Laurea Magistrale in Ingegneria Meccanica

NIVERSITA'
DEGLI STUDI
DELL'AQUILA

MSc in Mechanical Engineering

Laurea Magistrale in Ingegneria Meccanica

MSc in Mechanical Engineering

A.A.: 2013-2014
Contact info: *Ing.Meccanica@Univaq.It*
Info: *http://www.ing.univaq.it/cdl/mostra_corso.php?codice=I4M*
Location: Via Campo di Pile, Zona Industriale di Pile, 67100 L'Aquila
Duration: 2 years
Programme code: LM-33 - Ingegneria meccanica
Tracks: Design
Energy
Director of the degree programme in mechanical engineering: Paolo Di Stefano

Description

The "Corso di Laurea Magistrale in Ingegneria Meccanica" provides education at an advanced level for the exercise of highly qualified areas of the mechanical engineering field. Access is by a "Laurea" degree or a comparable foreign degree; admission is based on specific course requirements determined by the "regolamento del corso di Laurea" (*http://www.ing.univaq.it/facolta/cdcs/regolamenti/2013/reg_did_I4M.pdf*).

The studies last 2 years. The Laurea Magistrale in Ingegneria Meccanica degree is awarded to students who have gained 120 ECTS/CFU credits and dissertation.

The Laurea Magistrale in Ingegneria Meccanica degree is equivalent to the master of science degree in Mechanical Engineering.

List of courses

	Lecturer	**ECTS Credits**	**Semester**
BUSINESS MANAGEMENT & ORGANIZATIONAL DESIGN	L. FRATOCCHI	6	II
COMPUTER AIDED DESIGN AND ENGINEERING	P. DI STEFANO	6	I
DESIGN OF FLUID MACHINERY	E. CHIAPPINI	6 - 9	I
DYNAMICS AND CONTROL OF MACHINES	R. CIPOLLONE	9	II
ELECTRICAL DRIVES AND MOTORS	F. PARASILITI	6	II
ELEMENTS OF LINEAR CONTROL SYSTEMS	A. D'INNOCENZO	6	I
FUNDAMENTALS OF PRODUCTION SYSTEMS	M. PALUMBO	9	II
GENERAL ENERGY, SYSTEMS AND APPLICATIONS	D. PAOLETTI	12	I
INDUSTRIAL INSTRUMENTATION MANAGEMENT	G. D'EMILIA	6	I
MACHINE COMPONENT DESIGN	E. D'AMATO	9	II
MANAGEMENT OF ENERGY CONVERSION SYSTEMS	R. CARAPELLUCCI	9	II
MECHANICAL AUTOMATION AND MECHATRONICS	T. RAPARELLI	9	I
MECHANICAL VIBRATIONS	W D'AMBROGIO	6 - 9	I
MECHANISMS DESIGN	F. DURANTE	6	I
NON TRADITIONAL MANUFACTURING PROCESSES	A. PAOLETTI	9	II
NUMERICAL METHODS AND MODELS in ENGINEERING	E. PELLEGRINO	6	I
PRODUCT DESIGN AND DEVELOPMENT	P. DI STEFANO	9	II
TURBOMACHINES AND INTERNAL COMBUSTION ENGINES	M. ANATONE	12	II

Language

All the courses are taught in Italian. The examination and the formal test can be held in English. For each course textbooks in English are indicated.

Course:
BUSINESS MANAGEMENT & ORGANIZATIONAL DESIGN

Lecturer: FRATOCCHI LUCIANO
Contact info: 0862434356, FAX 0862434303, e-mail: luciano.fratocchi@univaq.it
ECTS Credits: 6
Lecture hours: 60 Lab hours: ORE DI LABORATORIO
Semester:II
Language: Italian
Course code: I0239

Description

Subjects of the course

Managerial Control: definition and aims, Variable vs Fixed Costs, Break Even Point Analysis, Direct vs indirect cost, Full costs, Standard costs, Budgeting, Reporting, Make or buy decisions.

Recommended readings and text books

Anthony Hawkins & Merchant Accounting: Text and Cases, 11th Edition, Mc Graw Hill.

Examination and formal test

Course:

COMPUTER AIDED DESIGN AND ENGINEERING

Lecturer: DISTEFANO PAOLO
Contact info: 0862434314, FAX 0862434203, e-mail. paolo.distefano@univaq.it
ECTS Credits: 6
Lecture hours: 60
Semester:I
Language: Italian
Course code: I0223

Description

Computer aided design is a project-based course that develops engineering design skills with a particular focus on the proficient use of modern CAD-integrated analysis tools. The course covers modern tools and methods for product design. The student will develop detailed knowledge and understanding of the most recent advances in 3D computer aided design and in product engineering and simulation. The course lays a firm foundation in 3D modeling theory and the use of computer aided design tools, enable the student to develop creative and innovative solutions to real-world design problems. Teaching is supported by educational workshop with state-of-the-art software and excellent technical support. The student will be equipped with the knowledge and skills to work in computer aided design, specifically in 3D design.

Subjects of the course

Introduction to CAD CAE CAX systems. Principal components of CAD systems. Computer-aided drafting and 3D geometric modeling systems. Properties of a valid representation scheme. Representation schemes for solids: Spatial occupancy enumeration, Constructive solid geometry, Boundary representations, Finite elements representations, Wire frame models. Procedural or explicit geometric model. Feature-based and parametrics modeling.
Representation and manipulation of curves and surfaces. CAD and CAE integration. Geometric data exchange between systems. Standard for exchange of product data. Methods for the generation of surface grids and mesh. Rapid prototyping technologies. Reverse engineering. Engineering design visualization. Product lifecycle management.

Recommended readings and text books

Ibrahim Zeid, "Mastering CAD/CAM", McGraw-Hill, 1 edition (May 21, 2004).
Kunwoo Lee, 1999, "Principles of CAD/CAM/CAE Systems", Addison- Wesley.
A.A.G. Requicha, 1980, "Representations for Rigid Solids: Theory, Methods, and Systems", Computing Surveys, Vol.12, n°4, pp.437-464.
Böhm W., Farin G. e Kahmann J.,"A survay of curve and surface methods", Computer Aided Geometric Design, 1, North-Holland, 1984 pp.1-40.
Mortenson M.E., "Modelli geometrici in Computer Graphics", McGraw-Hill.

