

VERBALE DEL CONSIGLIO DELLA SCUOLA DI DOTTORATO DEL POLITECNICO DI BARI

Seduta n. 5/2018

del giorno 27 novembre 2018

Il giorno 27 novembre 2018 alle ore 9:30, a seguito di convocazione del 20/11/2018, si è riunito presso l'Aula della sezione Macchine ed Energetica del DMMM il Consiglio della Scuola di Dottorato del Politecnico di Bari, per discutere il seguente

ORDINE DEL GIORNO

1. Comunicazioni del Direttore.
2. Offerta didattica A.A. 2018-2019

Sono presenti:

	PROF			Presente	Assente giustific.	Assente
1	PROF.	ALBINO	Vito		X	
2	PROF.	CUPERTINO	Francesco	X		
3	PROF.	DE PALMA	Pietro	X		
4	PROF.	DEMELIO	Giuseppe Pompeo	X		
5	PROF.	GIGLIETTO	Nicola		X	
6	PROF.	MASTRORILLI	Pietro	X		
7	PROF.	MENGHINI	Anna Bruna		X	
8	PROF.	MOCCIA	Carlo		X	
9	PROF.	MOSSA	Michele		X	
10	Prof.	GRIECO	Alfredo	X		
11	DOTT.	NOCERA	Francesco	X		

Alle ore 9.30, il Direttore, accertata la presenza del numero legale dei componenti, dichiara aperti i lavori del Consiglio. Viene nominato segretario il prof. Alfredo Grieco.

P.1) Comunicazioni del Direttore

Il Direttore comunica che è in fase di sviluppo il nuovo sito della Scuola sul server dell'amministrazione centrale del Politecnico.

P.2) Offerta didattica A.A. 2018-2019 e 2019-2020

Su invito del Direttore, alcuni Coordinatori hanno effettuato un'indagine tra i colleghi del proprio Dipartimento per discutere e raccogliere proposte di insegnamenti al fine di configurare l'offerta formativa della Scuola di dottorato a partire dal prossimo anno accademico 2018-2019. Sono pervenute 17 proposte dal DEI; 10 proposte dal DICAR; 9 proposte dal DICATECH; 16 proposte dal DMMM.

Dopo ampia discussione, il Consiglio delibera di erogare 25 corsi per l'A. A. 2018-2019 e 25 corsi per l'A. A. 2019-2020.

Per assicurare un'elevata qualità della didattica erogata e l'aggiornamento della stessa, tutti i corsi saranno valutati impiegando moduli di valutazione che dovranno essere compilati dagli studenti frequentanti. In base alla valutazione degli studenti e al numero di studenti frequentanti, il Consiglio potrà decidere in futuro le variazioni da apportare all'offerta didattica della Scuola.

L'elenco dei corsi da erogare nell'A. A. 2018-2019, e quindi da bandire per supplenza nel breve termine, è il seguente:

1. Numerical approaches to solid and applied mechanics: Boundary Elements Methods (BEM)_____CFU 3 (30 ore); SSD: ING-IND 13

Theory of BEM. Linearity and Translation Invariance. Green's function. BE methods for contact mechanics: formulation for linear elastic and viscoelastic materials, role of the geometric domain (smooth and rough contacts), solution schemes (Fourier vs Real space), adaptive mesh. FEM vs BEM. Coupling BEM and Finite Difference: the case of soft lubrication. Other applications of BE methodologies: BEM for crack mechanics; BEM for modal analysis including fluid-structure interaction.

2. Dynamical systems and chaos: theory

CFU 2 (20 ore); SSD: ING-IND/08

1. Introduction

General examples and classification of systems. Phase space and trajectories. Examples of simple systems: Lotka-Volterra equations

2. First order systems

Fixed points and linear stability analysis. Potentials. Bifurcations: saddle-node, transcritical, pitchfork, supercritical/subcritical, imperfect bifurcation and catastrophes. Bifurcation diagrams. First order systems in a periodical phase space. Examples: the logistic equation and the population growth; the overdamped mass-spring systems; the overdamped bead on a rotating hoop; the solid state laser.

