2021-2022	Mechanical Engineering	Year 3 - Sem. 5
MECA307	**Kinematics and dynamics of machinery**	**Mandatory**
ECTS: **4**	*Coordinator:* Dr. Rani Rizk	*Language:* English/French
Total hours: **54 h**	*Lectures:* Dr. Mohammad A.Wahab, Dr. Rani Rizk, Dr. Jaafar Hallal.	

Description:

The student in the end of this course has to be able to analyze a planar mechanism. The student should know how to develop the forward and inverse kinematics and differential models as well as to develop the equations of motions and to compute the forces in the mechanism. The student must can calculate constrain forces in the mechanism as well as required forces and torques to overcome the inertia and applied external loads. In this course the student learns also the linkage and mechanism synthesis. The student learns to find the size of a linkage and the shape of a cam. Mainly crank slider, four-bar linkage, cams and gears are the mechanisms studied in this course.

Learning outcomes:

- Understand the closed loop chain principle for the development of the forward kinematics and differential models,
- Understand the virtual work theorem and the Lagrange equation to be able to calculate the equation of motion
- Develop the forward and inverse kinematics model of the crank slider mechanism and to compute internal forces and torque actuator.
- Carry out a complete kinematics study of a four bar linkage, develop the equation of motion and design a four-bar linkage.
- Develop kinematics analysis of a cam follower mechanism with the equation of motion.
- Find the shape of the cam based on the displacement diagram.
- Compute the speed and ratio of a classical gear train and to analyze different forces in the gears.
- Understand the epicyclical gear train and the differential mechanism.
- Understand the gyroscopic effects.
- Develop a static and dynamic balancing for different linkages.

Content:

- General introduction about the world of mechanisms. Technical terminology, development of the forward and inverse kinematics model, development of the forward and inverse differential model and singularities. Static forces analysis, elimination of internal forces, virtual work theorem, total potential energy. Dynamic forces analysis, inertia forces, shaking forces, internal forces elimination, Lagrange equation. Applications on the crank-slider mechanism.
- Four-bar linkage analysis, forward kinematics model, transmission angle, forward and inverse differential model, singularities. Kinetostatics analysis, dynamic forces analysis, fourbar linkage synthesis.
- Introduction to the cams, Cam classification, kinematics parameters, kinematics variables, transmission angle, cam synthesis, static and dynamic analysis. Cam synthesis.
- Gears calculations, classical gear train, planetary gear trains, and Differential mechanism, Statics and dynamics forces in gears.
- Balancing, static balancing, dynamic balancing, linkage balancing
- 3D dynamics, inertia tensor, gyroscopic effects, free torque motion.

References:

- Theory of mechanisms and machines, John J. Uicker, Gordon R. Pennok, Joseph E. Shigley, fifth edition..

Evaluation Method:

Assessment in the following areas will be converted to points, to compute your final grade in this course:

- Mid-Term
- Practice project
- Final Exam

- Attendance and Participation

Description :

Ce cours a pour but d'améliorer la créativité mécanique de l'étudiant. A la fin de cours, l'étudiant doit pouvoir effectuer le calcul cinématique dynamique ainsi que la conception de n'importe quel mécanisme plan. Le cours traitre notamment quatre types de mécanismes, le piston bielle manivelle, mécanisme à quatre barres, les cames et les engrenages ou éléments de transmission de puissance. Le cours traite aussi l'équilibrage statique et dynamique des mécanismes ainsi que les effets gyroscopique et la dynamique spatiale.