UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT			
ACADEMIC YEAR			
ANNO ACCADEMICO EROGAZIONE			
SUBJECT			
CODE			
SCIENTIFIC SECTOR(S)			
HEAD PROFESSOR(S)	ZUCCARELLO BERNARDO	Professore Ordinario	Univ. di PALERMO
OTHER PROFESSOR(S)	D'ACQUISTO LEONARDO	Professore Ordinario	Univ. di PALERMO
	ZUCCARELLO BERNARDO	Professore Ordinario	Univ. di PALERMO
CREDITS			
PROPAEDEUTICAL SUBJECTS			
MUTUALIZATION			
YEAR			
TERM (SEMESTER)			
ATTENDANCE			
EVALUATION			
TEACHER OFFICE HOURS	**D'ACQUISTO LEONARDO** Thursday 08:30 10:00 Edificio 8 - stanza docente **ZUCCARELLO BERNARDO** Monday 10:00 12:00 UFFICIO EDIFICIO 8		

DOCENTE: Prof. BERNARDO ZUCCARELLO

PREREQUISITES	For the Mechanical Design module: Mechanics of solids, Theory of structures. For the Mechanical Measurements module: General concepts of mathematical analysis (calculus of derivatives and integrals), General concepts of phisycs (knowledge of main physical quantities, measurement units' systems) . Basic principles of electrotechnology (resistive, inductive and capacitive circuits).
LEARNING OUTCOMES	For the Mechanical Design module: Knowledge and understanding. Knowledge and understanding of the methodological-operational aspects of materials mechanics, construction science and machine construction; Ability to understand, develop and apply ideas and concepts with originality. • Ability to apply knowledge and understanding Ability to use the knowledge of mathematics and basic sciences to interpret and describe simple problems of structural engineering and materials in the mechanical field; Ability to identify, formulate and solve problems concerning the resistance of materials and mechanical components, using the methodologies of construction science and mechanics of materials; Ability to design mechanical components to meet resistance, durability and cost requirements; Ability to operate in compliance with laws and regulations and safety requirements, taking due account, in a balanced way, of costs and benefits and the socio-environmental impact of the proposed solutions; Decision-making skills concerning the choice of materials, test methods, calculation techniques and simplification of problems, aimed at mechanical design. • Autonomy of judgment Autonomy in collecting and interpreting data useful for determining judgments; Autonomy in devising innovative solutions; • Communication skills Ability to present and discuss problems and needs of resistance and safety of components and systems and of choice of building materials. • Learning skills Knowing how to complete the preparation in the field of teaching topics also through individual study. For the Mechanical Measurement module: Knowledge and understanding. The student, at the end of the course, will have knowledge about methodologies to apply and solve effectively the problems of measurement of mechanical and thermal quantities. Applying knowledge and understanding. The student will have acquired knowledge, methodologies and the conceptual approach requested to analyze and solve problems related to the identification and selection of measurement techniques fit to the correct measurement of the quantity of interest. Making judgments. At the end of the course the student will be able to integrate knowledge and handle complexity, as well as to make judgments based on limited information. Communication skills. The student will be able to properly communicate with language skills, both to expert or common level people, its conclusions as well as the underlying knowledge and rationale about issues related to the approach to the definition and development of a measurement process. Learning skills. The student will have developed those learning skills that let him to autonomously master issues such as the optimization of the resources used for the purpose of reducing uncertainty associated with the measurement result.
ASSESSMENT METHODS	For the Mechanical Desig module: The oral exam consists of an interview, aimed at establishing the possession of the disciplinary skills and knowledge required by the course, the ability to contextualize and expose. The evaluation is expressed out of thirty. The candidate will have to answer at least four questions posed orally, on all the parts of the program, with reference to the recommended texts. The final exam aims to assess whether the student has knowledge and understanding of the topics, has acquired interpretative competence and autonomy of judgment of concrete cases. The sufficiency threshold will be reached if the student demonstrates knowledge and understanding of the topics at least in general terms and minimum applicative skills in order to solve concrete cases. He will also have to possess expository and argumentative skills such as to allow the transmission of his knowledge to the examiner. Below this threshold, the examination will be insufficient. The more, however, the examiner with his argumentative and expository skills manages to interact with the examiner, and the more his knowledge and application skills go into the detail of the discipline being tested, the more the evaluation will be positive. The maximum score is obtained if the verification establishes the full possession of the following three aspects: a capacity for judgment able to describe emerging and/or little explored

