity of fine bulk silicon containing materials	13.376 lacs	DST	PI- VK Agrwal
10	Preparation of baseline document on handling and transportation of flyash	16.524 lacs	DST, New Delhi	PI: Prof V Seshadri Co-PI- VK Agrwal
11	To Strengthen the Research on Tribology in the ITMMEC(FIST)	237.00 Lacs	DST	PI: N Tandon, OP Gandhi Co-PI:J Bijwe, VK Agarwal, RK Pandey
12	Study and development of new piston ring face profiles for improvement in the performance of IC engines	4.7 lacs	CSIR	PI- R.K. Pandey, Co-PI N. Tandon
13	Vibration and noise monitoring of ball bearings with local defects	25.194 lacs	DST	PI-N. Tandon, Co-PI- R.K. Pandey

3.10. Industry consultancies

Sl. No	Title	Budget / Amount, (Rs)	Funding Agency	CI & Co-CI
Consultancy Projects				
1	Development of brake-linings based on PBZ resins	0.5 Lacs	MACCAS, Faridabad	CI- J Bijwe
2	Tyre Waste-Separation of Polyamide from rubber FT/03/o77/95/Vol-V	0.5 Lacs	M/S M V Enterprizes	CI- J Bijwe
3	Studies & analysis of thermal conductivity of friction materials	0.4 Lacs	Aliied Nippon Ltd	CI- J Bijwe
4	Studies & analysis of thermo-physical behavior of Railway brake-blocks	2.24 Lacs	Friction Industries	CI- J Bijwe
5	Studies & analysis of friction composites	1.907 Lacs	Friction Industries	CI- J Bijwe
6	Development of composites for low friction & wear applications-	1.3 Lacs	Gharda Chemicals Pvt Ltd, Mumbai	CI- J Bijwe
7	Developing complaint surfaces & lubricating oils for reduced oil consumption-Phase I	6 Lacs	GE India Technology Centre Private Ltd Bangalore	CI- J Bijwe
8	Investigations on worn surfaces	0.673 Lacs	Hindustan Composites Aurangabad	CI- J Bijwe
9	Developing complaint surfaces & lubricating oils for reduced oil consumption Phase I	6.6 Lacs	GE India Technology Centre Private Ltd Bangalore	CI- J Bijwe

10	Development of composites for tribological applications	3.86 Lacs	Gharda Chemicals Pvt Ltd, Mumbai	CI- J Bijwe
11	Development of friction composites for exploring potential of solid lubricants	USD 3000 +ST	Chemetall Ges. M.b.H.Karntner strbe Austria	CI- J Bijwe
12	Development of friction composites for exploring potential of various graphites	Euros 12,000	CRNS- France & Timcal Switzerland	CI- J Bijwe
13	Studies on Thermal conductivity of brake blocks	0.68 Lacs	Hindusthan Composites Aurangabad & Industrial Laminates Mumbai	CI- J Bijwe
14	Tribo-Studies on polymers in reciprocating conditions	1.9854 Lacs	GE Technology Centre Pvt Ltd- Bangalore	CI- J Bijwe
15	Development of Polyurathane and modified Polyurathane with nano-materials coatings for power plant application	4.97 Lacs	BHEL, Hyderabad	Mangla Joshi Co CI-A Ghosh, J Bijwe
16	Development of process of hardening for booster pump shaft- alternative to hard chrome plating-Phase I-	1 Lacs	BHEL, Hyderabad	CI- J Bijwe
17	Development of wear resident grades composites based on high performance polymers (Gharda)	6.74 Lacs	Gharda Chemicals Pvt Ltd, Mumbai	CI- J Bijwe
18	Worn surface analysis of brake-blocks	0.45	Industrial	CI- J

	with SEM	Lacs	Laminates Indai Pvt Ltd Mumbai	Bijwe
19	Development of Brake-shoes & pads for two-wheelers-Phase I	5.62 Lacs	ASK Automotives Pvt Ltd, Gurgaon	CI- J Bijwe
20	Development of specialized tests for railway brake-blocks followed by failure	1.29 Lacs	Industrial laminates	CI- J Bijwe
21	Hypersonic High vacuum Coal Conveying System	5.47lacs	Midwest Coal Pvt Ltd, Hyderabad	CI- VK Agrwal Co-I: Prof V Seshadri
22	Design of Long Distance Pipeline for Pneumatic Conveying of Flyash	3.31 lacs	Mecgale Pneumatics Pvt Ltd, Nagpur	CI- VK Agrwal
23	Design Inputs for Pneumatic Conveying of Flyash	1.99 lacs	MELCO India Pvt Ltd, Faridabad	CI- VK Agrwal
24	Basic Design of Ash Evacuation System from ESP Hoppers at TPP, Yamunanagar	1.99 lacs	Reliance Infrastructure, NOIDA	CI- VK Agrwal
25	Basic Design of Ash Evacuation System from ESP Hoppers at TPP, Hisar	1.99 lacs	Reliance Infrastructure, NOIDA	CI- VK Agrwal
26	Basic Design of the Pneumatic Conveying System for Flyash	1.12 lacs	MELCO India Pvt Ltd, Faridabad,	CI- VK Agrwal
27	Analysis of Design of bush bearing/pins on backhoe loader 3DX	6.8 lacs	JCB India Limited,	CI – RK Pandey

			Ballabhgarh	C0-PI: OP Gandhi
28	Re-Design of Journal Bearings of Sugar Cane Crushing Mills in Light of its Failure Study	4.45 lacs	I.S.G.E.C	CI – RK Pandey
29	Study of failed pads of Hydrodynamic Thrust Pad Bearing	1.5 lacs	Tata Chemicals Ltd., Babrala, Distt. Badaun, UP	CI – RK Pandey
30	Study of failed pads of hydrodynamic thrust pad bearing	1.5 lacs	M/s Tata Chemicals Ltd.	CI - R.K. Pandey Co-CI-N. Tandon
31	Barrier design for noise mitigation along the new runway at IGI airport, New Delhi	13 lacs	M/s Delhi International Airport Pvt. Ltd. (DIAL)	CI- Ashish Darpe Co-CI- S.P. Singh, Co-CI-N. Tandon V. Matsagar
32	Barrier design for noise mitigation along the new runway at IGI airport, New Delhi	8.43 lacs	M/s LG Software India Pvt. Ltd.	CI-Ashish Darpe Co-CI- S.P. Singh, Co-CI-N. Tandon

3.11. New areas of research which are different from the faculty's PhD thesis area.

i) Dr. Deepak Kumar: Tribological study on magnesium base alloys, Lubricant formulation based on nanoparticles

ii) Prof. J. Bijwe: Development and performance evaluation of nano-composites, dry bearings; nano-oils, high temp adhesives/nano-adhesives; non-asbestos friction materials for brake- pads; condition monitoring through oil analysis.

iii) Prof. N. Tandon: Gear vibration and acoustic emission monitoring

iv) Prof. O.P. Gandhi: Maintainability, Availability, and supportability.

v) Prof. V.K. Agarwal: Design of Gas Solid Flow Pneumotransport systems, Fluidised Motion Conveying Systems

3.12. Methodology for (i) identifying obsolescence in research areas, and (ii) identification of new areas for future research – through future areas and vision of the Centre.

