Course Name:: ***A Selection of Materials Science Lectures***

Doctorate: Electrical Engineering

Lecturer: ***Gianfranco Coletti (gianfranco.coletti@unige.it)*** *;*

Duration: 24 hours

Credits: 6

This course will be intensive and will be delivered in English. Interactive modes will be adopted as often as possible along the classroom hours. The course contents would cover the interests of 3rd level students having different "roots": mechanical, electrical, electronic, bio-engineering, informatic roots, or medicine, chemistry areas et altera.

The exam dates will be agreed with the students during the lectures. Exam duration: up to 45-60 min.

Aims of the course:

this interactive course would support the students in designing a personal frame to various physical phenomena starting from basic knowledge (matter, 1D-2D-3D types, nanotechnology basis, electrical and thermal conduction, polarization, mechanical behaviour) , considering time, frequency and voltage dependance and arriving at long term phenomena, including electromagnetic interactions. The course aims at making the students capable of understanding and combining basic elements mainly through INTERACTION and DIALOGUE. This way they would become capable of solving different problems , along a personal path.

Topics:

Matter: atoms , molecules, crystalline grains, domains, polymers et al. - Metals in Structures. - Defects. – Toughness, hardening and annealing. Tensile and compression strength in metals as well as in reinforced composites. Effects of Heat and temperature. - Diffusion in solids.: Fick laws.

Exploring basic nanotechnologies in detail : 3D, 1D (nanotubes) and 2D (graphene) materials.
Nanoparticles-. EU Scenihr Opinions and rules concerning nanosafety
Electrical Conduction in solids: Drude, Sommerfeld and Band Theory Models

Insulating Fluids:
Retrieving basic electrical elements concerning electrical conduction: Townsend theory, Paschen law, photo-ionisation, avalanches, thermionic effect.
Insulating solids:
outlines of AC/DC thermal breakdown and electronic breakdown. Role of defects.

Polarization mechanisms: from DC to lasers. Composite insulators: polarisation
Notes about electrical damages: electrostatics, electrical failures, partial discharges .

Solid materials: short and long term properties.
Revisiting General approaches for inorganic/organic materials . Models: Physical, phenomenological (De Saint-Venant) and empirical models. Ageing : a general approach (non valid for bioengineering cases). TEAM models. Accelerated tests. Montsinger rule. Arrhenius law –Single stress and multistress conditions.

Retrieving basic elements: a) electric current and magnetic field. b) Electromagnetic force. Lorentz force. c) Electromagnetic waves, periodic phenomena. d) Magnetic aspects of materials: physical modelling and energy losses. Role of order/disorder (entropy) in such cases.

The role of Standards in Practical applications (e.g. IEC).

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Exam: Oral exam . Duration: up to 45-60 min. - Positive range: 18 -30, Negative range: 0 – 18.

Basic References: Lecture notes, written by the lecturer

Additional References for deeper studies:

- J.J.O'Dwyer "The theory of electric conduction and breakdown in solids"

- W.Hauschild and W:Mosch " Statistical techniques for high voltage engineering"

- O.M. Kazarnovsky et al " Testing of Electrical Insulating Materials"

- K.J.Pascoe "Properties of Materials for Electrical Engineers"

- B.R.Coles and A:D:Caplin " The electronic structures of solids"

- C.P.Poole and F.J.Owens "Introduction to Nanotechnology"

-further material written by the lecturer