Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Advanced Topics on Machine Design I – Materials behavior and machine elements II – Finite Element Method (FEM)
Course code	47503
Scientific sector	ING-IND/14
Degree	Master in Mechanical Engineering and Industrial Management
Semester	2 and 3
Year	*I / II*
Academic year	2019/20
Credits	5+5
Modular	Yes / No

Total lecturing hours	60 (32 + 28)
Total lab hours	
Total exercise hours	30 (12 + 18)
Attendance	
Prerequisites	none
Course page	https://www.unibz.it/en/faculties/sciencetechnology/master-industrial-mechanical-engineering/

Specific educational objectives	The course aims to introduce the design mindset and the main methods for the design of mechanical systems, to provide exposure to the practice of design through application and to encourage understanding of the broader implications of design.

Module 1	**Materials behavior and machine elements**
Lecturer	Franco Concli Email: franco.concli@unibz.it Ph.: 0471017748 Office: K0.05
Scientific sector of the lecturer	ING-IND/14
Teaching language	English
Office hours	By appointment
Teaching assistant (if any)	no
Office hours	
List of topics covered	The course covers the following main topics: • Principle of virtual work

	• Shafts and shaft components a. Interference fits (hub and key) b. Deflections c. Natural frequencies d. Hyperstatic structures • Gears a. Failure modes (bending - pitting - micro pitting - scuffing) b. Gear types (spur - helical - bevel - worm) c. Gear configurations (parallel axis, orthogonal axis, planetary) d. Synthetic factors (sizing) e. Strength calculation (ISO 6336) f. Gear efficiency (Power losses) g. Gear stiffness (Deformation under load) h. Examples of gearboxes (motorcycle and car transmissions) • Bearings (journal bearing) a. Full-Sommerfeld theory b. Half-Sommerfeld approximation c. Ocvirk's short-bearing approximation • Bolted connections (screwed joints) a. Pretension b. Tearing c. Sheetyielding • Belts (flat - V – Round - Timing) a. Types b. Forces • Welded connections • Pressure vessel • Low cycle fatigue of materials a. Masing Hp. b. Ramberg-Osgood eq. c. Neuber Hp. d. Basquin-Coffin-Manson eq. e. Loading spectra
Teaching format	Frontal lectures, exercises, labs, projects, etc.

Module 2	**Finite Element Method (FEM)**
Lecturer	Prof. Gorla Carlo
Scientific sector of the lecturer	ING-IND/14
Teaching language	English
Office hours	15
Teaching assistant (if any)	no
Office hours	By appointment
List of topics covered	The second module of the course introduces the finite element method FEM for the analysis of solid structural

	problems. The background of the finite element method and its solution procedures for linear and nonlinear analyses, contact analysis, large deformation analysis, modal analysis and structural instability analysis will be presented. Beside the theoretical part, students will apply the above-mentioned approaches to the design of real mechanical component such as those presented in the first module (shafts, slider and rolling-elements bearings, springs, threaded fasteners, power transmission and gears, pressure vessels, welding) and more complex systems for which an analytical approach is not available.
Teaching format	Frontal lectures, exercises, labs, projects, etc.

Learning outcomes	**Intended Learning Outcomes (ILO)** By the end of the course, students should be able to: Knowledge and understanding 1. Handle the analysis methods used in structural design of mechanical systems. Applying knowledge and understanding 2. Know how to face a new project of a mechanical system starting from its functional design. Making judgements 3. Identify the critical zones and the corresponding stress states of all components of a mechanical system, under service loading conditions. 4. Choose the geometry and materials able to satisfy the requirements of each component in terms of strength, deformation, fatigue life, and so on and realizing the technical drawing of the system. Communication skills 5. Oral communication skills (technical language) Ability to learn 6. Ability to autonomously extend the knowledge acquired

<table>
<tr><td>Assessment</td><td>
Formative assessment
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<tr><td>Form</td><td>Length /duration</td><td>ILOs assessed</td></tr>
<tr><td>In class exercises</td><td>15 X 120 minutes</td><td>2, 3, 4</td></tr>
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Summative assessment
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<tr><td>Form</td><td>%</td><td>Length /duration</td><td>ILOs assessed</td></tr>
<tr><td>Written exam – exercises</td><td>50 %</td><td>3/4 exercises (2.5 hours)</td><td>2, 3, 4</td></tr>
<tr><td>Oral exam – theory</td><td>50 %</td><td>open-ended questions - Theoretical knowledge (40%) - Ability to provide examples/applications of the theoretical concepts (30%) - Ability to establish relationships between topics (20%) - Mastery of language (also with respect to teaching language) (10%)</td><td>1, 5, 6</td></tr>
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<tr><td>Assessment language</td><td>English</td></tr>
<tr><td>Evaluation criteria and criteria for awarding marks</td><td>The final mark will be obtained combining the evaluations of the final written test and of the oral examination.</td></tr>
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<tr><td>Required readings</td><td>Lecture notes and documents for exercise will be available on the reserve collections</td></tr>
<tr><td>Supplementary readings</td><td>

R.S.KHURMI AND J.K. GUPTA, A Textbook of Machine Design, S Chand (ENG)
Shigley's Mechanical Engineering Design, McGraw-Hill (ENG)
G. NIEMANN, H. WINTER, Maschinenelemente, Springer (GER)
P. HAEFELE, L. ISSLER, H. RUOSS, fertigkeitslehre

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	– Grundlagen, Springer (GER) • P. DAVOLI, M. FILIPPINI, C. GORLA, A. LO CONTE, Lezioni sugli organi di macchine, Politecnica (ITA) • P. DAVOLI, A. BERNCASCONI, M. FILIPPINI, S. FOLETTI, Comportamento meccanico dei materiali, McGraw-Hill (ITA) Olek C Zienkiewicz, Robert L Taylor, J.Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, Seventh Edition (ENG) Bernd Klein, Grundlagen und Anwendungen der Finite-Element-Methode im Maschinen- und Fahrzeugbau, Springer Verlag (GER) Giovanni Belingardi , Il metodo degli elementi finiti nella progettazione meccanica, Levrotto&Bella (ITA)