Examination and formal test

The final examination is divided into written and oral test. The written test can be replaced by the individual project development.

Laurea Magistrale in Ingegneria Meccanica

MSc in Mechanical Engineering

Course:
DESIGN OF FLUID MACHINERY

Lecturer: CHIAPPINI ENRICO
Contact info: FAX 0862 434303
ECTS Credits: 6 - 9
Lecture hours: 60/90 Lab hours:
Semester: I
Language: Italian
Course code: I2525

Description

Subjects of the course

Recommended readings and text books

Examination and formal test

Course:

DYNAMICS AND CONTROL OF MACHINES

Lecturer: CIPOLLONE ROBERTO
Contact info: 0852 43.4319; FAX 0862434303 e-mail: roberto.cipollone@univaq.it
ECTS Credits: 9
Lecture hours: 90 Lab hours:
Semester: II
Language: Italian
Course code: I0221

Description

Subjects of the course

Dynamics of physical processes. Steady and unsteady processes. Quasi-steady phenomena. Lumped and distributed parameters models. Characterization of processes in terms of characteristic times of causes and effects propagation: examples applied to thermal (conduction, convection – natural and forced –, radiation), fluid dynamic (compressible and uncompressible), electrical processes. Unsteady conservation equations: mass, momentum, energy, entropy. Lagrangian and Eulerian approaches. Exercises and engineering applications. Electrical, thermal, fluid dynamical analogies.
Unsteady fluid dynamic processes: 1D characteristics method, boundary conditions referred to many engineering situations (plenums of infinite and finite capacities, valves, reciprocating machines, dynamic machines, positive displacement machines, sudden area restrictions and enlargements, etc...). Pressure waves propagation and boundary conditions intersections. Riemann's variables and generalized approaches. Analysis of typical transients in fluid dynamics in engines, compressed air distribution, etc… Experimental activities: pressure waves measurements and predictions.
Thermal unsteady processes: characteristics times of causes and times of thermal energy transfer. Unsteady conduction and convection. Thermal field inside unsteady conduction according to a 1D approach: penetration depth of thermal waves. Influence of thermal diffusivity and frequency of the causes. Unsteady thermal field in 2D and 3D geometries: Heichelberg's method to define equivalent convective heat transfer coefficient and equivalent sink temperature. Measurements of unsteady heat fluxes and temperatures.
Control of thermal engines and relevant engineering processes.
Control laws and specs in transients and steady conditions. Direct and feedback control: the role of models in improving control laws. Linearization of processes and Laplace and Fourier transfer function. Dynamical behaviour and control requirements to fulfil transient and steady requirements during set points and disturbances changes during time. Bode diagrams of transfer functions and Nyquist analysis in mechanical, thermal and fluid dynamic processes. Position (translation and rotation) and force (and torque) control.
The control of the propulsion systems in terms of torque/power and position and direction. The power, steering, temperature, A/F, pollution control in ICE. Technological evolution.
The speed and power control in gas and steam turbine plants. Dynamics of the electrical power plants when they are in parallel on a distribution electricity grid. The control of steam boiler: mass flow rate, power, pressure, pollutants. Practical exercises and designs.

Recommended readings and text books

Maurice J. Zucrow, Joe D. Hoffman - Gas Dynamics – Wiley, 1977
H. A. Shapiro - The dynamics and thermodynamics of compressible fluid flow – Roland Press Co.
Notes of the Course - Dinamica e controllo delle machine – Roberto Cipollone

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Examination and formal test

Oral test

Course:
ELECTRICAL DRIVES AND MOTORS

Lecturer: PARASILITI FRANCESCO
Contact info: 0862/434433 FAX 0862434403, e-mail: Francesco.parasiliti@univaq.it
ECTS Credits: 6
Lecture hours: 60 Lab hours:
Semester: II
Language: Italian
Course code: I0241

Description

Subjects of the course

Introduction to adjustable speed drives. Electrical Machines models: DC motors, induction motors,. Steady state models. DC motor speed control and multiquadrant operation. Separately excited DC motors: armature voltage control, armature current control, field control. Induction motors speed control: variable voltage, constant voltage/frequency control, current control, flux weakening operation. DC converters: rectifiers and choppers. DC motor drives: single and multiquadrant drives. AC converters: voltage source inverter. Six-step inverter and PWM inverter, modulation techniques, current control. Speed control AC motor drives: voltage/frequency control.

Recommended readings and text books

G. K. Dubey, Power Semiconductor Controlled Drives, Prentice-Hall International Editions;
J.M.D. Murphy, F.G. Turnbull, Power Electronic Control of AC Motors, Pergamon Press

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Examination and formal test

Oral test

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NIVERSITA' DEGLI STUDI DELL'AQUILA

MSc in Mechanical Engineering

Course:
ELEMENTS OF LINEAR CONTROL SYSTEMS

Lecturer: D'INNOCENZO ALESSANDRO
Contact info: +39 0862 434473, FAX +39 0862 434403, e-mail: alessandro.dinnocenzo@univaq.it
ECTS Credits: 6
Lecture hours: 60
Language: Italian
Course code: I0217

Description

Analysis and design of linear control systems in the time and frequency domain.

Subjects of the course

Examples of control systems. Classification of control systems. Continuous-time linear control systems. Lagrange formula. Laplace transform: definition and properties. Introduction to stability theory. Routh criterion. Root Locus: definition and main properties. Stabilization via root locus. Steady state and type k systems. Astatic systems. Harmonic response. The frequency response. Bode Diagrams and Nyquist criterion. Elements of realization theory for linear systems.

Recommended readings and text books

Gene F. Franklin, J. D. Powell, A. Emani-Naeini. "Feedback Control of Dynamic Systems", Fourth Edition. Prentice Hall, New Jersey, 2002.

Examination and formal test

Written test.

