A) COURSE

Course Id:	Course
5619	TRANSPORT PHENOMENA

Class Hours per Week	Lab hours per week	Complementary practices	Credits	Total hour course
5	0	5	10	80

B) GENERAL COURSE INFORMATION:

	EE (IEA)	ME (IM)	MME (IMA)	EME (IME)	MTE (IMT)
Level:		VIII	VI	VI	
Course Type (Required/Elective)		Required	Required	Required	
Prerequisite Course:		Thermal machines	Thermal machines	Thermal machines	
CACEI Classification:		ES	ES	ES	

C) COURSE OBJECTIVE

At the end of the course, the student will be capable of:
To acquire knowledge that will enable student to understand the physical and mathematical foundations of the heat transfer mechanisms for use in practical applications in their professional development. The student knows and can analyze mixtures of reactive systems (combustion) and nonreactive. (Gases and gas-vapor mixture)

D) TOPICS (CONTENTS AND METHODOLOGY)

COURSE INTRODUCTION		**5 hours**
Specific Objective:	To become familiar with the course contents, its objective, methodology, grading politics, textbook, and references.	
1.1 Trabajo. Potencia. 1.2 Potencia calorífica. 1.3 Rendimiento térmico. 1.4 Rendimiento de máquina y motor térmico. 1.5 Rendimiento mecánico.		
Readings and other resources	Read the topics suggested bibliography.	
Teaching Methodologies	Exposition in classroom, students questioning, dialogue, solving typical problems, meet laboratory practices, clarification of doubts.	
Learning Activities	Do exercises of theme, taken from the suggested bibliography, lab practices and classroom discussion of the results obtained in the laboratory.	

1.- IDEAL GAS MIXTURE AND GAS-VAPOR. (NO REACTIVE SYSTEMS)	**12 hrs**

Specific Objective:	The student learns how to get the properties of a gas mixture.
1.1.- Mixture description. 1.2.- Mixture properties. 1.3.- Gas mixtures with phase change sustances. 1.4.- Dew point. 1.5.- Relative humidity. 1.6.- Humidity ratio. 1.7.- Adiabatic saturation. 1.8.- Wet bulb temperature. 1.9.- Psychrometric chart. 1.10.-Elaboration of psychrometric ddiagram. 1.11.- Psychrometic enthalpy, internal energy and1entropy of a gas mixture and vapor. 1.12.- Other gas and vapor mixtures different from air and vapor. 1.13.- Stream mixtures. 1.14.- Cooling towers.	
Readings and other resources	Read the topics suggested bibliography.
Teaching Methodologies	Exposition in classroom, students questioning, dialogue, solving typical problems, meet laboratory practices, clarification of doubts.
Learning Activities	Do exercises of theme, taken from the suggested bibliography, lab practices and classroom discussion of the results obtained in the laboratory. And identifying compression curves.

2.- COMBUSTION (REACTIVE SYSTEMS)	**10 hrs**
Specific Objective:	To understand how heat can be extracted from combustion.
2.1.- Fuels. 2.2.- Combustion. 2.3.- Chemical equation balance 2.4.- Garavimetric analysis. 2.5.- Combustion products. 2.6.- Combustion products analysis. 2.7.- Heat obtained from combustion. 2.8.- Adiabatic combustion temperature.	
Readings and other resources	Read the topics suggested bibliography.
Teaching Methodologies	Exposition in classroom, students questioning, dialogue, solving typical problems, meet laboratory practices, clarification of doubts.
Learning Activities	Do exercises of theme, taken from the suggested bibliography, lab practices and classroom discussion of the results obtained in the laboratory. Analysis of real problems on internal combustion engines.

3 -. BEHAVIOR PRESSURE-VOLUME-TEMPERATURE IN REAL GASES	**14 hrs**
Specific Objective:	Students learn to operate a real gas.
3.1 -. State equation of Van der Walls. 3.2 -. Other equations of state (Berthelot, Dieterici). 3.3 -. Mixture of real gases.	
Readings and other resources	Read the topics suggested bibliography.
Teaching Methodologies	Exposition in classroom, students questioning, dialogue, solving typical problems, meet laboratory practices, clarification of doubts.

Learning Activities	Do exercises of theme, taken from the suggested bibliography, lab practices and classroom discussion of the results obtained in the laboratory. Analysis of problems related to gas turbines.

4.- FUNDAMENTAL CONCEPTS OF HEAT TRANSFER		**11 hrs**
Specific Objective:	Understand the fundamental laws governing heat transfer and identify the situations that occurs each one of them.	
4.1 Fourier law of heat conduction. 4.2 Newton's law of cooling: Heat convection. 4.3 Stefan Boltzmann Law: Heat Radiation. 4.4 Principle of energy conservation. 4.5 Combined mechanisms. 4.6 General equation of heat diffusion in Cartesian coordinate system, cylindrical and spherical. 4.7 Solution of the heat diffusion equation in one-dimensional systems. 4.8 Steady-state analysis in one-dimensional systems for thermal resistances. 4.9 Analysis in extended surfaces.		
Readings and other resources	Read the topics suggested bibliography.	
Teaching Methodologies	Exposition in classroom, students questioning, dialogue, solving typical problems, meet laboratory practices, clarification of doubts.	
Learning Activities	Do exercises of theme, taken from the suggested bibliography, lab practices and classroom discussion of the results obtained in the laboratory. Teamwork for obtaining the characteristics of nozzle design.	

5.- HEAT CONDUCTION IN TWO DIMENSIONS		**5 hrs**
Specific Objective:	That students learn a numerical method for solving partial differential equations.	
5.1 Solution of the heat diffusion equation by the finite difference method.		
Readings and other resources	Read the topics suggested bibliography.	
Teaching Methodologies	Exposition in classroom, students questioning, dialogue, solving typical problems, meet laboratory practices, clarification of doubts.	
Learning Activities	Do exercises of theme, taken from the suggested bibliography, lab practices. Presentation of topics related to the subject.	

