

The Brazilian Federal University of Itajubá – UNIFEI Minas Gerais, Brazil Energy

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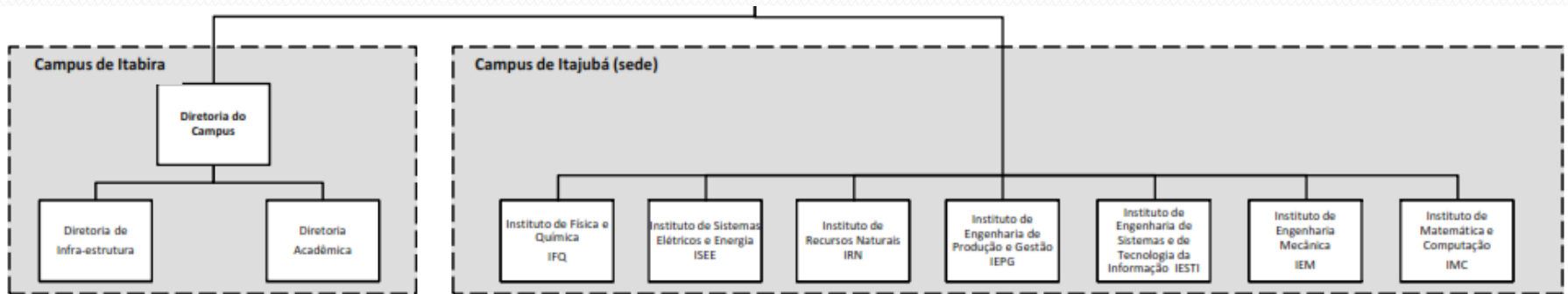


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Universidade Federal
de Itajubá-MG

The Brazilian Federal University of Itajubá – UNIFEI



Energy Engineering undergraduate and post-graduate studies at UNIFEI

- These new paradigms have been the basis for the curriculum development in :
 - Energy Efficiency: ISO 50001 - competitiveness and marketing element
 - Renewable Sources, several of them are already or are in the process of being commercial: solar, wind, small hydro power, biomass and biofuels and other.
 - Energy Conversion of waste, and low-potential energy flows
 - Microgeneration and Combined Heat and Power (Organic Rankine Cycle, gasification etc./ Hydrokinetics turbines, etc).
 - Technology for clean coal - almost commercial.
 - Sustainability Assessment – Life Cycle Assessment



English Version of the document “Ciencia, tecnología, ingeniería e innovación para el desarrollo: una visión para las Américas en el siglo XXI”. ISBN 0-8270-4909-9, . Organization of American States. Office of Education, Science and Technology. Q127.A6 S3 2005 (S), 105 p.

Energy Engineering undergraduate and post-graduate studies at UNIFEI

- Intelligent Networks and energy storage.
- Carbon sequestration : i.e. oxycombustion
- power / energy integrated Systems
- Bio-refinery and poly generation
- Integration and optimization of processes ..
- Needed for new materials studies
- The extensive using of computational design tools - CFX[®], Aspen[®], HYSYS[®], Gate-Cycle[®] etc.
- Alternative Transport, etc.

English Version of the document “Ciencia, tecnología, ingeniería e innovación para el desarrollo: una visión para las Américas en el siglo XXI”. ISBN 0-8270-4909-9, . Organization of American States. Office of Education, Science and Technology. Q127.A6 S3 2005 (S), 105 p.

Energy Engineering undergraduate and post-graduate studies at UNIFEI

- Since its creation (in 1913) UNIFEI has focused on the theme of energy in its academic activities and research
- The administration of our university encourages and supports the development of projects and courses in the undergraduate and post-graduate studies in the area of energy
 - considering the expertise in this area, it is one of the strongholds of the institution
- Since 1999, there is a Masters Degree Course in Energy Engineering and Since 2011, an undergraduate degree in the same subject

Professors from UNIFEI, who work in the energy, has been publishing papers in scientific journals as Energy Policy, Renewable Energy, Biomass and Bioenergy, etc.



