# UNIVERSITÀ DEGLI STUDI DI PALERMO

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| **DEPARTMENT** | Ingegneria |
| **ACADEMIC YEAR** | 2017/2018 |
| **MASTER'S DEGREE (MSC)** | CIVIL ENGINEERING |
| **SUBJECT** | COMPLEMENTS OF ROADS, RAILWAYS AND AIRPORTS |
| **TYPE OF EDUCATIONAL ACTIVITY** | B |
| **AMBIT** | 50353-Ingegneria civile |
| **CODE** | 17616 |
| **SCIENTIFIC SECTOR(S)** | ICAR/04 |
| **HEAD PROFESSOR(S)** | GRANA' ANNA Professore Ordinario Univ. di PALERMO |
| **OTHER PROFESSOR(S)** | |
| **CREDITS** | 9 |
| **INDIVIDUAL STUDY (Hrs)** | 144 |
| **COURSE ACTIVITY (Hrs)** | 81 |
| **PROPAEDEUTICAL SUBJECTS** | |
| **MUTUALIZATION** | |
| **YEAR** | 2 |
| **TERM (SEMESTER)** | 1° semester |
| **ATTENDANCE** | Not mandatory |
| **EVALUATION** | Out of 30 |
| **TEACHER OFFICE HOURS** | **GRANA' ANNA**<br>Monday 11:00 12:30 ufficio del docente, su appuntamento<br>Tuesday 12:00 13:00 ufficio del docente, su appuntamento<br>Thursday 12:00 13:00 ufficio del docente, su appuntamento |

**DOCENTE:** Prof.ssa ANNA GRANA'

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| **PREREQUISITES** | No prerequisite is required; however, it is appropriate that the students have already acquired basic knowledge and abilities on geometric design and transportation. |
| **LEARNING OUTCOMES** | Knowledge and Comprehension Abilities: the student, at the end of the teaching activities, will have acquired specialized knowledge to address both the functional analysis of road intersections, and the design of railway and airport infrastructures. The student will be able to: i) analyze the requirements and the elements for the choice of the intersection layout and the insertion of the intersection into the road network; ii) design the component elements of the intersection layout; iii) analyze the requirements for the location and the correct design of airport landside and airside areas; iv) examine the issues specifically related to insertion of the railway into the environment.<br>Ability to Apply Knowledge and Comprehension: the student will be able to apply the knowledge and the methods learned during the teaching activities for:<br>- focusing the territorial aspects related to intersection location, the choice of intersection type (at grade, signalized or roundabout, interchanges), and the connection of intersections to the road network (existing or planned);<br>- designing the geometric elements of the intersection, consistent with the constraints (architectural, topographical and regulatory) and according to criteria of road safety and traffic quality.<br>The student will also be able to apply the knowledge and methods learned during the classroom lessons for:<br>- focusing the territorial and environmental aspects related to the location of the airport, based on criteria of airplane-airport compatibility;<br>- characterizing the airside and designing the terminal;<br>- designing the elements of the horizontal and vertical alignment of railways.<br>Judgement Autonomy: the student will be able to analyze and synthesize, in a personal way, the requirements related to design of road intersections according to efficiency and safety criteria; he/she will examine possible alternative design choices based on performance analysis and will address the problems related to the implementation of different design solutions in relation to the context of installation. The student will be also able to analyze and summarize in a personal way both the needs related to planning/design of airport infrastructures in terms of economy, efficiency and safety, and the risks of the rail traffic.<br>Communication Abilities: the student will acquire the ability to illustrate with competence and propriety of language, even in specialized contexts, issues related to the course contents, in particular those relating to the level-of-service calculation for intersections (at grade intersections, roundabouts, ramps, weaving sections), the quantitative and qualitative evaluation of road safety, the project of railways and airports.<br>Learning Abilities: the student will be able to deal autonomously issues related to road intersections and investigate complex issues on airport and railway safety, in relation to operational problems of contexts in which he/she will have the opportunity to work. |
| **ASSESSMENT METHODS** | Oral exam, also with presentation and discussion of design themes assigned during the course. Evaluation criteria:<br>The student must answer at least four oral questions on all topics of the program, with reference to the recommended texts (see below). The final evaluation for each student (each questioned) aims at appraising whether he/she possesses a good knowledge and understanding of the topics, whether he/she has acquired interpretative expertise and he/she is able to perform autonomous assessments with reference to the exercises (at least 4 design themes), assigned during the course (see "Teaching methods").<br>The pass mark will be reached if the student will demonstrate knowledge and understanding (at least in general terms) of the topics specified in the program (and explained during the teaching activities) and the student will have minimal application skills in order to solve the case studies assigned during the course and discussed during the exam. The student must be able to present to the examiner and discuss with competence the issues related for example to:<br>- the typological classification of road intersections, driver behavior and road safety;<br>- the functional verification of the geometric design of road intersections (at grade intersections, interchanges, signalized intersections and roundabouts), ramps and weaving sections;<br>- airport geography (air side and land side), runway characterization and airport infrastructures, terminal;<br>- design of railways, horizontal and vertical alignment and geometric design of track sections and railway stations.<br>Below this threshold, the student will not be able to pass the examination. On the contrary, the more the student will be able to interact with the examiner and discuss the topics, and the more he/she will prove to have acquired in-depth knowledge and practical skills on the topics of the Course, the higher the evaluation grade will rise towards the top marks. The range of evaluation grade is comprised between 18 and 30 cum laude, according to the following criteria: |