- Identifying obsolescence in research areas based on
    - Global publication statistics
    - Irrelevance for Market/Industry needs
- Identification of new areas for future research:
    - Trends in global publications
    - Based on demands of the industry and thrust areas identified by Government agencies
    - Depending on the allocation of grants by sponsoring agency

3.13. Number of large interdisciplinary projects (within department's areas, and across the institute) –

1	Design and development of cushion bonded/rigid bonded organic, cerametallic, cookies & single/duel sintered buttons (copper/iron based) ceramic cookies & annular ring clutch discs and matching cover assemblies	188.5 Lacs	CSIR NMITLI	PI-J Bijwe
2	Development of self-lubricated and surface engineered bush bearings with polymeric nano-composites- Approved in Feb 2014	145 lacs	DST	PI-J Bijwe Co-PI- R K Pandey Mech Engg Dept

4. Innovation, Design and Development

4.1. No. of students who have been funded for innovating (TePP, PRISM, etc.) – Nil

4.2. Technology developed (*give list and brief information*).

Developed successful technology for high temperature adhesives with desired performance features for rivet-less clutch-facings in NMITLI (New millennium Indian technology leadership initiative) project funded by CSIR. Clutch Auto Ltd (Faridabad) was prepared for technology transfer. However, since loan was not repaid to CSIR by the Industry, all the further activities were abandoned.

4.3. Technology transferred (*give list and brief information*) - Nil

4.4. Number of patents filed and patent granted as a fraction of patents filed

Granted: 2, as following.

i) J Bijwe & P V Gurunath Friction materials having resins incorporated therein and process for producing them- WO patent 2008 149381.

ii) J Bijwe & P V Gurunath , A process for solvent-less synthesis of benzoxyzine (BZ) WO patent 2008 2008149380.

4.5. Innovations of products, processes, designs, etc. in the department - Nil.

4.6. Availability and access to students' workshops, "tinkering laboratories" so that they may pursue their own ideas – Not specifically.

4.7. No. of students/teams who have competed in national / international competitions, and outcome - Nil.

5. R & D Environment

5.1 No. of post-doctoral scholars hired in the department/centre and their durations, from (i) abroad, (ii) on project, and (iii) others, and outcomes - Nil.

5.2 No. of foreign students enrolled in (i) Masters, and (ii) PhD programmes - Nil.

5.3 No. of Indian and foreign faculty/researchers who have spent a sabbatical in the department - Nil.

5.4 Sabbatical taken by faculty and where spent – Nil.

5.5 Number of seminars (education and research separately) given by the faculty (i) in the department, (ii) in other departments, (iii) at other institutions.

i) In ITMMEC for industrial visitors from TOTAL, “Formulation of low friction lubricants”, July 2013. By Dr. Deepak Kumar

ii) In Mechanical Engineering Department, lecture for ONGC Engineers under the course on Tribology, “Lubricity of oil-water emulsion in metalworking: A Nanotribological Approach”, October 2013. By Dr. Deepak Kumar

iii) Invited lecture on Condition monitoring through oil analysis 8-9, April, 2010 in Recent Advances in Eco-Friendly Lubricants (RAIEFL-2010) at I I Sc-Bangalore conducted by Prof.S.V.Kailas Dr.R.T.Naik: By Prof. J Bijwe

iv) Invited lecture on Wear Studies on Brake Pad Materials May 13 in QIP course in “Tribology in Practice” in Mechanical Department, IIT Delhi 10-14 May 2010 : By Prof. J Bijwe

v) Invited lecture on Influence of metals in friction composites in National Seminar on Tribology and Materials (NSTM)” I I T Madras by Prof Siva Prasad & Sheshadri Shankar on 26th August 2011: By Prof. J Bijwe

vi) Invited Lecture delivered on Role of Metallic Fillers in Non-asbestos Organic (NAO) Friction Materials " (IWAAFC-3) held in I I T Delhi (9th & 10th Feb 11) (Organized by J. Bijwe)-appeared in the proceedings p-1-17: By Prof. J Bijwe

vii) Invited lecture on Fundamentals of Tribology in Program of CEP Course on "Recent Trends in Fuels & Lubricant" DMSRDE Kanpur 21st Feb2011: By Prof. J Bijwe

viii) Invited lecture on Recent Developments in Friction Materials with Special Reference to Nano-rubber Particles" during Technical Seminar (Concepts of using new materials & Technology for manufacturing quality rubber products) Organized by Indian Rubber Institute, Delhi Branch India Habitat Centre on 6th Oct 2012: By Prof. J Bijwe

ix) Invited lecture on Nano-treatment of fibers-A novel method to strengthen the fiber-matrix interface for enhanced performance of composites on 20th June IVW, Kaiseslautern Germany (during research stay (7-6-13-25-6-13) in Institut für Verbundwerkstoffe GmbH Kaiserslautern, Germany During collaborative project funded by DFG Germany. : By Prof. J Bijwe

x) Key note lecture on 16th Oct 2013 on "Friction materials; A class of tribo-materials- Concepts & Evolution" in ICATES- International Conference on Advances in Tribology and Engineering Systems; L D College of Engineering, Gujarat, India, Oct 15 – 17, 2013.

xi) Invited lecture on Lubricants, types, classification & selection- in ONGC course conducted by Dr Harish Hirani IRD conference Hall on 30th Sept 2013: By Prof. J Bijwe

xii) Delivered lecture on "Maintenance and reliability overview", in QIP & ONGC courses; conducted by Dr Harish Hirani IRD conference Hall, 14th and 15th Feb. 2012. By Prof. O.P. Gandhi

xiii) Delivered lecture on "Troubleshooting of Tribological faults", in QIP course; conducted by Dr Harish Hirani, IRD conference Hall, 14th Feb. 2012. By Prof. O.P. Gandhi

xiv) Delivered Keynote lecture on “Graph theory applications”, YMCA University, Faridabad, 14th January 2014. By Prof. O.P. Gandhi

Industry:

Series of following lectures (5) delivered in ASK Automotive Pvt Ltd Gurgaon, Manesar; Prof. J. Bijwe

1. Friction materials: A class of tribo-materials- Concepts & Evolution –I on 17th Aug 2013
2. Friction materials: A class of tribo-materials- Concepts & Evolution II on 24th Aug 2013
3. Friction materials: A class of tribo-materials- Concepts & Evolution-Influence of ingredients –I on 7th Sept 2013
4. Friction materials: A class of tribo-materials- Concepts & Evolution-Influence of ingredients -II on 5th Oct 2013
5. Friction materials: A class of tribo-materials- Concepts & Evolution-NVH on 9th Nov 2013

