

National academy of arts and trades
Pole sciences and industrial technology (STi pole)
Energy
Pulpit of turboshaft engines and engines

Academic year 2006-2007

ENERGY and ENVIRONMENT **MACHINES and THERMAL ENGINES**

Energetics and more particularly the production and the rational use of energy are in the middle of the current world concerns (exhaustion of the resources, pollution and climatic upheaval). For the professionals of the sector, that must result in the search for alternative solutions. *Energy optimization, cogeneration of energies mechanical and thermal, combined cycles of gas turbines and steam turbines, development of wind and hydraulics, fuels alternative, optimized management of transitory operations in partial load in the heat engines, "hardware down-sizing" and turbosuralimentation of the engines, new fashions of combustion in the engines, reduction of the emissions to the source and postprocessing, depollution* are as many problems of current events than you will study at the time of your studies to the national Academy of arts and trades (CNAM).

The CNAM proposes to you vocational trainings, modular and individualized to help you to carry out your personal and professional project in the exercise of your current trade or to come from specialist energetician in strong interaction with industry and the professional organizations.

Build the course of your choice

The various courses **entitled to European format LMD** (License, Master and Doctorat) are proposed in the form of **units of teaching (EU)** to which are allotted **European appropriations (ECTS)**. You can build the course of your choice and train you at your rate/rhythm by capitalizing your results gradually. You are registered with one or more units to acquire a modular base of knowledge and competences in présentiel or remote formation (FOD). The professional experience takes part in the construction of the diplomas and a validation of the assets of experiment (VAE) and studies higher (VES) is also possible.

Your correspondents with the team of turboshaft engines and engines

Francis Miller, professor responsible for the team,
Ghalia Al, 01 40 27 21 60 (after midday), secretariat,
George Descombes, georges.descombes@cnam.fr, lecturer, person in charge for the lesson of engines,
Christelle Périllon, perillon@cnam.fr, lecturer, person in charge for the lesson of machines,
Pierre Podevin, engineer of research out of engines,
Michel All Saints' day, engineer of research out of machines.

Site of the pulpit of turboshaft engines (in construction): HTTP: www.cnam.fr/turbomachines-moteurs
Cnam - pulpit of turboshaft engines, 292 street Saint Martin's day 75141 Paris cedex 02

To know some more about the studies with the CNAM, **you to inform, you to direct**

www.cnam.fr

- Cnam Information-formation: 01 40 27 23 30,
- For the trainings of engineer: <http://www.cnam.fr/ecole-ingenieurs>
- for the formations at distances: <http://www.cnam.fr/fodparis> and <http://fod.cnam.fr/SiteFod/>

Inscriptions from the 7 to September 23, 2006

To inform you on the spot in Paris from the 7 to September 23, 2006:

Tuesday, Wednesday and Friday of 12h30 with 18h00, Thursday of 12h30 with 19h00 and Saturday of 10h with 16h30, closed Sunday and Monday.

1, street Montgolfier- Paris 3rd – subway Arts and Trades.

An appointment with the teachers of the pulpit can also be obtained on request preliminary.

Run proposed out of machines and engines

(places suitable for modifications to be controlled on <http://emploi-du-temps.cnam.fr/emploidutemps>)

Machines with fluids - TBM103 - 6 appropriations

General relations in the machines with fluids

Volumetric machines

Principle of a volumetric machine (analyzes functional, fluid conveyed, curved characteristics, outputs, fields of application). Volumetric machines with incompressible fluid: - Pumps: with pallets, oscillating pistons, multipalettes, with liquid rings, roots, with gears. - Mechanical Pumps dry. Hydraulic engines. Volumetric machines with compressible fluid: piston compressors alternate, membranes, pallets, lobes, single-screw, double screw.

Turboshaft engines

Principles of a turboshaft engine (operation, conveyed fluid, curve characteristic, outputs, similarity, fields of application). Turboshaft engines with incompressible fluid: pumps and fans centrifugal and axial. Water turbines. Turboshaft engines with compressible fluid: blowers and compressors centrifugal and axial. Axial flow and centripetal turbines.

Special devices of energy conversion

Ejectors, converters and hydraulic clutches

Selection criteria of a machine with fluid

Bibliography

Michel Pluviose - Machines with fluids - principles and operation (Ellipses 2002)

Schedules and places

1st six-month period: **Run** Wednesday 18h15 - 21h30 **Site:** Pinel lecture theater then L4 room, ENSAM (155 boulevard of the Hospital - 75013 Paris) - Opened in **fod**

Design of the machines – TBM106 - 6 appropriations

Introduction

Standardization - Elements of mechanics of the solid and the fluids for the applications to the machines. Concepts on the theory of elasticity.