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Energy Engineering undergraduate and post-graduate studies at UNIFEI

- The undergraduate course in Energy Engineering should have its first graduates in 2015
- Since 2008, the Masters Degree Course in Energy Engineering had a total of 86 graduates
 - A current assessment of their professional status shows that 16 of them are or were doctorates at other Universities, 21 are professors at different levels of education and 15 working in government agencies and 36 different companies

UNIFEI laboratory infrastructure: Energy

- Our Engineering of Energy includes professors of various institutes of the university:
- IRN- Institute of Natural Resources, ISEE- Institute of Electrical Systems and Power; and IEM- Institute of Mechanical Engineering
- and is supported by several research groups of recognized nationally and internationally prestige :
- The NEST - Nucleus of Excellence in Thermal Electrical and Distributed Generation (www.nest.unifei.edu.br), the EXCEN - Center of Excellence in Energy Efficiency (www.excen.com.br) and the CERPCH - National Reference Center of Small Hydroelectric Power Plants (www.cerpch.unifei.edu.br)
 - The research activities of these groups have funding for various projects with the CNPq, CAPES, Petrobras, CPFL, Cemig, AES, and other national companies.

The CERPCH - National Reference Center of Small Hydroelectric Power Plants

(www.cerpch.unifei.edu.br)



CERPCH

- CERPCH is located at Unifei, and it was created through an agreement signed on July 24th of 1998, looking for the assistance of the resolution of the III Encounter for the Solar, Wind, Biomass, and Small Hydro Power Plants Energies development, accomplished under the auspices of the Permanent Forum of Renewable Energies of the Brazilian Ministry of Science and Technology

The CERPCH - National Reference Center of Small Hydroelectric Power Plants

(www.cerpch.unifei.edu.br)



- The hydro-mechanical Small-Hydropower-Plants Laboratory (LHPCH, in Portuguese), which is composed by test benches for performance analysis and optimization of hydraulic turbines, allows UNIFEI to expand the range of actions in professional qualification and technological improvement of this kind of power generation.



The CERPCH - National Reference Center of Small Hydroelectric Power Plants

(www.cerpch.unifei.edu.br)



- With LHPCH it is possible to develop research and innovation projects in the area and to provide solutions and high-level studies to the hydro power sector, contributing to the strengthening of national technological chain.



The CERPCH - National Reference Center of Small Hydroelectric Power Plants

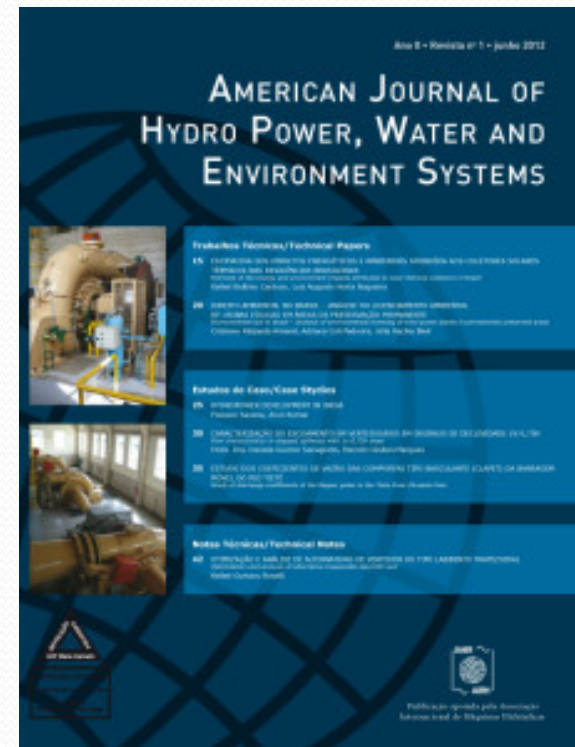
(www.cerpch.unifei.edu.br)

- A group of Latin American researchers and companies after participating in worldwide meetings of *International Association for Hydro-Environment Engineering and Research*, IAHR's Hydraulic Machines Committee, decided to join efforts to increase interaction in Latin America for developing regional research as well as to improve dissemination of these researches around the world
- Thus, on 2010 the Latin American Working Group was launched during IAHR conference held in Romania under the coordination of Prof. François Avellan (EPFL-Switzerland) President of IAHR's Hydraulic Machines & Systems Committee on that time, and started its activities on 2012



The CERPCH - National Reference Center of Small Hydroelectric Power Plants (www.cerpch.unifei.edu.br)

- Publications:
- American Journal on Hydropower, Water, Environment and Systems, ISSN: 2317-126X
- *International Association for Hydro-Environment Engineering and Research* (IAHR)
- Latin American Working Group
- Events: <http://www.latiniahr.org/meeting/about-event/>



The CERPCH - National Reference Center of Small Hydroelectric Power Plants

(www.cerpch.unifei.edu.br)