5.6 No. of faculty/researchers/scholars invited by the department for giving (i) seminars, (ii) spending at least a week in the department

i) Invited by the Centre

1. Prof. Desplanques Yannick, Centrale Graduate Engineering School in Lille (France) Local aspects of brake-induced phenomena-Feb 2011
2. Dr. Dufrenoy, Philippe, University of Lille 1 (Science and Technology), France Brake squeal: from the excitation at the contact to the vibration of the brake components Feb 2011
3. Prof. Ho Jang, Korea University, Korea on Abrasives and their roles on brake performance Feb 2011
4. Prof. Peter Filip, Director, Center for Advanced Friction Studies, Southern Illinois University Carbondale, USA On airborne nano/micro–sized wear particles released from low–metallic automotive brakes Feb 2011

5. Prof. Staffan Jacobson, Uppsala University, Ângström Laboratory, Tribomaterials Group, Swden The brake pad surface –dynamic materials formation, disintegration and regeneration at the nanoscale -Feb 2011
6. Prof. Rohatgi Pradeep, Director, UWM Centers for Composites and Advanced Materials Manufacture University of Wisconsin Milwaukee, USA Polymer Flyash-natural fiber composites for clutch facings Feb 2011
7. Mr. Radhey Shyam*,* Executive Director (M&C),(RDSO), Ministry of Railways A study on heating effects of Non-Asbestos Composition Brake Block on rolling stock wheel of Indian Railways; Feb 2011
8. Mr. Bart Van de Worp, Technical Consultant, Friction materials, Lapinus Fibres Improved corrosion resistance of brake pads by using Rockbrake ®Roxul ®1000 fibers Feb 2011
9. Mr. Jim Hagerott, President, Sterling Fibers, USA An Overview of Acrylic Fibers for the Friction Material Industry Feb 2011
10. Mr.Wodetzki Andreas*, Senior Technical Account Manager, Teijin Aramid GmbH, Germany* A new sustainable Twaron® pulp Feb 2011
11. Prof. Desplanques Yannick, Centrale Graduate Engineering School in Lille (France) Material and surface heterogeneities, related multi-scale aspects at the rubbing interface Feb 2014
12. Dr. Dufrenoy, Philippe, University of Lille 1 (Science and Technology), FranceOn the influence of friction material formulation and loading history on brake Feb 2014
13. Prof. Ho Jang, Korea University, Korea Minimization of friction induced instability by modifying the surface properties of friction materials Feb 2014
14. Mr. Kapoor Vishal, Indian Railways Service of Mechanical Engineers, Director Standards (Wagon), Ministry of Railways; Research Designs and Standards Organization At the edge of friction: Composition Brake Blocks on Indian Railway Freight cars Feb 2014
15. Mr. Hagerott Jim President Sterling Fibers, Inc.USA Topic: An Overview of Acrylic Fibers for the Friction Material Industry Feb 2014

16. Mr. Kerssemakers Arno Lapinus fibers, Netherlands Investigation into the impact of Mineral Fibre properties on the performance and comfort of brake pads Feb 2014
17. Dr. Khatri D. S. Consultant to ASK Automotive Pvt Ltd Gurgaon,Development of NAO brake-shoes for two wheelers- Influence of ingredients Feb 2014
18. Dr. Rhee, S. K. President, SKR Consulting, USA Friction Material Performance Improvement by Inorganic Lubricants & II lecture on Brake Noise and Vibration Feb 2014
19. Dr. Rothe Jürgen TEIJIN ARAMID GmbH Germany Morphology of Twaron© p-Aramid pulps and its importance for friction materials Feb 2014
20. Prof. Dr.-Ing. Walter Krenkel Universität Bayreuth, Germany Carbon/Ceramic Brake Disks and Pads for Passenger Cars and Other Transportation Systems Feb 2014

ii) Spending at least a week in the Centre

1. Prof K Friedrich from Institut für Verbundwerkstoffe GmbH Kaiserslautern, Germany- Research stay from 13th to 17th Feb 2013 During collaborative project funded by DFG Germany. Delivered lecture on 14th Feb 2013 on Nanoparticles for the Improvement of Wear Resistant Polymer Composites in ITMMEC committee room.
2. Dr B Wetzel from Institut für Verbundwerkstoffe GmbH Kaiserslautern, Germany- Research stay from 11th Feb to 25th Feb 2014 During collaborative project funded by DFG Germany. Delivered a lecture on tribology of nanocomposites on 24th Feb 2014

5.7 No. of faculty/researchers who visited the department on their initiative for giving (i) seminars, (ii) spending at least a week in the department.

i) On their initiative

1. Prof Vipin Kumar, Univ of Washington, Seattle “An Overview of

Microcellular Foams", Jan., 2010"

2. Sujeet K. Sinha Department of Mechanical Engineering, Indian Institute of Technology, Kanpur Micro-patterning, physical/chemical surface modifications and nano-lubrication for wear durability of micro-machines, 31st May 2013.
3. Prof David Mills, Former Professor, Glasgow, Caledonian University, UK,
4. Prof Mark Jones, University of Newcastle, Australia, Prof Jones is also a Conjoint Professor in ITMMEC, IIT Delhi, 2012 and 2013.

5.8 Adequacy of research infrastructure – Not adequate

5.9 Adequacy of technical staff – existing numbers and competency areas; competency areas in which there is a shortage-

Number inadequate.

5.10 Work space available for

(a) Masters students - Nil,

(b) Ph.D. students- 430 Sq ft,

(c) Project staff - 132 Sq ft,

(d) Post doctoral scholars - Nil

5.11 No. of national conference/workshops/seminars attended by PhD students (*total and per student for 5 years*)

Sl. No.	Conference	Paper title	Authors	Date	Location
1	9th International Conference on Vibration Problems	Review of Defect Detection Techniques of Ball Bearings in the Presence of External Noise	Patel V. N*., Tandon N., Pandey R. K.	Jan. 19-22, 2009	IIT Kharagpur
2	Conf. Proc. of national conference	Volvo bus disc brake testing on a brake inertia	Mukesh Kumar*, S. Malliak, J.	Dec.11-12, 2009	IIT Delhi, India

	on *Tribology of Automotive systems*	dynamometer	Bijwe		
3	National Symposium on Rotor Dynamics-NSRD	Experimentalstudies of vibrations of deep groove ball bearing in presence of waviness on races	Babu C. K*, Tandon N., Pandey R. K.	Dec. 19-21, 2011	IIT Madras
4	2nd ICIAME-2014	Fault size estimation in the outer race of ball bearing using discrete wavelet transform of the vibration signal	S. Khanam*, N. Tandon, J. K. Dutt	7-8 March,2014	Anand, India
5	5thNational Tribology Conference – NTC-2011	Review for Role of Textured Surfaces on Vibrations of Rolling Concentrated Contacts	U.Sudeep*, R K Pandey,N.Tandon	8-10 Dec, 2011	IIT Roorkee, India
6	IMechE-10th International Conference on Vibrations in Rotating Machinery-VIRM 10	Fault identification of rolling element bearings from vibration signals: an application of Kalman and H_∞ filters	S Khanam*, N Tandon, J K Dutt	11-13Sep., 2012	IIT Kharagpur