	aspects of the discipline; a strong ability to highlight the impact of the course contents within the sector/discipline in which the contents are registered; finally, a mastery in the ability to represent innovative ideas and/or solutions within the professional, technological or socio-cultural context of reference. As regards the verification of the exposition skills, there is a minimum evaluation in the event that the candidate demonstrates a language property adequate to the professional context of reference but this is not sufficiently articulated, while the maximum evaluation can be achieved by who demonstrates full mastery also of technical language. In summary, the final evaluation will be graded according to the following grid of judgments. Excellent: 30-30 cum laude Excellent knowledge of the topics, excellent language properties, very good analytical skills, the student is able to apply the knowledge to effectively address the required problems. Very good: 26-29 Good mastery of the topics, full ownership of language, the student is able to apply the knowledge to adequately address the required problems. Good: 24-25 Basic knowledge of the main topics, good language properties, with limited ability to autonomously apply the knowledge to the solution of the required problems. Satisfactory: 21-23 He does not have full mastery of the main topics but has some knowledge of them, satisfactory language properties, poor ability to independently apply the acquired knowledge. Sufficient: 18-20 Minimum basic knowledge of the main topics and technical language, very little or no ability to independently apply the acquired knowledge. Insufficient: 0-17 Negative result, the student demonstrates that he has not achieved the minimum learning outcomes required for the course. For the Mechanical Measurements module: The oral test consists of an interview, in order to check that you have skills and knowledge disciplinary provided by the course; the evaluation is expressed in thirtieths. The questions, both open both semi-structured to test the results of learning provided for, will tend to occur: a) the knowledge captured; b) the processing capacity, c) have adequate display capacity on the course contents. The final evaluation will be formulated according the following graduation of knowledge of the student. Excellent 30-30 and praise, very good knowledge of the topics, excellent properties of language, good analytical ability, the student is able to apply knowledge to effectively solve measurements problems proposed 26-29 Very Good, Good command of the topics, full of language, the student is able to apply knowledge to solve measurements problems proposed 24-25 good, basic understanding of the main topics, discrete properties of language, with limited ability to independently apply the knowledge to the solution of the proposed problems Satisfactory 21-23, has not fully mastered the main teaching subjects but it has the knowledge, satisfactory property language, poor ability to independently apply the knowledge acquired Sufficient 18-20, Minimum basic understanding of the major teaching and technical language issues, very little or no ability to independently apply the knowledge acquired Insufficient, it does not have an acceptable knowledge of the contents of the topics covered in the teaching The final evaluation is given by the mean of the votes obtained into eachh module.
TEACHING METHODS	For the Mechanical Design module: Teaching consists of lectures, numerical exercises and laboratory. For the Mechanical Measurements: Teaching consists of lectures and exercises in laboratory.

MODULE
CONSTRUCTION ELEMENTS

Prof. BERNARDO ZUCCARELLO

SUGGESTED BIBLIOGRAPHY

1) Dispense del corso.
2) Progetto e Costruzione di Macchine; autori: Shigley, Budynas, Nisbett; editore: McGraw-Hill Education.

AMBIT	83130-AttivitÃ formative affini o integrative
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54

EDUCATIONAL OBJECTIVES OF THE MODULE

Adequate knowledge of the theoretical-practical methods used in engineering, related to the design and to the verification of the struyctural integrity of components and mechanical structures usually used in the aeronautial field. Such an acquired knowledge will allows the student to analyze, interpret, describe and evaluate correctly the main matters connected to the strenght of materials, components and structures typical of the mechanical engineering design.

SYLLABUS

Hrs	Frontal teaching
2	Introduction to the design of components, structures and joints.
3	Properties of isostropic and anisotropic materials and relative experimental mechanical characterization.
3	Theoretical, numerical and experimental methods for the engineering design.
3	Strenght criteria and stress concentration phenomena.
6	Metal Fatigue: experimental evidencies and Woheler digramm, main influence parameters, average stress effects and random fatigue.
2	Elasto-plastic behaviour of materials and residual stresses.
3	Cylindrical components under pressure: theoretical analysis of the stress-strain field, circling processes.
3	Transmission shafts: static and fatigue design; Soderberg method and Gough-Pollard criterion for complex service loading.
3	Wear and lubrification: experimental evidence, Stribeck diagramm, Reynolds theory e formulas for spherical couples. Wear analysis.
2	Rolling bearings: tipologies and selection criteria, duration and reliability.
3	Screws and bolts: stress concetration, tightening moment and seal effect. Static and fatigue design.
3	Mechanical joints and cone Morse: theoretical analysis and strenght evaluation.
2	Welding joints: typologies and design formulas.
2	Springs: typologies, static and fatigue analysis.

