UNIVERSITÀ DEGLI STUDI DI PADOVA

SCUOLA DI SCIENZE

Bollettino Notiziario - A.A. 2021/2022

LAUREA MAGISTRALE IN SUSTAINABLE CHEMISTRY AND TECHNOLOGIES FOR CIRCULAR ECONOMY (ORD. 2021)

Curriculum: Corsi comuni

CIRCULAR AND SUSTAINABLE WASTE MANAGEMENT

Titolare: Prof.ssa MARIA CRISTINA LAVAGNOLO

Periodo: I anno, 1 semestre

Indirizzo formativo: Corsi comuni

Tipologie didattiche: 72A; 9,00

Prerequisiti:
Basic knowledge of chemistry and biochemistry

Conoscenze e abilità da acquisire:
The aim of this course is to enlighten the state of the art in technology, organizational and legislative developments and practices, burdens and benefits of handling solid wastes, with a holistic approach that considers social, cultural, economic and technological aspects. Circularity and closing the loop of the materials, sustainability of the Solid Waste Management (SWM) system in the different contexts are considered the pillars of the course. KNOWLEDGE The students will be able to understand: • chemical and biochemical processes, at the base of the SW treatments and final disposal; • the principles and techniques of solid waste management, including the legislative, environmental, technical, economic and social drivers; • the SWM strategies in different contexts; SKILLS The students will be able: • to calculate the mass, energy and emissions balance of the different treatment systems • to assess chemical and biochemical processes and to suggest useful modifications • to define the proper SWM system in the specific context • to identify and design a SW treatment master plan • to evaluate an existing SWM system and to suggest improvements • to apply a holistic approach - considering social, cultural and technological aspects – for a sustainable SWM system • to discuss and face the open issues related to SWM, considered important for the future improvement of the system

Attività di apprendimento previste e metodologie di insegnamento:
The course includes frontal teaching, presentations and discussion of case studies, exercises, group activities on assignments, quizzes, visit to SW treatment plants, laboratory experiences. The course is based on the active learning methodology, online instruments will be used.

Contenuti:
ICAR/03 (6 ECTS) • Waste management systems and strategies: circularity, sustainability and closing the loop of the materials • Worldwide waste production and quality (including experiences in laboratory) • Glance at the current international legislations about waste management: definitions, European Waste Catalogue, Hazardous waste classification • Scheme of resource recovery and disposal of residues • Waste collection and transport, separate collection and material recovery • Mechanical selection schemes and processes, efficiencies and possibilities, separation of single fractions • Recycling and recovery processes of materials • Bio-stabilization processes for the biodegradable fraction: biochemical aerobic and anaerobic processes (1 ECTS-CHIM/11) • Technologies of composting and anaerobic digestion • Biorefinery of waste: biochemistry and processes (1 ECTS- CHIM/11), future possibilities • Thermal energy recovery from waste: thermal processes (gasification, pyrolysis, incinerator); RDF (refuse derived fuel) production and possibilities • Management and disposal of residues: strategies, landfill technologies and design (materials, barriers; leachate and biogas collection, treatment, land reutilisation); the sustainable landfill and the geological repository • Hazardous waste management • Innovative visions: Integrated waste and water management and recovery. • Health and Waste • The experiences of Private and Public Companies (ARPAV, UTILITALIA) in the management of waste (1 ECTS - D)

Modalità di esame:
The exam consists into two parts: 1. Three quizzes (using moodle) during the course: questions based on classroom lectures to test knowledge 2. Homeworks, on some specific insights to be carried out in groups of two people during the course, homeworks will be presented and discussed in class.

Criteri di valutazione:
Each part of the exam will be evaluated: 1. quizzes maximum 15 points 2. homeworks maximum 15 points Extra points will be awarded for active participation during the course. Final mark will be the sum of the single evaluations. Group homeworks will be evaluated according to the criteria of: correctness of the contents, ability to elaborate knowledge, synthesis ability, graphic accuracy, property of scientific language. Anyway at the beginning of

the course, the evaluation criteria will be presented by the teacher.