7	8th Int. national Conference on Industrial Tribology-ICIT-2012	Experimental Studies for Roles of Surface Textures on Friction and Vibration of Lubricated Concentrated Rolling/Sliding Point Contacts	U.Sudeep*, N.Tandon, R K Pandey	7-9, Dec, 2012	Pune, India
8	4th internation al conference on recent advances in composite materials (ICRACM)	Studies of carbon Fabric - polyethersulphone composites against steel surfaces with DLC coatings	S. Tiwari*, J. Bijwe, S. Panier	Feb 18-21 2013	Goa, India.
9	Intl Conf. on Advances in Tribology & Engineering Systems (ICATES)	Fiber surface modification to endorse tribological performance of advanced polymer nano-composite	M. Sharma*, J. Bijwe	October 15-17 2013	Ahmedabad, Gujarat
10	Intl Conf. on Advances in Tribology & Engineering Systems	Enhancement of tribological properties of CF-PEI composites through surface	S. Tiwari*, J. Bijwe, S. Panier	October 15-17 2013	Ahmedabad, Gujarat

	(ICATES)	treatment of fibers			
11	International Conference on Advances in Tribology and Engineering Systems (ICATES)	Strengthening Fiber-Matrix Adhesion to Improve Tribo-Performance of Composites	Ajay Kumar* Kadiyala, Jayashree Bijwe	October 15-17 2013	Ahmedabad, Gujarat
12	5th AsiaTrib-2014	Cyanate-ester resin as a binder for NAO Friction Material – Studies on influence of amount on tribo-properties	Aranganathan N* and Jayashree Bijwe	17-20 February 2014	Agra, India
13	2nd ICIAME-2014	Friction and vibration behaviors of lubricated laser textured point contacts under reciprocating rolling motion with highlights on the used laser parameters	U.Sudeep*, R K Pandey, N.Tandon	7-8 March,2014	Anand, India

5.12 No. of international overseas conference/workshops/seminars attended by PhD students (*total and per student for 5 years*).

Sl. No	Conference	Paper title	Authors	Date	Location
1	Nanotech 2010: Advanced Materials, CNTs, Particles, Films and Composites	Surface tailoring of carbon fabric reinforced PES composites with micro and nano PTFE fillers	M. Sharma*, J. Bijwe,	June 13-16. 2010	Anaheim, USA
2	Intl. Tribological Congress, Asiatrib 2010	Tribological studies on polyetherimide composites based on gamma irradiated carbon fabric	S. Tiwari*, J. Bijwe, S. Panier	December 5-9, 2010.	Perth, Australia
3	18th Intl. Conf. on Wear of Materials (WOM) 2011	Tribological studies on polyetherimide composites based on carbon fabric with optimized oxidation treatment	S. Tiwari*, J. Bijwe, S. Panier	April 3-7, 2011	Philadelphia, USA
4	Polymer Networks 2012	Effect of blending on thermal behaviour of cardanol based bisbenzoxazine	Sini N K*, Jayashree Bijwe and Indra K Varma	August 12-16 2012	Wyoming, USA

		monomer and bisimides			
5	19th International Conference on Wear of Materials (WOM) 2013	Surface lubrication of graphite fabric reinforced epoxy composites with nano- and micro-sized hexagonal boron nitride	Ajay Kumar* Kadiyala, Jayashree Bijwe	April 18, 2013	Portland, USA
6	5thWord Tribology Congress-WTC-2013	Influence of Surface Dimpling on Tribology of Lubricated Rolling/Sliding Point Contacts Subjected to Short Stroke Reciprocating Motion	U.Sudeep* , N.Tandon, R K Pandey	8-13,Sept, 2013	Turin, Italy
7	5th World Tribology Congress 2013(WTC 2013)	Role of Amount of Aramid Fibers on the Tribo-Performance Properties of NAO Friction Materials	Aranganathan N* and Jayashree Bijwe	8-13th September 2013	Turin, Italy

5.13 No. of PG students who have continued to Ph.D.

i. In the Centre - 4,
ii. Other departments of IITD - 4,
iii. In India - 2, and
iv. Abroad - 2.

5.14 No. of projects with co-guide from industry – 1

5.15 No. of students who have spend time in industry as part of thesis/project work (give number and duration): 4

1. Shekhar Kansara 2009JIT3119 Development of a Screening Test for Assessing the Anti-Scuffing Properties of Marine Cylinder Lubricants for joint M Tech with Dr Ramakumar IOCL Faridabad- one month.
2. Debashis Puhan 2011JIT2668 Studies on influence of size of solid lubricant particles on tribo-performance of polymer composites for M Tech project spent 4 days with Garda Chemicals Ltd, Mumbai
3. Kamlesh Kumar 2012JIT2480 Investigations on possible synergism of two solid lubricants of varying sizes and amounts in polymer composites M Tech project spent 3 days with Gharda Chemicals Ltd, Mumbai

4. Mr Sanjeev Sharma Institute for Composite Materials (IVW), Kaiserslautern, Germany during the research stay for the period of three months (May- July 2013)

5.16 Self assessment reports of the department/centers/schools if any - Nil.

5.17 Placement of M.Tech. and PhD graduates in technical careers - Refer *Annexure-4*.

5.18 Inter-disciplinary work:

(i.) Joint thesis guidance by faculty across groups within a department, or across departments/centres,

M Tech theses

1. P V Karthikeyan Tribological properties of 3D stitched composites 2009 (Dr Algirusawami- main Guide)

2. Shekhar Kansara Development of a Screening Test for Assessing the Anti-Scuffing Properties of Marine Cylinder Lubricants 2011 (Dr Ramakumar –IOCL- co guide)
3. Tarun Kumar Yadav Wear studies on surfaces finished by Magnetic Abrasive Finishing Process2011 (Dr P M Pandey; Co-guide)
4. Praveen Kumar Gupta Tribological properties of glass fiber non crimp fabric composites-2011 (Prof Algirusawami; Main guide)
5. Manish Gairola Tribological Studies for Improving the Performance of Ceramics Concentrated Contacts using Micro/Nano Texturing 2013 (Dr R K Pandey; Co-guide)

Ph.D. Theses

1. Mr. Sanjay Gupta; Applied Mechanics Department "An experimental investigation on a fluidized motion conveying system", Completed – 2008 Supervisor Prof. V.K. Agarwal, Co- supervisors: Prof V Seshadri and Prof S N Singh, Applied Mechanics Department, IIT Delhi
2. Mr Niranjana Behra; ITMMEC, "Fluidized Dense Phase Pneumatic Conveying of Fine Particles, Completed October 2013, Supervisor Prof. V.K. Agarwal, Co-supervisor: Prof Mark Jones, University of Newcastle, Australia
3. Mr Hongliang Ding; University of Newcastle, Australia., "Development of design models for Air Slide Fine Powder Transport" University of Newcastle, Australia, Supervisor Prof. V.K. Agarwal, Co-supervisor: Dr Kenneth Williams and Prof Mark Jones, Co-supervisor Prof. V.K. Agarwal, (In Progress).
4. Mr Vivek Bhradwaj; ITMMEC, Supervisor: Prof. V.K. Agarwal, Co-supervisor: Dr R K Pandey, Mechanical Engineering Department. (In Progress).
5. Mr Sanjeev Sharma Development of Polymer nano-composites: Influence of fillers on performance properties, jointly with Prof Stephane Panier Mines Douai, France (In Progress).

