POLITECNICO
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PREREQUISITES FOR THE AUTOMATION AND CONTROL ENGINEERING MSc. PROGRAMME *POLITECNICO DI MILANO*

Before attending classes in the Automation and Control Engineering MSc. Programme, it is advisable that the students have a satisfactory background in:

- Linear algebra
- Automatic control
- Applied mechanics
- Electrical machines

Textbooks

Linear algebra

- G. Strang
  Linear algebra and its applications
  Harcourt Brace & Co,
  See also the on-line lectures:
  http://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/index.htm

Automatic control

- K. J. Åström and R. M. Murray
  Feedback Systems: An Introduction for Scientists and Engineers
  available on the web:
  http://www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page
- G. F. Franklin, J. D. Powell, M. L. Workman
  Digital control of dynamic systems
  Addison Wesley, 1997

Applied mechanics

- H. Josephs and R. L. Huston
  Dynamics of mechanical systems
  CRC Press, 2002
- R. C. Hibbeler
  Engineering Mechanics – Dynamics
  Prentice Hall, 2009

- J. L. Meriam and L. G. Kraige
  Engineering Mechanics – Dynamics
  Wiley, 2006

Electrical machines

- A. E. Fitzgerald, C. Kingsley Jr. , S. Umans
  Electric Machinery - - McGraw-Hill
  See also the on-line lectures:
  http://castellidezza.faculty.polimi.it/?page_id=249&lang=enhttp://castellidezza.faculty.polimi.it/?page_id=249&lang=en
- N. Mohan, T. M. Undeland, W. P. Robbins
  Power Electronics: Converters, Applications, and Design
  John Wiley & Sons

Prerequisites

Linear algebra

- Vectors, matrices, inverse and transpose: Strang, Chapter 1
- Vector spaces and fundamental subspaces: Strang, Chapter 2 (2.1-2.4)
- Linear transformations: Strang, Chapter 2 (2.6)
- Orthogonality: Strang, Chapter 3 (3.1 and 3.4)
- Determinants: Strang, Chapter 4
- Eigenvalues and eigenvectors: Strang, Chapter 5 (5.1, 5.2, and 5.4)
- Similarity transformations: Strang, Chapter 5 (5.6).

Automatic control

- System modeling (modelling concepts, state space models, examples): Åström & Murray, Chapters 2, 3;
- Dynamic behavior (differential equations, qualitative analysis, stability): Åström & Murray, Chapter 5 (5.1-5.3);
- Linear systems (matrix exponential, input/output response, linearisation): Åström & Murray, Chapter 6;
- Transfer functions (frequency domain modelling, transfer function, block diagrams, Bode plots, Laplace transform): Åström & Murray, Chapter 9;
- Frequency domain analysis (loop transfer function, Nyquist criterion, stability margins, Bode's relations, generalised gain and phase): Åström & Murray, Chapter 10 (10.1, 10.2, 10.3);
- PID control: Åström & Murray, Chapter 11;
- Frequency domain design: Åström & Murray, Chapter 12;
- Basics of discrete time systems and digital control: Franklin, Powell & Workmann, Chapters 3-7.

Applied mechanics

- Fundamentals of vector analysis: representation through scalar components and complex numbers, vector sum, scalar product, vector product.
- Taylor Series and Fourier Series.
- Constant coefficient linear ordinary differential equations.
- Planar kinematics of particles and rigid bodies: position, motion, velocity and acceleration of a particle/rigid body, instantaneous rigid motion of a rigid body and instant centre of rotation, relative-motion analysis.
- Forces and moments. Active and constraint forces. External and internal forces.
- In-plane static equilibrium of a rigid body and of a system of rigid bodies: equilibrium equations, principle of virtual work.
- Mass properties of a rigid body: center of mass, moment of inertia about a given axis.
- Planar dynamics of a particle, of a rigid body and of a system of rigid bodies: Newton's laws of motion, Energy Methods, Lagrange’s Equations

Electrical machines

- *Electric Circuit Analysis:* Phasor theory, Three-phase circuits, Real, reactive and complex power
- *Magnetic Circuits:* Magnetic flux, Faraday's law, Flux linkage
- *Transformers:* Single phase and three-phase transformer, Principles of operation, Steady-state equivalent circuits, No-load and short-circuit condition
- *Introduction to Rotating Machine:* Principles of operation and steady-state equivalent circuits of a dc machine, Speed-Torque characteristics of a separately excited dc machine, Space-phasor theory: the dq0 transformation, Rotating magnetic field
- *AC Machines:* Principles of operation and steady-state equivalent circuits of a synchronous machine, Capability curves of a synchronous machine, Principles of operation and steady-state equivalent circuits of an induction machine, Speed-Torque characteristics of an induction machine
- *Semiconductor circuit elements:* Main characteristics of diode, MOSFET, BJT, IGBT (Mohan-chapter 2: Overview of Power Semiconductor Switches)