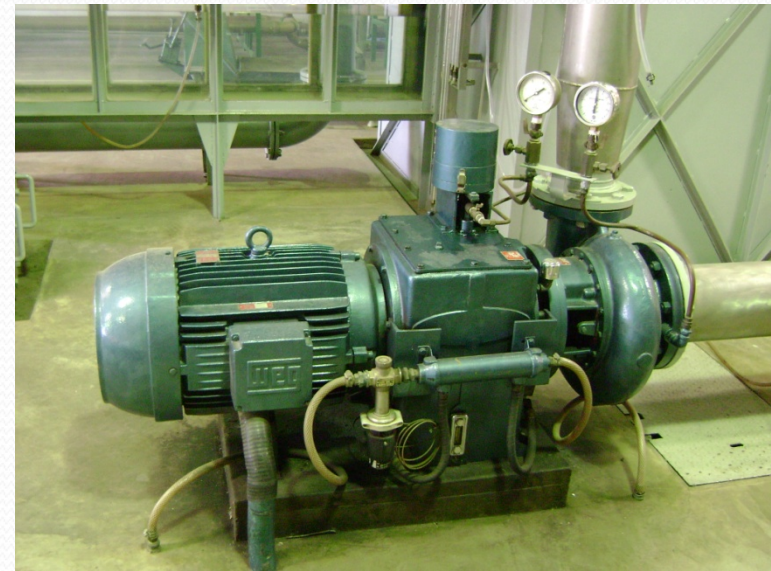
- Publications: PCH Notícias & SHP News. ISSN: 1676-0220



The CERPCH - Hydro-mechanical Laboratory of Small Hydroelectric Power Plants (LHPCH)



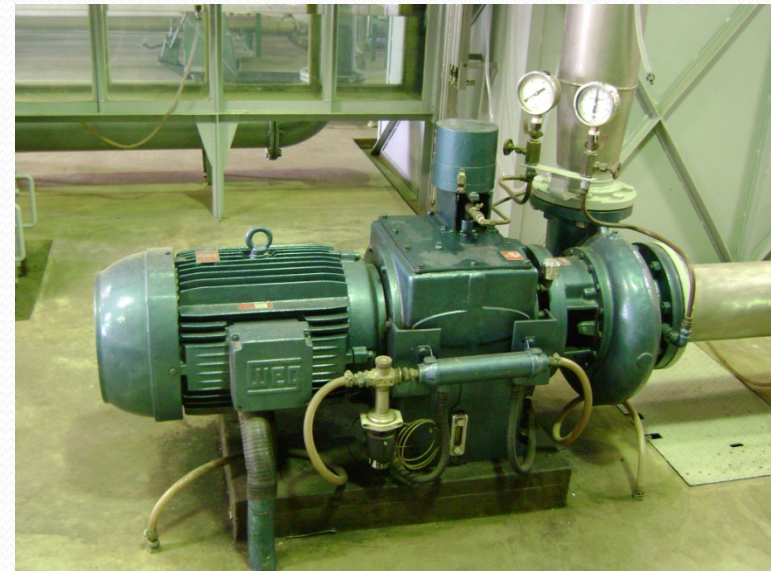
- The **LHPCH** has the benches described as follows and the respective testing engines:
 - **Demonstration Bench of Central Deviation** : hydraulic transients, discharge measurements (by spillway and ultrasound), head losses and data acquisition test
 - **Visualization workbench of flowing in discharge measurements** : head losses, attrition factor in runoff hydraulically rough determining, calibration of flow meters, visualization of cavitation, and characteristics of valves.



The CERPCH - Hydro-mechanical Laboratory of Small Hydroelectric Power Plants (LHPCH)



- **Bench for hydraulic transient studies:**
hydraulic transients and acquisition of test data
- **Demonstration bench with *Michell-Banki* micro-turbine:** discharge measurements, pressure measurements, calculation of the generator group efficiency and loading control.
- **hydraulic *ram* demonstration bench:** to demonstrate appropriate technology for small quantities of water pumping, to demonstrate principles of hydraulic transients and efficiency test of the hydraulic *ram*



The CERPCH - Hydro-mechanical Laboratory of Small Hydroelectric Power Plants (LHPCH)



- The **pump running as turbine bench demonstration** (BFTE, in Portuguese): to demonstrate the feasibility of hydraulic pumps using, by working in reverse, a turbine for small power generation
- In addition to the aforementioned benches, the LHPCH also allows the following tests:
 - commissioning of generators; test of basic field of operation; measurements of discharge in pipelines by *Venturi* using; measurements of discharge in free flowing (by *reel* and spillway); Hydraulic heatspot, discharge in *Greageer* threshold; generators groups test with variable speed and parallelism and loads rejection operation in hydroelectric power plants