Testi di riferimento:
Raffaello Cossu, Rainer Stegmann, Solid waste Landfilling: concepts, processes, technologies. Amsterdam: Elsevier, 2019

Eventuali indicazioni sui materiali di studio:
To be used: class slides, compulsory readings, link to selected web site - suggested for specific insights - and all the materials (papers, articles, scientific literature) used during the course will be available in moodle. Some videos will be available too. Students will be requested to find proper materials by their own, in case of homeworks.

ECONOMICS FOR THE CIRCULAR ECONOMY

Titolare: Dott.ssa MARTA CASTELLINI

Periodo: I anno, 2 semestre

Indirizzo formativo: Corsi comuni

Tipologie didattiche: 48A; 6,00

Prerequisiti:
nessuno

Conoscenze e abilità da acquisire:
vedi descrizione in inglese

Attività di apprendimento previste e metodologie di insegnamento:
vedi descrizione in inglese

Contenuti:
vedi descrizione in inglese

Modalità di esame:
Lavori di gruppo / esame scritto

Criteri di valutazione:
vedi descrizione in inglese

Testi di riferimento:
CONTENUTO NON PRESENTE

Eventuali indicazioni sui materiali di studio:
vedi descrizione in inglese

EUROPEAN UNION ENVIRONMENTAL AND ENERGY LAW

Titolare: Prof. BERNARDO CORTESE

Periodo: I anno, 2 semestre

Indirizzo formativo: Corsi comuni

Tipologie didattiche: 48A; 6,00

Prerequisiti:
No particular prerequisite

Conoscenze e abilità da acquisire:
CE professional should be capable of understanding the pillars of the law of the EU internal market, including competition and State aid law, as the overall framework in which CE activities need to be programmed, and a CE undertaking is bound to operate. Knowledge of the legal principles defining the freedom of circulation of goods in the EU internal market, including recyclable waste and new materials; understanding of the relationship between national and EU laws: harmonization, coordination, derogatory measures; understanding of the role of private rules of self- and co-regulation, including the s.c. harmonized standards. He should be capable of understanding the relationship between CE goals and a) EU energy policy measures, including those related to energetic transition goals, b) EU environmental policy measures, including the ecosystemic approach to water.

Attività di apprendimento previste e metodologie di insegnamento:
Frontal classes; classroom presentation by students; collective discussion of cases;

Contenuti:
General Part • Introductory Unit: Law, National Law(s), International Law, European Union Law; The role of law, and of EU law in particular, in the regulation of economic activities, with special focus on goods production; The role of law, and of EU law in particular, in the regulation of technological innovation • The Law of the EU Internal Market, including EU Competition Law a) Freedom of Circulation of Goods: The notion of goods, including waste and energy; national (technical) rules applicable to goods as obstacles to trade between Member States – justifications – the principle of mutual recognition; (EU Directives:) harmonization vs coordination of national measures; EU “comitology”/delegated uniform executive measures (technical progress); national measures implementing EU directives; the “new approach” and the role of EU “harmonized standards” – co-regulation; b) EU competition law: Rules applicable to undertakings (agreements, abuse of dominant position), rules applicable to States (State Aid) Special Part • EU Environmental and Energy Law: Waste, recyclable waste; Industrial emissions; REACH; Product labelling; Eco-management and audit scheme (EMAS); EU energy policy and renewables; EU approach to water; New technologies, R&D and competition law; EU State Aid Law in the field of environmental standards and in the field of energy transition schemes

Modalità di esame:

Oral discussion of a written paper on the influence of EU law on the development of CE projects/activities.

Criteri di valutazione:
Degree of understanding of the principles of EU law covered during the course; ability to apply these principles to actual cases.