6. Siddra Khanam; ITMMEC, Supervisor: Prof. N. Tandon, Co-supervisor: Prof. J.K. Dutt, Mechanical Engineering Department. (In Progress).
7. Chettu Kanna Babu; ITMMEC, "Dynamic Studies of Rolling Element Bearings with Waviness as a Distributed Defect", Supervisor: Prof. N. Tandon, Co-supervisor: Dr R K Pandey, Mechanical Engineering Department.
8. Patel Vinodkumar N.; ITMMEC, "Studies of ball Bearing Vibrations Caused by Local Defects and Improvements in Fault Detection", Supervisor: Prof. N. Tandon, Co-supervisor: Dr R K Pandey, Mechanical Engineering Department.
9. Mr. Mohammad Asjad; ITMMEC, "Development of a methodology for supportability of mechanical systems", Supervisor: Prof. O.P. Gandhi, Co-supervisor: Dr M.S. Kulkarni, Mechanical Engineering Department. (Thesis submitted).
10. Mr. V.R.S. Raju; ITMMEC, "Process mapping and performance measurement in aviation maintenance", Supervisor: Prof. O.P. Gandhi, Co-supervisor: Prof. S,G, Deshmukh, Mechanical Engineering Department.
11. Mr. Samir Chabra; ITMMEC **"**Enhanced depot level maintenance of defense aerospace assets through supply chain management transformation**",** Supervisor: Prof. O.P. Gandhi, Co-supervisor: Prof. S,G, Deshmukh, Mechanical Engineering Department.
12. Mr. Shailendra Kumar; JMI, "Some studies in design for maintainability of mechanical systems: Psychology factors perspectives", Supervisor: Prof. O.P. Gandhi, Co-supervisor: Prof. I.A. Irshad, JMI.
13. Mr. Girish Kumar; ITMMEC**, "**Development of integrated methodology of petri nets and Makov for RAM analysis of mechanical systems", Supervisor: Prof. O.P. Gandhi, Co-supervisor: Dr. Vipul Jain. (In Progress)
14. Ajith Tom James; ITMMEC, Supervisor: Prof. O.P. Gandhi, Co-supervisor: Prof. S,G, Deshmukh, Mechanical Engineering Department. (In Progress)

15. Sudhir Tiwari; ITMMEC, "Role of Fiber-Matrix Interface on Mechanical and Tribological Properties of Carbon Fabric Polyetherimide Composites", Supervisor: Prof. J. Bijwe, Co-supervisor: Dr. Stephane Panier.

(ii.) Proposals submitted and funded – PI - CoPI and their group/department affiliations.

i) J Bijwe and Dr R K Pandey (Mechanical Engineering Department) Development of self-lubricated and surface engineered bush bearings with polymeric nano-composites" Project approved by SERB DST, Feb 2014

ii) Dr. Deepak Kumar, Novel Approach towards the Development of Metalworking Fluid Based on Paraffinic Oil, Submitted to DST under Extra Mural Research Funding Scheme.

6. Outreach / External stakeholder engagement

6.1 Educational

(a) Workshops/Short term courses – topical research for disseminating research of IITD.

1. Organized International workshop on advances in asbestos-free friction composites (IWAAFC 3) on 9th & 10th Feb 2011 in IIT Delhi.
2. Organized International workshop on advances in asbestos-free friction composites (IWAAFC 4) on 13th & 14th Feb 2014 in IIT Delhi.

(b) Workshops/Short term courses – educational methods (teaching, learning resources, pedagogy) - Nil.

(c) Learning, research material on the website - Nil.

(d) Science & technology for public information – on website: Nil.

(e) Courses taught to students of other IITs/NITs/Other institutions - Nil.

(f) Courses taught via NKN - Nil.

(g) Courses developed for NPTEL - Nil.

(h) Books, monographs, study material made available outside IITD –

1. J. Bijwe, M. Sharma, W. Hufenbach, K Kunze and A. Langkamp, Surface engineering with micro and nano-sized solid lubricants for enhanced

performance of polymer composites and bearings, In: Friedrich K, Schlarb A K (eds.) Tribology of Polymeric Nano-composites, Elsevier BV, (published in USA) (2013) 687-716

2. J Bijwe, M Sharma “Nano and micro PTFE for surface lubrication of Carbon fabric reinforced Polyethersulphone composites” In J. Paulo Davim (ed.) Tribology of Nano composites, Springer (2012) 19-40
3. J Bijwe and M Sharma “Tribological Aspects of Carbon Fabric Reinforced Polymer Composites”In J. Paulo Davim (ed.) Wear of Advanced Materials, ISTE-Wiley (2011) 1-59.
4. VK Agarwal and David Mills, Pneumatic Conveying Systems: Pneumatic Conveying Systems, Troubleshooting With particular reference to Pulverised Fuel Ash, Trans Tech Publications, Germany, 2001 (1st Ed., ISBN 00-87849-126-0), 2009 (2nd Ed., ISBN 978-3-8343-3127-4).
5. VK Agarwal, David Mills and Mark G. Jones, Handbook of Pneumatic Conveying Engineering, Marcel Dekker Inc. USA 2004, ISBN 0-8247-4790-9.
6. Anand Parey and Naresh Tandon, “Fault Detection of Spur Gears Using Vibration Monitoring: With emphasis on dynamic modelling of gear vibrations and advanced signal processing techniques for fault detection”, Lambert Academic Publishing, Germany, 2010, ISBN-978-3-8383-9034-5.

(i) Experiments developed and made available to other institutions - Nil.

(j) Seminars live/via NKN, web to other institutions in India/abroad - Nil

(k) Reach out to schools, NCERT, KVs, etc. (e.g. K-12 programmes)- Nil.

(l) Mentoring of other institutions, e.g. new IITs, NITs, universities, etc. including faculty mentoring, curriculum development, laboratory development, etc. – Nil.

6.2 Industry collaboration

a. No. of students (Ph.D./Masters) directly linked to industry funded projects - Nil.

b. No. of industry staff/engineers who have taken a regular course(s) for entire semester - Nil.

c. Technology transfer to companies, entrepreneurs, local and other governments/government agencies, NGOs (separately) - Nil.

d. Continuing education/courses for industry.

- Short term course on “Transportation and Storage of Flyash’ For participants from various industries. 15 – 17 November 2010
- Short term course on “Coal and Ash Handling at the Thermal Power Plants” For participants from various industries. 19-21 November 2012.

e. Faculty secondment to industry - Nil.

f. Research projects undertaken with industry as partner - Nil.

g. Laboratories, equipment, etc. provided by industry for use in UG / PG teaching laboratories and student projects - Nil.

h. Seminars/workshops held with industry by the department - Nil

6.3 Professional

(a) Service as Board, Senate, selection committee member at other IITs, NITs, and Universities.