Aerodynamic and energy aspects of the design of the machines and their receiving circuits

Design of the circuit of the machines - Design of the bladings of the turboshaft engines - Methods of calculation numerical applied to the flows in the machines and the circuits associated - Noise of the machines - Design with the stages, thrusts, trimmings - Transmission of the power - Valves and fittings.

Aspects structures of the design and construction of the machines and their receiving circuits

Mechanical and thermal problems of their construction - Technology and construction of the bodies, rotors and bladings - Characteristics of materials for turboshaft engines - Limitation in fatigue - mechanical and thermal Constraints as of the bodies - Constraints in the blades - Constraints in the discs - Vibrations of the bladings - Critical engine failure speeds trees - dynamic Balancing of the revolving parts - Methods of calculation numerical applied to the structures in the machines and their circuits.

Maintenance applied to the machines

Diseases, accidents and the ageing of the machines.

Interactions fluid structure in the receiving machines and their circuits

Bibliography

Michel Pluviose - Engineering of the turboshaft engines (Ellipses 2003)

Schedules and places

Closed this year

Use of the turboshaft engines - TBM107 - 6 appropriations

General sight on energy

Multicellular machines

Multicellular pumps - multicellular Turbines and compressors - Calculation of a multicellular machine - Operation with the partial loads.

Turboshaft engines with gases industrial and aeronautical

Turboshaft engines with vapor

Cycle steam turbines - Power stations with fossile fuel - Nuclear thermal power stations - Evolution of the unit power of the groups -

Turbine with condensation and racking - Bodies of adjustment - Condensation of the vapor.

Turbines of recuperation of energy

Hydro-electric power stations - Energy of the seas - Solar energy - Wind power - Geothermal energy.

Combined cycles, cogeneration

Regulation of the machines

General diagram of a system of regulation. Regulation of the steam turbines and application to the regulation of the steam turbines and the gas turbines.

Bibliography

Michel PLUVIOSE - Energy transformation by turboshaft engines (Ellipses 2004)

Schedules and places

2nd six-month period: **Run** Wednesday 18h15 - 21h30 **Site:** Father Lachaise (50 bld of Ménéilmontant - 75020 Paris) - Open in **fod**

Development of the machines in conversion of energy - TBM210 - 6 appropriations

Introduction to the use of professional software - compressible Examples of flows

Turboshaft engines in the aircraft industry

Thermodynamics: total sizes, centrifugal field, output, cycle of the gas turbine. Particular studies of the turbojets.

Aerodynamics: axial compressors, centrifugal compressors, axial flow turbines, conduits.

Cogénération, mixed cycles using of the machines.

Exploitation and maintenance

Speakers - Control of an installation - Maintenance - Role and organization - technical Aspects. Steam turbines: thermodynamic cycles - technology - exploitation - maintenance.

Demonstrations in laboratory, conferences

Bibliography

Diffused by the various speakers.

Schedules and places

1st six-month period: **Run** Saturdays 09h00 - 13h00 **Site:** 31.2.09 (Cnam 2 street Told - 75.003 Paris)

Combustion and impact on environment

TBM104 - 6 appropriations

Introduction

Bases of combustion - Structure of the matter, concepts of organic chemistry, fuels. Chemical reaction of combustion.

Thermodynamics of combustion

: first principle of thermodynamics, internal energy and enthalpy of combustion, temperature of adiabatic end of combustion, calorific values, second principle of thermodynamics, balances chemical, composition with balance.

Kinetics of combustion

: law of action of mass, reactional mechanism, thermal explosions, spontaneous combustion of hydrocarbons, field and time of spontaneous combustion.

Flames

laminar, turbulent and of diffusion. Stability of the flames. Waves of deflagration and detonation.

Industrial applications of combustion, emissions of pollutants and treatment the source.

Combustion in the engines with continuous flow - terrestrial Gas turbines.

Combustion in the engines with discontinuous flow - Engine with preliminary, diesel engine carburation.

Combustion in the industrial and domestic boilers - Control of a combustion.

Combustion and jet propulsion - Turbojets monoflux and with dilution, post-combustion, rockets, ramjets.