3. Second order systems

3.1 Linear systems

Phase portraits. Lyapunov stability (global and asymptotical stability). Classification of linear systems: stable nodes, unstable nodes, saddles, centers, stable and unstable spirals, non isolated fixed points.

3.2 Nonlinear systems

Equilibrium points and linearization. Phase portraits: fixed points, periodic orbits, homoclinic orbits and heteroclinic trajectories. Conservative systems, reversible systems. Index theory. Stable and unstable limit cycles. Lyapunov functions. Poincaré-Bendixson theorem. Bifurcations on nonlinear systems: supercritical/subcritical Hopf bifurcation, saddle-node bifurcation of limit cycle, infinite period bifurcation, homoclinic bifurcation. Hysteresis. Poincaré maps.

Examples: Lotka-Volterra model; the pendulum dynamics (overdamped or not, forced or not); limit cycles on chemical reactions; Van-der-Pol oscillator; surge in turbomachinery.

4. Third order systems

4.1 Chaos

Lorenz equations and properties. Lorenz map. Strange attractors. Chaos and metastable chaos. Logistic map. Koenig-Lemmaray method. Lyapunov exponents. Universality: qualitative and quantitative. Fractals. Rossler systems.

Examples: the chaotic water wheel; instability and turbulence on convection cells; mechanical magneto-elastic systems; chaos on chemical reactions; subcritical transition to turbulence in shear flows.

5. Order n and infinite dimensions systems

Fixed points and limit cycles in an infinite dimensions system. Example of bifurcations.

Bifurcations in fluid dynamics. Self-sustained cycle of Hamilton-Kim-Waleffe: transient growth, lift-up, secondary stability of streaks, nonlinear effects. Exact coherent states, travelling waves and periodic orbits. Control of trajectories on periodic orbits. Edge states and edge of chaos and tracking method. Lebedev.

Numerical applications with matlab: tracking of the edge state for Waleffe model.

Numerical applications with channelflow: computation and continuation of exact coherent states.

3. Dynamical systems and chaos: applications

CFU 2 (20 ore); SSD: ING/IND-14

Lecture (10 hours)

1. Introduction: multiplicity of solutions in nonlinear dynamical systems
 2. The harmonic balance method: application to mechanical systems with polynomial damping force
 3. The multiple scale method: application to the extended Van der Pol oscillator
 4. Stability of periodic solutions: Floquet theory
 5. Numerical continuation of periodic solutions: sequential method, Arclength continuation, Pseudo-Arclength continuation
- Case studies (10 hours)
6. Friction-excited systems: stick-slip oscillations
 7. Externally excited systems: Duffing's oscillator
 8. Vibration localizations in weakly coupled chains
 - 8.1. Applications to self-excited systems: smooth and non-smooth dynamics
 - 8.2. Applications to externally excited systems with nonlinear stiffness restoring force

4. Statistical mechanics with applications to materials science

CFU 3 (30 ore); SSD: MAT/07

1) BASIC CONCEPTS

Observables; probability distribution; ensembles; free energy and entropy; partition function.

2) FLUCTUATIONS AND LINEAR RESPONSE

Brownian motion and diffusion; correlation functions; fluctuation-dissipation theorem.

3) INTRODUCTION TO PHASE TRANSITIONS

Critical points; symmetry breaking and order parameter; Landau theory.

4) MODELS

Ising and Heisenberg model; random ferromagnets; polymers; liquid crystals.

5. Calculus of variations with applications in continuum mechanics

CFU 3 (30 ore); SSD: MAT/05

Classical methods and Euler-Lagrange equations. Direct methods: scalar and vectorial problems. Convex problems with applications to linear elasticity. Nonconvex problems: notions of quasiconvexity, polyconvexity, rank one convexity. The variational problem in finite elasticity. Relaxation and Gamma-convergence. Applications to the deduction of low- dimensions theories of

continuum mechanics. Material instabilities: phase transitions and microstructures. Variational problems in optimal material design.

