Doctoral Program in Industrial Engineering
Università degli Studi di Padova
Dipartimento di Ingegneria Industriale

Course plan 38th cohort

rev 1.0 - 24-05-2022

Courses

Course title	Credits	Lecturers	2022/ 2023	2023/ 2024	2024/ 2025
Advanced methods for fatigue design	2	Alberto Campagnolo, Giovanni Meneghetti	×	×	×
Analysis and Optimization of Sustainable Energy Technologies in Buildings	4	Jacopo Vivian	×	×	×
Bibliographic resources and research tools for PHD students in Industrial Engineering	1.5	Librarians	×	×	×
Bioelectromagnetics	2	Elisabetta Sieni	×	×	×
Coupled electrical-thermal-structural Finite Element Analyses	3	Giovanni Meneghetti, Mattia Manzolaro	×	×	×
Eco-informed Materials Choice	3	Enrico Bernardo	×	×	×
Ecotoxicology as an heuristic approach to environmental engineering	1.5	Luca Palmeri	×	×	×
Electromagnetic fields and biological tissues	2	Elisabetta Sieni		×	×
Entrepreneurship and Startup	5	Moreno Muffatto, Francesco Ferrati	×	×	×
Experimental measurements in thermal fluid dynamics	3.5	Stefano Bortolin, Arianna Berto	×	×	
Finite Element Method (FEM)	8	Giuseppe Gambolati	×	×	×
Geometric Modeling of Anatomical Parts and Medical Devices	2	Francesca Uccheddu	×	×	×
Green chemistry and technology	3	Roberta Bertani, Paolo Sgarbossa, Gioele Pagot,	×	×	×
Heat Transfer Modelling and Numerical Applications	3	Angelo Zarrella	×	×	×
Introduction to Model Order Reduction	2	Riccardo Torchio	×	×	×
Life Cycle Assessment of Energy Systems: fundamentals and applications	3	Alberto Benato, Anna Stoppato	×	×	×
Powder flowability	2	Andrea Santomaso	×	×	×
Reactive Fluid Mechanics	3	Paolo Canu	×	×	×
Smart Technologies for the sustainability of the food chain	4	Silvia Minetto, Antonio Rossetti	×		×
Statistics for Engineers	10	Luigi Salmaso, Rosa Arboretti, Marta Disegna	×	×	×
Stochastic methods for single- and multi-objective optimization	3	Piergiorgio Alotto		×	
Sustainable Energy in Buildings	3	Michele De Carli, Laura Carnieletto, Giuseppe Emmi, Jacopo Vivian	×	×	×
Technological Advancements in Electromobility	2	Manuele Bertoluzzo, Giuseppe Buja	×	×	×

Continued on next page

Course title	Credits	Lecturers	2022/ 2023	2023/ 2024	2024/ 2025
Technologies for boosting energy efficiency and spreading renewable plants	6	Alberto Benato, Anna Stoppato, Giovanna Cavazzini	×	×	×
Tutela della proprietà intellettuale	4.5	Liberi professionisti, Personale interno – Settore Trasferimento di tecnologia	×	×	×
Vibration energy harvesting	2	Alberto Doria	×		×
Yield criteria for polymer materials	2	Mauro Ricotta	×	×	×
		Total number of course hours per year	**340**	**336**	**334**

Total number of courses: 27

Total number of credits: 90

Ph.D. students are required to register for the courses listed above by using the Moodle platform (see `https://academics.dii.unipd.it/phd/training/`) and going to the page dedicated to the specific course they want to attend.
Students registered for a course who decide not to attend it, must inform the professor.
For updated information about actual dates or delivery mode, Ph.D. students are invited to exclusively refer to the Moodle page of each specific course.

Advanced methods for fatigue design

Lecturers:

Dr. Alberto Campagnolo, DII, University of Padova, alberto.campagnolo@unipd.it
Prof. Giovanni Meneghetti, DII, University of Padova, giovanni.meneghetti@unipd.it

Topics:

Introduction to fatigue assessment of mechanical components in presence of cracks or notches.
Derivation of stress fields ahead of cracks/notches: Airy stress function and complex potential function method (Kolosov and Muskhelishvili).
Case study: sharp V-notches under in-plane loading. Lazzarin-Tovo analytical derivation of local stress field based on complex potential functions and comparison with Williams' solution.
Definition of Notch Stress Intensity Factors (NSIFs) and introduction to local approaches based on NSIF-concept: averaged strain energy density (SED) and peak stress method (PSM)
Practical application of local approaches to fatigue strength assessment of mechanical components by means of FE analyses (Ansys FE code).

References:

Sadd M. H. Elasticity. Theory, Applications and Numerics. Elsevier; 2004.
Lazzarin P., Tovo R. A unified approach to the evaluation of linear elastic stress fields in the neighborhood of cracks and notches, Int. J. Fract. 78 (1996) 3–19.
Anderson T. L. Fracture Mechanics. Fundamentals and Applications. CRC Press; 1995.
Lazzarin P., Zambardi R. A finite-volume-energy based approach to predict the static and fatigue behavior of components with sharp V-shaped notches, Int. J. Fract. 112 (2001) 275–298.
Meneghetti G., Lazzarin P. Significance of the elastic peak stress evaluated by FE analyses at the point of singularity of sharp V-notched components, Fatigue Fract. Eng. Mater. Struct. 30 (2007) 95–106.
Radaj D, Vormwald M. Advanced methods of fatigue assessment. Springer; 2012.

Duration: 8 hours (2 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours.
Final evaluation will be based on a case study.

Analysis and Optimization of Sustainable Energy Technologies in Buildings

Lecturers:

Dr. Jacopo Vivian, Urban Energy Systems Lab - Swiss Federal Laboratories for Materials Science and Technology (EMPA), jacopo.vivian@hotmail.com

Topics:

Heating and cooling of buildings accounts for up to 40% of energy use and 20% of greenhouse gas emissions. The ongoing electrification of the heating sector via electric heat pumps, the refurbishment of existing buildings to low-energy standards and the increasing penetration of renewable sources will severely affect the patterns of power supply and consumption in the electrical distribution systems. In this context, the optimal use of energy in buildings will play an important role to maximize the energy efficiency at system level without affecting the comfort of the users. This course reviews the definitions of concepts such as energy communities, plus energy districts and energy flexibility. Then, two lectures will explain different optimization methods for the optimal management of both single buildings and entire districts. During the course some examples will be provided about real applications and Matlab code will assist students in the development of their own case-study, that will be openly discussed at the end of last lecture.