Testi di riferimento:
Geert Van Calster, Leonie Reins, EU Environmental Law. Cheltenham (UK): Edward Elgar Publishing, 2017 Rafael Leal-Arcas (ed.); Jan Wouters (ed.), Research Handbook on EU Energy Law and Policy. Cheltenham (UK): Edward Elgar Publishing, 2017

Eventuali indicazioni sui materiali di studio:
Materials will be made available on the Moodle platform; classes will be recorded and uploaded on Mediaspace; selected readings will be suggested from legal journals accessible to unipd.it domain users Reference texts as indicated below are especially recommended for students not attending the classes - please note that only a limited part of the Research Handbook will be used (see indication below) - note also that it is available not only as paper book, nut also as ebook, which is cheaper ;-) Students attending the classes will be given possible alternative readings from legal journals accessible to unipd.it domain users (free of charge)

GREEN CHEMISTRY AND INNOVATIVE CHEMICAL PROCESS

Titolare: Prof. MAURO CARRARO

Periodo: I anno, 1 semestre

Indirizzo formativo: Corsi comuni

Tipologie didattiche: 64A+12L; 9,00

Prerequisiti:
Basic knowledge of general and of organic chemistry.

Conoscenze e abilità da acquisire:
This course aims at giving a broad knowledge of the most common techniques of green chemistry and industrial processing. The base concepts on waste reduction will be thoroughly explained, while the replacement possibilities for toxic compounds and solvents will be explored by presenting the properties of the sustainable green alternatives and by showing several related examples. The students will thus be guided through the criteria for making a chemical reaction greener at both lab and industrial scale, in order to give them many tools for a critical revision of classic chemical transformations.

Attività di apprendimento previste e metodologie di insegnamento:
Classroom lessons and laboratory experiments on green procedures E-learning activities will be also planned, trhough the availability of slides and supplementary material.

Contenuti:
?Principles of Green Chemistry, environmental metrics ?Risk / wastes / pollution reduction in chemical processes ?Selection of solvents and reactants, design of reactions with high atom economy ?Alternative and not hazardous solvents: water, supercritical fluids, dimethyl carbonate, ionic liquids, deep eutectic solvents, polymeric and supramolecular solvents, solvents from renewable sources ?Use of renewable platform chemicals as starting reagents to obtain traditional and new chemical compounds ?Green catalysis with homogeneous, supported, heterogeneous catalysts, acids and solid bases, organocatalysts, biocatalysis ?Use of CO2 as carbon source/building block for carbon based compounds ?Green reagents: oxidations with H2O2, O2, reductions with H2 ?Alternative methods of activation: photochemistry, microwave or ultrasonic processing, electrochemistry ?Analysis of industrial processes and possible innovative interventions with economic and environmental considerations ?Examples of green industrial processes ?Intrinsically safer design and process intensification ?Practical examples of a green organic synthesis in the laboratory involving combined strategies (use of one alternative solvent, bio-based starting materials and catalysis)

Modalità di esame:
Oral exam; the student will also report on a case study.

Criteri di valutazione:
Evaluation will be based on the general knowledge of the green synthetic strategies, and on the capability to critically discuss a specific case.

Testi di riferimento:
CONTENUTO NON PRESENTE

Eventuali indicazioni sui materiali di studio:
Materials for the final exam preparation include: lecture notes, slides and suggested papers. No specific text is required. Some consultation books will be proposed.

OPERATIONS AND SUPPLY CHAIN MANAGEMENT

Titolare: Dott.ssa LAURA MACCHION

Periodo: I anno, 2 semestre

Indirizzo formativo: Corsi comuni

Tipologie didattiche: 48A; 6,00

Prerequisiti:
nessuno

Conoscenze e abilità da acquisire:
Il corso si propone di comprendere e acquisire i concetti e le tecniche essenziali nell'ambito di: -->Gestione della produzione: Lean Management, ottimizzazione dei processi e Total Quality Management -->Supply chain management: logistica integrata, struttura fisica e relazionale delle reti di fornitura, gestione dei processi interorganizzativi -->Catene di approvvigionamento a ciclo chiuso e logistica inversa

Attività di apprendimento previste e metodologie di insegnamento:

