NATIONAL UNIVERSITY OF ENGINEERING

COLLEGE OF PETROLEUM AND PETROCHEMICAL ENGINEERING

PETROCHEMICAL ENGINEERING PROGRAM

PQ321 – THERMODYNAMICS FOR CHEMICAL ENGINEERING I

I. GENERAL INFORMATION

CODE	:	PQ321 Thermodynamics for Chemical Engineering I
SEMESTER	:	6
CREDITS	:	4
HOURS PER WEEK	:	5 (Theory – Practice)
PREREQUISITES	:	PQ312 Physical Chemistry II, PQ313 Mass and Energy Balance
CONDITION	:	Compulsory

II. COURSE DESCRIPTION

This theoretical-practical course trains students in the application of thermodynamics dealing with the following context: fundamental concepts, first law of thermodynamics, energy balance, second law of thermodynamics, third law of thermodynamics, combination of the first, second and third laws of thermodynamics, cycle of stem and gases power, refrigeration cycle.

III. COURSE OUTCOMES

1. Identify, understand and assess the laws of thermodynamics and their application in different industrial activities within the country.
2. Learn concepts of engine, pump, fan, compressor, boiler, turbines, heat exchanger, as well as their different applications in industrial processes.
3. Learn concepts of power, steam and gas cycles, and recommend variable solutions to solve problem in the industry.
4. Learn principles of thermal machines: refrigerator, heat pump, and their different application in the food conservation, heat and cold transfer, air conditioning, and others.

IV. LEARNING UNITS

1. ENERGY AND PROPERTIES OF PURE SUBSTANCES / 20 HOURS

Matter, mole. Thermodynamic systems and states of equilibrium / Concepts of pressure, temperature, specific volume and density / Methodology for solving thermodynamic problems / Use of pipe tables / First law of thermodynamics / Concept of energy transfer / Energy of a closed system. Internal energy. Heat and work. Efficiency / Properties of pure substances / Ideal and real gases/ Equations of state / PVT relationship. Ideal gas model. Reduced state of compressibility factor / Specific heats / Compressed air in the industry / Manometers / use of thermodynamic tables for pure substances, enthalpies, specific volume, entropy. Energy analysis. Latent vapor of vaporization. Boilers / Problems applied to the industry.

2. ANALYSIS OF CLOSED SYSTEMS / 8 HOURS

Energy balance of closed systems / Energy analysis of cycles / Energy transfer / Energy is like a property / Isometric, isobaric, isothermal, adiabatic and polytrophic processes. Graphic application to different processes / Problems applied to the industry.

3. ANALYSIS OF OPEN SYSTEMS / 16 HOURS
Open systems. Steady-flow processes. Energy analysis of open system. Energy equations for open systems / Isometric, isobaric, isothermal, adiabatic and polytrophic processes in open systems / Analysis of industrial processes applying thermodynamic tables and state equations. Steam boilers, turbines, compressors, nozzles, diffusers, fans, pumps, condensers, hear exchangers / Problems applied to industry.

4. THERMAL MACHINES, POWER AND REFRIGERATION CYCLES / 12 HOURS
Thermal machines: refrigerators, heat pumps, thermal engines, coefficient of performance, efficiency / third law of thermodynamics. Power cycles / Refrigeration cycles / problems applied to the industry.

V. LABORATORIES AND PRACTICAL EXPERIENCES
Technical fieldtrips.

VI. METHODOLOGY
This course is carried out in theory and practical sessions. In theory sessions, the instructor introduces concepts and applications of the same. In practical sessions, problems are solved and their solution is analyzed in order to relate the theory with its application. The introduction and development of the course are carried out with the available multimedia resources for the presentation of slides and videos; internet access to use interactive pages (applets), online videos and pages of equipment suppliers.

VII. EVALUATION FORMULA
The average grade PF is calculated as follows:

PF = 0.25 EP + 0.25 EF + 0.40 PP + 0.10 PA

EP: Mid-Term Exam EF: Final Exam
PP: Quizzes average PA: Supports and attendance average

VIII. BIBLIOGRAPHY

1. **CENGEL, YUNUS A. AND BOLES, MICHAEL. A.**
   Thermodynamics (Spanish)
   McGraw-Hill Interamericana Editorial 2nd Edition (2006)

2. **MORAN, J. MICHAEL AND SHAPIRO, HOWARD N.**
   Fundamentals of Industrial Thermodynamics (Spanish)
   Reverte Editorial 2nd Edition, Spain (2005)

3. **PERRY, JOHN**
   Chemical Engineer's Handbook (Spanish)
   UTEHA Editorial, Mexico (2002)