References:

European Commission. Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency. 2018.

Fischer D, Madani H. On heat pumps in smart grids: A review. Renewable and Sustainable Energy Reviews 2017;70:342–57. https://doi.org/10.1016/j.rser.2016.11.182

Jensen SØ, Marszal-Pomianowska A, Lollini R, Pasut W, Knotzer A, Engelmann P, et al. IEA EBC Annex 67 Energy Flexible Buildings. Energy and Buildings 2017;155:25–34. https://doi.org/10.1016/j.enbuild.2017.08.044

Duration: 16 hours (4 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours.

Final evaluation will be based on the discussion of a case study within the individual PhD project.

Bibliographic resources and research tools for PHD students in Industrial Engineering

Lecturers:

Librarians, Biblioteca Centrale di Ingegneria, University of Padova, biblio.inge@unipd.it

Topics:

Online module: Engineering libraries and their services (local and interlibrary loan, document delivery, bibliographic reference, book purchase proposal. . .)
GalileoDiscovery as the University of Padova Library Search Tool
Scholarly Communication - Open Access - Open Data
Bibliometric indicators: quality measurements of scientific publication
Face to face module: Workshop to improve bibliographic research with tools and resources in the Digital Library of the University of Padova.
Engineering, Economics, Management databases (BSC, IEEE, Engineering Village, Reaxys. . .)
Citation databases: Scopus (Elsevier), Web of Science (ISI).
Author's rights and PhD Thesis
Basics of reference management software.

References:

Engineering Central Library – University of Padova website: http://biblioingegneriacentrale.cab.unipd.it/
University Library System website: https://bibliotecadigitale.cab.unipd.it/en specially about Open Science, Open Access, Open Data, Metrics. . . https://bibliotecadigitale.cab.unipd.it/en/digital-library/about-publishing
The Principles of Open Scholarly Infrastructure https://openscholarlyinfrastructure.org/
Aliprandi, Simone, and Simone Aliprandi. Fare open access: la libera diffusione del sapere scientifico nell'era digitale. Ledizioni, 2017.
Capaccioni, Andrea, et al. Ricerche bibliografiche: banche dati e biblioteche in rete. 2. ed, Maggioli, 2018.
Turbanti, Simona. Strumenti di misurazione della ricerca: dai database citazionali alle metriche del web. Editrice Bibliografica, 2018.

Duration: 6 hours (1.5 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is necessary.
Online module is required for attending the face-to-face module.
Written tests after online course and after face-to-face course, to confirm the participation and the training credits.

Bioelectromagnetics

Lecturers:

Prof. Elisabetta Sieni, Dipartimento scienze teoriche e applicate, Università dell'Insubria, elisabetta.sieni@uninsubria.it

Topics:

Introduction to bioelectromagnetics. Electromagnetic field coupled with the human body; physical quantities involved.
Brief introduction to tissue from the point of view of electromagnetic field coupling. Electrical properties of tissue as a function of the frequency.
Protection rules from effects related to electrical and magnetic fields at low and high frequency. ICNIRP and EU regulations. Safety in working and public environments. Typical sources in industrial and public environment. Measurements of the intensity of the magnetic field at low frequency.
Effects of electric, magnetic and electromagnetic field on cells and tissues, e.g. heating and electric stimulation, considering the frequency spectrum of the electromagnetic field: from low frequency to microwaves. Protection rules following ICNIRP rules. Electromagnetic fields in medicine

References:

[1] ICNIRP, «Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)», Health Phys., vol. 74, pagg. 494–522, 1998.
[2] ICNIRP, «Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz)», Health Phys., vol. 99, n. 6, pagg. 818-836 10.1097/HP.0b013e3181f06c86, 2010.
[3] International Commission on Non-Ionizing Radiation Protection (ICNIRP)1, «Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz)»:, Health Phys., vol. 118, n. 5, pagg. 483–524, mag. 2020, doi: 10.1097/HP.0000000000001210.
[4] «Amendment To The ICNIRP «Statement On Medical Magnetic Resonance (MR) Procedures: Protection Of Patients»», Health Phys., vol. 97, n. 3, pagg. 259–261, set. 2009, doi: 10.1097/HP.0b013e3181aff9eb.
[5] ICNIRP, «Guidance on Determining Compliance of Exposure to Pulsed Fields and Complex Non-Sinusoidal Waveforms below 100 kHz with ICNIRP Guidelines», Health Phys., vol. 84, pagg. 383–387, 2003.
[6] ICNIRP, «Guidelines on limits of exposure to static magnetic fields», Health Phys., vol. 66, pagg. 100–106, 1994.
[7] D. Andreuccetti et al., Protezione dai campi elettromagnetici non ionizzanti. IROE, 2001.

Duration: 8 hours (2 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on a written questionnaire.

Coupled electrical-thermal-structural Finite Element Analyses

Lecturers:

Prof. Giovanni Meneghetti, DII, University of Padova, giovanni.meneghetti@unipd.it
Eng. Mattia Manzolaro, Laboratori Nazionali di Legnaro, Istituto Nazionale di Fisica Nucleare, mattia.manzolaro@lnl.infn.it

Topics:

Course overview and introduction. General aspects of Finite Element analyses related to the structural, thermal and electrical fields. Structural analyses with plane and solid elements. Thermal analyses with plane and solid elements, implementing thermal conduction, thermal convection and thermal radiation. Coupled field thermal-structural analyses. Coupled field electrical-thermal analyses. Coupled field electrical-thermal-structural analyses. Presentation of a complex test case implementing all the aforementioned physical fields with a specific focus on complex geometry import.

References:

M. Manzolaro, G. Meneghetti, A. Andrighetto, Thermal–electric numerical simulation of a surface ion source for the production of radioactive ion beams, Nucl. Instrum. Methods Phys. Res., Sect. A 623 (2010) 1061–1069.
G. Meneghetti, M. Manzolaro, A. Andrighetto, Thermal–electric numerical simulation of a target for the production of radioactive ion beams, Finite Elem. Anal. Des. 47 (2011) 559–570.
M. Manzolaro, G. Meneghetti, INTRODUCTION TO THE THERMAL ANALYSIS WITH ANSYS® NUMERICAL CODE, edizioni LIBRERIA PROGETTO, 2014, Padova, ITALY.
G. Meneghetti, M. Manzolaro, M. Quaresimin, INTRODUCTION TO THE STRUCTURAL ANALYSIS WITH ANSYS® NUMERICAL CODE, edizioni LIBRERIA PROGETTO, 2014, Padova, ITALY.