Lezioni frontali e discussione di casi di studio

Contenuti:
--> Lean management e ottimizzazione dei processi: presentazione dei principi e delle tecniche che hanno apportato significative modifiche ai processi produttivi tradizionali in una nuova ottica di miglioramento continuo. --> Sistema di qualità. Partendo dai modelli tradizionali di gestione della qualità, vengono presentati i principi e gli strumenti che consentono l'applicazione di sistemi avanzati in ambito Qualità: l'approccio Total Quality Management (TQM), l'organizzazione per il TQM, l'applicazione del TQM, le tecniche e gli strumenti applicare e sostenere il TQM nel tempo (ad esempio Six Sigma, 5S, Value stream mapping, PDCA, tecniche statistiche per il controllo qualità). --> Supply Chain Management: verrà discussa la struttura fisica delle reti di fornitura e le relazioni tra gli attori della stessa rete. Verranno inoltre analizzati i processi interorganizzativi. --> Catena di fornitura a ciclo chiuso e logistica inversa

Modalità di esame:
--> prova scritta -->Analisi di casi studio: lavoro di gruppo durante il corso

Criteri di valutazione:
I criteri di valutazione si baseranno su: --> una prova scritta per valutare la comprensione degli argomenti e la capacità di analizzare casi aziendali reali --> l'analisi e la presentazione di casi studio in aula

Testi di riferimento:
Nigel Slack, A. Brandon-Jones, R. Johnston, A. Betts, Pamela Danese, Pietro Romano, Andrea Vinelli, Gestione delle operations e dei processi. Milano Torino: Pearson Italia, 2013 ROMANO P; DANESE P., Supply Chain Management: La Gestione dei processi di fornitura e distribuzione. : McGraw-Hill, Seconda Edizione, 2010

Eventuali indicazioni sui materiali di studio:
Il materiale per la preparazione dell'esame finale verrà fornito dal docente durante il corso

RENEWABLE ENERGY TECHNOLOGIES

Titolare: Prof. DAVIDE DE COL

Periodo: I anno, 1 semestre

Indirizzo formativo: Corsi comuni

Tipologie didattiche: 48A; 6,00

Prerequisiti:
Basic knowledge of applied thermodynamics (laws of thermodynamics, thermodynamic processes, cycles, fluids), heat transfer and energy science.

Conoscenze e abilità da acquisire:
Knowledge: • Knowledge of scientific, technical, economic and standards bases for the Renewable Energy Technologies • Knowledge of main characteristics of power plants based on renewable energy technologies. • Critical awareness of the multidisciplinary context for those dealing with renewable energy technologies Skills: • Ability to critically compare the renewable technologies • Ability to carry out a preliminary energy production analysis for the considered renewable energy technologies

Attività di apprendimento previste e metodologie di insegnamento:
Lectures Numerical exercises

Contenuti:
Potential of renewable sources, national and worldwide statistics, technical and economic problems for the exploitation of renewable energy sources. [4h] Solar radiation: characteristics, potential in buildings, exploitation in energy conversion [4h] Solar thermal technologies: theory, components, systems [6h] Solar photovoltaic technologies: theory, components, energy production [6h] Geothermal technologies: theory, components, energy generation [6h] Wind and Water: characteristics and exploitation in energy conversion [4h] Wind technologies: theory, components, energy generation [6h] Hydropower technologies: theory, components, energy generation [6h] Emerging technologies and storage technologies: tidal energy, energy from waves, available storage technologies, hybrid solutions [6h]

Modalità di esame:
The exam consists of a written test, comprehensive of numerical exercises and theory questions.

Criteri di valutazione:
The assessment criteria are: • Level of learning • Skills of applying acquired knowledge to numerical exercises • Ability to explain and critically analyse the concepts and procedures studies in the course

Testi di riferimento:
CONTENUTO NON PRESENTE

Eventuali indicazioni sui materiali di studio:
Notes and presentations given in class: all documents needed for the exam preparation are available in the Moodle page.

THERMODYNAMICS AND CATALYSIS FOR CIRCULAR ECONOMY (C.I.)

