UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2019/2020
BACHELOR'S DEGREE (BSC)	CIVIL ENGINEERING
SUBJECT	ROAD DESIGN
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50277-Ingegneria civile
CODE	09128
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	07873 - DESIGN AND CAD 07626 - TOPOGRAPHY
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**GRANA' ANNA** Monday 11:00 12:30 ufficio del docente, su appuntamento Tuesday 12:00 13:00 ufficio del docente, su appuntamento Thursday 12:00 13:00 ufficio del docente, su appuntamento

DOCENTE: Prof.ssa ANNA GRANA'

PREREQUISITES	Students must pass the exams of Design and Topography; it is appropriate that students have already acquired basic knowledge of mathematics and physics.
LEARNING OUTCOMES	Knowledge and Comprehension Abilities The course is aimed at the knowledge of the problems inherent to the geometric choices of the axis and the road platform, and to the comprehension of the issues, both technical and environmental nature, connected to the choice between different road alternatives and the location of the intersections, design of the geometric elements of the horizontal and vertical alignment of the roads, design of the cross section based on the predictable flow rate and an assigned level of traffic quality. This goal is achieved by attending lectures, library researches and seminars. The educational tools used for this goal are Power Point presentations, along with handbooks and manuals on the Road Infrastructures. Ability to Apply Knowledge and Comprehension The student will be able to use educational tools which can include worksheets and computer-aided design software; these tools are useful for drawing up some documents of the geometric road design at an executive phase. The student will be also able to frame problems of geometric design both for the horizontal alignment, vertical alignment and for the cross section, and will be able to face issues pertinent to environmental effects of design choices. Judgement Autonomy The student will be able to collect and analyze data relating to the geometric design of the (horizontal and vertical) alignment and the cross section; he/she will be able to acquire the necessary information for the preparation of the road project and set the implementation-related problems of different solutions. Communication Abilities The student will have the ability to communicate and express the issues concerning the object of the course, in particular those relating to the geometric design of roads and highways, as well as to highlight the basic problems relating to the technical and environmental implications of design choices and propose solutions. Learning Abilities The student will have knowledge related to the road geometry, road traffic and the design of the cross section, the preparation of the documents of the project at different stages of the design study; based on the above, he/she will be able to continue their engineering studies in order to study in depth the issues related to the road operations and road construction.
ASSESSMENT METHODS	Presentation of the documents of the geometric road design and oral exam on the topics of the course. Evaluation criteria: 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 and whether he/she has acquired interpretative expertise and autonomous assessments with reference to the concrete case of road design (see "Teaching methods"), assigned during the course and also developed in group (a maximum 5 students by group). 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 study assigned during the course and discussed during the exam. The student must be able to present to the examiner and to discuss with competence the issues related to the geometric design of urban streets and highways, and at-grade intersections. 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: 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 for road geometric design. 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 for road geometric design. 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 for road geometric design. Average (21-23): Basic knowledge of some subjects studied in the course, adequate language skills; poor ability to autonomously apply knowledge and methods learnt for road geometric design. Pass (18-20): Minimal knowledge of some geographic subjects and the technical language; very poor or inexistent ability to autonomously apply knowledge and methods learnt for road geometric design. Fail: The student does not have an acceptable knowledge of the subjects studied during the teaching activities.
EDUCATIONAL OBJECTIVES	The Course provides the elements that form the basis of the road design (standards, technical and behavioral aspects) and the knowledge needed to address concretely the design issues of the road infrastructure. Along with lectures, for a better understanding of the topics, the course includes some excercises dedicated to the most frequent practical and project applications in the professional field in which the student will be able to operate. After completing the course, the student, in addition to knowing how to properly frame the issue of the road geometric design, must be able to deal with real cases based on current standards and guidelines, both for roads, highways and intersections. Based on outlined above, the student will be able to recognize, analyze and solve problems of road engineering; as a result of other curricular subjects, he/ she will have also acquired the skills necessary for a self-improvement and updating of knowledge through the personal study, or through activities of post-graduate training.
TEACHING METHODS	Classroom lectures, classroom exercises, exercises for drawing up some documents of the road geometric design.
SUGGESTED BIBLIOGRAPHY	- Appunti alle lezioni - Santagata F.A. (a cura di), AAVV. Strade. Pearson, 2016. - Esposito T, Mauro R., Fondamenti di Infrastrutture Viarie 1 - La geometria stradale. Hevelius Edizioni, 2001. - Esposito T, Mauro R., Fondamenti di Infrastrutture Viarie 2 - La progettazione funzionale delle strade. Hevelius Edizioni, 2001. - Mannering F.L., Washburn S.S. Principles of Highway Engineering and Traffic Analysis, 5th ed. John Wiley & Sons, 2013. USA. - Benedetto A.. Strade, ferrovie Aeroporti. UTET, 2015. - Tesoriere G. Strade Ferrovie ed Aeroporti. Volume 1°, UTET Torino.

