COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

Syllabus
2024 - 2025

GENERAL INFORMATION

Data of the subject	
Subject name	Internal Combustion Alternative Engines
Subject code	DIM-MII-531
Mainprogram	Official Master´s Degree in Industrial Engineering
Involved programs	Máster Universitario en Ingeniería Industrial [First year]
Level	Intercambio
Quarter	Semestral
Credits	4,5 ECTS
Type	Obligatoria
Department	Department of Mechanical Engineering

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DESCRIPTION OF THE SUBJECT

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Contextualization of the subject

Prerequisites

There are not prerequisites strictly speaking. However, the subject is supported by some knowledges seen in previous subjects:

- Thermodynamics
  - Mass and energy balances
  - Reciprocating engine fundamentals
- Heat transfer
  - Heat exchangers
  - Convection heat transfer
- Fluid mechanics
  - Flow in pipes (compressible and incompressible)
  - Aerodynamic resistance

Course contents

Contents

Components and systems

Unit 1: ICE classification

1. Classification criteria and differencing characteristics.
2. Fundamental differences between compression ignition and spark ignition engines.
3. Main application fields.

Unit 2: Constitutives elements

1. The 5C: cylinder head, block, crankshaft, camshaft and connecting rod.
2. Fundamental systems: lubrication and cooling.
3. Other components.

Unit 7: Charge renovation. Volumetric efficiency and supercharging

1. Parameters to characterise the charge renovation process.
2. Pressure drop effect. Influence on pipes and valve design.
3. Compresibility effect. Influence on the valve design.
4. Flow inertia effect. Distribution diagram.
5. Pressure waves effect. Design of manifolds.
6. Warming-up effect.
7. Types of supercharging. Volumetric compressors, waves and turbochargers.
8. Supercharging effect.

Unit 8: Injection, ignition and combustion in SI-engines

1. Components.
2. Phases of combustion in SI.

3. Typs of injection: indirect and direct one.
4. Homogeneous and stratified charge.
5. Anomalous combustion.

Unit 9: Injection and combustion in CI-engines

1. Components.
2. Phases of combustion in CI.
3. Anomalous combustion.

Unit 10: Exhaust process

1. Exhaust system. components.
2. Acoustic emissions at ICE.

Unit 11: Mechanical losses. Cooling and lubrication.

1. Energy balance of the engine.
2. Origin of mechanical losses and estimation models.
3. Energy recovery at ICE.

Performance

Unit 3: Fundamental equations of ICE: Steady-state performance prediction model

1. Power and torque prediction.
2. Indicated and effective parameters.
3. Efficiencies.

Unit 4: Performance curves: parametric representation and outputs of ICE

1. Tests in workbench.
2. Full load curves.
3. Partial load curves. Willans curve.

Unit 5: Fundamental equations of longitudinal dynamics of vehicles

1. Forces over the vehicle: aerodynamic, rolling and slope.
2. Acceleration and constant speed.
3. Vehicle/engine coupling.
4. Performance, consumptions and CO2 predictions in vehicles.

Unit 6: Working thermodynamic cycles: Diesel, Otto, Atkinson and Miller

1. Cycle definition. Classification.
2. Phenomenological differences between actual and theoric cycles.
3. Theoric cycles of standard air.
4. Effect of cycle parameters.
5. Other theoric cycles.

Emissions and alternative propulsion

Unit 12: Polution and greenhouse effect. Reduction/supression systems

1. Gaseous emissions at SI.
2. Gaseous emissions aT CI.
3. Active and passive reduction systems.
4. Current regulations: WLTP at workbench and on road.

Unit 12: Alternative solutions to ICEs: Hybridation, gas, electric, fuel cell

1. Hybrid and electric vehicles.
2. Unconventional fuels.
3. Advanced combustion Skyactiv X.

EVALUATION AND CRITERIA

Evaluation activities	Evaluation criteria	Weight
Exams. Problem or case study questions.	Both the procedure as numerical results will be taken into account. Results might be incorrect, but they should be coherent and logical.	28,5
Exams. Test questions.	Identification of the right answer among a limited set of options.	28,5
Reports of laboratory sessions	Both previous preparation as report from data collected in laboratory session will be assessed.	19
Team works (presented in classroom).	The team will show the topic developed in the report at classroom. Understanding and answers to questions from the audience will be assessed.	5
Team works (written report).	The report should be structured, including at least motivation, state of the art and own calculations.	19

Grading

Final grade is obtained as:

- 57% comes from exams grading. Final exam will contribute with 38% to the final grade of the subject, whereas mid term exam will contribute with 19%.
- 5% comes from presentations of the work teams in the classroom.
- 19% comes from the written report of the team works.
- 19% comes from the written reports of the laboratory sessions.

If the resulting average grade is higher than 5.0 the subject grade will be such average; otherwise, the subject grade will be the minimum grade between such average and the final exam grade.

Ordinary summon

Final grade is obtained as:

- 57% comes from exams grading. Final exam will contribute with 38% to the final grade of the subject, whereas mid term exam will contribute with 19%.
- 5% comes from the presentation of the team work in the classroom.
- 19% comes from the written report of the team work.
- 19% comes from the written report og the laboratory sessions.

If the resulting average grade is higher than 5.0 the subject grade will be such average; otherwise, the subject grade will be the minimum grade between such average and the final exam grade.

Extraordinary summon

Final grade is obtained as:

- 30% comes from the weigthed average between the grade obtained in the work team (1/5) and the average grade of the reports of the laboratory sessions (4/5).
- 70% comes from the exam of the extraordinary summon.

If the resulting average grade is higher than 5.0 the subject grade will be such average; otherwise, the subject grade will be the minimum grade between such average and the exam grade.

Rules

- Attendance (see latter) at work team and lab reports performing is a necessary condition to pass the subject in both summons.
- Neither programmable calculators nor formulae summary, books and notes are allowed. In the exams a self-made formulae summary with a maximum extension of two pages (one sheet by the two sides) is allowed.
- Attendance: The absence of more than 15% of the total amount of classes can entail to fail the ordinary summon.

WORK PLAN AND SCHEDULE

Activities	Date of realization	Delivery date
Reading and study of the theoretical contents (solides and test when available).	After each session.	
Proposed problems solving.	After finishing the corresponding unit.	
Mid term and final exam.	Week 8 and ordinary exams period.	

Mid term exam preparation.	At least weeks 7 and 8.	
Final exam preparation.	At least weeks 13, 14 and 15.	
Laboratory sessions attendance.	Weeks 11, 12, 13 and 14.	
Writting of reports from laboratory sessions.		Weeks 12, 13, 14 and 15.
Preparation of presentation.	Weeks 3 to 15.	
Participation in presentations.	Weeks 3 to 15.	

BIBLIOGRAPHY AND RESOURCES

Basic References

Notes and slides available at Moodle.

Complementary References

F. Payri, J.M. Desantes, Motores de combustión interna alternativos. Ed. Reverté, 2011.