Duration: 12 hours (3 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours.
Final evaluation will be based on a case study developed during the lectures.

Eco-informed Materials Choice

Lecturers:

Prof. Enrico Bernardo, DII, University of Padova, enrico.bernardo@unipd.it

Topics:

Introduction to materials selection. 'Mono-property' graphs and 'Dual-property' charts. Materials selection indices: lines and directions in materials selection charts. Optimization of the stiffness/mass and strength/mass ratios in components under tension, compression and bending. Simultaneous optimization of properties: examples of trade-off charts.

The materials life cycle. Eco-data: values, sources, precision. Life cycle assessment and eco-audits. Examples of eco-audit. Energy balance with recycling. Energy balance considering functionality and ecoaudit. Definition of embodied energy and update of materials charts for the optimization of the stiffness/embodied energy and strength/ embodied energy ratios in components.

Strategies for eco-informed materials selection. Trade-off ecological sustainability vs. economic sustainability. Optimization of shapes as environmental tool.

References:

M.F. Ashby, Materials and the Environment, Butterworth Heinemann, Oxford, UK

M.F. Ashby, Materials Selection in Mechanical Design, Butterworth Heinemann, Oxford, UK

Duration: 12 hours (3 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on a written questionnaire

Ecotoxicology as an heuristic approach to environmental engineering

Lecturers:
Prof. Luca Palmeri, DII, University of Padova, Lpalmeri@unipd.it

Topics:
Introduction (1)
Introduction (2)
Regulations
Chemical classifications
Chemical classifications (II)
Chemical properties - chemicals (I)
Chemical properties - chemicals (II)
«Chemical properties - partition coefficient and degradation parameters (III)
Exercise on partition coefficient»
«Chemical properties - ecotoxicological parameters (IV)
Exercise. Ecological risk assessment»
«Exercise on chemical properties estimation
QSAR approach + Exercise»
«Environmental chemical profile - Chemical of the year
Fugacity model - assumptions»
«Toxicity testing
Dose response and time-response (I)»
«Toxicity testing
Dose response and time-response (II)»
Fugacity model + exercises (I)
Fugacity model + exercises (II)
Lab experience
Fugacity model + exercises (III)
AQUATOX APPLICATION for the RISK ASSESSMENT - case study (I)
AQUATOX APPLICATION for the RISK ASSESSMENT - case study (II)
Lab experience Lepidium sativum

References:
Ecotoxicology and Environmental Safety

Duration: 6 hours (1.5 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:
Attendance is required for at least 2/3 of the lecture hours.

Electromagnetic fields and biological tissues

Lecturers:

Prof. Elisabetta Sieni, Dipartimento di Scienze Teoriche e Applicate, Università dell'Insubria, elisabetta.sieni@uninsubria.it

Topics:

Introduction to electromagnetic field coupled with the human body.
Brief introduction on cell membrane and cell biology and electrical properties of tissues as a function of the frequency. Measurements of biological tissue electrical properties. Electric field distribution in inhomogeneous tissues.
Mechanism of electric stimulation. Muscle contraction. Tissue heating. Induced current and induced electric field.
Mechanisms involved in the interaction of cells/tissues with electric and magnetic field. The electric model of the cell. Coupling the tissue with electric and magnetic fields.
Medical uses of electromagnetic fields (e.g. electrochemotherapy, ECT, and magneto fluid Hyperthermia, MFH).

References:

Research papers and book chapters will be provided during the course.
[1] C. L. Dennis e R. Ivkov, «Physics of heat generation using magnetic nanoparticles for hyperthermia», Int. J. Hyperthermia, vol. 29, n. 8, pagg. 715–729, 2013.
[2] B. Hildebrandt et al., «The cellular and molecular basis of hyperthermia», Crit. Rev. Oncol. Hematol., vol. 43, n. 1, pagg. 33–56, 2002.
[3] G. F. Goya, L. Asín, e M. R. Ibarra, «Cell death induced by AC magnetic fields and magnetic nanoparticles: Current state and perspectives», Int. J. Hyperthermia, vol. 29, n. 8, pagg. 810–818, 2013.
[4] L. M. Mir et al., «Effective treatment of cutaneous and subcutaneous malignant tumours by electrochemotherapy», Br. J. Cancer, vol. 77, n. 12, pagg. 2336–2342, giu. 1998.
[5] L. M. Mir e S. Orlowski, «Mechanisms of electrochemotherapy», Enhanc. Drug Deliv. Using High-Volt. Pulses, vol. 35, n. 1, pagg. 107–118, gen. 1999, doi: 10.1016/S0169-409X(98)00066-0.
[6] J. Gehl, «Electroporation: theory and methods, perspectives for drug delivery, gene therapy and research», Acta Physiol. Scand., vol. 177, n. 4, pagg. 437–447, apr. 2003, doi: 10.1046/j.1365-201X.2003.01093.x.
[7] M. Marty et al., «Electrochemotherapy – An easy, highly effective and safe treatment of cutaneous and subcutaneous metastases: Results of ESOPE (European Standard Operating Procedures of Electrochemotherapy) study», Eur. J. Cancer Suppl., vol. 4, n. 11, pagg. 3–13, nov. 2006, doi: 10.1016/j.ejcsup.2006.08.002

Duration: 8 hours (2 credits)

Academic years: 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on a multiple choice questionnaire.

Entrepreneurship and Startup

Lecturers:

Prof. Moreno Muffatto, DII, University of Padova, moreno.muffatto@unipd.it
Ing. Francesco Ferrati, DII, University of Padova, francesco.ferrati@unipd.it

Topics:

Entrepreneurship
Technology based startup vs SMEs
Venture creation: different options
The team and the early decisions
Types and characteristics of founders' teams
Founders' decisions and their consequences
From the idea to the market
Innovation: technologies and markets
Market size
Development of the product/service concept
Intellectual Property Rights
The structure of a patent application (description, claims, etc)
Getting a patent: the patenting process (step by step)
Business Models
Business models case studies
Revenue streams
The financials of a startup
The structures of the financial statements
Evaluation of the value of the company
Funding a startup
New ventures' funding options
How and what investors evaluate
How to present a business idea to investors

References:

Thomas R. Ittelson (2009), Financial Statements: A Step-by-Step Guide to Understanding and Creating Financial Reports, Career Press.
Ferrati, F. & Muffatto, M. (2021). «Reviewing Equity Investors' Funding Criteria: A Comprehensive Classification and Research Agenda». Venture Capital, Vol. 23: No. 2, pp. 1-22.
Noam Wasserman (2013) The Founder's Dilemmas: Anticipating and Avoiding the Pitfalls That Can Sink a Startup, Princeton University Press.

