

Information Brochure – 2009

M. Tech in
Power Electronics and Power Systems



Power Electronics and Power Systems Group
Department of Electrical Engineering
Indian Institute of Technology Bombay,
Powai, Mumbai 400076

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IIT Bombay

IIT Bombay has a picturesque evergreen campus spanning 220 hectares, which lies between Powai Lake, Vihar Lake and hills to the north. The campus is recognized by the Bombay Natural History Society for bird watching with around 120 species of birds. IIT Bombay is a township in itself with most of the 10,000 strong community of students, faculty and staff residing on the campus. The campus has a wide range of facilities including a gymkhana, swimming pool, hospital, guest house, banks, schools, restaurant and one of the best technical libraries in the country. IIT Bombay has a vibrant culture covering all major sports and cultural activities and the annual calendar is packed with competitive, social and entertainment events. IIT Bombay organizes Mood Indigo and Techfest (leading cultural and technology festivals in India, respectively), in addition to a number of cultural, technical and entrepreneurial festivals annually. Additionally, the Electrical Department has its own library, study rooms, conference rooms, a PC laboratory for general computer usage and a refreshment counter. The department is wi-fi enabled.

Power Electronics and Power Systems (PEPS) Group

The Power Electronics and Power Systems (PEPS) Group of the Electrical Engineering Department at IIT Bombay conducts research in several areas. Masters and doctoral students are actively involved in this activity. Research areas include:

- Power system dynamics, computation, protection and planning
- Flexible ac transmission and HVDC systems
- Power system deregulation
- Distributed generation and microgrids
- Coupled field computations, transformer design, analysis and diagnostics
- Electric power quality and static compensation
- Non-conventional energy interfaces
- Electric machine design, analysis and control
- Power electronic and power system transient simulation

An important aspect of the group's programme is the integration of power electronics with the study of power systems. This has caused the group to be involved in several areas that are important to the development of the country's electric power infrastructure. Apart from undergraduate and postgraduate teaching, the group has been highly active in providing technical expertise to local industry through consultancy and continuing education programmes. The group faculty members and students regularly contribute papers and articles to international technical journals.

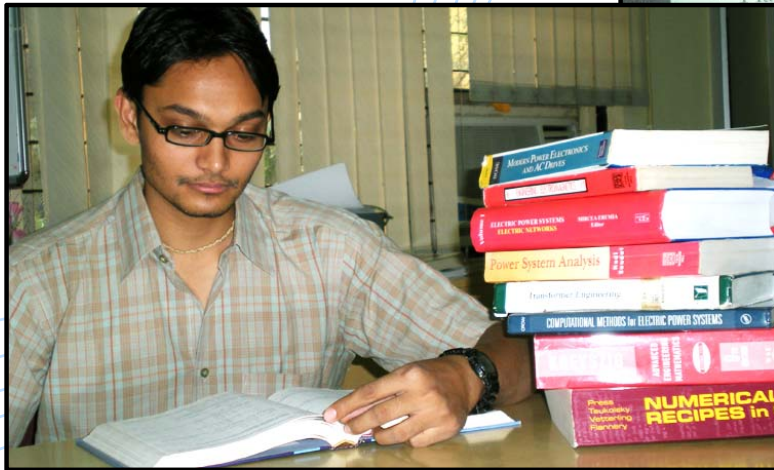
The Group hosts Inpowerg, an electronic discussion forum for power systems professionals and academics in India. In addition, the Group faculty members are active participants in the National Mission on Power Electronics Technology (NaMPET), an initiative of the Department of Information Technology of the Indian government.



M. Tech Program Structure

The Masters program in the PEPS group spans for 2-3 years depending on the kind of assistantship received by the student. The programme is geared towards balancing academic coursework and hands-on research experience. It also aims at developing the soft-skills of the individual such as presentation, report writing, communication by having regular seminars and interactive sessions amongst students and faculty. The projects on which the students work are mostly industry driven/sponsored. The high faculty-student ratio permits personalized attention towards each of the M.Tech. aspirant.

The group is equipped with the latest experimental and computational facilities for taking up R & D and consultancy activities in various fields, and these labs can be availed for 24 hours.

