Prerequisite Knowledge and Skills of 1st Year courses of the Master Degree Study Programme in Mechanical Engineering at Politecnico di Milano

095837 - CONTROL AND ACTUATING DEVICES FOR MECHANICAL SYSTEMS

Mandatory is the knowledge of basic modeling of mechanical systems composed of rigid bodies. The following topics are fundamental background: kinematics, dynamics and vibration of mechanical systems composed of rigid bodies with one and 2-n degrees of freedom.
As a mathematical support for developing modelling, obtain the equations describing the motion and solving them, matrix algebra, eigenvalues eigenvector calculation, systems of ordinary linear differential equations are needed.
Knowledge on meaning of FFT transform and frequency domain treatment of mechanical systems is also required.
Each of the two suggested references contains both the mechanical topics and also the relevant mathematical treatment (matrix algebra, FFT, and frequency domain approach):

[1] S.S. Rao, Mechanical Vibration, Prentice Hal
[2] W. T. Thomson, M.D. Dahleh, Theory of vibrations with applications, Pearson Education

095838 - APPLIED METALLURGY

Students are required to know the basic principles of physical metallurgy, the main tests for the mechanical characterization of metals (i.e. tensile tests, hardness tests, parameters associated to the fracture mechanics, fatigue tests), the equilibrium diagrams and the Fe-C diagram, the basic steel heat treatments and the CCT and TTT diagrams.
The following books can be used as references to check the expected knowledge in detail and cover possible gaps.

[1] Nicodemi W., Metallurgia - Principi generali (vol. 1), Editore: Zanichelli, Anno edizione: 2007
[2] Nicodemi W., Metallurgia - Acciai e leghe non ferrose (vol. 2), Editore: Zanichelli, Anno edizione: 2008
[3] Callister W.D., Rethwisch D.G., Scienza e Ingegneria dei Materiali, un'introduzione, Editore: Edises, Anno edizione: 2012 (versione Italiana)
[4] Callister W.D., Materials Science and Engineering, An Introduction, John Wiley & Sons Publisher: 1985 (English version)
[5] Askeland D.R., Fulay P.P., Wrighr W.J., Scienza e tecnologia dei materiali, Editore: Città Studi Edizioni, Anno edizione: 2017 (versione Italiana)
[6] Askeland D.R., Fulay P.P., Wrighr W.J,The Science and Engineering of Materials. Global Engineering publisher: 2010 (English version)

095839 - ENERGY SYSTEMS LM

In order to proficiently understand the topics of the course, the student should have a solid knowledge of the following topics taught in the bachelor level:

- Thermodynamics, thermodynamic properties of ideal gases and water (internal energy, enthalpy, entropy and their fundamental relationships), thermodynamic principles, main reversible/real thermodynamic processes (isothermal compression/expansion, adiabatic transformations, etc), basic thermodynamic cycles [1]
- Basic principles and equations of heat transfer phenomena (conduction, convection, radiation) [1]
- Fundamentals of fluid-mechanics (Bernoulli equation, Darcy law, hydraulics and compressible flows) [2]

- Fundamentals of turbomachines (operating principles of turbines and compressors/pumps), isentropic efficiency of turbomachines, nondimensional analysis of fluid machines [2, (chapters 1, 2)]
- Basic design for axial and radial machines [2, (chapters 4.1-4.10, 5.1-5.6, 7.1-7.4)]

[1] H. Struchtrup: Thermodynamics and Energy Conversion – chapters 1-9: http://link.springer.com/book/10.1007/978-3-662-43715-5/page/1

[2] S.L. Dixon and C.A. Hall: Fluid Mechanics and Thermodynamics of Turbomachinery (Sixth Edition) – chapters 1-2: http://www.sciencedirect.com/science/book/9781856177931

095840 - ADVANCED MANUFACTURING PROCESSES

In order to proficiently understand the topics of the course, the student should have a solid knowledge of the following topics taught in the bachelor level:

- Basic principles and equations of heat transfer phenomena, especially conduction, the Fourier's law and the 1d heat equation [1];
- Fundamentals of fluid-mechanics, especially the Bernoulli equation [2];
- Fundamentals of solid mechanics, especially the material behavior in the plastic field [3];
- Basic knowledge of traditional manufacturing processes (welding, metal forming, machining) and the respective fundamental phenomena (solidification of metals and alloys, plasticity) [4].