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NIVERSITA' DEGLI STUDI DELL'AQUILA

MSc in Mechanical Engineering

Course:

FUNDAMENTALS OF PRODUCTION SYSTEMS

Lecturer: PALUMBO MARIO
Contact info: 0862 43.4722; FAX 0862434303; e-mail: mario.palumbo@univaq.it
ECTS Credits: 9
Lecture hours: 90 Lab hours:
Semester: II
Language: Italian
Course code: I0219

Description

The aim of the course is to give the fundamental knowledge in designing, planning, managing and maintaining of production systems and their ancillary plants.

Subjects of the course

Introduction: Industrial Manufacturing. Structure of manufacturing systems and classification criteria for industrial enterprises. The manufacturing system in the industrial enterprise.
Feasibility Study: Market analysis. Production capacity sizing. Plant location. Technical - Economic - Financial assessments. Profitability indexes (PBP, NPV, DCFRR). Investment risk analysis.
Manufacturing system design: Plant layout. Queuing theory. Continuous and batch production. Economic Production Quantity. Sizing of the means of production.
Project planning: Reticular techniques and their use in the design, construction and operation of industrial plants. PERT and CPM.
Work measurement and organization: Taylor and the principles of scientific management. Methods and Time Measurement: stopwatch time study, predetermined times methods (Work Factor, MTM), work sampling. Manpower sizing.
Material Handling: Raw materials and finished goods storage. Economic Order Quantity. Quantity discounts. Techniques of inventory management. Safety stock.
Reliability: Reliability theory. Components and systems reliability. Fault Tree Analysis.
Ancillary plants: Industrial water supply and distribution. Fire-fighting systems. Production and distribution of compressed air. Electrical service. Thermal service. Combined Heat and Power systems.

Recommended readings and text books

Chan S. Park - Fundamentals of Engineering Economics - Prentice Hall
James Mendon Moore - Plant layout and design – Macmillan
Ruddell Reed - Plant location, layout, and maintenance
Phillip F. Ostwald, Jairo Muñoz - Manufacturing Processes And Systems - John Wiley & Sons
Joseph J. Moder, Cecil R. Phillips, Edward W. Davis - Project Management With CPM, PERT and Precedence Diagramming - Van Nostrand Reinhold
David J. Smith - Reliability, Maintainability and Risk – Newnes
C.R.Wynne Roberts, George Kanawaty - Introduction to Work Study - International Labour Office
Geoffrey Boothroyd, Peter Dewhurst, Winston Knight - Product Design For Manufacture And Assembly - Marcel Dekker
John F. Magee, David M. Boodman - Production planning and inventory control - McGraw-Hill
Harold Bright Maynard - Industrial Engineering Handbook - McGraw-Hill Book Co. (general reference)
Dennis Blumenfeld - Operations Research Calculations Handbook - CRC Press (general reference)

Examination and formal test

The examination is in oral form

Laurea Magistrale in Ingegneria Meccanica

NIVERSITA'
DEGLI STUDI
DELL'AQUILA

MSc in Mechanical Engineering

Course:
GENERAL ENERGY, SYSTEMS AND APPLICATIONS

Lecturer: PAOLETTI DOMENICA
Contact info: 0862434332/0862434336, FAX 0862434303, e-mail: domenica.paoletti@univaq.it
ECTS Credits: 12
Lecture hours: 120 Lab hours:
Semester:I
Language: Italian
Course code: I2P027

Description	
Subjects of the course	Energy and power, Energy usage and statistics, A historical perspective of energy in the world, Efficiency, Natural gas, petroleum, solid fuel, Solar energy fundamentals, Solar collectors, other solar thermal systems, Photovoltaic systems, Concentrated solar power, Biomass fundamentals, Biomass based fuels and products, Geothermal energy, Geothermal examples, Ground source heat pumps, Nuclear energy, fission and fusion power, Ocean energy, OTEC, wave energy, Energy and buildings, energy efficiency certificate, thermography, Fundamentals of lighting engineering, Cogenerations, Chemical and physical pollution, Global warming
Recommended readings and text books	B. K. Hodge - "Alternative Energy Sistems and Applications"
Examination and formal test	Oral test and experimental project

Course:
INDUSTRIAL INSTRUMENTATION MANAGEMENT

Lecturer: D'EMILIA GIULIO
Contact info: 0862434324-0862434344, Fax: 0862434303; e-mail: giulio.demilia@univaq.it
ECTS Credits: 6
Lecture hours: 60 Lab hours:
Semester:I
Language: Italian
Course code: I0229

Description

The aim of this course is to study topics connected to the instrumentation management for process/product control and product quality assessment, taking into account a quality management system scenario. Technical and economical aspects will be taken into account, in order to set up an efficient measurement management system, to be integrated with all others company departments.

Subjects of the course

GENERAL CONCEPTS:
Measurements for process/product control: IS of Units – Logical organization of measuring instruments - Instrumentation calibration - Traceability, SIT, EA – Uncertainty evaluation accordion to the international technical standards – Dynamical measurements– Bandwidth – Integrated measurement systems – Management procedure of site distributed measurement systems for plant/production lines monitoring – Data acquisition and transmission– Sampled signals – Aliasing.
MEASUREMENT SYSTEM MANAGEMENT:
Measurement system management in a quality scenario – Technical requirements of instrumentation according to technical standards – Instruments adequateness according to standards – Calibration laboratories: in either out with respect to the company – Operation and economic comparison – Instrumentation integration in automated production systems to document and information company databases – Application cases – Measurement of mechanical and thermal quantities (length, pressure, flow rate, temperature)

Recommended readings and text books

Doebelin E.O., Measurement Systems: Applications and Design, McGraw Hill, 2005, Gopel H., Hesse J., Zemel J.N., Sensors: A Comprehensive Survey, VCH, Weinheim, 1994. – Professor lecture notes. – Technical Standards: UNI ISO 9001:2000, UNI CEI ENV 13005 : 2000, UNI EN 10012: 2004, UNI ISO 10014: 2007.

