ACADEMIC YEAR: 2019-2020			
COURSE: Machine Design I			
TYPE OF EDUCATIONAL ACTIVITY: Characterizing			
TEACHER: Katia Genovese			
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phone: +39-0971-205019 (office)/5013 (lab)		mobile (optional);	
Language: Italian			
ECTS: 6	n. of hours: 60 30 theoretical lessons 30 tutorials	Campus: Dept./School: School of Engineering Program: Mechanical Engineering	Semester: II

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

The course of Machine Design I provides the fundamentals on the mechanical behavior of materials with regards to the application of current methodologies for the mechanical design of components and machines on the basis of applied loads and constraints under general working conditions.
The student will learn about:

- Mechanical behavior of materials (with and without defects) under static and dynamic loading.
- Brittle/ductile failure modalities.
- Standard tests for the assessment of the fatigue strength and fracture toughness of materials.
- Notch effect.
- Residual stresses.
- Different methods for the solution of a structural problem: Analytical, experimental and numerical approaches.
- Basics of bolted and soldered joints design.

The course aims to provide the student with the following skills:

- Analyze and design structural members subjected to combined loads. Solving a structural problem. Evaluate the safety factor of a mechanical structure.
- Mechanical design of shafts, bolted and soldered joints.
- Fatigue analysis of mechanical components and soldered joints.

The student should enlarge his/her knowledge on the course topics by obtaining further insights through autonomous documentation and he/she should demonstrate correctness of technical speech.

PRE-REQUIREMENTS

Some topics covered by the courses of Mathematical Physics, Strength of Materials and Manufacturing Technologies are considered as course prerequisites as following:

- Beam theory.
- Solution of structural problem for isostatic structures.
- Standard tests for the mechanical characterization of materials (tensile, hardness and resilience tests).

SYLLABUS

Fundamentals of Machine Design.
Steps of the machine design process. Design for static and fatigue endurance. Safety factors. Machine design approaches: safe-life, fail-safe, damage-tolerant.

Stress and strain. Beam linear elastic theory.
Summary of the strength of materials main concepts. External and internal forces. Tension, shear, torsion and bending. Mohr's circle. Failure criteria. Multiaxial loading. Stress-strain relationship in the elasto-plastic range of deformation.

Mechanical characterization of materials.
Tensile test, hardness test, resilience test. Fracture analysis. Ductile/brittle fracture. Fracture surface analysis. Material selection. Notch effect, stress concentration. Residual stress.

Fatigue.
Introduction to high-cycle fatigue failure. Cyclic loading with constant amplitude. Whöler diagram. Parameters affecting the fatigue life. Notch effect. Haigh diagram. Cyclic loading with variable amplitude. Cycles counting methods and damage accumulation models. Palmgren-Miner's hypothesis. Multiaxial fatigue: Gough-Pollard diagram. Fatigue of shafts.

Fracture mechanics.
Linear elastic fracture mechanics. Fatigue crack propagation. Irwin's theory. Stress intensification approach to fracture mechanics. Test standards for fracture toughness evaluation. Parameters influencing K_{IC}. Evaluation of the stress intensity factor. Crack propagation under cyclic loading. Fatigue testing. Paris' diagram.

Design and selection of machine elements.
Nomenclature for bolted and soldered joints. Design of bolted and soldered joint under static loading. Design of soldered joints under cyclic loading (at constant and variable cycle amplitude).

TEACHING METHODS

Lectures and tutorials.

EVALUATON METHODS

Student learning assessment is done through a written and an oral examination. The exam is representative of the course content and objectives. The written test consists of one/two problems. It is possible to use a single formulary. The use of PC and smart-phones is not allowed during the test. Written test duration is three hours. The student can postpone the oral examination to the next exam session.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

Lecture notes and supplemental material is made available in a shared folder.

Reference books:

R. Giovannozzi. *Costruzione di Macchine*, Voll.1-2, Patron editore, Bologna.
F.P. Beer, E.R. Johnston, J.T. DeWolf, D.F. Mazurek. *Meccanica dei solidi: elementi di Scienza delle Costruzioni,* McGraw-Hill, Milano, 2002.
L. Vergani, *Meccanica dei materiali,* McGraw-Hill, Milano, 2001.
R.C. Juvinall, K. M. Marshek, *Fondamenti della progettazione dei componenti delle macchine,* Edizioni ETS, Pisa, 2001.
A. Bernasconi, M. Filippini, M. Giglio, A. Lo Conte, G. Petrone, M. Sangirardi, *Fondamenti di costruzioni di macchine*, McGraw-Hill, Milano, 2002.

INTERACTION WITH STUDENTS

During the first lecture, the main aims and the program of the course will be illustrated. The student will be informed about teacher's email address and telephone number as well as about the office hours. Lecture notes and supplemental material will be made available in a shared folder. The teacher will be available for questions and discussion at the end of each lesson. Office hours is Tuesday 12:30-13:30 (office - 5th floor or laboratory - 1st floor).

EXAMINATION SESSIONS (FORECAST)[1]

A final examination comprehending a written and an oral session will be scheduled bimonthly starting form January. The dates will be published on the ESSE3 system as soon as available.

SEMINARS BY EXTERNAL EXPERTS YES □ NO □

FURTHER INFORMATION

[1] Subject to possible changes: check the web site of the Teacher or the Department/School for updates.