6.- TRANSIENT HEAT CONDUCTION		**7 hrs**
Specific Objective:	That the student identifies the mathematical models corresponding to different situations in transient heat conduction processes.	
6.1 Method for thermal conduction resistance negligible (Bi<0.1). 6.2 Spatial effects when (Bi>0.1). 6.3 Solution for a semi-infinite solid (Bi>>0.1).		
Readings and other resources	Read the topics suggested bibliography.	
Teaching Methodologies	Exposition in classroom, students questioning, dialogue, solving typical problems, meet laboratory practices, clarification of doubts.	
Learning Activities	Do exercises of theme, taken from the suggested bibliography, lab practices. Presentation of topics related to the subject.	

7.- CONVECTION.		**5 hrs**
Specific Objective:	That the student understands the basic concepts of heat convection.	

7.1 Hydrodynamic boundary layer. 7.2 Thermal boundary layer. 7.3 Convective coefficient concept. 7.4 Analogy between heat and momentum transfer. 7.5 Heat convection parameters: Nusselt and Prandtl number.	
Readings and other resources	Read the topics suggested bibliography.
Teaching Methodologies	Exposition in classroom, students questioning, dialogue, solving typical problems, meet laboratory practices, clarification of doubts.
Learning Activities	Do exercises of theme, taken from the suggested bibliography, lab practices. Presentation of topics related to the subject.

8.- FORCED CONVECTION CORRELATIONS IN EXTERNAL AND INTERNAL FLOW.		**8 hrs**
Specific Objective:	That the student understand the correlations used in the determination of the convective coefficient in external.	
8.1 Correlations for the flat plate. 8.2 Correlations for a cylinder in cross-flow. 8.3 Correlations for cross flow in a tube bank. 8.4 Correlations for laminar and turbulent flow inside cylindrical tubes.		
Readings and other resources	Read the topics suggested bibliography.	
Teaching Methodologies	Exposition in classroom, students questioning, dialogue, solving typical problems, meet laboratory practices, clarification of doubts.	
Learning Activities	Do exercises of theme, taken from the suggested bibliography, lab practices. Presentation of topics related to the subject.	

9.- HEAT EXCHANGERS.		**8 hrs**
Specific Objective:	That students know the different types of heat exchangers and learn the different calculation methods for the thermal design.	
9.1 Heat exchangers classification. 9.2 Concentric tubes heat exchangers 9.3 Heat exchangers calculation by the logarithmic mean difference method. 9.4 Heat exchangers calculation by the effectiveness and the number of transfer units method.		
Readings and other resources	Read the topics suggested bibliography.	
Teaching Methodologies	Exposition in classroom, students questioning, dialogue, solving typical problems, meet laboratory practices, clarification of doubts.	
Learning Activities	Do exercises of theme, taken from the suggested bibliography, lab practices. Presentation of topics related to the subject.	

E) TEACHING AND LEARNING METHODOLOGIES

a) Conventional exposure of each subject by the teacher.
b) Analysis of theoretical-practical concepts.
c) Solution of problems related with the course contents.

F) EVALUATION CRITERIA:

Evaluation:	Schedule	Suggested Form of Evaluation and weighing	Topics

1st. Partial Evaluation	16 Sessions	Exam 80%, Tasks 20%	1 y 2
2nd Partial Evaluation	16 Sessions	Exam 80%, Tasks 20%	3 y 4
3rd. Partial Evaluation	16 Sessions	Exam 80%, Tasks 20	5
4th. Partial Evaluation	16 Sessions	Exam 80%, Tasks 20	6 y 7
5th. Partial Evaluation	16 Sessions	Exam 80%, Tasks 20	8 y 9
Final Ordinary Evaluation		100% (Average of the Partial Evaluations)	
Other activities:			
Extraordinary Exam	Week 17 of the semester in course	Exam 100%	Topics 100%
Title Exam	According to the program of the School Secretary.	Exam 100%	Topics 100%
Regularization Exam	According to the program of the School Secretary.	Exam 100%	Topics 100%

G) BIBLIOGRAPHY AND ELECTRONIC RESOURCES

Main Books

1. INCROPERA F., Fundamentos de Transferencia de Calor y Masa, Wiley, 2004.
2. MORAN M.J., SHAPIRO H.N., Fundamentos de Termodinámica Técnica, Wiley, 2000.
3. FAIRES V.M., Thermodynamics, 6a. ed.
4. FAIRES V.M., Problems on thermodynamics, Macmillan, 6th. ed.
5. KENNETH WARK, Termodinámica, McGraw-Hill, 4ª ed.
6. UNAM, Tablas de vapor, Servicios y representaciones de ingeniería (UNAM).

Complementary Books

1. CARROLL M. L. & MALEEV V. L., Heat power fundamentals, Pitman
2. JONES, J.B.& HAWKINGS, G.A., Engineering thermodynamics, an introductory text book, John Wiley & sons, Inc, 2nd edition, New York, 1986.
3. JONES J.B. y DUGAN R.E., Ingeniería termodinámica, Prentice Hall, 1997.
4. LEVENSPIEL O. Fundamentos de termodinámica, Prentice Hall, 1997.
5. WOODRUFF E. B. & LAMMERS H.B., Steam plant operation, McGraw-Hill
6. ZEMANSKY & VAN NESS, Basic engineering thermodynamics, Mc Graw-Hill N.Y., 1976.
7. KARASIKE IGOR, Bombas.

Internet Links