COURSE SYLLABUS

1. Program information

1.1. Institution	Petroleum-Gas University of Ploiesti
1.2. Faculty	Petroleum Refining and Petrochemistry
1.3. Department	Petroleum Processing Engineering and Environmental Protection
1.4. Field of study	Chemical engineering
1.5. Study cycle	Master
1.6. Study program	Chemical Engineering for Refineries and Petrochemistry

2. Course information

2.1. Course title	Thermal integration, energy efficiency and utility systems		
2.2. Course coordinator	Negoiţă Loredana Irena		
2.3. Seminar coordinator	Popa Maria		
2.4. Project coordinator			
2.5. Year of study	1		
2.6. Semester *	II		
2.7. Evaluation type	written exam		
2.8. Course type - formative category **	DD	2.8. Type of subject matter ***	C

* the semester number is in accordance with the curriculum;

** fundamental = DF; domain = DD; speciality = DS; complementary = DC; thoroughgoing = DA; synthesis = DSI.

*** compulsory = C; optional = O; elective = E

3. Total estimated time (teaching hours per semester)

3.1. Number of hours per week	6	of which: 3.2. course	3	3.3. Seminars/laboratories	2	3.4 Project	1
3.4. Total hours from curriculum	84	of which: 3.6 course	42	3.7 Seminars/laboratories	28	3.8 Project	14

3.9. Time distribution	hours
Study of textbook, course support, bibliography and notes	10
Further reading in the library, on online platforms and fieldwork	2
Preparing seminars / laboratories, homework, portfolios and essays	8
Tutoring	2
Examinations	2
Other activities	0

3.10.Total hours of individual study	24
3.11. Total hours per semester	108
3.12. Number of credits	6

4. Prerequisites (where applicable)

4.1. of curriculum	Heat transfer processes, Thermo energetics
4.2. of skills	

5. Requirements (where applicable)

5.1. of course	The classroom with blackboard, screen, video projector
5.2. of seminars/project	The room with blackboard, screen, video projector, computers

6. Specific competences

Professional competences	PC1. Description, analysis and advanced utilization of engineering concepts and fundamental theories in petroleum refining. PC2. Equipment, process and plant design. PC3. Real time control of processes and plants in chemical industry.
Cross-curricular competences	TC1. Documentation, information and scientific literature research. TC2. Independent and autonoms achievement of individual professional tasks. TC3. Advanced knowledge of computer, internet and specific chemical engineering software. TC4. Management organization and planning of professional teams and organizations.

7. Course objectives (based on the competence grid)

7.1. General objective	The main objective of the course is to deepen and develop knowledge in the fields of heat transfer and thermoenergetics in order to facilitate the finding of energy efficient solutions in certain technological processes.
7.2. Specific objectives	At the end of the course, students will be able to: - identify the practical situations in which heat transfer mechanisms occur; - illustrate the role of utility systems in technological processes; - define and list the composition and characteristics of heat supply systems and utilities; - find solutions to increase energy efficiency.

8. Contents

8.1. Course	Time	Teaching methods	Comments
1. Heat Transfer Mechanisms	2		
2. Partial and overall heat transfer coefficients	2		
3. Heat exchangers. Thermal and hydraulic calculation	6		
4. Performance indicators of heat exchangers. Increase the efficiency of heat exchangers	3		
5. Combustion processes. Tubular furnaces. Real and optimized heat	6		

balance		Interactive exposition, problem-solving, heuristic conversation, exemplification.	
6. Thermal energy regenerative systems	2		
7. Thermal energy recovery systems	2		
8. Cooling water systems used in refinery	3		
9. Production and use systems of steam in refinery	5		
10. Thermoenergetics systems with cogeneration	5		
11. Thermal integration of heat exchanger networks using the Pinch method	2		
12. Fuel supply systems	2		
13. Inert gas supply systems	2		