Duration: 20 hours (5 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 70% of the lecture hours (i.e. 14 hours).
Final evaluation will be based on the discussion of a case study of a technology-based startup.

Experimental measurements in thermal fluid dynamics

Lecturers:

Prof. Stefano Bortolin, DII, University of Padova, stefano.bortolin@unipd.it
Dr. Arianna Berto, DII, University of Padova, arianna.berto@unipd.it

Topics:

Introduction to the expression of uncertainty in measurements: theory and practical examples.
Measurements of pressure, temperature (thermocouples, infrared thermography, resistance temperature detectors) and flow rate.
Introduction to the determination of the heat transfer coefficient during two-phase flow (condensation, flow boiling) inside channels.
Liquid film thickness measurements inside channels by means of optical techniques (shadowgraphy, chromatic confocal imaging, interferometry).
Heat transfer measurements during dropwise condensation of steam.
Measurements of solar radiation and concentrated solar flux.
Experimental calibration of a thermocouple.
Experimental measurement of temperature and mass flow rate during two-phase flow.

References:

- GUM: Guide to the Expression of Uncertainty in Measurement. http://www.bipm.org/en/publications/guides/gum.html
- Termodinamica applicata, A. Cavallini, L. Mattarolo, CLEUP Editore, cap. XIII.
- V.J. Nicholas, D.R. White. 1994. Traceable Temperatures – An Introduction to Temperature Measurement and Calibration, John Wiley & Sons Ltd, West Sussex, England.
- Bortolin S., Tancon M., Del Col D., Heat transfer enhancement during dropwise condensation over wettability-controlled surfaces, in: M. Marengo and J. De Coninck (Eds.), The Surface Wettability Effect on Phase Change, Springer, Cham, 2022, DOI: https://doi.org/10.1007/978-3-030-82992-6_3
- Del Col D., Bortolin S., Azzolin M., Measuring Heat Transfer Coefficient During Condensation Inside Channels, in: J. Meyer and M. de Paepe (Eds.), The art of measuring in thermal sciences, CRC Press (Taylor and Francis Group), Boca Raton, 2021, DOI: https://doi.org/10.1201/9780429201622

Duration: 14 hours (3.5 credits)

Academic years: 2022/23, 2023/24

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours.
Final evaluation will be based on a home assignment.

Finite Element Method (FEM)

Lecturers:

Prof Giuseppe Gambolati, Dipartimento di Ingegneria Civile, Edile e Ambientale (DICEA), University of Padova, gambo@dmsa.unipd.it

Topics:

Introduction. Sparse linear systems of large size. Conjugate gradient like methods for symmetric positive definite matrices. Acceleration of convergence by preconditioning. Preconditioners. Computation of the smallest eigenvalues of symmetric eigenproblems. Outline of PDEs' of second order of elliptic, parabolic and hyperbolic type. Interpolation with piecewise polynomials. Linear, bilinear, biquadratic, bicubic, quadrilateral, serendipity and isoparametric finite elements. Variational principles. FEM (Finite Element Method). Variational approaches of Ritz and Galerkin. Weak formulations. Method of weigthed residuals. Non conforming elements and patch test. Integration in time by Finite Differences (FD). Stability analysis. Solution to sets of nonlinear equations

References:

Handouts from the lectures.
Giuseppe Gambolati and Massimiliano Ferronato, Lezioni di Metodi Numerici per Ingegneria, Progetto, 2° Ed., 571 pp, 2017.
Thomas J.R. Huges, The Finite Element Method: Linear Static and Dynamic Finite Element Analysis, Prentice-Hall, 833 pp, 1987.
Myron B. Allen et al., Numerical Modeling in Science and Engineering, J. Wiley, 412 pp, 1988.
O.C. Zienkiewicz and R.L. Taylor. The finite element method. Fifth
edition. Butterworth-Heinemann, Oxford (UK), 2000.

Duration: 32 hours (8 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours.
Final evaluation will be based on an oral examination.

Geometric Modeling of Anatomical Parts and Medical Devices

Lecturers:

Prof. Francesca Uccheddu, DII, University of Padova, francesca.uccheddu@unipd.it

Topics:

Within the framework of the so-called personalized medicine, the course aims to provide the student, through conventional lectures and practical demonstrations, an overview on geometric modeling techniques for digital and physical fabrication of anatomical parts and for the realization of personalized medical devices.
Topics:
General aspects of Reverse Engineering
External/Internal anatomic parts acquisition methods
Free form/Surface modeling design of anatomical replicas
CAD modeling design of medical devices
Clinical cases description

References:

Mussi, E., Furferi, R., Volpe, Y., Facchini, F., McGreevy, K. S., & Uccheddu, F. (2019). Ear reconstruction simulation: from handcrafting to 3D printing. Bioengineering, 6(1), 14.
Buonamici, F., Furferi, R., Governi, L., Lazzeri, S., McGreevy, K. S., Servi, M., ... & Volpe, Y. (2020). A practical methodology for computer-aided design of custom 3D printable casts for wrist fractures. The Visual Computer, 36(2), 375-390.
Mussi, E., Mussa, F., Santarelli, C., Scagnet, M., Uccheddu, F., Furferi, R., ... & Genitori, L. (2020). Current practice in preoperative virtual and physical simulation in neurosurgery. Bioengineering, 7(1), 7.
Volpe, Y., Furferi, R., Governi, L., Uccheddu, F., Carfagni, M., Mussa, F., ... & Genitori, L. (2018). Surgery of complex craniofacial defects: A single-step AM-based methodology. Computer Methods and Programs in Biomedicine, 165, 225-233.
Uccheddu, F., Ghionzoli, M., Volpe, Y., Servi, M., Furferi, R., Governi, L., ... & Messineo, A. (2018). A novel objective approach to the external measurement of pectus excavatum severity by means of an optical device. The Annals of thoracic surgery, 106(1), 221-227.

Duration: 8 hours (2 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on a clinical case study developed during the lectures.