Hrs	Practice
6	Examples of static design of components (cylinders, shafts, bearings, springs) and joints (treaded, mechanical, cone Morse and welding joints) used in the industrial field.
6	Examples of fatigue design of components (cylinders, shafts, bearings, springs) and joints (treaded, mechanical, cone Morse and welding joints) used in the industrial field.

Hrs	Workshops
2	Application of experimental methods for the stress analysis of structural components.

MODULE
MECHANICAL MEASUREMENTS

Prof. LEONARDO D'ACQUISTO

SUGGESTED BIBLIOGRAPHY

- Vallascas R. : Fondamenti di misure meccaniche e termiche Grandezze statiche e sistemi. Editore: HOEPLI , 2008
- Doebelin, Ernest O. - “Strumenti e metodi di misura” “ II edizione – McGraw-Hill, 2008
- Dispense a cura del docente in formato pdf

AMBIT	83130-AttivitÃ formative affini o integrative
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54

EDUCATIONAL OBJECTIVES OF THE MODULE

OBJECTIVES OF CORSE
The overall aim of the present course is to present the topics of measuring systems as an integrated and coherent subject. Actually, sensors and instruments are of utmost importance in a wide range of applications. The growth in the sophistication of instruments have been particularly significant, however little efforts are posed to the data validation, that is the full exploitation of inaccuracy associated to the collected data. Thus, questions still linger over how to objectively assess: the accuracy, response
time, residual life, and other characteristics of employed instrumentation. The Course in Mechanical and Thermal Measurements is intended: to offer practical means to identify them; to assess their consequences; and to help resolve them. Therefore, the aim of the course is to provide a solid foundation for the design of effective measuring systems in Industrial Engineering and for reaching valid experimental data.

SYLLABUS

Hrs	Frontal teaching
20	Basics of measurements, instruments and measuring systems. Analytical models of instruments' dynamic response - Introduction to the evolution of the most widespread systems of measurement units. International system of measurement units and reference standards - Types of measuring instrument applications: Observation of processes and operations - Regulation of processes and operations - Experimental investigation in engineering - General configuration and operating principles of the measuring instruments: functional elements of an instrument - Active and passive sensors - Analogical or numerical operating method - Compensation or direct reading instruments - Input and output quantities of an instrument - Methods for reducing the effects of influencing quantities - Generalized operating characteristics of measuring instruments and systems 1 - Static characteristics - Measurand, instrument, operator, environment. Resolution. Stability. Interaction with the environment. Repeatability, the limit of the potential of a measurement system. Reproducibility, a concrete assessment of the potential of a measurement system (outline). Accuracy, need for a reference sample. The calibration of an instrument. The traceability of measuring instruments to national standards. Measurement compatibility. Typical errors: linearity, hysteresis, inversion, mobility, mobility threshold. Calibration - Repeatability - Accuracy - Systematic error - Sensitivity - Linearity - Threshold value - Resolution - Hysteresis - Dead space - Scale readability - Useful range - Input impedance - Effect of applying the instrument on the quantity to be measured
5	Elements of statistics for measurement data analysis. Evaluation of measurement uncertainty .
20	Sensors and transducers for mechanical and thermal measurements Motion , displacement and strain measurements - Relative linear and angular displacements: Resistive transducers - Differential transformers - Inductive and capacitive sensors - Synchro systems - Piezoelectric sensors - Linear and angular relative speeds: Indirect measurement - Mechanical and electrical tachometers - Stroboscopes - Electromagnetic transducers - Seismic instruments for measurements of displacements, speeds and absolute accelerations - Strain measurement - Electric resistance strain gages. Electrical resistance. Sensitivity to deformation of the SG: sensitivity to axial and transverse strain, the K calibration factor , experimental determination of K. Linearity, temperature coefficient of the calibration factor. Sensitivity to temperature: apparent thermal strain, compensation by compensating SG and self-compensated SG. The resistance measuring circuit. The Wheatstone deviation bridge - strain gauge equation. The zeroing bridge, the reference bridge method. Bridge supply systems. Types of connection: quarter bridge, half bridge, full bridge. Dynamic characteristics. - Measurements of mechanical forces and torques: primary conversion elements - Measurements of torques on rotating shafts. Strain gauge load cells - Pressure measurements: Primary conversion elements - Diaphragm pressure gauges - Electric vacuum gauges - Temperature measurements: Mechanical thermometers - Thermocouples - Resistance thermometers - Pyrometers. Use of Plank's law. Total irradiation pyrometers. Monochrome lamp pyrometers. - Measurements at room temperature with infrared systems within the infrared field

Hrs	Practice

6	Elements of statistics and uncertainty evaluation with applications to practical cases of uncertainty evaluation procedures
3	Calibration procedures of measurement instrumentation for mechanical and thermal measurements