Light protection of mobile systems

Academic Year: (2022 / 2023) **Review date: 20-06-2022**

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

Coordinating teacher: PERNAS SANCHEZ, JESUS

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Materials Strength

OBJECTIVES

- Designing protection systems and mobile systems infrastructure under localized impact and explosive charge.
- Plan and perform validation tests protection systems.
- Develop systems to ensure the safety of infrastructure against intrusion.
- Plan infrastructure security installations, existing or new construction.
- Identify potential threats and vulnerabilities of infrastructure.
- Define security plans to harness the technologies implemented in the infrastructure.
- Design oriented systems integration infrastructure for physical protection, combining technologies architectural design and structural protection with electronic and communication technologies.
- Know the basic laws governing fluid motion and know how to apply the analysis of simple problems. Ability to apply dimensional analysis to simplify troubleshooting of fluid mechanics.

- To understand and to apply the general wave propagation equations
- To solve simply problems of wave propagation in deformable solids identifying the main variables of the real problem
- To know the behavior and the test methods of materials in dynamic conditions
- To understand the materials fracture mechanisms in dynamic conditions
- To know the fundamental concepts regarding Penetration Mechanics in solids
- To know the response principles of lightweight armors regarding localized impact, knife bust and blasting, distinguishing the specific aspects of the metallic, ceramic, fabrics, composite materials and transparent protections
- To understand and to apply simplified models widely used for lightweight armors and structural
- To know the test and acceptation standards of impact protections

DESCRIPTION OF CONTENTS: PROGRAMME

The principles for the analysis of mobile systems (vehicles and persons) protections against impacts and impulsive loads are developed. Additionally the knowledge for modeling, design and standards tests is also given. First of all, the one-dimensional wave propagation in elastic, elastic-plastic viscoelastic and viscoplatic material media will be considered and theory will be extended for the case of three-dimensional wave propagation in such materials. Then, Penetration Mechanics fundamentals and concepts will be introduced in order to treat the analysis and modeling of metallic, ceramic, fiber-reinforced composite and transparent materials subjected to local impacts, impulsive loads and steel blade attack. The last part of the course will be devoted to the tests methodologies and the existing standardization for experimental assessment.
DETAILED PROGRAM:
Lightweight protection of mobile systems
Theme 0: Lightweight protection:
0.1 Continuum mechanics in protection and its importance
0.2 General aspect about Lightweight protection
0.3 Threats and projectiles
0.4 Metals and alloys
0.5 Concrete
0.6 Ceramic materials
0.7 Textiles and composite materials
Theme 1: Materials behaviour
1.1 Failure criteria in metals: Tresca, Von Mises

1.2 Other failure criteria: Drucker-Prager, modelos CAP, Johnson-Holmquist.
1.3 Mechanics of composite materiasl: Behaviour, failure and damage (Hashin, LaRC)
Theme 2: Elastic wave
2.1 Fundamentals
2.2 Classifications
2.3 Propagation and reflection in elastic waves
Theme 3: Elastoplastic waves
3.1 Fundamentals
3.2 Elastic wave 1D strain: Hugoniot Límit
3.3 Shock waves: Equation of state
Theme 4: Dynamic behaviour materials
4.1 Strain rate and constituive equation.
4.2 Characterization testing: Low medium velocity (Charpy, drop weight tower)
4.3 Characterization testing: high velocity (Split Hopkinson Bar Test, Taylor test)
4.4 Characterization testing: Ultra high velocity (Gas cannon, Flying Plate)
Theme 5: Dynamic fracture of materials
Theme 6: Penetration mechanics in metals
6.1 Fundamentals
6.2 Empirical models
6.3 Analytic models
Theme 7: Penetration mechanics in ceramics
7.1 Fundamentals
7.2 Analytic models of mixed protection ceramic/model
Theme 8: Penetration mechanics in textile and composites
8.1 Fundamentals
8.2 Analytic models of textiles and composites
Theme 9:Transparent protections
Theme 10: Applicable Standards
10.1 UNE-EN 1063
10.2 CEN 1063
10.3 Others

LEARNING ACTIVITIES AND METHODOLOGY

50% of the formative activities are oriented to the acquisition of theoretical knowledge. The remaining activities (50%) are oriented to the acquisition of practical capabilities in relation to the subject program.
Master lectures, sessions of problems resolution, student presentations, individual sessions, and personal student work for theoretical knowledge (3 ECTS).
Practical sessions of laboratory and sessions of problems in reduced groups, individual sessions, and personal student work for practical knowledge (3 ECTS). Attendance and active participation in the labs is mandatory in order to pass the course.

Due to the uncertainty about the teaching format to which the health circumstances will lead us during the next course, it is expected to start in the semi-attendance mode, and may lead to training 100% classroom or 100% online depending on the evolution of the spread or control of the pandemic and the health and hygiene standards dictated by the authorities of the sector.

ASSESSMENT SYSTEM

Final exam (obligatory): 40%
Continuum evaluation: 60%
- Laboratory report: 20%
- Evaluation controls: 40%

In order to pass the course, the attendance of the laboratory practices foreseen in the weekly planning are compulsory. The weighting of the practice mark in the continuous assessment corresponds to that established in the course, in accordance with the regulations of the university.

% end-of-term-examination:	30
% of continuous assessment (assigments, laboratory, practicals…):	70

BASIC BIBLIOGRAPHY

- Johnson W. Impact Strength of Materials, Edward Arnold, 1972

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

BASIC ELECTRONIC RESOURCES

- Jesús Pernas Sánchez, jose ALfonso Artero Guerrero . Videotutoriales: https://www.dynamicsuc3m.com/courses/75