Green chemistry and technology

Lecturers:

Prof. Roberta Bertani, DII, University of Padova, roberta.bertani@unipd.it
Prof. Paolo Sgarbossa, DII, University of Padova, paolo.sgarbossa@unipd.it
Prof. Gioele Pagot, DII, University of Padova, gioele.pagot@unipd.it
Other experts in the fields of green chemistry and engineering for topic lessons (defined each year)

Topics:

The aim of the course is to cover the various aspects of green or sustainable chemistry, a new way of looking at and designing industrial chemical processes. Different aspects will be considered, such as:
basis of green chemistry and green engineering,
green solvents,
green synthesis,
green catalysis,
green nanotechnology,
green metrics,
aspects of REACH legislation.
The lessons will be accompanied by examples of application and case studies which will contribute to the understanding of the approach to the conversion of traditional processes to green or greener ones.

References:

Sheldon R.A., Arends I., Hanefeld U., Green Chemistry and Catalysis, 2007, Ed. Wiley
Anastas P.T. and Lapkin A. (editors), Green Chemical Engineering, 2018, Ed. Wiley
Other updated references will be provided to the enrolled students.

Duration: 12 hours (3 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours.
Final evaluation will be based on a short essay written on a specific aspect or process among those treated during the course and its discussion.

Heat Transfer Modelling and Numerical Applications

Lecturers:

Prof. Angelo Zarrella, DII, University of Padova, angelo.zarrella@unipd.it

Topics:

The course looks at an introduction to the principal concepts and methods of heat transfer, both analytical and numerical solutions, oriented especially to buildings and their plant systems. The objectives of the course are to develop modelling skills of heat transfer, corresponding numerical implementation and solving in order to explore the implications for the thermal behavior (in steady and transient state) of the system/case study. During the course the implementation and programming of some common thermal problems in real-world applications are presented. PhD Students will have the opportunity to see these examples and take familiarity and ability to work on heat transfer. These outcomes will be demonstrated through an assignment that will be discussed at the end of the course.

References:

ASHRAE Fundamentals.
Incropera F., De Witt D. Fundamentals of Heat Transfer, John Wiley&Sons. 1981 or other edition.

Duration: 12 hours (3 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours.
Final evaluation will be based on the discussion of a case study within the individual PhD project.

Introduction to Model Order Reduction

Lecturers:
Ing. Riccardo Torchio, DII, University of Padova

Topics:
Model order reduction (MOR) is a technique for reducing the computational complexity of mathematical models in numerical simulations. As such it is closely related to the concept of metamodeling, with applications in all areas of mathematical modelling. In this short course, the main numerical approaches to perform MOR will be presented. In particular, the Proper Orthogonal Decomposition (POD) will be discussed and a basic implementation of the algorithm will be presented. This basic POD algorithm will be then applied to speed up time domain simulations of a thermal problem in MATLAB.

References:
Benner, P., Feng, L. (2014). A Robust Algorithm for Parametric Model Order Reduction Based on Implicit Moment Matching. In: Quarteroni, A., Rozza, G. (eds) Reduced Order Methods for Modeling and Computational Reduction. MS&A - Modeling, Simulation and Applications, vol 9. Springer, Cham. `https://doi.org/10.1007/978-3-319-02090-7_6`

Feng, L., Yue, Y., Banagaaya, N. et al. Parametric modeling and model order reduction for (electro-)thermal analysis of nanoelectronic structures. J.Math.Industry 6, 10 (2016). `https://doi.org/10.1186/s13362-016-0030-8`

Benner P., Grivet-Talocia S., Quarteroni A., Rozza G., Schilders W., Magdeburg L. M. S. Model Order Reduction. Three volumes. Doi: 10.1515/9783110499001

Y. Liang, H. Lee, S. Lim, W. Lin, K. Lee, and C. Wu. Proper orthogonal decomposition and its applications—part i: Theory. Journal of Sound and Vibration, vol. 252, no. 3, pp. 527–544, 2002

Duration: 8 hours (2 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:
Attendance is required for all the lecture hours. Final evaluation will be based on the code implemented during the course.

Life Cycle Assessment of Energy Systems: fundamentals and applications

Lecturers:

Prof. Alberto Benato, DII, University of Padova, alberto.benato@unipd.it
Prof.ssa Anna Stoppato, DII, University of Padova, anna.stoppato@unipd.it

Topics:

Life Cycle Assessment (LCA) is today one of the most accredited assessment methods at the international level for the quantification of the environmental impact of a product or a process. It assesses, in a systematic way, the environmental aspects and potential environmental impacts throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal.
The National Risk Management Research Laboratory of the United States Environmental Protection Agency, stated that «LCA is a technique to assess the environmental aspects and potential impacts associated with a product, process, or service, by:
- Compiling an inventory of relevant energy and material inputs and environmental releases.
- Evaluating the potential environmental impacts associated with identified inputs and releases.
- Interpreting the results to help you make a more informed decision.»

Therefore, LCA is a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. In practice, the associated environmental impacts are evaluated with a cradle-to-grave or cradle-to-cradle approach. This investigation technique guarantees to go beyond the geographical boundaries of the production process and to assess the impacts throughout the «value chain», such as those associated with emissions due to the entire energy and materials supply chain as well as construction, operation and decommissioning phases of plants.
Then, LCA information can be used to improve processes, support policy, and provide a sound basis for informed decisions.
During the Ph.D. course lessons, the four stages of the LCA will be presented following the specifications stated on the standards ISO 14040 and 14044:
- Goal and scope.
- Inventory analysis.
- Impact assessment.
- Interpretation.

The most used and complete models and methods for the impact assessment and updated databases for the Inventory analysis will be presented. The use of LCA for the environmental labels system will be analyzed. The course focuses on the assessment of energy systems and the energetic aspects; for this reason, the proper evaluation of the reference system for the electricity and heat production will be deepened.
Several examples of LCA will be presented with the aim of understanding the importance of:
- The functional unit.
- The system boundaries.
- Any assumptions and limitations.
- Data quality requirements.
- The allocation methods.
- The impact categories.
- Etc..

Finally, the code SimaPro, a professional tool to collect, analyze and monitor the sustainability performance data of products, services, etc., will be presented and used to conduct a Life Cycle Analysis of a Renewable Plant.

