UCL Faculté des sciences appliquées

FSA

| MECA2802 | Mécanique des robots et systèmes articulés |

[30h+30h exercises] 5 credits

This course is taught in the 2nd semester

Teacher(s):   Jean-Claude Samin
Language: french
Level: 2nd cycle course

Aims

Give students a complementary education in the field of mechanics of systems of rigid bodies (geometry, kinematics, dynamics) bu studying the modelling aspects of complex articulted systems.
Develop the sutdents capacities in designing, writing and/or using multibody modelling software for robots, vehicles, suspensions systems and other mechanisms,.. with a view to their geometrical, kinematical and dynamical analysis.

Main themes

Definition and classification of multibody systems. Description of the various methods used by multibody softwares. Multibody formalisms for tree-like multobody systems (e.g. serial robot manipulators) and closed-loop systems (e.g. parallel manipulators, vehicles,...) : automatic computer generation of the dynamical eduations and numerical integration algorithms for differential-algebraic equations (DAE)

Content and teaching methods

1. Definition and classification of multibody systems (NBS). Principal characteristics of the computer programs used in modelling and analyzing multibody systems.
2. Multobody formalisms for tree-like systems (e.g. serial robots) or closed-loop mechanisms (e.g. vehicles)
- definition of barycentric quantities
- automatic generation of the dynamical equations using the Lagrange multipliers technique (use of the virtual power principle and Newton-Euler recursive algorithm)
- algorithms for numerically integrating systems of differential-agebraic equations (DAE) : Baumgarte method (constraint relaxation) and coordinate partitioning method.
3. Minimal parametrization of MBS and dynamical identification.
4. Particular applications : serial and parallel robots, road vehicles, railway vehicles, multibody systems with flexible elements.
5. Robotics (serial industrial manipulators) :
- direct and inverse geometrical models
- direct and inverse kinematic models
- optimized inverse models for redundant manipulators (use of pseudo-inverse).
Students are invited to design and implement a programming project for a specific application by using the symbolic multibody software ROBOTRAN developed at UCL.

Other information (prerequisite, evaluation (assessment methods), course materials recommended readings, ...)

Prerequisites : first basic courses on classical mechanics and computer programming (Matlab and C).
Exam : oral examination. The exam consist of two parts :an examination on the theory (with lecture notes available) and a discussion about the project (theory, modelling and software implementaiton).
support : lecture notes and copies of the slides used during the lectures.
Basic reference : J.-C. Samin and P. Fisette : "Symbolic Modeling of Multobody Systems", Kluwer Academic Publishers, Dordrecht/Boston/London, 2003.
Recommended readings :
- Parviz E. Nikravesh, Computer-Aided Analysis of Mechanical Systems, Prentice Hall Inc., 1988.
- Haug, E.-J. : Computer Aided Kinematics and Dynamics of Mechanical Systems, Allyn and Bacon, Boston, 1989.
- B. Gorla et M. Renaud, Modèles des Robots Manipulateurs : Application à leur Commande, Cepadues éditions, 1984.
- E. Dombre et W. Khalil, Modélisation, Identification et Commande des Robots, Traité des Nouvelles Technologies : Série Robotique, Hermes, 2ème édition, 1999.

Other credits in programs

ELME23/M	Troisième année du programme conduisant au grade d'ingénieur civil électro-mécanicien (mécatronique)	(5 credits)
MECA21	Première année du programme conduisant au grade d'ingénieur civil mécanicien	(5 credits)
MECA22	Deuxième année du programme conduisant au grade d'ingénieur civil mécanicien	(5 credits)
MECA23	Troisième année du programme conduisant au grade d'ingénieur civil mécanicien	(5 credits)