The Laboratory of Pump Labelling

- The **Laboratory of Pumps Labelling**: enables testing of grid interest for energy efficiency in Sanitation Companies, such as tests of cavitation up to 50kW and efficiency in the field up to 5000kW, among others
 - Centrifugal pump efficiency tests up 50kW
 - Flow Meter calibration up to 12 “
 - Pressure transducers and calibration gauges up to 200mca (meters of water column)
 - cavitation tests up to 50kW
 - field efficiency tests to 5000kw
 - valves testing up to 12



Selo Procel

Bombas e Motobombas

The Laboratory of Hydraulic Structures

- The **Laboratory of Hydraulic Structures** allows for calibration of sensors Hydrometrical data testing; calibration of sensors for discharge and pressure sensors; in addition to the testing of installation and operation of ultrasonic sensors for discharge, pressure, level and flow with electronic sensors; data acquisition by electronic means, *software* configuration for data acquisition, and a platform for data collection
- **Laboratory of Computational Fluid**



The Solid Waste, Hydrogeology and Water Quality Laboratory (Labres)

- Total, sedimentary, and soluble Solids
- Temperature, color and turbidity - Preparation of solutions and standardization
- Potentiometric titration
- Acidity
- Alkalinity
- Hardness
- Chemical Oxygen Demand (COD)
- Dissolved Oxygen; and Biological Oxygen Demand (BOD)
- Spectroscopy UV/vis; The *Beer* Law
- Oils and greases
- Organic Nitrogen
- Gas Chromatography (GC)
- This lab conducts researches on chromium chemicals of scholarship students.



The EXCEN - Center of Excellence in Energy Efficiency (www.excen.com.br)

- Laboratory of the final usage
 - It allows for performing tests and studies related to energy conversion engines, light bulbs, pumps and compressors, among others systems
 - Through the lab is possible to see the potential of new technologies and the most appropriate operational procedures for reducing energy losses



The EXCEN - Center of Excellence in Energy Efficiency (www.excen.com.br)

- Laboratory of cogeneration
 - It has a micro-turbine and an alternative gas engine an absorption chiller, boiler and heat exchangers associated with a control loop and monitoring
 - All these devices make it possible to demonstrate the actual operation of cogeneration systems, which work aiming to reduce to a minimum the losses in the fuel usage



The Brazilian Society of Energy Planning

- Events and publications (The Brazilian Journal of Energy) ISSN: 0104-303X



- Publications (The Brazilian Journal of Energy) ISSN: 0104-303X



The NEST - Nucleus of Excellence in Thermal Electrical and Distributed Generation (www.nest.unifei.edu.br)



- LABORATORY GAS TURBINES AND BIOMASS GASIFICATION

- There is a didactic turbine of 0.5 kW, T200D model of Italian manufacturing.
 - T200D unit allows to perform thermal tests such as: calculation of cycle and unity efficiency; compression and combustion efficiencies; monitoring its behavior during operation (it is provided by a digital system for measuring process parameters)
- Three Capstone gas microturbines are installed in this laboratory, with a maximum capacity of 30 kW and 26% of efficiency



Figure 1 – Capstone microturbine

The NEST - Nucleus of Excellence in Thermal Electrical and Distributed Generation

(www.nest.unifei.edu.br)

- This laboratory also includes a fluidized-bed gasifier for biomass coupled to a 30 kW gas microturbine through a gas cleaning system
- This laboratory has been implemented in order to assess the quality of the gas quality
- absorption chiller in the output of 30 kW gas capstone turbine, forming a cogeneration system that produces electricity and cold
- This system allows to evaluate the performance of the thermal cycle cogeneration for different thermal and electrical charges



Figure 2– View of gasifier biomass feeder silo and the gasifier bed section.



