UNIVERSITÀ DI PISA

APPLIED MECHANICS IN MACHINE DESIGN

MASSIMO GUIGGIANI

Anno accademico	2021/22
CdS	MECHANICAL ENGINEERING
Codice	108II
CFU	12

Moduli	Settore/i	Tipo	Ore	Docente/i
MECCANICA APPLICATA ALLE MACCHINE	ING-IND/13	LEZIONI	120	ALESSIO ARTONI MASSIMO GUIGGIANI

Syllabus

1-MECHANISMS AND MACHINES Definitions, kinematic pairs, degrees of freedom of plane mechanisms and mechanisms in space. Absolute and periodic regime conditions, efficiency, machines in series and in parallel, retrograde motion.
2-COUPLING BETWEEN ELEMENTS OF MACHINES
a - SLIDING AND ROLLING CONTACTS Sliding friction: static and kinetic friction coefficients, Coulomb laws. Rolling friction: rolling friction coefficient. Wear: basic concepts and laws. Determination of the contact pressure between solids in relative motion. Applications of hypotheses and laws in elementary pairs and simple mechanisms.
b - LUBRICATED CONTACTS Fundamental equations of fluid mechanics: Navier-Stokes equations. Reynolds equation, Laplace equation. Laminar flow through ducts. Turbulent motion. Solution of the Reynolds equation in the plane case and application to the thrust torque limited by plane walls. Coefficient of friction: Stribeck curve, lubrication regimes. Finite size flat shoe (correction factors and diagrams). Thermal effects. Approach lubrication. Lubricated rotational torque: finite axial length torque, practical use diagrams. Lubrication of the upper pairs. Application formulas. Fluid-static lubrication: applications to thrust and load-bearing bearings. Choice of bearings.
3-ARTICULATED SYSTEMS Recall of the properties of plane motions. Center of accelerations, trajectories, center of curvature (Euler Savary's formula), circumference of inflections. Conjugate profiles, relative motions, motions in space (spherical and general).
Articulated quadrilateral: definitions, hints on synthesis problems, articulated parallelogram and its uses, analysis with the graphic method (determination of velocity and acceleration of points of the connecting rod) and analytical. Thrust crank mechanism: definitions, graphical and analytical analysis. Spatial articulated systems: methodology for kinematic analysis. Example of a quadrilateral articulated in space: Cardano joint. Kinetostatic analysis: analytical and graphical methods.
4-TRANSMISSION OF THE MOTION
a - MECHANISMS WITH TOOTHED WHEELS Transmission of motion between shafts: general. Motion transmission between parallel axes: spur gears with straight teeth (with involute profile), transmission ratio, contact line and arc of action, non-interference condition, correction, efficiency, cylindrical gears with helical teeth. Motion transmission between incident axles: bevel gears with straight and curved teeth, face gear. Motion transmission between skewed axles: hypoidal wheels, screw-helical wheel couple. Ordinary gear trains: transmission ratio and outline of the design criteria. Planetary gears: examples of gears with 1 and 2 degrees of freedom, efficiency.
b - MECHANISMS WITH FLEXIBLE ORGANS Stiffness of flexible members (ropes, chains, belts, tapes). Lifting machines: fixed and mobile pulleys. Motion transmission between two shafts: pulleys with flat belts, trapezoidal and toothed belts, chains.
5-DYNAMICS
a - SYSTEMS WITH RIGID ELEMENTS Review of fundamental formulas and equations: forces, moments, kinetic energy. D'Alembert and energy equations, direct and inverse dynamic problem, reduction of forces and masses. Dynamic balance of the thrust crank mechanism, forces acting on the frame, compensation of inertia forces. Kinetic energy. Notes on the dynamics of the articulated quadrilateral. Dynamics of plants operating in a periodic regime: definition and calculation of the degree of irregularity (graphic and analytical methods), flywheel. Static and dynamic unbalance of the rotors, balancing.
b - SYSTEMS WITH DEFORMABLE ELEMENTS Systems with one degree of freedom: free vibrations, forced vibrations with sinusoidal excitatory force, vibration isolation; forced vibrations with arbitrary excitation. Two degrees of freedom systems: free vibrations, proper modes (mass, stiffness and damping matrices), forced vibrations; dynamic damper. Proportional damping. Systems with many degrees of freedom. Effects of vibrations.

Updated: 17/01/2022 12:42