Harmful effects of combustion

Fight against fire.

Bibliography

Michel PLUVIOSE - Combustion and environmental impact (duplicated lecture note of course)

Schedules and places

1st six-month period: **Run** Tuesday 18h15 – 21h30 **Site:** room 416 Cnam Saint-Denis (61 street of Landy - 93210 the Plain-Saint-Denis, the RER B the plain-stage of France) – open in fod.

Construction of alternate engines

TBM108 - 6 appropriations

Mechanics of the alternate engine

Kinematics of the alternate engine: rod crank; distribution.

Dynamics of the alternate engine: balancing; vibrations of torsion; vibrations of structure.

Technology of the engine

Cylinder head - Piston - Shirt. Crankshaft - Bearing - Rod.

Thermal transfers and cooling

Heat exchange - thermal Loads Assessments thermics-Cogénération of the engines

Maintenance of the engines

Lubrication

Cooling

Adaptation of the engine to the actuated machine

Regulation of the engines

Bibliography

J. - L. MAGNET and G. DESCOMBES - - Duplicated CNAM.

Schedules and places

2nd six-month period: **Run** Monday 18h15 – 21h30 **Site:** L4 room, ENSAM (155 boulevard of the Hospital – 75013 Paris) - Opened in fod

Operation of the alternate engines

TBM109 - 6 appropriations

Definitions

Internal combustion engine. Effective Average pressure and power of a thermal engine. Output. Mechanical loads and thermal loads.

Principles of operation

Food into combustive. Food while carburizing. Course of combustion. Evacuation of the products of combustion. Continuous combustion. Discontinuous combustion.

Cycle driving

Theoretical cycles and real cycles.

Air supply and expulsion of gases

Characteristics engine attached to the food, the expulsion of gases. Chocks of cam. Load factor. Air flow. Dynamics of the fluids and acoustics of the engines - Overfeeding: the compressor. Drive of the compressor. Refrigeration of the air. Gas supply of the turbine, the

exhaust manifold. The various modes of driving coupling, harnesses, compressing. Compounding.

Introduction of fuel and formation of the mixture

Solid, liquid and gas fuels. Heterogeneous mixture and homogeneous mixture

Emissions of pollutants and treatment

Monitoring of the engines

Bibliography

Technique of the Engineer: Treaty of mechanics and heat B3 Thermal engines.

J. - L. MAGNET and G. DESCOMBES - Duplicated CNAM.

Schedules and places

Closed this year

Development of engines and

cogeneration in energy transformation - TBM211 - 6 appropriations

Panorama of the applicatif market of the engines. Concepts exergetic and anergetic of the energy production. Similarity of the thermal engines. Engines with recuperation of energy and environment. Suralimentaion, cogeneration and trigeneration. Dynamics of the pulsated fluids and filling in air of a piston engine.

Digital techniques, case studies and work practice on console. Application of the method of the characteristics to the calculation of the flows in the engines. Training with the use of the industrial codes of thermomechanical calculation of 4th generation.

Formation of the air-fuel mixture, thermocinetic reactions of combustion and treatment of the emissions to the source.

Thermodynamic modeling of the cycles, laws of release of heat and controlled production of energy.

Postprocessing of the emissions, fuels of substitution and gas engines. Vibroacoustic phenomena and vibratory dynamics. Characteristics of the engines of agricultural mechanization and advanced techniques of refrigeration.

Adaptation of the thermal engine to the machine actuated and application to an engine of propulsion, work practical on test bench in transient state.

Nonconventional engines, driving thermics-electric hybrids, fuel cells and environment.

Bibliography

J. - L. MAGNET and G. DESCOMBES - Duplicated CNAM.

Schedules and places

1st six-month period: **Run** Saturdays 09h00 – 13h00 **Site:** Open **DENIS saint in fod.**

Certificate of specialization out of thermal engines

Energy transformation and reduction of the CO₂ emissions in the thermal engines (TBM218)

Short formation (2 EU of 6 appropriations each one) over one academic year, specialized in energy and reduction transformation of the CO₂ emissions which addresses to a graduate public of minimum level vat + 5 (engineers general practitioners) and eager to obtain a professionnalisant complement recognized by industry and validated by a certification of establishment of the CNAM. Contact: georges.descombes@cnam.fr

The recent creation of this certificate of specialization (THESE) entitled answers at the request of the profession in direction of the young professionals who wish to acquire a short specialization in their sphere of activity, like the existing specialities in medicine, accountancy, management and many other fields.