(i) Prof. O.P. Gandhi:

Selection Committee member at IIT Roorkee, NIT Kurukshetra, NIT Hamirpur,

Member; Board of studies at ISM Dhanbad, NIT Srinagar, NITTTR Chandigarh

(b) Service as Ph.D. thesis examiner at other institutions.

1. Prof. V.K. Agarwal - University of Newcastle, Australia, Barkatulla University, Bhopal;
2. Prof. O.P. Gandhi - IIT Mumbai, IIT Roorkee, BITS Pilani, NIT Kurukshetra, NIT Hamirpur, ISM Dhanbad, Thapar University, Jamia Milia Islamia University, AcSIR – NPL.

3. Prof. J. Bijwe: IIT Kanpur, IIT Guwahati, NUS Singapore, NIT Hamrpur, NSIT Delhi.

(c) Service as technical expert on committees – MHRD, DST, DSIR, DRDO, Pan-IIT initiatives, other ministries, state and local governments.

- Prof. N. Tandon: on CSIR assessment committee for recruitment/promotion of scientists.
- Prof. V.K. Agarwal - Member of the PAC, Flyash Unit, Department of Science and Technology, New Delhi.
- Prof. V.K. Agarwal - International Expert to review Research Proposals for funding by the Australian Research Council.
- Prof. J. Bijwe: Subject Expert Committee (SEC) on Engineering Sciences (ET) in Women Scientist Scheme (WOS-A) –by DST from 2009 till date.
- Prof. J. Bijwe: Member of Local Project Advisory Committee (LPAC) of National Science & Technology Management Information System (NSTMIS), Department of Science & Technology (DST), Ministry of Science a Technology, Government of India from June 2013- Feb 2014.
- Prof. J. Bijwe As a member of review committees of DST & CSIR for evaluating proposals for funding

(d) Technical expert on policy, regulatory, laws, standards committees - Nil.

(e) Member of Board/Advisory Board of public and private sector corporations - Nil.

(f) Positions (e.g. Director, Vice Chancellor, etc.) held by faculty on lien –Prof. VK Agarwal, Director Echelon Institute of Technology Faridabad, India, 2009-2010.

6.4 Contribution to national development goals:

(a) Projects undertaken and their outcome -

- Prof Bijwe worked in the area of replacement of asbestos (which is a serious health hazard for the human health) in friction materials though project (Rs 91 lacs in 2009) funded by DST. The developed formulations were successful and several research papers were published. State of Art facilities testing facilities were set up which are not available with any research Institute in India but available at very few places (research Institutes) globally.
- Prof Bijwe developed technology for high temp. adhesives with desired performance properties for rivet-less clutch facings (organic and ceramettallic) through CSIR sponsored project (NMITLI) (1.9 Crores) where Clutch Auto Ltd Faridabad was an Industry partner
- The applied research undertaken by Prof. V.K. Agarwal on Handling and Transportation of Flyash; especially dry flyash conveying has been of significant value to the thermal power plants, consultants and designers of the system. In view of the ever increasing generation of flyash due to the capacity addition, the Government made it mandatory for all plants to collect coal ash in dry form and promote its utilisation. The work undertaken at IIT Delhi has helped in the following;
  - The design criterion for different grades of coal ash was established by experimental and empirical modelling. Earlier the design was based on same operating conditions leading to unsatisfactory performance of the dry ash handling system.
  - Methodology for design and analysis of stepped pipelines was established. For all systems conveying ash over long distance and using high pressure gradient, stepped pipelines are a must.
  - Guidelines were suggested to the Central Pollution Control Board for optimum layout of the total ash handling scheme for thermal power plants. These were implemented by the plants.

- Hundreds of engineers were educated on the subject through training programmes. This helped them in troubleshooting of the dry flyash conveying systems more professionally.

(b) Policy inputs – implications, visible impact on society - Nil.

(c) Entrepreneurship development - Nil.

6.5 Alumni engagement

(a) Regular interactions / engagement with alumni and outcomes - Nil.

(b) Contributions from alumni - Nil.

6.6 Recognitions and Awards

(a) Awards to faculty.

(b) Fellows of academies, INAE, etc. – Nil

(c) Editor, Member of Editorial Board, etc.

Prof. J. Bijwe:

1. Member, Editorial Board, Wear Journal; Elsevier, since 2007
2. International Advisory Editorial Board; Tribology International – Dec 2008-Dec 2011
3. Member, Editorial Board, Industrial Lubrication & Tribology, Emerald; since 2004.
4. Member, Editorial Board, The Open Nano-science Journal, Bentham Science Publishers Ltd; since 2007.
5. Member, Editorial Advisory Board, Recent Patents on Engineering, Bentham Science Publishers Ltd; 2006 – December 2012.
6. Member, Editorial Board, The Open Materials Science Journal, Bentham Science Publishers Ltd; since 2007.
7. Member, Editorial Board, ISRN Tribology International Scholarly Research Network, Hindawi Publishing Corporation; since March 2012.
8. Member of National Steering committee ASIA TRIB- 2014 17-20 February 2014 at the Jaypee Palace Hotel and Convention Centre, Agra.
9. Advisory board member-of Euro Brake conf (alternately schedules in Lille-France & Dresden, Germany every year) since 2010

10. Distinguished member of SAE Brake colloquium & Exhibition USA since 2009.
11. Steering committee member of Wear of Materials (Intl conf supported by Elsevier) to be held in Canada in April 2015

7. Governance

7.1 Governance

(a) Organization structure – their autonomy/ terms of reference –

As per the practice followed in the institute.

(b) Planning documents developed by the department – space, faculty, staff related - Nil.

(c) Records of discussions within the department – internal documents (meeting minutes, position papers, discussion papers, concept papers, etc.)

In the Head / Centre's Office.

(d) Physical resources – percentage utilization for PG core and electives teaching separately, PG student projects, Ph.D. student research. Projections for future –.

(e) Financial resources –

(i) Funds provided to the department (last 5 year) –

Planned: 151.8 Lacs

Non-Planned, 17.5 Lacs

(ii) Processes of distribution –

Through Faculty Board of the Centre.

(iii) Funding for focus areas,

Through institute and outside funding agencies.

(iv) funding for UG and PG core teaching laboratories.

Through institute funding

(v) Outcomes of funds utilization. Changes in funding pattern and funds utilization, and effects on departmental strategy.

Training of PG and PhD Students

Publications; as listed in 3.5 (Appendix -1).

(f) Delegation of decision making within department/centre. List the processes and structures for financial and academic management, and the methodology for their review.

Through Professorial committee and Faculty board of the Centre.

7.2 Department management and operations

(a) Organization structure - mandates, flexibility, etc.

As per the practice followed in the institute.

(b) Processes for curriculum planning

Initiation at the Centre through PEC and forwarded to the institute level committees for approval.

(c) Processes and methods for teaching resources management.

Institute provides the necessary resources as per the requirement given by the faculty.