References:

Stoppato A., Benato A., De Vanna F. (2021), «Environmental impact of energy systems integrated with electrochemical accumulators and powered by renewable energy sources in a life-cycle perspective», Applied Sciences, Volume 11, Issue 62.
Stoppato A. and Benato A. (2020), «Life cycle assessment of a commercially available organic Rankine cycle unit coupled with a biomass boiler», Energies 13(7),1835.
Cavallin Toscani A., Stoppato A., Benato A. (2019), «LCA of a concert: Evaluation of the Carbon footprint and of Cumulative energy demand», ECOS 2019 - Proceedings of the 32nd International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems pp. 3203-3213.
Fantinato, D., Stoppato A., Benato A. (2019), «LCA analysis of a low-energy residential building», ECOS 2019 - Proceedings of the 32nd International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems pp. 3153-3165.
Stougie, L., Giustozzi, N., van der Kooi, H., Stoppato, A. (2018), «Environmental, economic and exergetic sustainability assessment of power generation from fossil and renewable energy sources», International Journal of Energy Research 42(9), pp. 2916-2926.
Stoppato A. (2008), «Life cycle assessment of photovoltaic electricity generation», Energy 33(2), pp. 224-232.

Duration: 12 hours (3 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours while final evaluation is based on an oral examination.

Powder flowability

Lecturers:

Prof. Andrea Santomaso, DII, University of Padova, andrea.santomaso@unipd.it

Topics:

The course presents the basic knowledge and fundamental concepts that are needed by engineers dealing with problems related to powder flowability.
Relevant properties and characterization of particulate materials (particle shape, size, apparent density, surface area, porosity).
Types of interactions between particles (solid-solid contact) and definition of cohesion. Definition and assessment of powder flowability.
Static and dynamic analysis of stresses in solids (solid mechanics).
Yielding criteria in powders (Mohr-Coulomb analysis).
Active and passive state of stresses (Rankine analysis).
Criteria of storage design for flow (Jenike analysis).

References:

Holdich, Richard G., Fundamentals of Particle Technology. Shepshed: Leicestershire, Midland Information Technology & Publishing, 2002.
Rhodes, Martin J., Introduction to Particle Technology. Chichester: Wiley, 1998.
Nedderman R.M., Statics and Kinematics of Granular Materials, Cambridge University Press, 1992

Duration: 8 hours (2 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours.
Final evaluation will be based on an oral examination.

Reactive Fluid Mechanics

Lecturers:

Prof. Paolo Canu, Dipartimento di Ingengeria Industriale, University of Padova, paolo.canu@unipd.it

Topics:

The course on Reactive Fluid Mechanics will be held by presenting the following topics:
Review of the essential of non-reactive, isothermal, incompressible flow field computation and coupled effects.
The prediction of temperature distribution in convective, unreactive flows. The variable density case, including buoyancy (subsonic flows). Mixing.
Homogeneous and heterogeneous reactions: concepts, examples, implementation, effects.
The specific case of porous materials.

References:

Multiphase reacting flows: modelling and simulation, Marchisio D and Fox, R. (Eds.) Springer, 200
Lanny D. Schmidt, «The Engineering of Chemical Reactions» 2nd Ed. Oxford Univ. Press, 2004
«COMSOL Multiphysics Reference Manual, version 5.5», COMSOL, Inc, www.comsol.com

Duration: 12 hours (3 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for all the course.
The final evaluation is based on the oral discussion of one of the case studies developed during the course or independently by the student, on a specific application of his/her interest

Smart Technologies for the sustainability of the food chain

Lecturers:

Ing. Silvia Minetto, Istituto per le Tecnologie della Costruzione, Consiglio Nazionale delle Ricerche-Padova CNR-ITC, silvia.minetto@itc.cnr.it
Ing. Antonio Rossetti, Istituto per le Tecnologie della Costruzione, Consiglio Nazionale delle Ricerche-Padova CNR-ITC, antonio.rossetti@itc.cnr.it

Topics:

General aspects of technologies for the sustainability of the food chain: integration, interaction and optimisation of energy flows within and between food chain sectors, use of natural fluids, energy efficiency and improved preservation conditions.
Refrigeration systems and heat pumps working with natural refrigerants.
State-of-the art technologies in commercial refrigeration and in transport refrigeration and last mile delivery.
Field monitoring, control and management; field data processing.
Experience with a CO2 unit for transport refrigeration at thermal-fluid dynamic lab at CNR-ITC.

References:

A. Rossetti, F. Fabris, S. Marinetti, S. Minetto, 2022. Field-Data Based Model for Integrated Supermarkets System Seasonal Performance Evaluation. 7th IIR conference on Sustainability and the Cold Chain | April 11-13 | Newcastle, United Kingdom
F. Fabris, P. Artuso, S. Marinetti, S. Minetto, A. Rossetti, 2021. Dynamic modelling of a CO2 transport refrigeration unit with multiple configurations. Applied Thermal Engineering, Vol. 189
P. Gullo, A. Hafner A, K. Banasiak, S. Minetto, E. Kriezi, 2019. Multi-ejector concept: A comprehensive review on its latest technological developments. Energies, Vol 12, Issue 3
S. Minetto, S. Marinetti, P. Saglia, N. Masson, A. Rossetti, 2018. Non-technological barriers to the diffusion of energy-efficient HVAC&R solutions in the food retail sector. International Journal of Refrigeration, 2018, 86, pp. 422–434

Duration: 16 hours (4 credits)

Academic years: 2022/23, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours.
Final evaluation will be based on processing and analysis of lab/field data from a food chain system.

Statistics for Engineers

Lecturers:

Prof. Luigi Salmaso, Department of Management and Engineering, University of Padova, luigi.salmaso@unipd.it
Prof. Rosa Arboretti, Department of Civil, Environmental and Architectural Engineering, University of Padova, rosa.arboretti@unipd.it
Prof. Marta Disegna, Department of Management and Engineering, University of Padova, marta.disegna@unipd.it

Topics:

In this course will be offered an introduction to statistical methods most frequently used for experimentation in Engineering.
The course aims to develop knowledge of the fundamental statistical processes, techniques and ideas used in the collection, presentation, analysis and interpretation of data; develop the ability to understand, interpret, and communicate quantitative results and show how quantitative methods may be used to provide reliable information; develop an understanding of the scope and limitations of quantitative analysis.
The indicative content of the course is as follows: elements of univariate statistical methods, including descriptive statistics, probability and inferential statistics (point estimate, confidence interval and hypothesis tests); linear and non-linear regression models; multivariate data analysis; Design of experiment.
Lectures will cover both theoretical aspects and the analysis of practical problems. The applications will be conducted using MINITAB, licensed to University of Padova, and R/ Rstudio, open-source software.