Public concerned, conditions of access and competences concerned

- Young engineers graduate general practitioners in initial formation or professionals attesting of an experiment commonly entrusted to engineers.
- To justify at least recognized diploma of level vat + 5 or an attested professional experiment of level engineer. The EU current (of 6 appropriations) combustion and environmental impact and of machines with fluids of the cycle of license and master in energetics of the CNAM option machines and engines are recommended.
- To certify knowledge and competences out of internal combustion engines to answer a request clearly identified in the professional environment.
- The inscription with this certificate is subjected to the approval of the professor.

Training scheme

- Coupling of the transfers of mass and energy.
- Exergetic and systemic optimization.
- Energetic valorization and polygeneration.
- Acyclism and engine control
- Project tutoré with dominant industrial research equivalent to 1UE of 6 appropriations with development of a written report.

First half of the year: Saturday 9h00-13h00 in Saint DENIS (with TBM211 and MASTER of the university Paris 6, the CNAM and the School of the mines of Paris). Second six-month period Monday 18h15-21h30 in room L4 ENSAM (with TBM108).

Conferences in free access on preliminary inscription

Conferences on the topic of the rational use of energy in the heat engines and the environment are organized each year. To approach the teachers.

Memory of engineer CNAM

The diploma for the occupation of engineer CNAM is concretized after the success of a probatory general examination by the realization of a research project or one academic year a professional mission full-time. It is held in the company of the listener on a subject which answers a request of its framing or in the research laboratories of the CNAM.

It dissociates projects of end of studies of schools of engineers or academics in initial formation. Listener CNAM has the academic assets required and recognized by the commission of the titles, but it justifies also professional experiment validated and recognized in its training area in direct catch with realities of the trade.

Report CNAM is neither three years a university thesis, nor a project of end of studies of initial formation of a few months. It is a scientific project led by a listener immersed in the professional world and having vocation to evolve to functions of engineer.

Doctorate in energetics

The Academy is entitled to deliver the title of doctor of the CNAM in the energy speciality. To approach the enquiring teachers of the option. The technological activity of research and innovation led by the researchers of the CNAM is centered on the **reduction of the gas emissions for purpose of greenhouse in the heat engines** (clean combustion, diphasic mixture and engine control, recuperation of energy, transfers thermal, overfeeding, cogeneration, hybrid

motorizations, containing hydrocarbon of substitution. The analysis of cycle of life supplements from now on in a transverse way the activity of research.

Formation opened remotely (FOD) 2006-2007

The remote lesson of the courses of machines and engines leaves freedom to the listeners in France and to organize abroad their studies compared to their professional obligations and personal. The autonomy of which they lay out supposes on the other hand a great discipline in the management of their time.

List lesson of machines and engines proposed in fod:

- TBM103 machines with fluids (ex machines B0 04427): opened
- *TBM106 design of the machines (ex machines B1 04454): 1 year out of 2, closed this year.*
- TBM107 use of the turboshaft engines (ex machines B2 14905): 1 year out of 2, open this year.

- TBM104 combustion and impact known the environment (ex driving B0 04436): opened
- TBM108 construction of the alternate engines (ex driving B1 14923): 1 year out of 2, open this year,
- *TBM109 operation of the alternate engines (ex driving B2 14932): 1 year out of 2, closed this year,*
- TBM211 development of the engines and cogeneration in energy transformation (ex driving C0 14941): opened.

This lesson (course, TD and test of car-evaluation) is accessible on platform Internet pleiad or by postal way. The duplicated lectures note or books of course are available in complement to the bookstore of arts and trades, 33 street of Réaumur, 75003 Paris. Tel.: 01 42 72 12 43 – arts@privat.fr

Conditions of professional experience for the diplomas

For the diploma for the occupation of high-level technicien or the DPCT: 2 years of experiment in the speciality (or 2 years except speciality and training course of at least three months in the speciality or effective entry in an occupation of the speciality).

For the license: 3 years in the speciality (or 3 years except speciality and 6 months of training course in the speciality) for the listeners admitted on the level vat. For the admitted listeners with bac+2 (entered in L3): 1 year in the speciality (or 1 year except speciality and training course a 6 months).