6. Mechanical characterization of materials by advanced ultrasonic tests

CFU 3 (30 ore); SSD: ING-IND/14

Fundamental of Nondestructive tests and Ultrasonic tests. Application of ultrasonic tests for mechanical characterization of materials and for the diagnosis of structures. Ultrasonic waves propagation in elastic materials: Linear elastodynamics theory. Ultrasonic waves propagation in anisotropic materials. Ultrasonic waves propagation in prestressed materials. The Acoustoelastic theory.

Experimental applications: Ultrasonic immersion tests. Laser ultrasonic tests. Ultrasonic characterization of isotropic and anisotropic materials.

7. Combustion processes and pollutant emissions

CFU 2(20 ore); SSD: ING/IND-08

This course will enable students with general knowledge in energy generation to move to an integrated understanding of combustion, by illustrating the fundamental principles of combustion chemistry, how they relate to experimental observations and how they can be used in theoretical and numerical modeling.

The course will cover aspects ranging from a review of thermodynamics and kinetic theory of gases to the concept and applications of detailed kinetic modeling.

Deflagration and detonation waves, premixed and non-premixed flames, laminar and turbulent flame speeds will be introduced.

A description of the main theories of kinetics, including collision theory, statistical mechanics, transition state and unimolecular reaction rate theories, will be provided.

The course will then move the study of reaction mechanisms, from the identification of explosion limits in H₂/O₂ system to the complex hydrocarbons oxidation. Flammability limits and ignition processes will be discussed, as well.

Some of the most relevant reaction paths involved in hydrocarbons oxidation and leading to gaseous and soot emissions formation will be discussed in more detail.

8. Advances in Geomatics Engineering

CFU 3 (30 ore); SSD: ICAR/06

Multimedia cartography and information delivery;

Geospatial Information Science and Geographic Databases;

Geospatial Web and Big Data;

Technologies and methods in Remote Sensing (proximal/drone/aerial/satellite platforms);

Survey and 2D/3D geospatial data processing;

Geospatial data modelling and analysis.

The advanced topics may serve as an introduction to research skills that may be useful at multidisciplinary level.

9. How to build an ontology that lasts

CFU 3 (30 ore); SSD: ICAR20

Part 1: Introduction, motivations, history, ontology classification

Part 2: Protege, how to practically build an ontology, how to merge ontologies

Part 3: Building an ontology: from the analysis to the software

Part 4: How to model resources, functionalities, plans and tasks.

10. Models and methods for logistics and sustainable transportation

CFU 2 (20 ore); SSD: ICAR/05

Sustainable Transportation: Concepts and Current Practices, Bike-Sharing and Car-Sharing Systems;

Decision-Making Optimizations Methods in Sustainable Transportation;

Modelling, Simulation and Fleet Optimization in a Sustainable Transport System;

Sustainable Logistics with Cargo Bikes: Methods and Applications;

MATLAB Coding for Sustainable Transportation Problems - exercises.

11. Statistical data analysis starting from the highway engineering case

CFU 2 (20 ore); SSD: ICAR/04

The lectures will be organized by explaining general methodologies for data analyses starting from examples of dataset from the highway engineering. The methodologies covered are: Exploratory analyses of dataset, Tests of differences between groups (parametric vs non-parametric), Regression modelling (considering calibration). Even based on infrastructure, traffic and accident data, the transferability of the presented methodologies to other fields will be stressed, to ensure the usefulness of the course at a multidisciplinary level. Moreover, basic knowledge in using the open-source statistical software "R" may be of interest for all research fields. Verification. Based on a report explaining the development of a model or the application of statistical tests on sample of data (virtual or real) which are relevant to the individual research of each student, by means of the explained methodologies.