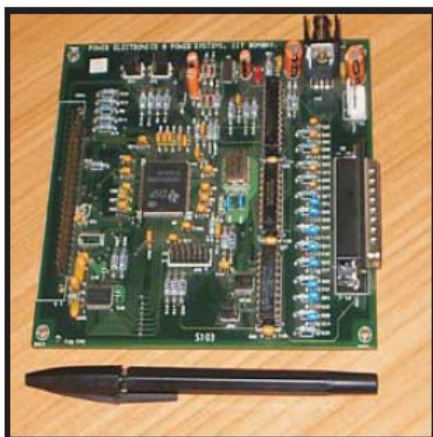


Several lectures, workshops, and conferences are a regular feature in the PEPS group. This is an opportunity to meet eminent speakers and exchange ideas. A number of challenging projects are in progress in various areas and are funded by government agencies and private industries, both Indian and multi-national. Research problems are also being addressed in collaboration with universities in India and abroad.

M. Tech Program Structure

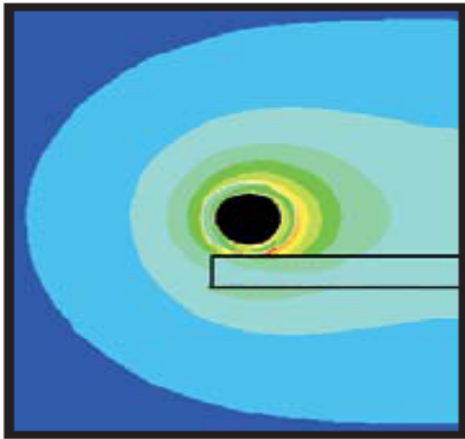
The following table outlines the course work and project work required for the 2 year M. Tech programme.

	No. of Courses to be taken			
	First Year		Second Year	
	Sem I	Sem II	Sem I	Sem II
PEPS Core courses	2			
EE Dept. Elective	2	4		
Other Dept. Elective		1	1	
Lab Courses	1			
Seminar	1			
Project		1		
Communication skills course	1			
Master's Project			Stage I	Stage II



M. Tech Courses

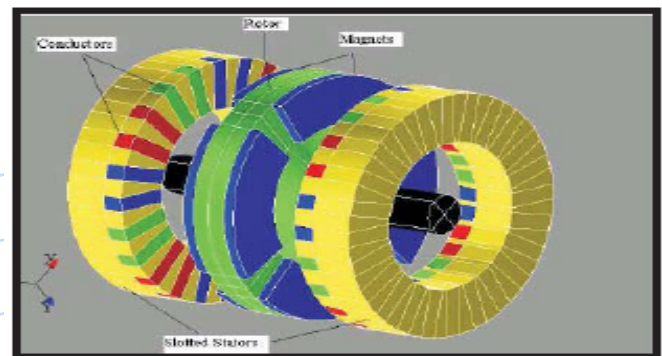
Core courses and Electives*



- Power Electronics – I
- Power Electronics – II
- Computer Aided Power System Analysis
- Electrical Machine Analysis & Control
- Power System Dynamics and Control
- A First Course in Optimization
- Microprocessor Applications in Power Electronics
- Application of Power Electronics to Power Systems
- Power System Protection
- Electric Drives – I
- Restructured Power System
- Computational Electromagnetics
- Power System Reliability
- Matrix Computations
- Digital Signal Processing and Applications

Electives from other departments*

- Information Technology Project Management
- Object Oriented Systems
- Data Mining
- Information System
- Energy Systems Modelling & Analysis
- Non-conventional Energy Sources
- Computer-Aided Applied Statistics
- Cost-Benefit Analysis
- Applied Economics



* This list is not exhaustive and only indicative of kinds of courses.
The actual choice of courses available is much larger

Research Labs



Applied Power Electronics Lab: Power electronics for renewable resources, Development of power supplies, Software tools: PSPICE, Facilities Environment chamber to test circuit under different temperature and humidity conditions. The laboratory supports research on renewable energy sources, their power conditioning and interconnection with the grid. Photovoltaic and fuel cell sources are available for experimentation. Facilities are also available for EMI/EMC testing of electronic and power electronic systems.