For the diploma of person in charge in industrial production or the DEST: 2 years in the speciality (or 3 years except speciality and a training course of at least 3 months in the speciality)

For the diploma for the occupation of engineer: 3 years of professional experience including at least 2 in the speciality (or a close speciality) in an employment at least equivalent to that of high-level technicien.

Diploma for the occupation of high-level technician and license sciences and industrial technology energy course machine-engines

Admission with bac+0

Scientific bases (mathematics) MVA013	Scientific bases (méca/electricity) PHR 020	Technology of materials MTX001	Data-processing tools
Reliability of the mechanical systems MEC 004	General thermodynamics 1 TBM001	<u>Choice selected:</u> Technology of the machines and engines TBM013	Occupation 18 ects

Approach physical (thermo/thermal) PHR021	Measure in laboratory and industry MTR 001	Thermal bases THD006	Electric energy transformation ELT002
Data-processing tools	General thermodynamic TP 2 TBM002	<u>Choice selected:</u> Mechanics of the fluids AER003	Occupation 18ects

Obtaining the diploma for the occupation of high-level technician
(Vat + 2)

Thermodynamics applied with energetics PHF101	Machines with fluids TBM103	Transfers of heat THD101	<u>Choice selected:</u> Combustion and environmental impact TBM104
<u>Choice selected:</u> Energy TP TBM105 or Modeling CSC111	<u>Choice selected:</u> (See teacher) Machines TBM106 or driving TBM109	Scientific paper ETR101 + English (Bulat level 1)	Occupation 18ects

Obtaining the license (Vat + 3)

Diplomas of person in charge in industrial production and engineer in energetics machine-engines

Admission with bac+2

Thermodynamics applied with energetics PHF101	Machines with fluids TBM103	Transfers of heat THD101	Combustion and environmental impact TBM104
Energy TP TBM105 or Modeling CSC111 (see remark 1)	Choice See the teacher	Choice See the teacher	Professional experience

(1 notices): TBM105 is obligatory for obtaining the diploma of person in charge while CSC111 is obligatory for that of engineer

Vat + 3

Admission of the graduates of the energy license Cnam under conditions to see with the teacher.

Design of machines TBM 106 Or: construction of engines TBM 108	Use of turboshaft engines TBM 107 Or: operation of engines TBM109	Choice See the teacher	Management EME 102
Social management and communication TET102	Professional experience		

Obtaining the diploma of person in charge in industrial production (vat +4)

Development of machines TBM210 Or: development of engines TBM211	Energy and durable development PHF208	Communication for the engineer in energetics TBM112	Management of project for engineer ENG110
The engineer in XXIe century ENG200	English test (BULAT level 2)	Preparation with the report	Memory

Obtaining the diploma for the occupation of engineer (vat +5 and equivalence mastère)

FORUM OF INFORMATION OF ORIENTATION AND INSCRIPTION

Level 2 – room 33.2.11

**THURSDAY SEPTEMBER 07 AT SATURDAY SEPTEMBER 23,
2006**

FIRM MONDAYS SEPTEMBER 11 & 18

<u>DAY</u>	<u>SCHEDULE</u>	<u>TEACHER</u>	pulpit
Thursday September 07	12h 30 - 19h00	J.P. DOMBLIDES B. TREMEAC	cold cold
Friday September 08	12h30 - 18h00	Mr. GODIN G. DESCOMBES	thermics engines
Saturday September 09	10H00 – 12h30 12h30 – 16h30	G. DESCOMBES	engines
Tuesday September 12	12h30 - 18h00	Mr. GODIN	thermics
Wednesday September 13	12h 30 - 18h00	Mr. ALL SAINTS' DAY	machines
Thursday September 14	12h30 - 19h00	C.PERILHON	machines
Friday September 15	12h30 - 18h00	Mr. DUMEZ G.DESCOMBES	thermics engines
Saturday September 16	10h00 - 12h30 12h30 – 16h30	Mr. CLAUSE C.PERILHON	cold machines
Tuesday September 19	12h30 - 18h00	J.P. DOMBLIDES B. TREMEAC	cold cold
Wednesday September 20	12h30 - 18h00	Mr. ALL SAINTS' DAY	machines
Thursday September 21	12h30-19h00	Mr. DUMEZ	thermics
Friday September 22	12h30-18h00	Mr. GODIN	thermics
Saturday September 23	10H00 – 12h30 12h30 – 16h30	Mr. DUMEZ C. PERILHON	thermics machines

Diagram of the course engineer