Bibliography

1. Incropera, F., Dewitt, D. P., Fundamentals of heat and mass transfer, Seventh edition, John Wiley and Sons, U.S.A., 2011.
2. Popescu, N., Dinu, R. C., Energetica instalaţiilor de producere a energiei în cogenerare, Editura Universitară, Craiova, 2013.
3. Allan, P. R., Improve Energy Efficiency via Heat Integration, American Institute on Chemical Engineering, December, 2010.
4. Cao, E., Heat transfer in process engineering, The McGraw-Hill Companies, USA, 2010.
5. Green, D.W, Perry R. H., Perry's Chemical Engineers' HandBook, 8nd ed., McGrawHill, USA, 2008.
6. Lienhard, J. H. IV, Lienhard J.H.V, A heat transfer Textbook, 4th ed., Phlogiston Press, Cambridge, Massachusetts, U.S.A., 2011.
7. Rokni, M., Introduction to Pinch Technology, Kgs. Lyngby: Technical University of Denmark, 2016, http://orbit.dtu.dk/files/123620478/Pinch_Tech_1.pdf.
8. Jiří, J. K., Zdravko, K., Forty years of Heat Integration: Pinch Analysis (PA) and Mathematical Programming (MP), Current Opinion in Chemical Engineering, Vol. 2, No. 4, 2013.

8.2. Seminar	Time	Teaching methods	Comments
Logarithmic mean temperature difference for flows in a heat exchanger. Heat exchangers - with and without phase transformation - applications	12	Seminars are conducted interactively, discussing the results	
Combustion calculations and thermal balances on furnaces - applications	4		
Thermal power plants - applications	4		
Optimizing a heat exchanger network by applying the PINCH method - example of calculation	8		

Bibliography

1. Green, D.W, Perry R. H., Perry's Chemical Engineers' HandBook, 8nd ed., McGrawHill, USA, 2008.
2. Allan, P. R., Improve Energy Efficiency via Heat Integration, American Institute on Chemical Engineering, December, 2010.
3. Lienhard, J. H. IV, Lienhard J.H.V, A heat transfer Textbook, 4th ed., Phlogiston Press, Cambridge, Massachusetts, U.S.A., 2011.
4. Rokni, M., Introduction to Pinch Technology, Kgs. Lyngby: Technical University of Denmark, 2016, http://orbit.dtu.dk/files/123620478/Pinch_Tech_1.pdf.

8.3 Project	Time	Teaching methods	Comments

Presentation of a technological unit	1	Interactive exposition, problem-solving, discussing the results	
Establishing initial design data, example application	2		
Presentation of the thermal balance for a heat exchanger	2		
Calculation of heat transfer coefficients for the heat exchanger; Setting the calculation algorithm in the Excel program. Simulation of results with PROII software.	6		
Interpretation of the results obtained	1		
Project evaluation	2		

Bibliography

1. Dobrinescu, D., Procese de transfer termic şi utilaje specifice, EDP, Bucureşti, 1983.
2. Pătraşcu, C., Termoenergetica prelucrării petrolului, Editura UPG, Ploieşti, 2003.
3. Popa , B., Manualul inginerului termotehnician, Ed.Tehnică, Bucureşti,1986.
4. Ludwig, E., Applied Process Design for chemical and Petrochemical Plants, Golf Publishing Company, Texas,1987.
5. Incropera, F., Fundamentals of Heat and Mass Transfer, John Wiley & Sons, New York, 2002.
6. Leca, A., Transfer de căldură şi masă, Ed. Tehnică, Bucureşti, 1998.

9. Correlation of the course contents with the demands of the epistemic community representatives, professional associations and representative employers in the field of the program

The course syllabus was developed in cooperation with representatives of engineering companies in Ploiești and Bucharest that have hired graduates of similar master programs.

10. Evaluation

Activity	10.1. Evaluation criteria	10.2. Evaluation methods	10.3. Percentage of final grade
10.4. Course 10.5 Seminar	Theoretical knowledge evaluated by questions related to the subjects presented in the course	Written exam	35 %
	Applied knowledge evaluated by solving problems / numerical applications similar to those presented at the seminar		40%
10.6. Project	Theoretical knowledge evaluated by questions related to the subjects presented in the project; Rhythmicity for each stage of the project.	Oral test	25 %

Evaluation conditions	The weighting in the final note applies if, by both assessment methods, notes are at least 5.
10.7. Minimum performance standard	
Written examination: ➢ For 5, it is necessary to obtain a minimum score of 50% for theoretical knowledge, as well as to prove a minimum level of understanding and solving the applications in the exam subject (minimum 50%). ➢ For 10 it is necessary to obtain a maximum score for theoretical knowledge and complete and correct solving of the applications in the exam subject (minimum 95%).	