Examination and formal test

Oral, with discussion of real situations and test cases

Course:

MACHINE COMPONENT DESIGN

Lecturer: D'AMATO ENRICO
Contact info: 0862 43.4353 FAX 0862434303; e-mail: enrico.damato@univaq.it
ECTS Credits: 9
Lecture hours: 90 Lab hours:
Semester: **II**
Language: Italian
Course code: I0215

Description

The course is a course that completes the knowledge of the bachelor course of Machine Design and Construction, by means three fundamentals sections of program:

- Advanced methods and tools for machine design, mainly focusing the capabilities of integrated CAD-FEM platforms for mechanical design;
- Selection of engineering materials for mechanical design, leaving from standard application of metallic ferrous and non-ferrous materials up to plastic and composites materials;
- Principles and application of Finite Element Method.

The application of theory and methods is developed by means a parallel project activity, in charge of one or more students, with a subject proposed by the students or by the teacher, leaving from a data sheet of the application up to a complete technical documentation, including a technical report and drawings for construction.

Subjects of the course

Advanced methods and tools for machine design; integrated platforms of development CAD-FEM. Selection of engineering materials: classification for use of structural steel, aluminium alloys; special metallic alloys. Plastic materials and their application: time variant behavior of polymers; design of mechanical components made of polymers; classification for use. Composite materials: lamina's theory; laminate's theory.
Principles and application of Finite Element Method: definition of stiffness matrix and determination by application of equilibrium equations and energy methods; principles and methods for the accuracy control of FEM numerical solutions; the use of Ansys software for FEM analysis in Machine Design.

Recommended readings and text books

Budynas−Nisbett, Shigley's Mechanical Engineering Design, Eighth Edition;
Ashby, Materials Selection in Mechanical Design, 3rd ed., Elsevier Butterworth-Heinemann, 2005.
O. C. Zienkiewicz, R. L. Taylor, The Finite Element Method, 4th ed., Voll. 1, 2., McGraw-Hill, 1991.

Examination and formal test

The exam is developed in two parts:

- Presentation and discussion of the project developed during the course;
- Discussion about the program of the course based on the formulation of questions on almost two fundamental sections.

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NIVERSITA' DEGLI STUDI DELL'AQUILA

MSc in Mechanical Engineering

Course:
MANAGEMENT OF ENERGY CONVERSION SYSTEMS

Lecturer: CARAPELLUCCI ROBERTO
Contact info: 0862 43.4320; FAX 0862434303, e-mail: roberto.carapellucci@univaq.it
ECTS Credits: 9
Lecture hours: 90 Lab hours:
Semester:II
Language: Italian
Course code: I0235

Description

The course aims to examine the methodologies for the analysis, management and optimization of energy conversion systems. It also deals with the study of liberalized markets for electricity and natural gas, as well as traditional power systems with high efficiency (combined cycles and cogeneration plants) and innovative technologies with reduced environmental interactions (fuel cells and CO2 capture technologies).

Subjects of the course

ANALYSIS AND OPTIMIZATION OF ENERGY CONVERSION SYSTEMS
Exergy analysis. Energy and entropic analysis. Various forms of exergy. Exergy balance for a control volume. Exergy analysis of elementary processes and integrated systems. Pinch Technology analysis. Design and optimization of heat exchangers networks (HEN). Heat exchangers and performance characteristics. HEN design for maximizing energy recovery. HEN energy relaxation. HEN design for minimizing annual costs.
THE MARKET FOR ELECTRICITY AND NATURAL GAS
Italian electricity system: production and demand. Liberalization and tariff system. Structure of the electricity market and operators. Electricity exchange and transport costs. Management of the generation power plants.
TRADITIONAL ENERGY SYSTEMS WITH HIGH PERFORMANCE
Combined gas-steam power plants. Combined cycles based on heavy duty gas turbines: peculiarities and characteristics. T-Q profiles of the heat recovery steam generator (HRSG). Influence of additional combustion. Energy balances and layout of heat sections in multi-pressures HRSG. Combined heat and power systems. Peculiarities of cogeneration. Characteristic parameters and fields of application. Cogeneration plants based on gas turbines and steam turbines.
INNOVATIVE ENERGY SYSTEMS WITH REDUCED ENVIRONMENTAL INTERACTIONS
Fuel cells. Introduction and classification. FC operating principle. Integrated plant schemes in stationary and mobile applications. FC fields of application. Power plants integrated with carbon dioxide capture systems. Carbon dioxide capture in thermoelectric power plants. CO2 removal upstream and downstream the combustion process. Effects on energetic and economic performance. Layout of integrated power plants.

Recommended readings and text books

Kotas, T.J., The Exergy Method of Thermal Plant Analysis, Butterworths, London.
Bejan, A., Tsatsaronis, G., Moran, M., Thermal Design & Optimization, John Wiley & Sons, Inc., New York.
Kehlhofer, R.H., Combined-Cycle Gas Steam Turbine Power Plants, PennWell, Tulsa, Oklahoma.
DOE, Fuel cell handbook, Department of Energy, USA, NETL, November 2004.

Examination and formal test

One written-oral test.

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NIVERSITA' DEGLI STUDI DELL'AQUILA

MSc in Mechanical Engineering

Course:

MECHANICAL AUTOMATION AND ECHATRONICS

Lecturer: RAPARELLI TERENZIANO
Contact info: 0862 43.4313 FAX 0862434303; e-mail: terenziano.raparelli@polito.it
ECTS Credits: 9
Lecture hours: 90 Lab hours:
Semester: I
Language: Italian
Course code: I2S017

Description

Properties of pneumatic, fluidic systems. Fluid properties. Units of measurements, measuring instruments and transducers. Pneumatic actuators, cylinders and their regulations. Control valves and equipments. Design of pneumatic circuits. Pneumatic valves characteristics. Valve coefficients. Transducers and sensors in fluid automation. Peripheral and subsidiary components. Fluid system interface design. Logic pneumatic components. Digital techniques on pneumatic circuits. Layout of an automatic machine. Functional diagrams. Control with wired logic and programmable logic. P.L.C. (programmable logic controller) and field bus. Circuit operation. Plant supply. Air treatment. Reliability. Energy, ecology and security side. Dynamic behaviour of pneumatic systems. Proportional systems and model outlines