References:

Stark, P.B., 1997. SticiGui: Statistics Tools for Internet and Classroom Instruction with a Graphical User Interface.
Montgomery DC, Design and Analysis of Experiments, 2010, Wiley.
Lattin J, Carroll JD, Green PE, Analyzing Multivariate Data, 2003, Duxbury Applied Series.
Johnson RA, Wichern DW, Applied Multivariate Statistical Analysis,1998, Prentice Hall; 4th edition.
Hollander and Wolfe, Nonparametric Statistical Methods, 2nd edition, 1999, Wiley Series in Probability and Statistics.
Shumway RH, Stoffer DS, Time Series Analysis and Its Applications (With R Examples), 2nd Edition, 1998, Springer Texts in Statistics, NewYork.
Everitt, B. S., Landau, S., Leese, M., & Stahl, D. (2011). Cluster analysis (Fifth ed.). Wiley series in probability and statistics: John Wiley & Sons, Ltd.

Duration: 40 hours (10 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on the discussion of a case study, preferably drawn from the individual PhD project of one of the group members.

Stochastic methods for single- and multi-objective optimization

Lecturers:

Prof. Piergiorgio Alotto, DII, University of Padova, piergiorgio.alotto@unipd.it

Topics:

- Particle Swarm Optimization (PSO):
Objectives of the lecture, Origins, Basics, Terminology,Implementation (Matlab code), Numerical experiments, The missing details, Conclusions
- Differential Evolution (DE)
Objectives of the lecture, Hystorical notes, Basics, Implementation (Matlab code), Improvement strategies, Constraint handling, Conclusions
- Surrogate Modelling
Objectives of the lecture, Rationale, Surrogate modeling, 1D problem, Radial basis functions (RBFs), A successive zooming algorithm, Conclusions
- Multiobjective Optimization
Objectives of the lecture, Multiobjective optimization, Eating out as an engineering problem, Objective weighting, Fuzzy optimization, Pareto optimization, A more general framework, Front characteristics, General (abstract) algorithm, Conclusions
- From Single-objective to Multi-objective
Objectives of the lecture, Multiobjective optimization, MO-PSO (Naive implementation, Archive, Nondominated sorting), MO-DE (Naive implementation, Nondominated sorting, Archive) Conclusions

References:

Copies of all slides will be provided

Duration: 12 hours (3 credits)

Academic years: 2023/24

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on a small project.

Sustainable Energy in Buildings

Lecturers:

Prof. Michele De Carli, DII, University of Padova, michele.decarli@unipd.it
Dr. Laura Carnieletto, DII, University of Padova, laura.carnieletto@unipd.it
Dr. Giuseppe Emmi, Università di Ferrara, giuseppe.emmi@unife.it
Dr. Jacopo Vivian, DII, University of Padova, jacopo.vivian@unipd.it

Topics:

Efforts to reduce CO2 emissions have become a pivotal environmental priority of this century. Buildings are responsible for about 40% of total energy consumption in Europe and similar values are also found in other countries. To decrease this value some of the open options are those of improving the quality of buildings' envelopes or of using energy-efficient heating and cooling technologies based on renewable energies. The current tendency when new constructions are being designed is to plan low or nearly zero energy buildings. The course looks at the assessment of current and potential future energy systems in buildings, covering conversion, and end-use, with emphasis on meeting regional and global energy needs in a sustainable manner. Different renewable and conventional energy technologies will be presented and their attributes described within a framework that aids in evaluation and analysis of energy technology systems in the context of environmental goals. During the course modelling approaches, methods, simulation tools and instruments to evaluate the energy performance of buildings and indoor environmental quality will be also presented and used. During the course, the CoreCare Laboratory to evaluate the thermal comfort and indoor environmental quality will be also presented.

References:

ASHRAE Handbooks and Standards
AiCARR guidelines, international standards, examples of design of efficient buildings and systems.

Duration: 12 hours (3 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours.
Final evaluation will be based on a written questionnaire.

Technological Advancements in Electromobility

Lecturers:

Prof. Manuele Bertoluzzo, DII, University of Padova, manuele.bertoluzzo@unipd.it.
Prof.Giuseppe Buja, DII, University of Padova, giuseppe.buja@unipd.it

Topics:

The course is divided into four 2-hour lessons. The first lesson deals with the different architectures of the powertrain of the purely electric and hybrid vehicles. The second lesson deals with the energy storage devices (batteries and supercapacitors) on-board the electric vehicles. The third lesson deals with the infrastructures for the wired charging of the batteries of the electric vehicles and introduces the relevant classification. The fourth lesson addresses the working principles of the wireless charging of the electric vehicles considering both the static and the dynamic implementations.

References:

The course slides and papers in electronic form will be available in the Moodle platform

Duration: 8 hours (2 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours.
Final evaluation will be based on a colloquium.

Technologies for boosting energy efficiency and spreading renewable plants

Lecturers:

Prof. Alberto Benato, DII, University of Padova, alberto.benato@unipd.it
Prof.ssa Anna Stoppato, DII, University of Padova, anna.stoppato@unipd.it
Prof.ssa Giovanna Cavazzini, DII, University of Padova, giovanna.cavazzini@unipd.it

Topics:

To move towards a sustainable power generation system, there is a need to properly use the energy produced by renewable energy plants as well as to better exploit each source of waste heat. To do that, the point is to have access to energy storage technologies and waste heat recovery units as well as to be able to integrate them into more complex energy systems.
The idea is to build up hybrid energy systems in which renewable- and fossil-based plants, energy storage systems and waste heat recovery units work in synergy to supply electricity, heat, cold, water and fuels (e.g., hydrogen, biogas, bio-methane, etc.) in the most effective mode.
In this context, the first aim of the COURSE is to present and classify the energy storage technologies and the waste heat recovery units as well as to define the hybrid system concept and working principle.
After that, the attention will be paid on the design of the storage technologies and of the waste heat recovery units.
In particular, for the storage units, the focus will be on the mechanical and thermal energy storage technologies and will consider the thermodynamic cycles, the up-to-date ways of construction and the economic aspects. In this way, the technologies will not be analyzed only as a black-box storage devices, but considering, e.g., the thermodynamic cycles itself allowing the conversion of electricity into heat during the charging phase and the conversion of heat into electricity during the discharge process. In addition to that and based on the grid or renewable plant's needs, different reference cycles and configurations will be presented as well as their control strategies.
In a similar way, the waste heat recovery units will be presented taking into account the thermodynamic, the economic and the technical point of views.
After the technologies overview, they will be compared based on technical, economic, and environmental indexes.
Finally, being storage and waste heat technologies fundamental to boost energy efficiency and spreading renewable plants, the benefits of inserting all of them in a unique hybrid system will be presented in conjunction with optimization techniques able to take into account not only the requested fluxes (electricity, heat, cold, etc.) but also the specific features of each technology. In this manner, the most suitable hybrid system configuration can be designed.

