lgciv2042

2021

Dynamics of structures

4.00 credits	20.0 h + 15.0 h	Q1

Teacher(s)	Saraiva Esteves Pacheco De Almeida João ;
Language :	English
Place of the course	Louvain-la-Neuve
Prerequisites	Background on strength of materials, structural mechanics and structural analysis (e.g. courses LGCIV1031, LGCIV1022 and LGCIV1023).
Main themes	See "content"
Learning outcomes	**At the end of this learning unit, the student is able to :**
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Evaluation methods	Assignments (35%), project (40%), and written evaluation (25%).
Teaching methods	Lectures based on course slides and exercise solving with student participation. Project.
Content	
Inline resources	Available in Moodle.

At the end of this learning unit, the student is able to :

Contribution of the course to the program objectives:

AA1.1, AA1.2, AA1.3, AA2.1, AA2.2, AA2.3, AA2.4, AA3.1, AA3.2, AA4.2, AA4.4

Specific learning outcomes of the course :

- At the end of the course, the student will be able to:
- Understand the field of application of different models: single-degree-of-freedom (SDoF) systems versus multi-degree of freedom (MDoF) systems, material and geometric linearity versus nonlinearity, static versus dynamic problems.
- Write the equations of motion and understand solution methods for SDoF and MDoF systems, both for linear and nonlinear problems.
- Characterize the dynamic properties of a SDoF system and compute its response under various loadings.
- Characterize the dynamic properties of a MDoF system and compute its response under various loadings.
- Characterize dynamically a system by the frequency response function, represent loading as a summation of harmonic components (Fourier transform), compute response to harmonic components (convolution in the frequency domain), transform sum of harmonic responses to time domain (inverse Fourier transform), understand consequences of sampling and aliasing errors.
- Understand principles of seismic modelling and analysis of frame structures accounting for material and geometric nonlinearity.
- Solve practical problems of different structures affected by critical vibrations (induced by people, machines, wind, traffic and construction activities, earthquakes) for serviceability and safety limit states.

Evaluation methods: Assignments (35%), project (40%), and written evaluation (25%).

NOTE: These instructions take into account a "green" or "yellow" Covid scenario at UCLouvain. Modifications can be made in case of "orange" or "red" scenario, or restrictions in classroom capacities.

Content:

- Linear single--degree--of-freedom (SDoF) systems: free vibration, damping values in structures, harmonic loading, evaluation of viscous damping and frequency, response to unit impulse and other forces, methods of solution, force transmission, response to ground motion, and vibration isolation.
- Nonlinear SDoF systems: numerical time-domain integration (central difference, constant average acceleration and linear acceleration, Newmark), classification, stability, computational error, algorithmic damping, inelastic response (bilinear system).
- Linear multidegreeoffreedom (MDoF) systems: free vibration of undamped systems (natural vibration frequencies and modes, modal and spectral matrices, orthogonality of mode shapes, normalisation, modal expansion), free vibration of damped systems, damping and energy dissipation in linear (and nonlinear) analyses, damping models, modal analysis, displacement response and element forces, restated form, modal contribution factors, modal responses and required number of modes, influence of dynamic response factor, applications (including ground motion).
- Nonlinear multidegreeoffreedom (MDoF) systems: numerical time-domain integration, applications.
- Frequency-domain method of response analysis.

Bibliography	• « Dynamics of structures: Theory and Applications to Earthquake Engineering », Anil K. Chopra, Prentice Hall, 2012. • « Dynamics of structures », Ray W. Clough and Joseph Penzien, Computers & Structures, 2003. • « Vibration problems in structures: Practical guidelines », Hugo Bachmann et al., Birkhauser Verlag, 1995.
Other infos	• Use of Matlab / Python scripts and structural analysis program.
Faculty or entity in charge	GC

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Mechanical Engineering	MECA2M	4		🔍
Master [120] in Electro-mechanical Engineering	ELME2M	4		🔍
Master [120] in Civil Engineering	GCE2M	4		🔍