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Subjects of the course

Mechatronics, pneumatics and fluid power technology, PLC, pneumatic motion control system, vision systems for automation the Mechatronics Laboratory provides the ideal setting for education and research in pneumatics. Students learn basics of fluid power and acquire practical skills in pnemumatics and electro-pneumatics components, circuits, testing and troubleshooting.
State of the art lab equipment allows students to have hands on experience in fluid power, learning the basics of pneumatic components, studying pneumatics and electric circuits, motion control and PLC programming

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Recommended readings and text books

G. Belforte, A. Manuello Bertetto, L. Mazza, Pneumatica: corso completo, Tecniche Nuove, Milano, 1998. G.Belforte, Manuale di Pneumatica, II Edizione, Tecniche Nuove, Milano, 2005.
A. Barber, Pneumatic Handbook, Elsevier Advanced Technology, UK, 1997.

Examination and formal test

Evaluation of written report of laboratory experiences. Oral and written tests

Course:
MECHANICAL VIBRATIONS

Lecturer: D'AMBROGIO WALTER
Contact info: 0862434352, FAX 0862434203, e-mail. walter.dambrogio@univaq.it
ECTS Credits: 6
Lecture hours: 60 Lab hours:
Semester:I
Language: Italian
Course code: I0233

Description

Reminder on vibration of single degree of freedom systems. Multiple degree of freedom systems. Free vibration: eigenvalue problem, orthogonality of eigenvectors. Forced vibration: modal analysis. Damping. Continuous systems: longitudinal, torsional and bending vibration. Free vibration: eigenvalues, orthogonality of eigenfunctions. Forced vibration: modal analysis. Approximate methods: Rayleigh, Rayleigh-Ritz, Galerkin. Signal processing: time sampling (aliasing), time truncation and windowing (leakage), discrete Fourier transform. Frequency response function measurement. Experimental modal analysis. Random vibrations. Waves: wave train closure principle.

Subjects of the course

Vibrations of single degree of freedom systems. Complex representation of harmonic signals. Undamped and viscously damped free vibration. Forced harmonic vibration: dynamic amplification and phase diagram. Resonance. Response to base motion. Response to periodic excitation: Fourier series. Response to general excitation: time and frequency domain; step response, impulse response, convolution integral. Frequency response function: relation with impulse response. Structural damping. Frequency response functions: receptance, mobility and inertance. Vibration isolation: air springs. Measurement of vibration: seismic transducers; working principle of vibrometer and accelerometer; piezoelectric accelerometer. Non linearities in vibrating systems.
Vibration of multiple degree of freedom systems. Kinetic and potential energy: mass and stiffness matrices. Dissipation function: damping matrix. Equation of motion. Free undamped vibration: eigenvalue problem, orthogonality and normalisation of eigenvectors. General solution of free problem: eigenvectors as mode shapes. Multiple eigenvalues, vibration of suspended rigid bodies. Forced vibration: dynamic stiffness matrix. Coupling of coordinates: principal coordinates. Modal analysis of undamped systems. Kinetic and potential energy in modal coordinates. Harmonic excitation: frequency response function in terms of modal parameters. General excitation: time and frequency domain. Modal analysis of damped systems. Proportional viscous damping. Non proportional viscous damping: state space formulation. Structural damping: proportional and non proportional damping. Frequency response function in terms of modal parameters: viscous and structural damping, proportional and non proportional damping. Rayleigh ratio: stationarity. Damped vibration absorber.
Vibration of continuous systems. Transverse vibration of a string: equation of motion. D'Alembert solution; solution by separation of variables. Eigenvalue problem: fixed-fixed string, fixed-sliding string. Orthogonality and normalisation of eigenfunctions. General solution of free problem: initial conditions, physical meaning of the eigenfunctions. Axial vibration of rods: equation of motion. Eigenvalue problem: free-free rod, fixed-free rod. Torsional vibration of shafts: equation of motion, eigenvalue problem. Bending vibration of beams: equation of motion. Free vibration. Bending waves in beams and plates. Solution by separation of variables. Eigenvalue problem. Orthogonality and normalisation of eigenfunctions. General solution of free problem: initial conditions, physical meaning of the eigenfunctions. Forced vibration: modal analysis. Lumped excitation. Harmonic excitation: lumped harmonic excitation, frequency response function. Approximate solutions: Rayleigh method, Rayleigh-Ritz methods, comparison with finite element method; forced problems: assumed modes method, Galerkin method, collocation method.
Signal analysis. Analog to digital conversion: effect of the number of bits. Sampling: Fourier

	transform of a sampled signal. Aliasing: minimum sampling frequency as function of the maximum frequency of the signal. Reconstruction theorem (Shannon). Discrete Fourier transform. Effect of signal truncation: leakage and smearing. Minimisation of leakage: time windowing. Modal testing. Physical model, modal model, response model. Aim of modal testing. Input-output tests (experimental determination of frequency response function); output-only tests. Excitation tools: electrodynamic shaker, instrumented hammer. Methods to restrain the structure: rigid and elastic supports. Mounting of the exciter. Types of excitation: stationary (step sine, slow sine sweep) or transient (impulse, fast sine sweep). Experimental modal analysis. Identification of modal parameters in the frequency domain. Theoretical bases of Single Degree of Freedom (SDOF) methods: estimation of natural frequency from FRF plots (modulus, phase, real part, imaginary part, Nyquist plot). Damping estimate: half power points. Modal circle: natural frequency and damping factors estimate. Inverse plot. Extension to N degrees of freedom systems: the SDOF assumption. SDOF methods: peak amplitude, quadrature response, circle fit, line fit (Dobson). Low and high frequency residuals. MDOF methods: Non Linear Least Squares (NLLS); Rational Fraction Polynomials (RFP), etc. Comparison among mode shapes: modal assurance criterion (MAC). Random processes. Basic probability theory. Random variables and probability distributions. Expectations of functions of a random variable. Stochastic processes: ensemble averages. Stationarity. Correlation functions. Ergodicity: time averages. Power and cross spectral density. Wide band and narrow band processes: white noise. Random vibrations. Linear system response to random input. Single DoF systems: frequency response function estimation. Response to white noise. Coherence function: effect of measurement noise. Response of N-DoF systems to random inputs. Response of continuous systems to random inputs. Waves. Longitudinal and quasi-longitudinal waves. Bending waves: phase and group speed, energy relations. Wave motion on rods and beams of finite length: longitudinal natural vibrations, natural vibrations in bending, wave train closure principle.
Recommended readings and text books	Lecture notes (in Italian) Rao, Mechanical Vibrations, Prentice-Hall, 2005.
Examination and formal test	Written and oral test