(d) Guest faculty, affiliation for teaching core, elective PG courses -

(e) Faculty short-listing criteria –

Minimum institute level criteria

(g) How collectiveness of the faculty has enhanced academic output and enhanced quality, etc. –

(g) Nature, quantum and quality of support from of secretarial staff, stores and inventory management, purchases, ambience, etc. –

Adequate.

7.3 Faculty

(a) Faculty profile, and a critique of the same –

Relevant to the Centre.

(a) Diversity in faculty profile by:

(i) Gender: 5 males, 1 female

(ii) Category: 4 Professors, 1 Assistant professor, 1 Design engineer

(iii) Region:--

(iv) Ph.D. institution: 4 - IIT Delhi, 1 - IISc Bangalore

(v) Post-doctoral institutions worked in: ETH Zurich, Switzerland.

(v) Organizations/industry worked in: Bridge and Roof Company India Limited

(vi) Employment prior to joining the department.

(b) Procedure for faculty searches – through advertisement and personal interaction through email.

(c) Result of faculty searches – area-wise (Refer Annexure 3), number of applicants, short-listed and offered a position, their educational qualifications & experience.

The last faculty selection held in December 2012, with one candidate joining.

(d) Success in recruitment (data for last 5 years), and offers that the persons had from other IITs/IISc/TIFR - 1.

(e) Faculty lost to other institutions post selection - Nil.

(f) Faculty time utilization –

In class: 20%, in meetings: 10%, project management: 25%, Ph.D. guidance: 20%, Masters project guidance: 15%. Administrative work: 10%

(f) Level of harmony amongst department faculty – Good.

7.4 Students

(a) Criteria for short-listing and selecting students for admission to Master's and Ph.D. programmes of past 5 years:

For Master's Programme:

Criteria for 2013:

GATE Scores 550, 495, 400, 350 and 350 for General, OBC, SC, ST and PH category candidates.

Criteria for 2012:

GATE Score- 550 or more & 60 % aggregate or 6.75 CGPA on 10 point scale at B Tech level.

(*a) OBC candidate-*

GATE Score- 475 or more & 60 % aggregate or 6.75 CGPA on 10 point scale at B Tech level

(b) SC, ST & Physically handicapped-

GATE Score- 350 or more & 55 % aggregate or 6.25 CGPA on 10 point scale at B Tech level

Criteria for 2011

GATE Score- 550 or more & 60 % aggregate or 6.75 CGPA on 10 point scale at B Tech level.

(*a) OBC candidate-*

GATE Score- 495 or more & 60 % aggregate or 6.75 CGPA on 10 point scale at B Tech level

(b) SC, ST & Physically handicapped-

GATE Score- 350 or more & 55 % aggregate or 6.25 CGPA on 10 point scale at B Tech level

(c) Sponsored candidates- (GE & OBC) –

60 % aggregate or 6.75 CGPA on 10 point scale at B Tech level.

Criteria for 2010

(a) General candidates-

GATE Score- 500 or more & 60 % aggregate or 6.75 CGPA on 10 point scale at B Tech level.

(b) OBC candidate-

GATE Score- 450 or more & 60 % aggregate or 6.75 CGPA on 10 point scale at B Tech level

(c) SC, ST & Physically handicapped-

GATE Score- 310 or more & 55 % aggregate or 6.25 CGPA on 10 point scale at B Tech level

(d) Sponsored candidates- (GE & OBC) –

60 % aggregate or 6.75 CGPA on 10 point scale at B Tech level along with NOC from employer

Criteria for 2009

(a) General candidates-

GATE Score- 460 or more & 60 % aggregate or 6.75 CGPA on 10 point scale at B Tech level.

(b) OBC candidate-

GATE Score- 460 or more & 60 % aggregate or 6.75 CGPA on 10 point scale at B Tech level

(c) SC, ST & Physically handicapped-

GATE Score-280 or more & 55 % aggregate or 6.25 CGPA on 10 point scale at B Tech level

(d) Sponsored candidates- (GE & OBC) –

55 % aggregate or 6.75 CGPA on 10 point scale at B Tech level along with NOC from employer

For Ph.D.: 65% marks or 7.25 CGPA on 10 Point Scale in Master Degree in Engineering & Technology for General Candidates, while for SC / ST / PH candidates, 55% marks or 6.25 CGPA on 10 Point Scale in Master Degree in Engineering & Technology.

(b) Facilities provided to students and their maintenance/management System –

- Contingency grant to Ph.D. students for Xeroxing, Books, etc.
- Financial assistance to attend one National / International Conference.

(c) Mentoring seminars/sessions held for Ph.D. students for prospective faculty careers -

8. Benchmarking

8.1 Identify departments/centres within IITD as peers. – Mechanical engineering department, Applied mechanics, Textile engineering, Centre for polymers science and engineering, Centre for energy studies

8.2 Identify departments/centres/schools/divisions from other IITs, IISc, NITs, private universities as peers, and reasons/criteria there for.

Mechanical Engineering; Materials – IIT; Bombay, Kanpur and Kharagpur, Ropar, Roorkee and IISc Bangalore.

8.3 Identify departments/centres from institutions in other countries as peers.

ISM Dhanbad, MANIT Bhopal, SGSITS Indore, nCATS University of Southampton, University of LEEDS.

8.4 Define parameters for benchmarking

(i) Research – The number of PhD students and number of publications (impact factor and citations)

(ii) Curriculum:

Masters Programme - Total Course Credits Requirement, Core and Elective Credits, Maths Requirement, Thesis Requirement, Interdisciplinary / breadth requirement

Ph.D. Programme - Number of publications and patents produced

(iii) Teaching-learning processes-Feedback from students, Awards for best teacher

8.5 Perform benchmarking and report the analysis/findings for the last 5 (or 10) years. Annexure 2

9. Feedback systems and results

9.1. System for feedback from UG students and its results - NA.

9.2. System for feedback from PG, Master's and Ph.D., students, and their outcome.

For PG students, feedback for a course is taken twice, i.e. at the mid and end – semester. This is helpful for the teacher to take corrective action.

9.3. System for feedback from recruiters (i) on-campus, and (b) off-campus - separately for UG and PG graduates; and the results.--

9.4. Mechanism of obtaining industry feedback and the findings.---

9.5. Alumni feedback mechanism and its outcome.--

9.6. Placement records – Ph.D., M.Tech.;

MTech Student Placement:

Sl No	Entry No.	Name	Company	Sector
1	2011JIT2665	Pankaj Singh Chauhan	Graphic Era University	Teaching & Research
2	2010JIT3105	Ankur Bajpai	Sharda University	Teaching & Research
3	2009JIT2769	Chiranjit Sarkar	CT Group of	Teaching &

			Institutions	Research
4	2009JIT2774	Binu Urmise	Oceaneering	Core (Technical)
5	2009JIT2778	Ashique Ellahi	Mercedes-Benz Research and Development India Private Ltd.	Other
6	2009JIT3118	Manmohan Gorantala	Oceaneering	Core (Technical)
7	2009JIT3119	Shekhar Kansara	HPCL	Other
8	2009JIT3139	Priyank Kumar Khare	NBC Bearing	Core (Technical)
9	2009JIT2769	Chiranjit Sarkar	CT Group of Institutions	Teaching & Research
10	2008JIT2780	Phani Kumar Mallisetty	CSIR LABS	Other
11	2008JIT2783	Jitendra Kumar	National Engineering Industries Ltd.	Core (Technical)
12	2007JIT2780	Rajendra Kumar	Lovely Professional Univ.	Teaching & Research
13	2007JIT2783	Sweety Goyal	Lovely Professional Univ.	Teaching & Research
14	2007JIT2785	Arun Kumar Choudhary	General Motors Technical Center India	Other

PhD Students Placement

Sl No	Entry No.	Name	Company	Sectror
1	2006ITZ8208	Mohit Sharma	Sharda University	Teaching & Research
2	2005ITZ8236	Mukesh Kumar	The ICFAI University	Teaching & Research
3	2008ITZ8239	Niranjana Behera	VIT Vellore	Teaching & Research

10. Vision for next 5-10 years

10.1 Goals and benchmarking for future in relation to

(i) Curricula, - Enhanced relevance to the industrial requirement, Interdisciplinary approach.