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| | Excellent (30 – 30 e lode): Excellent knowledge of the subjects studied in the course, excellent language skills, good analytical and interpretative capacity; the student is fully able to apply knowledge and methods learnt to interpret the functional verification of the geometric design of road intersections and the design of airports, railways and railway stations.<br>Very good (26-29): Good mastery of the subjects studied in the course, very good language skills; the student is able to apply knowledge and methods learnt to interpret the functional verification of the geometric design of road intersections and the design of airports, railways and railway stations.<br>Good (24-25): Knowledge of the main subjects studied in the course, good language skills; the student shows a limited ability to apply knowledge and methods learnt to interpret the functional verification of the geometric design of road intersections and the design of airports, railways and railway stations.<br>Average (21-23): Basic knowledge of some subjects studied in the course, adequate language skills; poor ability to autonomously apply knowledge and methods learnt to interpret the functional verification of the geometric design of road intersections and the design of airports, railways and railway stations.<br>Pass (18-20): Minimal knowledge of some geographic subjects and of the technical language; very poor or inexistent ability to autonomously apply knowledge and methods learnt to interpret the functional verification of the geometric design of road intersections and the design of airports, railways and railway stations.<br>Fail: The student does not have an acceptable knowledge of the subjects studied in the Complements of Roads, Airport and Railways Course. |
| **EDUCATIONAL OBJECTIVES** | The Course aims at studying in depth both the issues related to the functional verification of the geometric design of road intersections, and the issues related to the design of railways and airports.<br>The Course aims at providing students suitable engineering tools for the functional analysis of the road intersections, appropriate methods for the quantitative/qualitative evaluation of road safety and efficiency, as well as appropriate knowledge for the design of airports, railways and railway stations that will enable them to relate with Administrations and/or Companies where he/she hopefully will operate. In order to improve the comprehension of the Course contents, the teacher will develop some exercises also based on real-world case studies. At least four exercises will be assigned to each students. |
| **TEACHING METHODS** | Classroom lectures, classroom exercises by the teacher, practical exercises assigned to the students to perform autonomously, even during the activities of design laboratory. The practical exercises shall concern on: the geometric and functional design of a stop-controlled intersection and signal plan; level-of-service calculation for a signalized intersection and traffic signal timing; evaluation of capacity and delay at roundabouts, a technical report on one or more existing airports and/or railway stations. |
| **SUGGESTED BIBLIOGRAPHY** | - Esposito T, Mauro R., 2001. Fondamenti di Infrastrutture Viarie 2: La progettazione funzionale delle strade. Hevelius Ed.<br>- F.A. Santagata (a cura di), AAVV. Strade. Pearson, 2016.<br>- Ranzo, A., 2007. Fondamenti di Ingegneria delle Infrastrutture Viarie, Ed. CompoMat, Configni (RI).<br>- Appunti alle lezioni<br>Testi consigliati per gli approfondimenti:<br>- Benedetto, A. Strade, ferrovie Aeroporti. UTET, 2015.<br>- Tesoriere, G., 1993. Strade, Ferrovie, Aeroporti, Infrastrutture aeroportuali Vol. III, UTET, Torino.<br>- Horonjeff, R., McKelvet, F., 2010. Planning and design of airports, MacGraw-Hill, 5th Edition. |