Figure 3 –Gas quality evaluating equipment (produced by the gasifier)

The NEST - Nucleus of Excellence in Thermal Electrical and Distributed Generation

(www.nest.unifei.edu.br)



- TRAINING LABORATORY FOR THERMOELECTRIC PLANTS OPERATORS
- PROCESS SIMULATION LABORATORY AND THERMAL SYSTEMS
 - Laboratory for 20 students relies on the GateCycle[®], Thermoflex[®], CFX-5[®] (versions 5.5 and 5.6), turbogrid[®], BladeGen[®], STAR-CD[®], Proam[®], PROSA[®], ESS[®], CHEMKIN[®], VISUAL FORTRAN and Office XP programs.
 - Training and research on design and evaluation of thermal power plants thermal schemes and cogeneration systems, thermal power plants operation, pollutant formation into combustion chambers and combustion chamber design, compressors and gas turbines have been carried out



The NEST - Nucleus of Excellence in Thermal Electrical and Distributed Generation (www.nest.unifei.edu.br)

- LABORATORY OF THERMAL SYSTEMS BY DIESEL STEAM

- It consists on a aquotubular boiler with automatic burner (capacity of 1,500 kg/h of steam at 15 atm pressure), a steam turbine with *Curtis* wheel, nominal power of 85 kW, an alternator phase, a velocity reducer, and a condenser with external water cooling tower
- It is also reductive station pressure of 12 kgf/cm² at 1.5-4 kgf/cm² in order to simulate a consumer.
- It also has a diesel generator set of 65 kVA with parallel frame to the network
- All measuring instruments are connected to a computer with data acquisition board and graphical interface



Figure 4 – 85 kw steam turbine with electric generator and aquotubular boiler by steam cycle

The NEST - Nucleus of Excellence in Thermal Electrical and Distributed Generation (www.nest.unifei.edu.br)

- GENERATION OF ADVANCED SYSTEMS
LABORATORY DISTRIBUTED



Figure 5 - SOLO Stirling engine



Figure 6 - Viebach Stirling engine by biomass

- This laboratory has two *Solo 161* stirling engines by German manufacture
 - Figure 5: it can operate with natural gas and LPG and can be used to conduct performance testing, to calculate the principal operating parameters such as electrical and cogeneration efficiency, fuel consumption, water consumption for cooling, operation at variable loads etc.
 - Figure 6: it is adapted to operate coupled to a biomass gasifier and operates from the combustion gases obtained from the gasification (this installation is pioneer in Brazil and one of the first in the world)

The NEST - Nucleus of Excellence in Thermal Electrical and Distributed Generation (www.nest.unifei.edu.br)

- Figure 7: there is a cell solid oxide fuel cell which operates with natural gas and can be adapted to operate with other fuels (this installation is the first one of its kind in Latin America)
- REFRIGERATION AND AIR CONDITIONING LABORATORY



Figure 7 - 5 kWe SOFC fuel cell



- Figure 8 - Refrigeration and air conditioning laboratory



The NEST - Nucleus of Excellence in Thermal Electrical and Distributed Generation

(www.nest.unifei.edu.br)



- The solar thermal energy laboratory

NEST
Núcleo de Excelência em Geração Termelétrica e Distribuída
16 ANOS construindo inovação e excelência



The Excellence Center in Smart Grids – CERIN (<http://cerin.unifei.edu.br/>)

- Laboratory of Compatibility and Power Quality (PQ)
 - Monitoring and analysis of power quality phenomena
 - PQ indicators study
 - Performance front processes the PQ disturbances
 - Performance and equipment immunity
 - Impact on power quality by adding renewable sources
 - Electrical Network Protection Laboratory



The Excellence Center in Smart Grids – CERIN (<http://cerin.unifei.edu.br/>)



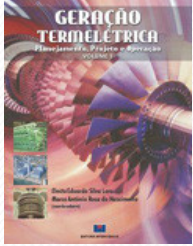






- Test dynamic performance of protective relays
 - Automation using protection relays and IEC61850
 - Protection for smart grids
 - Power Conditioning Laboratory
- Performance of different types of energy storers
 - Study and analysis of new conditioners

Some published books on the energy field by professors from UNIFEI

| | | | |
|--|---|---|---|
|  | <p><i>"Biofuels". 2. Vol.</i></p> <p>"Biocombustíveis". 2 Vol.</p> <p>Electo Eduardo Silva Lora and Osvaldo José Venturini</p> <p>ISBN: 9788571932289</p> |  | <p><i>"Instrumentation for Energy and Industrial Systems"</i></p> <p>"Instrumentação para Sistemas Energéticos e Industriais"</p> <p>Zulcy de Souza, Edson da Costa Bortoni</p> <p>ISBN: 9788599917022</p> |
|  | <p><i>"Treaty on Solid Waste - Management, use and sustainability"</i></p> <p>"Tratado sobre Resíduos Sólidos - Gestão, Uso e Sustentabilidade"</p> <p>Regina Mambeli Barros</p> <p>ISBN: 9788571932951</p> |  | <p><i>"Collection - Flowing Machines Designs"</i></p> <p>"Coleção – Projetos de Máquinas de Fluxo"</p> <p>Zulcy de Souza</p> <p>1 - Theoretical and Experimental Basis 2 - Hydraulic Pumps with Radial and Axial Rotors 3 - Hydraulic turbines with Francis rotors 4 - Hydraulic turbines with Axial rotors 5 - Fans with Radial and Axial rotors</p> |
|  | <p><i>"Hydro Power - Implementation and Commissioning"</i></p> <p>"Centrais Hidrelétricas - Implantação e Comissionamento"</p> <p>Zulcy de Souza, Afonso Henriques Moreira Santos, Edson da Costa Bortoni</p> | <div>  <p>FAPEMIG</p> </div> <div>  <p>Universidade Federal de Itajubá-MG</p> </div> | |