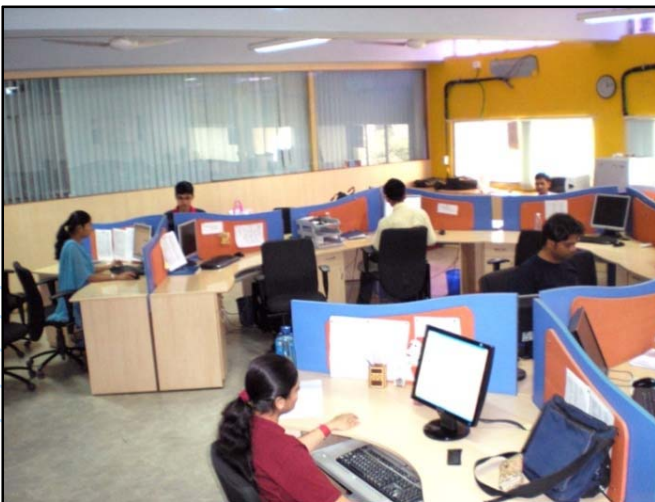
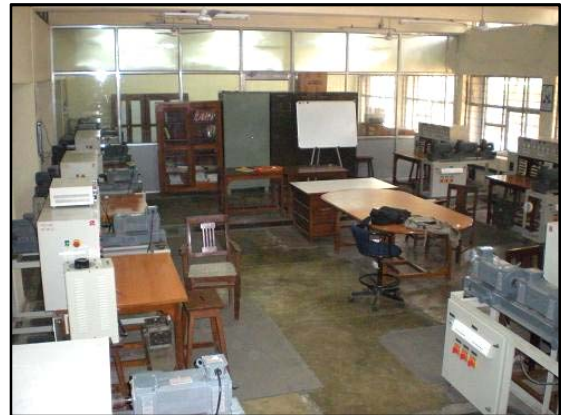
Field Computations Lab: The laboratory is intended for research in electromagnetic and coupled field systems. The laboratory has high-performance computing facilities and state-of-the-art software including ANSYS, FEMLAB and in-house developed software. Research is also carried out on Power System Analysis in the fields of restructured power systems, distributed generation, intelligent utility networks, design of architectures for modern SCADA/EMS systems and transmission systems planning. Both industry standard power system analysis software such as PSS/E, MiPower and DigSILENT as well as in-house software are used.



Insulation Diagnostics Lab: This recently developed laboratory has a 100 kV AC / 140 kV DC setup. It is also equipped with a partial discharge measurement setup. Research in this lab is in the fields of Partial discharge, Insulation life evaluation, Dielectric breakdown.

Research Labs

Machines Lab: This teaching and research laboratory has electric motor-generator sets, measuring instrumentation and power electronic drives. Students are exposed to concepts of machine characteristics and control through lab experiments. The research initiatives include Electric machine design, Modeling analysis and control, Variable frequency variable amplitude power supplies, along with Software tools such as FLUX and ANSYS.



Power Anser Lab (PAL): This is a laboratory set up in collaboration with TCS in March 2007 for development of various power system applications and making them available over the web - a first of its kind initiative. PAL collaborates with various consulting organizations and utilities. So far PAL has developed and made available web services for load flow analysis, transmission system usage and loss cost allocation, short term load forecasting, security constrained optimal power flow and transmission system planning.

Power Systems Lab: This laboratory houses a demonstration and experimental facility for power systems using scaled models of power system components such as alternators, exciters, HVDC converters, and FACTS devices.

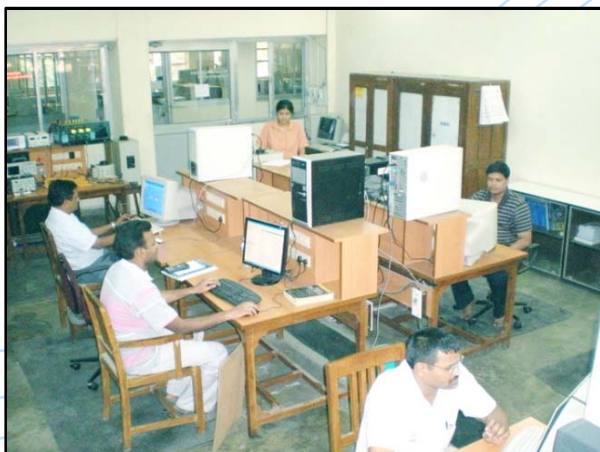


Research Labs



Power Electronics Lab – I: In this laboratory, research on the application of inverters for active power filters, switched reluctance motors and parallel operation of inverters in a microgrid are carried out. The inverters under use are three phase three wire and three phase four wire inverters fabricated by SEMIKRON.

