UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
BACHELOR'S DEGREE (BSC)	ENERGY ENGINEERING AND RENEWABLE ENERGIES
SUBJECT	SAFETY AND RISK ANALYSIS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50304-Ingegneria nucleare
CODE	06427
SCIENTIFIC SECTOR(S)	ING-IND/19
HEAD PROFESSOR(S)	GIARDINA MARIAROSA Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**GIARDINA MARIAROSA** Monday 12:00 13:00 Edificio 6, secondo piano, viale delle scienze Tuesday 12:00 13:00 Edificio 6, secondo piano, viale delle scienze Wednesday 12:00 13:00 Edificio 6, secondo piano, viale delle scienze

DOCENTE: Prof.ssa MARIAROSA GIARDINA

PREREQUISITES	•Basic knowledge of mathematical analysis, useful for calculating differential equations, integrals, evaluating logarithms, and numerical series. •Basic knowledge of probability calculation. •Basic knowledge of control systems operation in various industrial applications.
LEARNING OUTCOMES	Learning Outcomes 1. Knowledge and understanding. Students will acquire the ability to organize and apply the main concepts of risk assessment to complex industrial systems. They will be able to perform reliability analysis of components or systems, effectively manage safety and maintenance processes in high-hazard industries, and utilize tools and methodologies of risk analysis to improve the safety of components or systems, including advanced and innovative systems. 2. Applying knowledge and understanding. The student will develop the capability to produce technical reports regarding the safety conditions of industrial plants, utilizing the tools/methods learned and applied throughout the course. They will demonstrate the ability to autonomously and effectively select appropriate technical solutions based on the concept of risk reduction. 3. Making judgements. The student will develop the ability to manage and organize risk assessments, to write safety reports handled in a clear, unbiased way, enabling non-specialists to determine what safety issues are at stake, to identify accidental initiating events in complex industrial activities and to demonstrate an understanding of professional obligations related to the discipline of risk assessment. 4. Communication. The student will develop the ability to apply and effectively communicate the results of safety analyses and their conclusions. They will demonstrate a high level of clarity, fluency, and accurate use of the technical language commonly used in the field of safety. 5. Learning skills. The student will demonstrate logical, analytical, and critical thinking skills to make informed judgments and decisions regarding safety, even in situations where incomplete information or data about the systems under study are available. To achieve these goals, the course incorporates lectures, practical exercises involving the use of risk assessment tools, and discussions on relevant case studies. The acquisition of skills and knowledge is assessed through an oral test where students demonstrate their understanding and application of the course material.
ASSESSMENT METHODS	Assessment methods The exam includes an oral interview. - Aim: • To provide students with knowledge, skills, and expertise regarding improvements in the examined system in terms of reliability and availability requirements of safety devices. • To demonstrate that students have acquired knowledge and comprehension of strategies, tools, and methodologies required to perform risk assessments effectively, providing solutions in preventing or reducing the occurrence of an accident - Type: • Oral presentation of the main theoretical arguments discussed during the course. This presentation should include at least three questions that are distributed appropriately across the main subjects of the program, such as risk definition, reliability calculation related to components or complex systems, availability calculation related to components or complex systems, and description of tools used for risk analysis. • Resolution of an exercise focused on the reliability or availability of components or systems. This exercise should involve the application of qualitative and quantitative tools that are widely used to reduce the risk of accidents. - Ranking of assessment methods • 30-28 Excellent and clear exposition of principles, concepts, methods, and techniques in risk analysis, taking into account the detailed knowledge in relation to the different questions. Correctness and completeness of the exercise • 27-25 Good and clear exposition of principles, concepts, methods and techniques in risk analysis, although with a limited level of autonomy and effectiveness. The exercise is partially completed. • 24-18 Acceptable exposition of concepts and arguments in risk analysis. The exercise is partially completed or contains errors. • Exam is failed. No evidence of logical, analytical, and critical knowledge about the arguments of the course. Insufficient ability to communicate results and