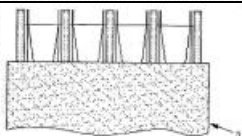
Some published books on the energy field by professors from UNIFEI

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|--|---|---|--|
|  <p>Máquinas Térmicas de Fluxo Cálculos Termodinâmicos e Estruturais</p> <p>Anton Stanislavovich Mazurenko Zulcy de Souza Electo Eduardo Silva Lora</p> | <p><i>"Flowing Thermal Machines - Thermodynamic and Structural Calculations"</i></p> <p>"Máquinas térmicas de fluxo – cálculos termodinâmicos e estruturais"</p> <p>Anton Stanislavovich Mazurenko, Zulcy de Souza, Electo Eduardo Silva Lora</p> |  <p>Geração Distribuída</p> | <p><i>"Distributed Generation"</i></p> <p>"Geração Distribuída"</p> <p>Electo Eduardo Silva Lora, Jamil Haddad</p> |
|  <p>GERAÇÃO TERMELÉTRICA Planejamento, Projeto e Operação</p> | <p><i>"Thermal Generation - Planning, Design and Operation"</i></p> <p>"Geração Termelétrica – Planejamento, Projeto E Operação"</p> <p>Electo Eduardo Silva Lora, Marco Antônio Silva Rosa</p> |  <p>Dendroenergia Fundamentos e Aplicações</p> | <p><i>"Dendro Energy - Fundamentals and Applications"</i></p> <p>"Dendro Energia – Fundamentos e Aplicações"</p> <p>Luiz Augusto Horta Nogueira, Electo Eduardo Silva Lora</p> |
|  <p>Geração Distribuída</p> | <p><i>"Distributed Generation"</i></p> <p>"Geração Distribuída"</p> <p>Electo Eduardo Silva Lora, Jamil Haddad</p> | <div>   </div> <p>FAPEMIG Universidade Federal de Itajubá-MG</p> | |

Some published books on the energy field by professors from UNIFEI

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|--|--|
|  | <p><i>"Pumps Working As Turbines"</i></p> <p>"Bombas Funcionando Como Turbinas"</p> <p>Augusto Nelson Carvalho Viana</p> <p>ISBN: 9788561325756</p> |
|  | <p><i>"Basic Fundamentals Of Electrical Machines"</i></p> <p>"Fundamentos Básicos de Máquinas Elétricas"</p> <p>Ângelo José Junqueira Rezek</p> <p>ISBN: 9788561325695</p> |

Some registered Patents (Brazil) by professors from UNIFEI

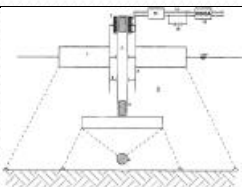


MU8601858-2 - Classification: E02B 7/40

"Mobile and self-operated comport for relief and protection against major floods"

"Comporta móvel e auto-operada para alívio e de proteção às grandes cheias"

Geraldo Lúcio Tiago Filho

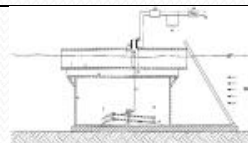


MU8603062-0U2 - Classifications: F03G 7/00 F03G 7/08

"Artifact for electricity generation through the waves of the sea -geo waves- "oceanic"

Artefato para geração de eletricidade através das ondas do mar -geoondas- "oceânico"

Geraldo Lúcio Tiago Filho



MU8603061-2U2 - Classification: F03B 13/12

"Hydrokinetic Artifact for electricity generation through a hydrofoil - "hidropólio"

"Artefato hidrocínético para geração de eletricidade através de um hidrofólio - "hidropólio"

Geraldo Lúcio Tiago Filho

Thank you for your attention!!!

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