References:

Redjeb Y, Kaabeche-Djerafi K., Stoppato A., Benato A. (2021), «The IRC-PD Tool: A Code to Design Steam and Organic Waste Heat Recovery Units», Energies, 14(18), 5611.
Cavazzini G., Pavesi G., Ardizzon G. (2018), «A novel two-swarm based PSO search strategy for optimal short-term hydro-thermal generation scheduling», Energy Conversion and Management, 164, 460-481.
Benato A. and Stoppato A. (2018), «Pumped Thermal Electricity Storage: A technology overview», Thermal Science and Engineering Progress, Vol. 6, pp. 301–315.
Benato A. and Stoppato A. (2018), «Energy and cost analysis of an Air Cycle used as prime mover of a Thermal Electricity Storage», Journal of Energy Storage, Volume 17, June 2018, Pages 29–46.
Benato A. (2017), «Performance and Cost Evaluation of an Innovative Pumped Thermal Electricity Storage

Power System», Energy, Volume 138, 1 November 2017, Pages 419-436
Stoppato A. and Benato A. (2017), «The Importance of Energy Storage». World Scientific Series in Current Energy Issues, Energy Storage - Volume 4, Pages: 1-26, Marcus Enterprise LLC, USA & University of South Carolina, USA.
Pezzuolo A., Benato A., Stoppato A., Mirandola A. (2016), «The ORC-PD: A versatile tool for fluid selection and Organic Rankine Cycle unit design», Energy, Volume 102, 01 May 2016, Pages 605-620.
Benato A., Stoppato A., Mirandola A. (2016), «Renewable Energy Conversion and Waste Heat Recovery Using Organic Rankine Cycles», Edited Book «Renewable Energy Systems». Published by Nova Science Publishers, USA, 1 January 2016.
Destro, N., Benato, A., Stoppato, A., Mirandola, A. (2016), «Components design and daily operation optimization of a hybrid system with energy storages», Energy, 2016, 117, pp. 569–577.
Cavazzini, G. and Dal Toso, P. (2015), «Techno-economic feasibility study of the integration of a commercial small-scale ORC in a real case study», Energy Conversion and Management, 99, 161-175.
Pérez-Díaz, J. I., Chazarra, M., García-González, J., Cavazzini, G., Stoppato, A. (2015), «Trends and challenges in the operation of pumped-storage hydropower plants», Renewable and Sustainable Energy Reviews, 44, 767-784.
Ardizzon, G., Cavazzini, G., Pavesi, G. (2014), «A new generation of small hydro and pumped-hydro power plants: Advances and future challenges», Renewable and Sustainable Energy Reviews, 31, 746-761.

Duration: 24 hours (6 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:
Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on an oral examination

Tutela della proprietà intellettuale

Lecturers:
Avv. Luca Giove - Libero professionista
Ing. Gianluigi Zanettin - Patent Attorney, Jacobacci & Partners Spa
Personale interno – Settore Trasferimento di tecnologia, Ufficio valorizzazione della ricerca, University of Padova

Topics:
1. La tutela dell'innovazione tecnologica: brevetti, modelli di utilità, altre privative e segreto industriale (Avv. Luca Giove)
2. Aspetti tecnici dei brevetti nel settore ingegneristico (Ing. Gianluigi Zanettin)
- Introduzione generale alla tutela della Proprietà Intellettuale
- Funzione e struttura del brevetto d'invenzione
- Esclusioni dalla brevettabilità: cenni alla brevettazione del software
- I requisiti di brevettabilità
- I diritti conferiti dal brevetto
- La valutazione dell'interferenza con diritti brevettuali di terzi
- Tutelabilità vs attuabilità, brevettabilità vs interferenza
- Esempi
- Le ricerche di anteriorità
3. I servizi dell'Ateneo ai dottorandi e ricercatori nel campo della proprietà intellettuale (Personale interno – Ufficio valorizzazione della ricerca, University of Padova)

References:
Materiale caricato dai docenti sulla pagina Moodle del corso

Duration: 18 hours (4.5 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: Italian

Evaluation:
Obbligo di frequenza per almeno 2/3 della durata prevista.
È prevista una prova scritta finale.

Vibration energy harvesting

Lecturers:

Prof. Alberto Doria, DII, University of Padova, alberto.doria@unipd.it

Topics:

Review on mechanical vibrations.
Fundamentals of vibration harvesting technologies, piezoelectric, electromagnetic and capacitive harvesters.
Mathematical modeling of piezoelectric harvesters. Coupled model of a cantilever harvester.
Solution of the equations of motion with the modal superposition approach.
Harmonic analysis calculations of the frequency response functions of voltage and stress.
Testing of piezoelectric harvesters with impulsive methods and by means of shakers
Applications of harvesters
Applications of piezoelectric harvesters (harvesters for vehicles, rain-drop harvesters)

References:

PRIYA, S., INMAN,D., Energy Harvesting Technologies, Springer 2009.

Duration: 8 hours (2 credits)

Academic years: 2022/23, 2024/25

Language: English

Evaluation:

The discussion of a case study

Yield criteria for polymer materials

Lecturers:

Prof Mauro Ricotta, DII, University of Padova, mauro.ricotta@unipd.it

Topics:

Introduction to polymer materials
Stress-strain curve.
Tensile and compressive static tests according to International Standards.
Macroscopic and microscopic yielding: damage mechanisms.
Definition of multiaxial stress state: octahedral normal and tangential stress components.
Yield criteria for macroscopic yielding: Bauwens criterion, Raghava Caddell Yeh criterion.
Yield criteria for microscopic yielding: Sternstein criterion.
Strain Energy Release Rate: definition, experimental evaluation according to the International Standards.
The Bucknall criterion
Examples

References:

Raghava et al, J Mater Science 1973
Bucknall, Polymer 48, 2007

Duration: 8 hours (2 credits)

Academic years: 2022/23, 2023/24, 2024/25

Language: English

Evaluation:

Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on written questionnaire