	conclusions The exercise is done incorrectly. “lode” is awarded when the knowledge and skills demonstrated are excellence.
EDUCATIONAL OBJECTIVES	The course aims to provide knowledge of the methodological and operational aspects necessary for studying safety issues in various industrial sectors, particularly in the energy sector where hazard sources are present. The objective is to build the necessary foundation for students to identify, describe, and interpret concepts related to accident risk, as well as propose appropriate technological solutions to improve safety. The acquired knowledge will enable students to identify problems and/or design flaws in terms of control and safety, manage maintenance procedures for components, perform safety analyses of industrial systems, including complex and innovative ones. This will be done using techniques and methodologies commonly employed in professional settings. Additionally, students will be capable of accurately interpreting operational data of a plant and applying the prescribed procedures to make the system efficient and safe.
TEACHING METHODS	Power-point presentations are used to explain principal matters of the course. The teacher utilizes the blackboard to demonstrate problem-solving techniques related to system safety requirements. The course offers dynamic and interactive sessions that encourage student engagement to use of examples and hands-on exercises. These sessions provide students with the opportunity to apply the knowledge they have acquired during the course. During the course, students are guided through the process of implementing reliability analysis for devices, developing maintenance procedures, and conducting risk assessments for complex systems. They are presented with examples that are relevant to various industrial applications and innovative technologies used in the energy field. These examples may include nuclear innovative reactors, technologies and methods for safe hydrogen and LPG storage, refineries, chemical reactors, and more. Student can identify his/her learning progress by “peer assignments” in class, or by submission of short assignments of which the teacher randomly selects a small proportion (to be discussed in class) to learn the acquired skills. The purpose is to provide students with a cognitive tool (response given by one of the course colleagues) that is useful for understanding the level of knowledge and competence achieved.
SUGGESTED BIBLIOGRAPHY	Il docente mette a disposizione degli studenti nella pagina web dell'UNIPA le dispense relative a ciascun argomento trattato. The teacher makes available to students on UNIPA web page the notes related to each topic dealt with.

SYLLABUS

Hrs	Frontal teaching
69	Introduction: definition of industrial risk, the measurement of risk, risks from natural hazard, Farmer curves, risk management, risk acceptance criteria. Reliability analysis: Reliability of component. Reliability of systems. Calculation of MTTF (Mean Time to failure). Reliability in a parallel configuration. Truth Tables. Decomposition method. Evaluation of MCS (minimal cut set) e MPS (minimal path set). Failure rate data: - reliability functions and bath-tub curve - updating of failure rates based on Method of Maximum Likelihood. Availability, Maintainability, MTTR (mean time to repair), MTBF (mean time between failures). Risk-based inspection and maintenance planning. Basic concepts in availability of a component under periodic test and maintenance. Markov Model Probabilistic Risk Assessment of Complex Systems: Qualitative and quantitative tools for risk analysis, Historical Risk Studies, data banks on industrial accidents, Check list, What if Hazard and operability studies (HAZOP), Failure Modes & Effects Analysis (FMEA) and Failure Modes Effects and Criticality Analysis (FMECA), Risk priority number (RPN), Fault Tree analysis (FTA), Event Tree Analysis (ETA). Human reliability Analysis (HRA): Techniques used in the field of human reliability assessment: HEART, THERP, CREAM Historical analysis of accidents in the energetic sector: Flixbourgh (1974), Seveso (1976), Three Mile Island (1979), Bhopal (1984), Chernobyl (1986), Deepwater Horizon (2010), Fukushima (2011), piattaforma petrolifera di Elgin (2012), Raffineria di Milazzo (2014). Incidents in wind and solar power systems. Safety regulations. Seveso I, II, III.

Hrs	Practice
12	EXERCISES Examples from Risk Assessments for Nuclear Reactors, hydrogen storage systems, Chemical plants