Course:
MECHANICAL VIBRATIONS

Lecturer: D'AMBROGIO WALTER
Contact info: 0862434352, FAX 0862434203, e-mail: walter.dambrogio@univaq.it
ECTS Credits: 9
Lecture hours: 90 Lab hours:
Semester:I
Language: Italian
Course code: I0233

Description

Reminder on vibration of single degree of freedom systems. Multiple degree of freedom systems. Free vibration: eigenvalue problem, orthogonality of eigenvectors. Forced vibration: modal analysis. Damping. Continuous systems: longitudinal, torsional and bending vibration. Free vibration: eigenvalues, orthogonality of eigenfunctions. Forced vibration: modal analysis. Approximate methods: Rayleigh, Rayleigh-Ritz, Galerkin. Signal processing: time sampling (aliasing), time truncation and windowing (leakage), discrete Fourier transform. Frequency response function measurement. Experimental modal analysis.

Subjects of the course

Vibrations of single degree of freedom systems. Complex representation of harmonic signals. Undamped and viscously damped free vibration. Forced harmonic vibration: dynamic amplification and phase diagram. Resonance. Response to base motion. Response to periodic excitation: Fourier series. Response to general excitation: time and frequency domain; step response, impulse response, convolution integral. Frequency response function: relation with impulse response. Structural damping. Frequency response functions: receptance, mobility and inertance. Vibration isolation: air springs. Measurement of vibration: seismic transducers; working principle of vibrometer and accelerometer; piezoelectric accelerometer. Non linearities in vibrating systems.
Vibration of multiple degree of freedom systems. Kinetic and potential energy: mass and stiffness matrices. Dissipation function: damping matrix. Equation of motion. Free undamped vibration: eigenvalue problem, orthogonality and normalisation of eigenvectors. General solution of free problem: eigenvectors as mode shapes. Multiple eigenvalues, vibration of suspended rigid bodies. Forced vibration: dynamic stiffness matrix. Coupling of coordinates: principal coordinates. Modal analysis of undamped systems. Kinetic and potential energy in modal coordinates. Harmonic excitation: frequency response function in terms of modal parameters. General excitation: time and frequency domain. Modal analysis of damped systems. Proportional viscous damping. Non proportional viscous damping: state space formulation. Structural damping: proportional and non proportional damping. Frequency response function in terms of modal parameters: viscous and structural damping, proportional and non proportional damping. Rayleigh ratio: stationarity. Damped vibration absorber.
Vibration of continuous systems. Transverse vibration of a string: equation of motion. D'Alembert solution; solution by separation of variables. Eigenvalue problem: fixed-fixed string, fixed-sliding string. Orthogonality and normalisation of eigenfunctions. General solution of free problem: initial conditions, physical meaning of the eigenfunctions. Axial vibration of rods: equation of motion. Eigenvalue problem: free-free rod, fixed-free rod. Torsional vibration of shafts: equation of motion, eigenvalue problem. Bending vibration of beams: equation of motion. Free vibration. Bending waves in beams and plates. Solution by separation of variables. Eigenvalue problem. Orthogonality and normalisation of eigenfunctions. General solution of free problem: initial conditions, physical meaning of the eigenfunctions. Forced vibration: modal analysis. Lumped excitation. Harmonic excitation: lumped harmonic excitation, frequency response function. Approximate solutions: Rayleigh method, Rayleigh-Ritz methods, comparison with finite element method; forced problems: assumed modes method, Galerkin method, collocation method.
Signal analysis. Analog to digital conversion: effect of the number of bits. Sampling: Fourier transform of a sampled signal. Aliasing: minimum sampling frequency as function of the maximum

	frequency of the signal. Reconstruction theorem (Shannon). Discrete Fourier transform. Effect of signal truncation: leakage and smearing. Minimisation of leakage: time windowing. Modal testing. Physical model, modal model, response model. Aim of modal testing. Input-output tests (experimental determination of frequency response function); output-only tests. Excitation tools: electrodynamic shaker, instrumented hammer. Methods to restrain the structure: rigid and elastic supports. Mounting of the exciter. Types of excitation: stationary (step sine, slow sine sweep) or transient (impulse, fast sine sweep). Experimental modal analysis. Identification of modal parameters in the frequency domain. Theoretical bases of Single Degree of Freedom (SDOF) methods: estimation of natural frequency from FRF plots (modulus, phase, real part, imaginary part, Nyquist plot). Damping estimate: half power points. Modal circle: natural frequency and damping factors estimate. Inverse plot. Extension to N degrees of freedom systems: the SDOF assumption. SDOF methods: peak amplitude, quadrature response, circle fit, line fit (Dobson). Low and high frequency residuals. MDOF methods: Non Linear Least Squares (NLLS); Rational Fraction Polynomials (RFP), etc. Comparison among mode shapes: modal assurance criterion (MAC).
Recommended readings and text books	Lecture notes (in Italian) Rao, Mechanical Vibrations, Prentice-Hall, 2005.
Examination and formal test	Written and oral test

Course:
MECHANISMS DESIGN

Lecturer: DURANTE FRANCESCO
Contact info: 0862 43.4028 FAX 0862434303; e-mail: durante@univaq.it
ECTS Credits: 6
Lecture hours: 60 Lab hours:
Semester: I
Language: Italian
Course code: I0225

Description

The course is about basical concepts and methods of functional mechanical design of machines by means of analysis and synthesis methods of mechanical systems.