Titolare: Prof. ANTONINO POLIMENO

Indirizzo formativo: Corsi comuni

Prerequisiti:
Basic knowledge of mathematics, physics, general & inorganic chemistry, organic chemistry and physical chemistry.

Conoscenze e abilità da acquisire:
Module A of the course aims at introducing the student to the application of formal methods, based on the principles of thermodynamics and kinetics of systems, for describing open systems, defining specific indicators for the assessment of sustainability, via quantifiable approaches and metrics and applying the aforementioned methods to diverse production cycles and processes. Module B of course aims at introducing catalysis and its application to

chemical manufacturing and environmental protection. Students should eventually know how catalysts work, which are best suited for some classes of reactions, as well as what are their scope in the current technical landscape and their perspective role in circular economy.

Modalità di esame:
Teamwork/oral exam; the student, either alone or in a team, will have the opportunity of reporting on a specific topic, or reading and commenting a reviewed paper

Criteri di valutazione:
Evaluation will be based on the level of comprehension of formal principles and use of technical language, ability to quickly and critically address key issues and establish connections between theoretical concepts and real cases.

Moduli del C.I.:
Catalysis for circular economy (Mod. B)
Thermodynamics of processes and materials (Mod. A)

CATALYSIS FOR CIRCULAR ECONOMY (MOD. B)

Titolare: Prof. MARCO ZECCA

Periodo: I anno, 2 semestre

Indirizzo formativo: Corsi comuni

Tipologie didattiche: 48A; 6,00

Contenuti:
Cinetica chimica in catalisi: ciclo catalitico, sito catalitico, catalisi "single-" e "multi-site"; TON e TOF; velocità di reazione e attività catalitica. Catalisi omogenea in fase liquida; catalisi acida e basica specifiche e generali; la fnzione di acidità di Hammet; ioni metallici come acidi di Lewis; "case-histories" nella catalisi acido-base. Prncipi di chimica di coordinazione e organomentallica dei metalli di transizione; "case-histories" nella catalisi omogenea con composti organometallici dei metalli di transizione. Reazioni di ossidazione radicalica catalizzate in fase liquida omogenea da composti dei metalli di transizione. Sistemi catalitici eterogenei gas-solid: catalizzatori non supportati e supportati; componenti e metodi di preparazione. Catalizzatori eterogenei in azione: la superficie attiva, adsorbimento e reazioni superficiali; isoterme di adsorbimento e approssimazione di quasi-equilibrio; meccanismi di Langmuir-Hinshelwood e Elays-Rideal; leggi cinetiche per le reaizoni superficiali; energia di attivazione apparente e ordini di reazione nelle reazioni catalitiche eterogenee gas-solido; disattivazione, durata e gestione dei catalizzatori eterogenei solidi. Catalizzatori non-porosi e porosi: misura del volume dei pori e dell'area superficiale specifica di un solido; dispersione e distribuzione del componente attivo in un catalizzatore supportato; limitazioni diffusive alla velocità di reazione; "case-histories" nella catalisi eterogenea in condizioni gas-solido per il controllo ambientale e la produzione industriale di sostanze chimiche. Bio-catalisi: struttura degli enzimi e il modello xhiave-serratura; cinetica di Michaelis-Menten e sua relazione con il meccasnismo di Langmuir-Hinshelwood. Il riciclo dei catalizzatori nell'economia circolare. Sfide e prospettive nella scienza e tecnologia della catalisi nell'ottica dell'economia circolare: transizione dalle materie prime fossili a quelle rinnovabili; attivazione della CO2; riciclo chimico dei polimeri.

Attività di apprendimento previste e metodologie di insegnamento:
Lezioni frontali, "active learning"

Eventuali indicazioni sui materiali di studio:
Non sono richiesti libri di testo. Il materiale per la preparazione dell'esame comprende appunti di lezione, presentazioni del docente durante le lezioni, letture consigliare. I riferimenti alle fonti di letteratura verranno forite durante il corso. L'annotazione di appunti personali durante le lezioni è fortemente consigliata.