SYLLABUS

Hrs	Frontal teaching
4	Introduction to the Course contents. General information on the components of the road system. Evolution of the transport infrastructures with reference to the territorial transformation processes. Summary of locomotion mechanics of road vehicles. Friction. Performance of road vehicles
4	The preparation of a road project: basic stages in the development process of the road design (purposes and phases of the conceptual development of the preliminary design, the definitive design and the executive design). Collection of basic data (topography, local emergencies). Selection and evaluation criteria of the horizontal and vertical alignment and the location of the intersections. Focus on the territorial and environmental issues. Technical constraints.
2	Road users: passenger, pedestrian, driver. Perception of road space during the conditions of motion.
4	Sight distances used in road design. Road network classification and road classification. Design speed
6	Horizontal alignment: maximum lenght of straights, circular arcs (minimum radius, superelevation, minimum lenght, visual criterion for the minimum radius), the clothoid (transition curve, inflection curve, egg-shaped curve)
4	Vertical alignment: maximum uphill slope for the vehicle start up and maximum downhill slope; maximum slope for given speed; (uphill and downhill) performance curves of heavy vehicles. Normative limits. Vertical curves: type and curve design based on visibility and comfort criteria.
4	Composition and organization of the roadway: basic dimensions of the elements of the traveled way, number of lanes, margins. Cross section in bridges. Accommodation of stopped vehicles. Auxiliary lanes for trucks. The geometric design of the horizontal and the vertical alignments of a road centerline and the road cross section.
2	Cross section in road curves: profile of the roadway edges and lane width.
6	Design Controls and Criteria: criteria for coordination of the horizontal and the vertical alignmets; the Design Speed Diagram and the Sight Distance Diagram
2	Urban roads and streets: vehicle classes, road geometric characteristics and functions, parking area.
4	Road intersections: general information, choice criteria, manoeuvers and conflict points, geometric and safety countermeasures, traffic channels, sight distances and margins.
6	Road traffic and cross section design: the traffic variables. Traffic volume and flow rate. Temporal variations in flow rate and frequency curves. The 30th highest hourly traffic volume. Time mean speed and Space mean speed. Density. Fundamental relations of traffic flow. Capacity and level-of-service. Level-of-service calculations for uninterrupted traffic flow conditions (Freeway, Two-lane highways and Multilane highways). The HCM approach

Hrs	Practice
6	Choice and definition of the horizontal and vertical alignments of the road: some engineering drawings used for the road projects (plan of the the horizontal centerline of the roadway; horizontal general plan and vertical profile).
3	The Design Speed Diagram and the Sight Distance Diagram.
3	Computation of excavation and embankment through the cross sections using the average and area method
3	Typical cross sections and constructive details of the roadbed and the traveled way
3	Earthwork volumes and mass diagrams: road embankment and excavation
3	The design of the horizontal layout and the vertical profile. Metric computation. General considerations on drainage design: ditches, berms, culverts.

Hrs	Workshops
12	Laboratory activities dedicated to the road project; for these activities, a temporary licence of computer-aided design software will be given to the students