Design of structures against impact

Academic Year: (2019 / 2020) **Review date: 21-03-2019**

Department assigned to the subject: Continuum Mechanics and Structural Analysis Department

Coordinating teacher: ARTERO GUERRERO, JOSE ALFONSO

Type: Electives ECTS Credits : 6.0

Year : 4 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

We advise you not to take this course if you have not passed the following subjects:

Mechanics of structures
Elasticity and Strength of materials.

OBJECTIVES

Knowledge of the types of protection used in transports and infrastructures against projectiles and explosives.

Knowledge of the main material models used for dynamic loadings

Acquisition of the fundamentals of the impact analysis and the propagation of elastic and plastic waves.

Knowledge about dynamic characterization of materials

Acquisition of the technological knowledge needed to calculate analytically protections of metals, ceramics, metal+ceramic, fabrics and composites

Ability to characterize experimentally material in the dynamic regime (medium and high strain rate).

Ability to use specific software to analyze, design and calculation of structural elements against impact, developing a critical awareness.

Know and apply science knowledge and technology based on the industrial technology engineering.

Capacity to design, develop, implement, formulate and solve problems inside wide and multidisciplinary context, being able to integrate knowledge, working on multidisciplinary teams.

Understand the impact of the industrial technology engineering on the environment, sustainable development and importance to work on a professional job environment.

Be able to communicate knowledge and conclusions clearly, orally or written, into specialized and non-specialized public

Learning ability that lets you to continue study along the whole life for an adequate professional development.

Incorporate new technologies and tools from the industrial technology engineering in its professional skills.

Managing projects and human teams.

DESCRIPTION OF CONTENTS: PROGRAMME

Topic 0: STRUCTURE AGAINST IMPACT: CONCEPT, INTEREST AND MATERIALS. Introduction.
Topic 0.1: Types of protection. Momentum, impact and impulse
Topic 0.2: Materials used for protection.
Topic 1: ADVANCE MATERIAL MODELS FOR DYNAMIC LOADING. Introduction
Topic 1.1: Metals. Tresca and Von Mises.
Topic 1.2: Ceramics. Mohr yandDrucker-Prager.

Topic 1.3: Composite. Orthotropic elasticity. Failure criteria (Tsai Hill) and damage model (linear). Delamination (Brewer failure criteria and linear damage model).
Topic 2:ELASTIC AND PLASTIC WAVES. Introduction.
Topic 2.1: Elastic wave propagation.
Topic 2.2: Plastic wave propagation.
Topic 2.3: Shock wave and Equation of state.
Topic 3: DYNAMIC MATERIAL CHARACTERIZATION. Introduction
Topic 3.1: Medium strain rate characterization. Charpy test and low velocity impact test.
Topic 3.2: High strain rate characterization. Hopkinson bars and Taylor tests.
Topic 4. : VIRTUAL TESTING: MEF MODELS APPLIED TO DYNAMIC CHARACTERIZATION. Introduction
Topic 4.1: Explicit MEF
Topic 5 PENETRATION MECHANICS OF METALS, CERAMICS, FABRIC AND COMPOSITE. Introduction
Topic 5.1. Penetration mechanics in metals. Piercing vs Plugging.
Topic 5.2. Empirical models. Thor, SRI and BRL equations. Cunnif curves. Lambert Jonas.
Topic 5.3. Analytical models. Pack-Evans. Tate & Alekseevskii. Rosenberg & Dekel. Energetic balance. Awerbuch & Bodner. Florence model
Topic 5.4. Penetration mechanics in composite and fabrics. Energy balance. Roylance.
Topic 6. APLICATION OF DESIGN OF STRUCTURE AGAINST IMPACT. Introduction.

LEARNING ACTIVITIES AND METHODOLOGY

In each week one lecture session (master class) and one practical session (in reduced groups) will be taught. The first is geared to the acquisition of theoretical knowledge, and the second to the acquisition of practical skills related to theoretical concepts. Additionally, students will complement the classes with work at home, using material provided on Aula Global.

This subject has an important practical component. In addition to these sessions, 2 laboratory practical sessions and 5 practical computer sessions using a FEM code (LS-DYNA) will be imparted. This labs are imparted in reduced groups (maximum 20 students). These practices are mandatory.

At the end of the semester tutorial session will be held. Students also have the possibility of individual tutorials.

During the course 2 partial exams will be done (45 min aprox) to evaluate the knowledge acquisition

ASSESSMENT SYSTEM

Final exam (compulsory): 40%
Continuum evaluation: 60%
- Report experimental lab: 10%
- Partial exam 1: 10%
- Partial exam 2: 10%
- Report numerical lab: 30%

To pass the subject it is required to obtain a 4 in the final exam.

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

BASIC BIBLIOGRAPHY

- Johnson W. Impact Strength of Materials, Edward Arnold, 1972
- P J Hazell Armour:materials, theory and design, CRC Press, 2016
- T. X. Yu, Xinming Qiu Introduction to Impact Dynamics, Wiley, 2018
- Z. Rosenberg and E. Dekel Terminal Ballistics, Springer Berlin Heidelberg, 2012
- Zukas et al Impact Dynamics, Krieger Publishing Company, 1992

ADDITIONAL BIBLIOGRAPHY

- Abrate, S Impact on composite structures, Cambridge University Press , 1998
- Graff, K. F Wave motion in elastic solids, Dover Publications, Inc. New York, 1975
- Sidney S. Jacobson Donald E. Carlucci, Donald E. Carlucci Ballistics: Theory and design of guns and ammunition, second edition, CRC Press, 2013
- Vicente Sánchez Gálvez Materiales para la defensa: Cuaderno 10, Cátedra ISDEFE-UPM, 2012

- Zukas, J.A High velocity impact dynamics, John Wiley & Sons, 1990
- Zukas, J.A., Walters, W.P.. Explosive efects and applications, Springer, 1998