Testi di riferimento:
CONTENUTO NON PRESENTE

THERMODYNAMICS OF PROCESSES AND MATERIALS (MOD. A)

Titolare: Prof. ANTONINO POLIMENO

Periodo: I anno, 1 semestre

Indirizzo formativo: Corsi comuni

Tipologie didattiche: 48A; 6,00

Contenuti:
MOD A - I semester • Circular Economy for sustainable development: ; introduction to the concept of Life Cycle Assessment, input/output models, thermodynamic interpretation. • Basic concepts of thermodynamics: systems, laws of thermodynamics, cycles and processes • Mass and energy conservation principles for control volume analysis; steady state and transient analyses of open and closed systems • Entropy analysis for closed and open systems; energy analysis for closed and open systems • Thermodynamics insights on the assessment of circular economy processes through case studies (e.g. food waste, steel production, other materials production, product refurbishment, vehicle provision, construction and equipment manufacture) • Chemical kinetics in solutions: reaction rate and its dependence on experimental conditions, energy of activation, energy vs reaction coordinate diagrams, kinetic laws from reaction mechanisms (elementary reactions, order and molecularity, steady-state approximation, rate determining step, complex mechanisms).

Attività di apprendimento previste e metodologie di insegnamento:
Lectures, seminars, active learning

Eventuali indicazioni sui materiali di studio:
No textbooks are required. Materials for the final exam preparation include lecture notes, class slides, and readings of suggested papers. Reference to literature sources will be given in due course. Taking personal notes during lectures is strongly recommended

Testi di riferimento:
CONTENUTO NON PRESENTE

WATER RESOURCES MANAGEMENT IN THE CIRCULAR ECONOMY

Titolare: Dott.ssa GIULIA ZUECCO

Periodo: I anno, 1 semestre

Indirizzo formativo: Corsi comuni

Tipologie didattiche: 48A; 6,00

Prerequisiti:
Basic knowledge of mathematics, physics, chemistry

Conoscenze e abilità da acquisire:
The students will learn how to appropriately understand and manage the critical issues related to water resources in anthropogenic landscapes, under different climate and anthropogenic forcing. The students will analyze some real case studies exploring mitigation solutions for specific contexts. The course also offers an introduction to some of the novelties related to remote sensing technologies for the monitoring of the Earth and water bodies, and it offers advanced applications of environmental data spatial analyses through GIS.

Attività di apprendimento previste e metodologie di insegnamento:
Lectures, seminars, active learning, storytelling, working in groups: Lectures & seminars: 16 hours Case studies discussion: 24 hours GIS lab: 8 hours

Contenuti:
Lectures, seminars, discussion • Introduction o Humans, Water, and Earth: the actual global challenges • Climate o Climate change and natural disasters (floods & drought) o Extremes, new trends, critical scenarios - Case studies - Roundtable Discussion • Society o Socio-economic impact on Earth: The Great Acceleration o Population dynamics and land use changes o Water scarcity and hydro-political risk o Water pollution and human health - Case studies - Roundtable Discussion • Water resources management o Water management in land reclamation areas o Water for agriculture o Water for urban areas - Case studies in EU and Italy - Roundtable Discussion • Sustainable water cycle o Integrated watershed management approach o Water and ecosystem services o Water for a sustainable socio-economic development - Case studies - Roundtable Discussion GIS Lab • Lab.1 - Remote sensing o Satellite, laser scanners, drones o Land use changes scenarios o NDVI and water stress • Lab.2 - Digital terrain analysis o Digital Elevation Models o Drainage system analysis

Modalità di esame:
Discussion of a case study through a technical report

Criteri di valutazione:
The capability of the candidate to discuss and present a real case study, raising problems, and highlighting likely solutions to mitigate a critical issue

Testi di riferimento:
CONTENUTO NON PRESENTE

Eventuali indicazioni sui materiali di studio:
No textbooks are required. Materials for the final exam preparation include: lecture notes, class slides, and readings of suggested papers.

Curriculum: Energy conversion and storage

Curriculum: Resources and product design and recycling