Strumentazione ed elettronica industriale

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0.1 Introduzione al corso

obiettivo del corso:

- provide students with key concepts in power electronics and power systems, in order to create a link between them
- suddivisione lezioni:
  - 40 h lezioni teoriche
    - introduction to concepts
    - Power systems basics
    - power electronics devices
    - data acquisition systems for industrial applications
    - Power converters
  - 20 h lezioni pratiche
    - labview programming
    - lab experiments on three-phases systems, power electronics devices and power converters
- references:
  - Power system Stability and Control, Mcgraw Hill
  - Power Electronics: Converters, application and design N Mohan, TM Undeland

  esame: parziale: crocette + orale, esercizio labview + orale totale: fare un progetto a casa + orale

Chapter 1

introduction to concepts

1.1 Power systems and electronic issues

mission: transfer, process and control the flow of electrical power both within and between systems in a way which is optimally suited for user loads
Primary goals:

- avoid or mitigate major faults as well as safety hazards for users and staff
  - reliability/protection issues
  - *power quality* issues
- Maximize efficiency
  - excessive cost of wasted energy
  - reducing equipment size, weight and cost
  - heat dissipation issues
  - energy conservation policies for green house gas emussui abd sustainability

types of power systems:

- Direct Current (DC)
  - constant (regulated) magnitude
  - Adjustable magnitude
- Alternating Current (AC)
  - Single-phase
    * constant frequency, adjustable magnitude
    * adjustable frequency and magnitude
  - Three-phase
    * constant frequency, adjustable magnitude
    * adjustable frequency and magnitude

Power Converters: systems based on power electronics devices and controlled by embedded processing platforms one of the following trasformations for adapting generators to loads:

- DC/DC
- AC/DC
- DC/AC

overview of the powergrid:

- Electrical power is transferred at High voltage to reduce th ohmic losses due to currents
- As the power is distributed the maximum rated power is decreased and the voltage is progressively reduced by multiple transformers to make it more suitable for final users

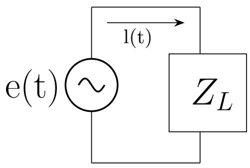
- most of electricity still generated at the transmission level, but the generation due to distributed energy resources (DERs) is growing (solar farms etc)
- in future significant bidirectional power flows between prosumers are also envisioned at the distribution level

joule effect of a single wire: $\frac{1}{2}RI^2$ the higher is the lenght the higher the tension should be to lower the joule effect

power grid basic features

- an electricity grid consists of buses and lines
- a bus is the point of a power system where feeders, generators and loads re connected
- a line consists of overhead or underground three-phase confuctors
  - Transmission Grids (HV)
    * mesh topology
    * lines inductance more significant than resistance $->$ large X/R ratio
    * symmetric and balanced systems $->$ single phase power flow analysis is usually enough
  - Distribution Grids (MV and LV)
    * radial topology (ad albero inverso)
    *

1.2 AC power transfer criteria



$$P(t) = e(t) \cdot i(t) = EI\cos(\omega_0 t + \varphi_e)\cos(\omega_0 t + \varphi_I) \qquad \begin{aligned} e(t) &= E\cos(\omega_0 t + \varphi_e) \\ i(t) &= I\cos(\omega_0 t + \varphi_I) \end{aligned}$$

$$\begin{aligned} \widetilde{E} &= Ee^{I\varphi_e} \\ \widetilde{I} &= Ee^{I\varphi_I} = \frac{\widetilde{E}}{Z_L} \end{aligned} \quad = \left(\frac{Ee^{J(\omega_0 t+\varphi_e)} + Ee^{-J(\omega_0 t+\varphi_e)}}{2}\right)\left(\frac{Ie^{J(\omega_0 t+\varphi_I)} + Ie^{-J(\omega_0 t+\varphi_I)}}{2}\right) =$$

$$= \frac{1}{4}\left(EIe^{J(\varphi_e \cdot \varphi_I)} + EIe^{-J(\varphi_e \cdot \varphi_I)}\right) + \frac{1}{4}\left(EIe^{J(2\omega_0 t+\varphi_e+\varphi_I)} + EIe^{-J(2\omega_0 t+\varphi_e+\varphi_I)}\right) =$$

$$\frac{1}{4}(\widetilde{E}\widetilde{I}^* \cdot \widetilde{E}^*\widetilde{I}) + \frac{1}{2}EI\cos(2\omega_0 + \varphi_e + \varphi_I) = P + \frac{1}{2}\Re\{\widetilde{E}\widetilde{I}^*\}\cos 2\omega_0 t + 2\varphi_I - \frac{1}{2}\Im\{\widetilde{E}\widetilde{I}^*\sin 2\omega_0 t + 2\varphi_I\} =$$

$$= P + P\cos(2\omega_0 t + 2\varphi_I) - Q\sin(2\omega_0 t + 2\varphi_I)$$