

Faculty	Ingegneria
Master	Mechatronic Engineering (La Spezia)
Year/Semester	1/I e II

Course Title	Materials and manufacturing technologies for mechatronics engineering
ID Course Code	56806
Course Credits (CFU)	12
Scientific-Disciplinary Sector	ING-IND/16
Course Type	mono-disciplinary course
Lecturer-in-charge	LONARDO Pietro; BRUZZONE Alessandro

Learning Outcomes:

The module on materials gives the knowledge necessary to choose and employ materials taking into account the technological processes and functional uses of the product. A particular importance is deserved to electrical, magnetic, optical properties and to innovative and smart materials used for sensors and mechatronic appliances.

The module on manufacturing technologies presents the information necessary to design and control the manufacturing processes that produce mechanical and mechatronic products and systems. Specifically the non-conventional machining processes, micro-products manufacturing and assembly, additive manufacturing, reverse engineering.

Course Organisation Details

Bonding in solids. Crystal structures: lattices, defects, dislocations. Metals, ceramics and glasses, polymers, composite materials. Physical properties of materials. Elastic properties: stress-strain relationships, anisotropy, elastomers, composites. Viscoelastic properties: models. Plastic properties: yield, criteria, strain and strength of crystals. Electrical properties: conductors, intrinsic and extrinsic semiconductors, p-n junction, wafer fabrication, superconductivity. Magnetic properties: physical parameters, types of magnetism, ferromagnetic materials, hysteresis, soft and hard magnets, magnetic recording. Optical properties: refraction index, reflection of insulators and metals, polarization, luminescence, LED, laser, optical fibres. Smart materials: piezoelectric materials, electrostrictive and magnetostrictive materials, shape memory alloys, electro- and thermo-chromic materials.

Manufacturing industries, plant layout, mass production, batch production, job shop production. Review of conventional manufacturing processes: removing material technologies, moving material technologies, structural joining technologies, assembly. Automated production systems: fixed, flexible and programmable automation. Numerical control production systems: architecture, functions, ISO 6983 language. Numerical control systems evolution: CAD/CAM. Standardization of the manufacturing process: Step NC, ISO 14649, Unconventional manufacturing processes: additive technologies, STL file format, rapid tolling. Reverse engineering: methodology, devices and systems for forms acquisition. Micro-engineering: size effect, definitions, classification and micro-products developments. Materials for micro-products. Technologies for micro-products manufacturing: classification, physical principles, tolerancing, hetero/hybrid/monolithic integration, MEMs/Energy-assisted/mechanical processes, replication, replication techniques, handling, assembly. Micro-factory: architecture, components and control, example of micro-factory for micro-products assembly.

Assessment	hours
Lectures	100.0
Practice	20.0
Laboratory	0.0
Integrative activities	0.0

References

P.M. Lonardo, *Lezioni di Materiali per l'energia Meccatronica*, 2009;

R.E. Kummel, *Electronic Properties of Materials*, Springer, 1992;
W. F. Smith, *Scienza e Tecnologia dei Materiali*, McGraw Hill, 1995;
N.E. Bowling, *Mechanical Behavior of Materials*. Pearson Prentice Hall, 2007.

A.A.G. Bruzzone, *Lezioni di Tecnologie di Produzione per l'Ingegneria Meccatronica*, 2009;
L. Alting, F. Kimura, H.N. Hansen, G. Bissacco, 2003, *Micro Engineering*, CIRP Annals, Volume 52/2, pp. 635-657;
A. A.G. Bruzzone et al., 2009, *Study and integration of microtechnologies for smart assembly of hybrid micro-products*, Int. J. Mechatronics and Manufacturing Systems, Volume 2/3 / 2009, pp. 265 – 293.

Organization and examinations

The course is held in two semesters. The oral examinations are made at the end of the course.

Pre-requisites

None