Power Electronics Lab - II: This lab works in the areas of shunt compensation, load emulation, Un-interruptible Power Supplies (UPS), condition monitoring of induction motors and the control of induction motors. The real-time interfaces for Data Acquisition Cards are also developed for real-time operating systems such as QNX.



Power Electronics Lab – III: This laboratory works on machine design and prototyping of axial flux machines, permanent magnet machines and machines for electric vehicle applications. Simulation and optimization of machine design is carried out using in-house codes as well as advanced FEM packages. Work on matrix converters and multi level inverter is also carried out.

Faculty in PEPS group

Core Faculty	Associate Faculty
1. V. Agarwal	1. H. Narayanan
2. M. C. Chandorkar	2. A. N. Chandorkar
3. K. Chatterjee	3. M. B. Patil
4. B. G. Fernandes	4. P. Apte
5. A. M. Kulkarni	5. H. Pillai
6. S. A. Khaparde	6. M. Belur
7. S. V. Kulkarni	
8. S. A. Soman	

V. Agarwal

Research Areas:

- High Frequency Link Power Conversion.
- Electro Magnetic Interference (EMI) in electronic and power electronic circuits.
- Intelligent control of electronic and power electronic systems (including DSP based real time applications and embedded systems).
- Sensorless control of electric drives.
- Power quality issues (power factor correction techniques, static VAR compensation, active filters).
- Non-conventional energy (solar PV, wind, fuel cell) and its conditioning, grid connected systems.

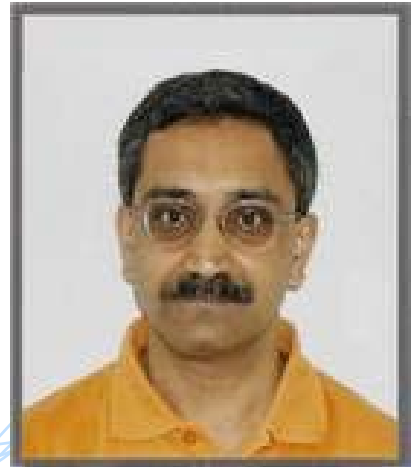


Faculty in PEPS group

M. C. Chandorkar

Research Areas:

- Electrical drives
- Power electronic converters and control
- Power system applications of power electronics, and electrical power quality for industrial and commercial installations
- DSP applications in power electronics and power systems
- Real-time digital simulation



K. Chatterjee

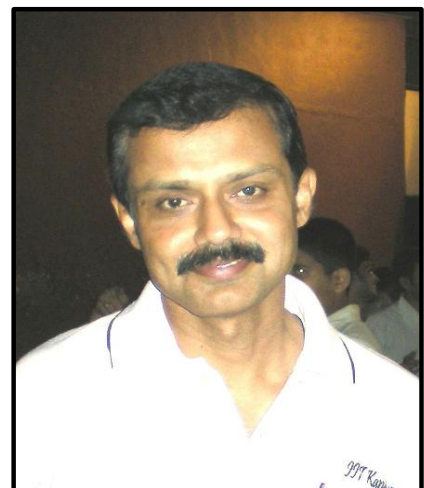
Research Areas:

- Utility friendly converter topologies
- Power factor correction techniques
- STATCOM
- Switched mode rectifiers
- Electronic ballast
- Control of electric drives

B. G. Fernandes

Research Areas:

- Switch-Mode Rectifiers, Switch-Mode Power Supplies, soft switching techniques for SMPS
- Permanent magnet machines and electric drives, power electronic circuits and applications, electrical machines
- Solid state drives, active filters
- Microcontroller application in drives



Faculty in PEPS group

S. A. Khaparde

Research Areas:

- Restructured power systems
- Transmission pricing
- Financial transmission rights
- Distributed generation and MicroGrids
- Transmission expansion planning
- Intelligent power grids



S. V. Kulkarni

Research Areas:

- Transformer design, analysis, and diagnostics
- Electromagnetic and coupled field computations
- Efficient finite element method computations
- Power engineering: distribution automation and distributed generation
- High voltage insulation design/diagnostics

A. M. Kulkarni

Research Areas:

- Power system dynamics
- Flexible AC transmission systems
- HVDC transmission systems