## SYLLABUS

| Hrs | Frontal teaching |
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| 2 | Introduction to the Course. Complements of Roads. Traffic flow: uninterrupted flow (in brief) and interrupted flow conditions; vehicle arrival models and headway distribution models. |
| 2 | Road junctions and intersections: definition of road intersection; site location criteria for road intersections; typological classification (at grade intersections, interchanges, signalized intersections and roundabouts); principles of geometrical and functional design; maneuvers; points of conflict; normative aspects. |
| 2 | At grade intersections: layouts; geometric design; auxiliary turning lanes and channelization; acceleration/deceleration lanes; traffic islands; width of the modular elements; sight distance triangle. |
| 2 | Calculation of the capacity and waiting phenomena at unsignalized intersections: driver behaviour at intersections; critical headway and methods of estimation. Capacity models at unsignalized intersections; control delay and performance measures; queuing theory. |
| 2 | Geometric aspects and functional analysis at two-way-stop-controlled intersctions: ranks of traffic streams; conflicting flows; impedence effects; calculation of capacity and control delay; level-of-service determination based on HCM. |
| 2 | Signalized intersections: introduction to the signal timing design; saturation flows; methodology for analyzing capacity, control delay and level-of-service based on HCM. |

# SYLLABUS

| Hrs | Frontal teaching |
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| 4 | Geometric schemes and functional analysis of the modern roundabouts: evolution and classification; geometric design of mini roundabouts, compact roundabouts and conventional roundabouts; capacity; control delay; performance measures and level-of-service. |
| 2 | Interchanges: schemes; ramps; geometry of the modular elements; horizontal and vertical alignments of the entry/exit ramps; weaving sections. |
| 3 | Road safety; crash phenomenon; definition and measure of road safety; objective and subjective safety in traffic; proactive and reactive risk assessment; Safety Performance Functions (generalized linear model); goodness-of-fit in safety estimation; Empirical Bayes methods; crash modifications factors; Highway Safety Manual; restraining devices |
| 2 | Airports: standards and guidelines; aeronautical authorities and associations; the airport manager and airport organization. International and national Air traffic trends; Air Traffic Management. |
| 3 | Airport geography: landside, airside; airplane/airport compatibility: airplane characteristcs in relation to design needs of airports; airport classification and airplane classification; critical and non-critical zones in airside; the Aircraft classification number – pavement classification number (ACN/PCN). Airport master planning. |
| 2 | Runway characterization: geometric design of the runway centerline; declared distances (ICAO); Takeoff and landing distances; runway orientation and location; taxiways; runway lighting and visual aids, markings and signs in airside. |
| 2 | Airport terminals and operational level of services; airport infrastrucutres and facilities (landside) and apron (airside). |
| 2 | Runways: take-off and landing (conventional takeoff and landing, balanced field takeoff, takeoff distance, landing distance, ground roll). Airport drainage (an introduction); obstacle Limitation Surfaces and safety zones around airports. |
| 2 | The airport capacity based on the runway layout. |
| 1 | An introduction to heliports and helidecks. |
| 2 | Airport safety and security. |
| 2 | Railways. An introduction to the evolutions of the railway system. European and national rules and standards; railway authorities and companies; railway track. |
| 2 | Railway stations: infrastructure, facilities and equipment. Station track plans through examples. |
| 2 | Design stages and approvals. Horizontal and vertical alignment and geometric design of track sections. Design issues of the horizontal and transition curves. Superelevation. Vertical layouts. Track geometry, tolerances and types of track tolerances. |
| 2 | Track cross section and track structure; High-speed rail; signal devices and signal aspects. |

| Hrs | Practice |
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| 3 | The geometric and functional design of a stop-controlled intersection and signal plan. |
| 3 | Level-of-service determination at two-way-stop controlled intersections. |
| 3 | Level-of-service calculation for signalized intersections and traffic signal timing. |
| 6 | Evaluation of capacity and delay at roundabouts: the single-lane and the multi-lane roundabouts. |
| 3 | Operational analysis of ramps and weaving sections. |
| 3 | Crash modelling approaches and software packages. Road safety analysis at unsignalized intersections and roundabouts. Effectiveness evaluation of engineering countermeasures. |
| 3 | Airplane/Airport compatibility: calculation of takeoff or landing distances based on aircraft performances; calculation of equivalent annual departures of the design aircraft. |
| 3 | Runway orientation criteria and examples; design of declared distances and safety area around the runway. |

| Hrs | Workshops |
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| 9 | Laboratory activities dedicated to practical and project applications, also by using computer-aided design software, pertinent to the course contents and assigned to the student during the classroom lectures. |