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

Doctorate: Electrical Engineering and STIET

Lecturer: ***Gianfranco Coletti (gianfranco.coletti@unige.it)****; cell. 347 8143 167*

Duration: 20 hours + 4 lab hours

Credits: 6

This course will be intensive and its lectures will be delivered in English. Interactive modes will be adopted as often as possible. The course contents do address the interests of "PhD" students having different "roots": mechanical, electrical, electronic, bio-engineering, informatic roots, or even interested students from the scientific areas (medicine, chemistry et altera).
The lectures will be delivered from distance in 10 two-ours Telematic sessions.
Platform: Microsoft TEAMS.
Here is a time schedule.

July 6: Monday 10-12
July 7: Tuesday 10-12
July 8: Wednesday 10-12
July 9 Thursday 10-12
July 10 Friday 10-12

July 13: Monday 10-12
July 14: Tuesday 10-12
July 15: Wednesday 10-12
July 16 Thursday 10-12
July 17 Friday 10-12

Each Lecture full text (Word or similar) file(s) will be sent to students at least one day before schedule.

The course will be closed by public exams.
Exam date: to be agreed with students.
Exam duration: 45-60 min.

Aims of the course:

This course will often make use of INTERACTION and DIALOGUE in order to 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, piezoelectric and mechanical behaviour) , considering time, frequency and voltage dependence and arriving at long term phenomena, including some electromagnetic interactions.

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 (simplified quantistic approaches).
Applied examples: 3D nano-concepts needed to achieve "rapid" conduction for deep-computing (i.e. need for metals (specific metals)).
Piezoelectricity: from historical to nowadays' applications. Advanced possibilities.
Notes about: Cracks and Fatigue failure (up to the Paris Curve)

Polarization mechanisms: from DC to lasers. Composite insulators: polarisation.
Retrieving (together) basics about electrical damages: electrostatics, electrical failures, piezoelectrics.
Notes about basics of electrical conduction in gases: Townsend theory, photo- avalanches, thermionic effect, AC/DC thermal breakdown and electronic breakdown. Role of defects.
Views about conduction/insulation in Liquids (time-frame et similia) and in solids.

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

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It is assumed that the basic knowledge elements are already known. For example, the following elements should be retrieved before attending this course:
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. e) the role of Standards in Practical applications (e.g. IEC, ISO, ASTM, etc).
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Basic References: Lecture Notes, produced by the course-master. + *Additional References:*

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

- *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"*

- *Fatigue Essential MIT books by prof. Suresh*

-further material suggested by the lecturer