Faculty in PEPS group

S. A. Soman

Research Areas:

- Power System Protection
- Wide Area Measurement Systems
- Power System computing & OR applications



Associated Faculty Members

- **H. Narayanan:**
Research Areas: Parallel circuit simulation, combinatorial modelling
- **A. N. Chandorkar:**
Research Areas: Power semiconductor devices
- **M. B. Patil:**
Research Areas: Power electronic circuit simulations
- **P. Apte:**
Research Areas: MEMS, condition monitoring
- **H. Pillai:**
Research Areas: Matrix computations, multivariable control
- **M. Belur:**
Research Areas: Behavioral theory of systems and control

Major Research Projects by PEPS group

Projects in Power Electronics:

S. no	Research project	Funding Agency
1	Development of a Combined Off-line and Real-time Simulator for Power System and Power Electronics Simulation	Ministry of Communications and Information Technology of India
2	Development of a Flexible Low Cost DSP/FPGA Platform for Power Electronics Control Implementation	Ministry of Human Resource Development (MHRD)
3	Study of Electric Arcs, their Detection, Characterization and Mitigation	Board of Research in Nuclear Sciences (BRNS)
4	Development of an Integrated GPS-INS System	Defense Research and Development Organization (DRDO)
5	Advanced Static VAR Compensator control development	Crompton Greaves Ltd
6	Development of High Power, High Frequency Power Supply	Board of Research in Nuclear Sciences (BRNS)
7	Design of Line start PMSM for Irrigation Pumps	Central Power Research Institute (CPRI)
8	Single phase STATCOM for railway applications	(Indian Railways)
9	DSP based DC drive	Bharat Bijlee, Bombay

Major Research Projects by PEPS group

Projects in Power Systems:

S. no	Research project	Funding Agency
1	Optimal Power Supply Bidding by Reinforcement Learning in Deregulated Power Market	Department of Science & Technology (DST)
2	Study of Infrastructure and Issues involved in Implementation of Distributed Generation in Rural India	Central Power Research Institute (CPRI)
3	Developing Criteria for Allocating Additional Distribution Outlets	Maharashtra Electricity Regulatory Commission (MERC)
4	Transmission Expansion Planning under open access in India	Department of Science & Technology (DST)
5	Intelligent Power Grid Initiatives in India	Energy and Utilities, IBM
6	Co-ordination of Over-current and Distance Relays for Meshed Power Systems in Object Oriented Paradigm	Central Power Research Institute (CPRI)
7	Measurement & Evaluation of Power Quality in BSES Ltd, Mumbai	Brihanmumbai Suburban Electric Supply (BSES)
8	PSS tuning for Eastern and Western Regional Grid	Western Region Electricity Board (WREB)
9	Distribution Automation	All India Council for Technical Education
10	Development of Demonstration Facility Using Scaled Models for Power System Dynamics, HVDC and FACTS	Central Power Research Institute (CPRI)
11	Planning Studies for Distributed Generation	Ministry of Human Resources and Development (MHRD)
12	A Fully Compensated, Hybrid, Distributed Generation System Based on Renewable Energy Sources - Feasibility Study and Implementation	Ministry of Human Resources and Development (MHRD)
13	Calculation of Transmission Losses based on Power Tracing	Power Grid Corporation of India Ltd. (PGCIL)
14	Development of web services for power system applications	Tata Consultancy Services & Tata Consulting Engineers Ltd.
15	Renewable Credit Trading In India	India Energy Exchange (IEX)

Alumni Corner

Udaya Kiran Ammu

Google Inc. Power Engineer, Mountain View, California

Thesis: **Single Stage Single Switch Power Factor Correction Techniques**

"IIT Bombay PEPS master's program has fostered my curiosity. We have a very wide range of research choice. The program offered me breadth in protection, computational methods, drives, HVDC, FACTS, DC-DC Converters, Renewable energy etc. Faculty and students are extremely helpful and professional. We have one of the best laboratory facilities. The regular seminar series helped me understand wide range of research problems. The program and the faculty members are widely recognized and acclaimed. It offers excellent job and research opportunities. State-of-the-art library, highly funded program, best location, fantastic hostels, and canteens make it a great setting to pursue graduate studies."