Subjects of the course

INTRODUCTION
Functional mechanical design. Design parameters, performance parameters, control parameters. Steps of mechanical design.
MECHANICAL SYSTEMS ARCHITECTURE
Calls. Degrees of freedom, generalized coordinates. Kinematic analysis, direct kinematic problem, inverse kinematic problem. Kinematic synthesis. Dynamic analysis, direct dynamic problem, inverse dynamic problem. Dynamic synthesis. Planar kinematic pairs, revolute/hinge joint, prismatic/slider joint, cam pair. Alternative classification: lower pair joints, higer pair joints. Couplings: shape coupling, force coupling. Mechanisms architecture. Members classification. Kinematic chain. Mechanism. Mechanisms representation, Oldham joint.
SYNTHESIS OF CAM MECHANISMS
Rising diagram. Acceleration diagram. Acceleration coefficent (Ca). Velocity coefficient.Law with minimum Ca. Pressure angle, transmission angle. Cams: introduction, characteristic parameters. Cam synthesis, profile processing, allowable values for the pressure angle. Limitation of maximum acceleration. Limitation of maximum negative acceleration. Limitation of maximum velocity. Limitation of driver torque. Rising diagram definition: case of generalized constant acceleration. Limitation of vibrations: cycloidal law. Trapezoidal acceleration law and modified trapezoidal law. Cam profile synthesis: graphical methods. Cam profile synthesis by analytical methods: cam with radial roller follower, cam with rocker roller follower, cam with reciprocating radial flat faced follower, cam with rocker flat follower. Determination of the base radius Rb0.
SYNTHESIS OF FOUR BAR LINKAGES
Four bar linkage. Grashof classification. Synthesis of four bar linkage crank rocker for transformation of continuum rotatory motion to reciprocating rotatory motion. Synthesis of ordinary crank mechanisns. Five bar linkages. Esalateri (six bar linkages): Watt kinematic chain, Stephenson kinematic chain. Synthesis of pilgrim step motion mechanisms with k.c. by Watt. Synthesis of pilgrim step motion mechanisms with k.c. by Stephenson. Mechanisms with dwell.
GENERAL METHODS FOR MECHANISMS SYNTHESIS: GEOMETRICAL METHODS
Synthesis of four bar linkage for angular function generation. Path generation: centrode, trajectory. Eulero-Savary theorem. Inflection circle: example to determine the center of curvature of the trajectory of a four bar linkage coupler. Synthesis of the crane port. Roberts guide. Use of atlates. Hrones Nelson atlas. Roberts theorem. Synthesis of four bar linkage for path generation. Synthesis of four bar linkage for rigid motion thru two positions. Synthesis of four bar linkage for rigid motion thru three positions.
GENERAL METHODS FOR MECHANISMS SYNTHESIS: ANALITICAL METHODS
Representation of members of mechanisms by complex vectors. Vectorial equations. Synthesis of four bar linkage for angular function generation. Synthesis of four bar linkage for path generation. Synthesis of four bar linkage for rigid motion.

Recommended readings and

P. L. Magnani, G. Ruggeri, meccanismi per macchine automatiche, Utet, Torino.

text books	E. Funaioli, A. Maggiore, U. Meneghetti, Lezioni di meccanica applicata, Patron Editore. Vol. 1 Teaching materials provided by the lecturer (in English) SOFTWARE: Working Model 2D, X-camme, AutoCAD, Matlab, Rhino 3D
Examination and formal test	During the course teaching exercises are performed. They are an important part of the training activity. The exercises must be carried out and presented in report form. The examination will be written and / or oral through questions about topics on the methods of synthesis studied during the course. Preliminary assessment is carried out through discussion of the exercises performed.

Laurea Magistrale in Ingegneria Meccanica

NIVERSITA' DEGLI STUDI DELL'AQUILA

MSc in Mechanical Engineering

Course:
NON TRADITIONAL MANUFACTURING PROCESSES

Lecturer: PAOLETTI ALFONSO
Contact info: 00862434328/0862434347, FAX 0862434303; e-mail. Alfonso.paoletti@univaq.it,
ECTS Credits: 9
Lecture hours: 90 Lab hours:
Semester:II
Language: Italian
Course code: I0639

Description

The course aims to illustrate the non conventional machining processes applied to the manufacturing of traditional and innovative materials, such as composite materials.

Prerequisites: Mechanical Technology

Expected learning results: Being able to identify, both from a technical and economic point of view the manufacturing process more suitable to make a component.

Subjects of the course

Plastic materials: classification, characterization, forming and machining processes.
Composite materials: fibres and matrices, mechanical properties, manufacturing methods, machining processes.
Powders metallurgy: powders production, compaction, sintering.
Non conventional welding processes.
Non conventional machining processes: electro-discharge machining, electrochemical machining, chemical machining, laser beam machining, electro-beam machining, plasma-arc machining, ultrasonic machining, water jet machining, abrasive water jet machining.
Surfaces technology: surface treatments. Coating processes: vapour deposition, sputtering

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Recommended readings and text books

J.A. Mc Geough: Advanced Methods of Machining, Chapman and Hall.
G. F. Benedict , Nontraditional Manufacturing Processes, Marcel Dekker Inc., New York.
Metal Handbook, Vol. 16: Non Traditional Machining Processes.

Examination and formal test

One written-oral test

Laurea Magistrale in Ingegneria Meccanica

NIVERSITA'
DEGLI STUDI
DELL'AQUILA

MSc in Mechanical Engineering

Course:
NUMERICAL METHODS AND MODELS in ENGINEERING

Lecturer: PELLEGRINO ENZA
Contact info: 0862434340, FAX 0862434303, e-mail: enza.pellegrino@univaq.it
ECTS Credits: 6
Lecture hours: 60 Lab hours:
Semester:I
Language: Italian
Course code: I0231

Description

Numerical solution of Ordinary Differential Equations (ODE) with initial values and boundary conditions using the differences and finite element methods, problems of partial differential equations (PDE) and trigonometric approximation.