(ii) Research - Cutting-edge research areas, modernization of laboratories.

(iii) Outreach – Conducting of Workshops / Conferences / Seminars, Industry collaboration, faculty interaction.

(iv) Processes for regular internal assessment –.

- Research publications in reputed journals
- Outcome of M.Tech. and Ph. D thesis
- Sponsored project funding
- Teaching activity including laboratory involvement
- Curricular development

10.2 Vision of curricula and teaching-learning processes - PG and Ph.D.; innovations proposed.

(i) Upgrading ITMMEC to Centre of Excellence (CoE) by roping-in funding from industries, involving other institutions and international collaboration.

10.3 Areas identified for improvement in (i) curriculum, (ii) teaching-learning processes – As per the feedback from graduated students and industries.

10.4 New areas for research and Masters programme, and industry participation in these.

New Areas for Research are a following:

i) Development of Nano lubricants, emulsified lubricants and cutting oils.
ii) Development of high performance adhesives and nano adhesives.
iii) Studies on Nanomechanics / Nanotribology / Nanomechanisms.
iv) Development of environment friendly friction materials and high performance bearing materials.
v) Design and development of mechanical systems from green maintenance initiatives
vi) Fault detection of very slow speed rotating machinery
vii) Acoustic emission studies for failure diagnosis of machines and components.

10.5 Projections for

(i) Funded projects: enhance by 100% next 5 years.
(ii) Journal publications: enhance by 40 - 50% next 5 years.

10.6 Projected graduation numbers –

Ph.D.: 20
M.Tech.: 75

10.7 Projected faculty profile, and areas for recruitment of faculty.

Meeting the institute minimum qualification and experience requirement, with specialization: Lubrication, Tribological materials, Maintenance and reliability, including condition mentoring.

10.8 Projections for future benchmarking (for comparison after 5 years) – institutions in India and abroad, and parameters for future comparison.

Publications, MTechs, PhDs, Patents and funding received.

10.9 Infrastructure and governance - limiting factors that affect achievement of benchmarks and methods to overcome these.

Faculty strength in required areas, research infrastructure and level of funding

10.10 Working with other departments/centers and institutions in teaching and research –

Work with the other departments / Centres will be further intensified.

10.11 New initiatives that the department/centre will undertake –

Outreach, through interaction with industry and research institutions.

10.12 Outreach goals and anticipated limitations in the attainment of these – Recruitment of young faculty, sate-of-art infrastructure and funding.

10.13 Mechanisms for effective changes based on feedback received and development and implementation of corrective measures.

A core group to implement suggestions proposed in the feedback.

10.14 Questions to which the department seeks answers from the Review Committee.

11. Information in public domain

11.1 Minutes of all meetings – in the office of the Centre.

11.2 All reports archived in the central/departmental/centre library-Yes

11.3 Past vision documents, review documents, Standing Review Committee documents – available in ITMMEC Office.

11.4 Any other documents developed by the department, a group/section of the department/centre –

11.5 Feedback documentation and action taken on the same, and its outcome –

Appendix- I: List of publication since 2009

Total Publications: 137

INTERNATIONAL JOURNALS

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Annexure -1

PLACEMENT DETAILS – On-campus
(Data for last 5 years)

Prog. Type	Prog. Name	No. of Graduating students	No. of core companies that asked for prog. by name	No. of students selected	No. of non-core companies that recruited students	No. of students placed in non-core companies	No. of students not placed at graduation time
M Tech	Industrial Tribology and Maintenance Engineering	61	3	14	4	8	-
PhD	-	10	1	2	2	2	-

Annexure - 2

BENCHMARKING OF CURRICULUM

(data for last 5 years)

Peer groups	ITMMEC, IIT Delhi	ISM Dhanbad	MANIT Bhopal	SGSITS Indore	University of Southampton	TRIBOS Consortium, LEEDs, UK
Masters	M.Tech- Industrial Tribology and Maintenance Engineering	M.Tech - Maintenance Engineering and Tribology	M.Tech - Maintenance Engineering	M.E- Tribology and Maintenance Engineering	MSc Advanced Tribology	Master programme in tribology of surfaces and interfaces
Duration	2 years	2 years	2 years	2 years	1 year	2 years
Total credits	60	75	90	74	120	153.5 (Course points)
Core credits	42	69	72	66	60	147.5
Electives credits	18	6	18	8	60	5
Thesis Requirement	Yes	Yes	Yes	Yes	No	Yes
Interdisciplinary	Yes	No	No	No	Yes	Yes

Annexure - 3

AREAS OF RESEARCH

(data for last 5 years)

Sl. No.	Name of research area (list from prospectus + any other)	Faculty involved Nos.	PhDs		Journal papers	Conf. papers	Sponsored projects (No and values)		Industry consultancies (No and values)		Listed in prospectus since
			completed	on-going	Nos	Nos	completed	In progress	completed	In progress	Give year
1	Tribology, including composites, Erosive wear, Pneumatic handling of bulk solid,	3	5	7	55	37	9 (Rs.370 Lacs)	2 (Rs.170 Lacs)	25 (Rs.55.86 Lacs)	1 (Rs.5.5 Lacs)	2009
2	Maintenance, including condition monitoring using vibration, oil analysis, acoustic emission, noise, etc., NDT, Reliability.	3	5	7	38	17	3 (Rs.267 Lacs)	-	6 (Rs.23.98 Lacs)	-	2009

Annexure - 4

PLACEMENT OF METCH AND PHD GRADUATES IN TECHNICAL CAREERS

(data for last 5 AND 10 years)

DEPARTMENT COLLECT DATA FROM SURVEY ALUMNI

Sl No.	Prog. Name	No. Graduating students	Nature of job for first 2-3 year after graduation	Nature of job for 5 after graduation	% of graduates in technical line of work	% of graduates started in technical line and are managers/ administrators
1	MTech (Industrial Tribology & Maintenance Engineering)	61	Core and Non-Core	Core and Non-Core	40%	40
2	PhD	10	Core and Teaching	Core and Teaching	30%	-