[1] https://ocw.tudelft.nl/courses/basics-transport-phenomena/ Section 4

[2] https://ocw.mit.edu/high-school/physics/exam-prep/fluid-mechanics/bernoullis-equation/

[3] http://ocw.nur.ac.rw/OcwWeb/Materials-Science-and-Engineering/3-22Spring-2004/LectureNotes/index.htm

[4] Any book on the fundamentals of manufacturing processes, e.g. Groover's Principles of Modern Manufacturing, by Mikell P. Groover, published by Wiley.

095841 - MACHINE DESIGN 2

In order to proficiently understand the topics of the course, the student should have a solid knowledge and capability of application related the following topics, that generally are taught in the courses for the bachelor degree and that are covered by [1]:

- General principles and fundamentals of the mechanical design of simple structures and machine elements
- Equilibrium of the rigid body ("free body diagrams")
- Beams and simple 2D beam structures. Constraints and kinematic analysis. Equilibrium and reactions. Internal actions and diagrams
- Stresses in beam sections (De Saint-Venant cases), 2D stress and strain analysis. Principal stresses and directions. Mohr Circles
- Stress concentration
- Mechanical properties of materials, failure criteria for static loading, assessment of structures and machine elements subjected to static loading
- Fatigue failure and fatigue assessment for simple cases
- Geometrical and functional properties, typical failure modes, pre-design and assessment of the main machine elements and simple assemblies, and in particular: springs, screws and bolted connections, shafts, bearings, gears, shaft-hub connections (shrink fit, splines, keys), shaft-shaft couplings, belt and chain transmissions.

[1] R.G. Budynas, J.K. Nisbett, *Shigley's Mechanical Engineering Design,* 10th Edition, McGraw Hill, 2015

095842 - MECHANICAL SYSTEM DYNAMICS

Mathematics: fundamentals of matrix algebra and vector analysis, Fourier series, Taylor series, linear ordinary and partial differential equations.

Basic Mechanics: planar kinematics of a particle and of a rigid body, forces and moments, in-plane static equilibrium of a rigid body, in-plane kinetics of a particle and of a rigid body, Lagrange's equations. [1]

Solid Mechanics: stress, strain and constitutive equations for a linear elastic material, bending of slender beams and axial loading of bars, elastic potential energy. [2]

Fundamentals of Vibration Analysis: free and forced vibration of single and multi-dof discrete linear systems. [3, 4]

[1] R. C. Hibbeler, Engineering Mechanics: Dynamics, Pearson Prentice-Hall, 2015
[2] F. P. Beer, E. Russell Johnston Jr., J. T. DeWolf, D. F. Mazurek, Mechanics of Materials, McGraw-Hill, 2014: https://www.mheducation.com/highered/product/mechanics-materials-beer-johnston-jr/M9780073398235.toc.html
[3] F. Cheli, G. Diana, Advanced Dynamics of Mechanical Systems, Springer, 2015: http://link.springer.com/book/10.1007/978-3-319-18200-1
[4] L. Meirovitch, Fundamentals of Vibrations, Waveland, 2010

095843 - MEASUREMENTS

In order to proficiently understand the topics of the course, the student should have a solid knowledge of the following topics taught in the bachelor level:

- Mechanical and thermal measurements: basic characteristics of measurement instruments, sampling and A/D conversion, signals, measurement uncertainty [1]
- Fundamentals of system dynamics, mathematical representation of first and second order systems, fundamentals of vibration measurements, sensors [1][2]
- Fundamentals of the theory of vectors, Fourier series and transform [2]
- Statistics: basic statistics, uniform and rectangular statistical distributions [3]

[1] E.O. Doebelin, Measurement Systems: Application and Design, 5th edition, McGraw-Hill
[2] A. Brandt, Noise and Vibration Analysis: Signal Analysis and Experimental Procedures, Wiley 2011
[3] D. Montgomery and G. Runger. Applied statistics and probability for engineers, (With CD). John Wiley & Sons, 2007.

095844 - DESIGN AND MANAGEMENT OF PRODUCTION SYSTEMS

The knowledge and skills related to the course 086448 MANAGEMENT AND INDUSTRIAL ENGINEERING (or 086468 MECHANICAL PLANTS or equivalent) are mandatory.
In particular, basic knowledge of cost accounting (e.g., fix vs. variable costs, investment evaluation, decision-making, …), statistics (e.g., probability density vs. cumulative distribution function, continuous vs. discrete distributions, Normal distribution, Standard Normal distribution, calculation of probability and inverse of the normal cumulative distribution, correlation, …) and organisation theory and design are not recalled during the course.

[1] [1] Jacqueline Birt, Keryn Chalmers, Suzanne Maloney, Albie Brooks, Judy Oliver. Accounting: Business Reporting for Decision Making, 6th Edition. ISBN: 9780730363415