Mital Kanabar

Pursuing PhD in University of Western Ontario, Canada

Thesis: **Grid Integration Issues of Distributed Generation (DG)**

"During my M.Tech, the dynamic curriculum, distinguished faculty, and state-of-the-art lab facilities offered by PEPS group at IIT Bombay have provided me the perfect platform to shape my career goals, and encouraged me to gain more focused and innovative approach in the area of Power. Individual guidance from the faculty on cutting-edge research areas and research oriented atmosphere have not only enhanced my knowledge and personality, but also motivated me to pursue higher studies and to contribute to the welfare of the society. I am proud to be an alumnus of PEPS @ IITB."



B. Sreenivas Reddy

Engineer/Technologist in GE Energy, Hyderabad Technology Centre

Thesis: **Transmission Expansion Planning in Restructured Power Systems**

"It was a great opportunity for me to go through Master's course in IITB in power systems. These two calendar years in my life are unforgettable because of the time spent with very highly qualified, cultured and most respected faculty in Indian power systems group. The improvement in me is not just limited to technical aspects, which come as default, but also in general life aspects. I am lucky and grateful to go through the process of being trained under such great personalities."



Alumni Corner

Kaushik Kalyanaraman

Technical staff, Nanotechnology and Seismology groups,
Computational Research Laboratories Ltd, Pune.

Thesis: **Analysis of Coupled Electromagnetic Problems Using Wavelet-Galerkin and Finite Element Methods**

“The diversity in research interests of people associated with PEPS group, both faculty and students, is, in my opinion, the single most unique aspect of the group. Personally, I believe that I have had the opportunity to understand and appreciate 'analysis' in both quantitative and qualitative terms from this diverse ensemble. This has enabled me to adapt the knowledge I had gained to solve problems in areas very different from what I have been formally trained in. My best wishes to PEPS associates, present and prospective, to both generate and sustain this technical and research prowess of the group.”



Y Santhosh Kumar

Senior Software Engineer, SoftJin Technologies Private Ltd, Bangalore

Thesis: **Block QR Decomposition to Power System Analysis**

“I must say that the faculty is the best and the dedication they show towards the research or in any form of sharing the knowledge with the students is immensely appreciated. The faculty is very much focused on the research and also they show interest and concern on the projects students work on. They work very closely with the students. The labs are fully equipped and can be accessed at any point of time.”



Naresh Vattikuti

Technical Manager, TATA Motors, Pune

Thesis: **Design and control of outer rotor segmented switched reluctance motor**

“Faculty is very good both in knowledge and teaching. They have given a correct direction and path to my life. Before Joining PEPS at IITB, I did not even know what research papers are. By the time I finished my Master's degree I have published three IEEE papers. We even obtained one patent on the design of a new reluctance motor. This shows how tremendous transformation that the faculty and the research environment at IITB can bring about. This gave me confidence to face any challenge in future.”



Hari Krishna Chaitanya

Design Engineer, Flight Test Centre, ARDC,
Hindustan Aeronautics Limited (HAL), Bangalore

Thesis: **Formulations for Inverse Problems in Electromagnetic Systems**

“The faculty of PEPS group, especially my guide has made me punctual, emphatic, prudent and successful in life.”



List of Recent Recruiters of PEPS students

1. General Electric (GE)
2. Tata Motors
3. Cypress Semiconductors
4. Fairchild Semiconductors
5. Reliance Industries
6. Lafarge
7. Emerson Network Power (India) Private Ltd
8. Oracle Software
9. Computational Research Labs (CR Labs)
10. Oil and Natural Gas Corporation (ONGC)
11. GAIL
12. DAR Group
13. IBM Software
14. Crompton Greaves
15. Siemens Information Systems (SISL)
16. Delphi
17. Softjin Technologies
18. Vishay Semiconductor

Important Dates

M.Tech Online Application Form submission starts on :	Mar 17, 2009 2:00:00 PM
Last date of filling forms online :	Apr 15, 2009 11:59:59 PM
Last date for receipt of supporting documents	Apr 15, 2009 11:59:59 PM

For any information regarding the admission procedure and online application form visit <http://www.iitb.ac.in/academic/pgprgm.html>

For any information regarding electrical engineering department and other specializations in electrical engineering department visit <http://www.ee.iitb.ac.in/>

For further information on power electronics and power systems group of electrical engineering department visit <http://www.ee.iitb.ac.in/~peps>