Subjects of the course

Numerical solution methods for ODE with initial values: one-step and multistep methods; consistency, stability and convergence; numerical solution using the software MATLAB tools ODEsuite.
Numerical solution methods for ODE with boundary conditions: Shooting method and finite differences for linear and non linear differential equations.
PDE problems: Recall on partial differential equations, characteristic lines, classification.
Explicit and implicit Finite Difference methods for initial value and the boundary problems; consistency, stability and convergence.
A brief introduction to finite element method.
Resolution of PDE problems using the toolbox MATLAB PDEtool.
Trigonometric approximation: The trigonometric polynomials of Fourier, Discrete Fourier Transform (DFT) and FFT

Recommended readings and text books

W. Gautschi: An introduction Numerical Analysis, Boston [etc.], Birkhauser , 1997.
W.J. Palm III: MATLAB 6 per l'Ingegneria e le Scienze. Mc. Graw Hill 2002.
A. Quarteroni, A.Valli: Numerical Approximation of Partial Differential Equations. Springer-Verlag 1997.
A. Quarteroni, R. Sacco, F. Saleri: Matematica Numerica. Springer-Verlag 2000.
J N Reddy: An Introduction to the Finite Element Method McGraw-Hill Series in Mechanical Engineering, Engineering Series. McGraw-Hill, 2005.
E. Santi: Appunti delle lezioni di Metodi Numerici per l'Ingegneria

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Examination and formal test

The examination is divided into a practical test on the resolution of a numerical problem to be carried out in computing laboratory and an oral test that begins with the discussion of the results of the practical test.
During the course are provided partial test that, if successful, exempts a student from the test practice.

Laurea Magistrale in Ingegneria Meccanica

NIVERSITA' DEGLI STUDI DELL'AQUILA

MSc in Mechanical Engineering

Course:
PRODUCT DESIGN AND DEVELOPMENT

Lecturer: DISTEFANO PAOLO
Contact info: 0862434314, FAX 0862434203, e-mail. paolo.distefano@univaq.it
ECTS Credits: 9
Lecture hours: 90 Lab hours:
Semester:II
Language: Italian
Course code: I2S020

Description

Product design and development is a project-based course that covers modern tools and methods for product design. The cornerstone is a project in which teams of students conceive and design an industrial product. The students work on real-life projects through our links with industry. Students are taught to do what design engineers do, namely to use innovative and creative skills. The course covers procedures that are not typically included in the engineering science subjects.

Subjects of the course

The scope of design process of industrial products. Strategies in new product development. Customer needs identification. Product specification. Independence of the functional requirements. Generate concepts and select them. Identification of the product functions and their decomposition. Product architecture development. Design-for-life cycle. Design to standards. The models of the product in the life cycle. Creative design and paradigmatic design. Embodiment design. Design for quality and minimum cost. Robust parameters design. Tolerance design: worst-case and statistical approach. Cost based optimal tolerances.

Recommended readings and text books

Kai Yang, Basem El-Haik, “Design for Six Sigma”, McGraw-Hill, 2003;
Norman Donald, “Emotional Design”, Basic Book, New York, 2004;
Suh Nam Pyo , "The principles of design", Oxford Press, New York, 1999, 2001;
Ulrich K. T. ed Eppinger S.D., “Product Design and Development”, McGraw-Hill, 2001.

Examination and formal test

The final examination is divided into written and oral test. The written test can be replaced by the team project development.

Laurea Magistrale in Ingegneria Meccanica

NIVERSITA' DEGLI STUDI DELL'AQUILA

MSc in Mechanical Engineering

Course:
TURBOMACHINES AND INTERNAL COMBUSTION ENGINES

Lecturer: ANATONE MICHELE
Contact info: 0862 434360, fax 0862434303, e-mail: Michele.anatone@univaq.it
ECTS Credits: 12
Lecture hours: 120 Lab hours:
Semester:II
Language: Italian
Course code: I0601

Description	The course aims to give deepen and broaden knowledge of the thermal power plants, turbomachines and internal combustion engines, considering aspects both operational and of design. It deals with the study of the off-design conditions of the Gas Turbine plants and the conditions of instability of compressors. The design concerns wih the Radial Equilibrium Theory. Follows the study of Internal Combustion Engines, treating the thermodynamics and the most relevant phenomena that characterize its performance. LEARNING OUTCOMES EXPECTED Knowledge of the operating principles and criteria of use of machines and ability to assess the behavior and performance of integrated energy systems.
Subjects of the course	THEORY OF SIMILARITY AND DIMENSIONAL ANALYSIS. Derivation of dimensionless groups for the description of the performance of incompressible and compressible flow turbomachines. Characteristic curves of turbines and compressors. Specific speed. Total thermodynamic parameters. MACHING OF THERMO-FLUIDYNAMIC SYSTEMS. Equilibrium of a single-axis and double-axis gas turbine plant. Equilibrium of the gas generator and the power turbine. Analysis of off-design conditions. CONDITIONS OF INSTABILITY OF COMPRESSORS. Stable, unstable, and indifferent equilibrium. Stall. Surge, Greitzer model. RADIAL EQUILIBRIUM THEORY. ISRE and NISRE equations. Boundary conditions and influence of the project law on the blades shape. Free vortex, forced vortex and three parameters laws. Design of the stage of an axial fan. Internal Combustion Engines. Classification and thermodynamic cycles. Ideal, and real thermodynamic cycles. Equations for the power. Volumetric efficiency and analysis of phenomena that influence it. Organic (mechanical) efficiency. Flow field inside the cylinder. Turbulence and organized motions of the charge. Supercharging. Analysis of combustion in spark ignition and compression ignition engines.
Recommended readings and text books	Dixon, Fluid Mechanics, Thermodynamics of Turbomachinery, Butterworth-Heinemann Cohen, Rogers, Saravanamuttoo, Gas Turbine Theory, Longman. Horlock, Axial Flow Compressors, Krieger Heywood, Internal Combustion Engines, McGraw Hill
Examination and formal test	Written and oral