12. Climate Change: Impacts & Responses. How vegetation causes an alteration of hydrological conditions and spreading process in natural flows

CFU 2 (20 ore); SSD: ICAR/01

Aquatic vegetation provides a wide range of ecosystem services. The uptake of nutrients and production of oxygen improve water quality. The widespread planting in waterways could strongly contribute to the removal of nitrogen and phosphorous. Seagrasses form the foundation of many food webs and vegetation promotes biodiversity by creating different habitats with spatial heterogeneity in the stream velocity. Marshes and mangroves reduce coastal erosion by damping waves and storm surge, as well riparian vegetation enhances bank stability. Even more in times of a changing climate, which could alter hydrological conditions, the monitoring of vegetation development is a fundamental activity in coastal and river management, to both protect ecological services and control flood or erosion risks. A further key point remains poorly investigated and still deserves a thorough study, that is the effect induced by vegetation or similar obstructions on a discharged effluent assumed as a turbulent jet. The present course shows how vegetation greatly affects the jet entrainment, reversing it into a detrainment process, the diffusion and advection of the jet solute and particles and the jet momentum, demonstrating that it is one of the main causes of the river morphology alteration.

13. Elements of Probability for Engineering Sciences

CFU 3 (30 ore); SSD: ING-INF/03

Basic Concepts of Probability Theory: Random phenomena, Sample space, Events, Algebra of events,

Axioms of Probability, Independent events, Conditional probability, Total probability Theorem, Bayes Theorem.

Random Variables: Notion of r.v., Cumulative Distribution Function (c.d.f.), Probability Mass Function (p.m.f.), Probability Density Function (p.d.f.), Moments of r.v., Functions of a r.v., examples.

Characteristic Function, Properties of Characteristic Function, Application to Exponential, Erlang, Poisson, Binomial, Geometric r.v.

Pairs of Random Variables: Joint c.d.f., Joint p.d.f. for continuous r.v., One function of two r.v., Correlation and Covariance of two r.v., Correlation coefficient, examples. Conditional Density functions,
Conditional Expectation, Examples.
Sums of Random Variables and Long-Term Averages: Central Limit Theorem (CLT), Weak law of Large Numbers (WLLN), Introduction to Linear Estimation
Probability Models in Engineering: Communication over Unreliable Channel
Selected Applications: Defined in agreement with interested students

14. Reasoning on the Web of Data

CFU 3 (30 ore); SSD: ING-INF/05

Modeling and querying the Web of Data: RDF and SPARQL

Reasoning on the Web of data:

- Methods for cutting knowledge-relevant portions of linked data ensuring feasible reasoning solutions
- Definition of reasoning services in RDF

Inferring strategic knowledge from the Web of Data: examples of applications implementing reasoning services in RDF

15. Industry 4.0: Optimization, Control and Security

CFU 3 (30 ore); SSD: ING-INF/04

The course includes the following four main sections:

- 1) Industry 4.0 – Introduction and innovations for the industrial companies.
- 2) Cloud computing system: architecture and design.
- 3) Optimization and control in a Cloud computing system: virtual sensors and distributed systems, centralized and decentralized optimization, multi-agent optimization (distributed task assignment, consensus, etc.), Programmable Logic Controller (PLC).
- 4) Opacity notion and algorithms to defend crucial information by intruder attacks.

16. Applications of MATLAB

CFU 3 (30 ore); SSD: ING-INF/04

Environment of the MATLAB Software

Predefined functions

Working with matrices

Graphical functions

Functions defined by the user

Inputs and outputs controlled by the user

Control structures and logical functions

Symbolic math

Modeling and simulation in Simulink

17. Multi-energy and configuration of microgrids: planning, management and control

CFU 3 (30 ore); SSD: ING-IND/33

Power system evolution – smart grids and microgrids

Planning, management and operation of microgrid in the presence of electric and thermal demand

The role of microgrid in markets and enhanced grid integration through ancillary services

Design, programming and control of DC microgrid for supplying electric vehicles

Experiences on experimental microgrid management and operation

18. Research Methodologies

CFU 3 (30 ore); SSD: ING-IND/31

The course of Research Methodology comprises four main sections:

1. Research Theory
2. Research Methods
3. Research Instruments/Techniques
4. Research Proposal
5. Writing a Research Report

Each of them can include also examples and case studies

19. Management and control approaches for flexible and efficient smart grids

CFU 3 (30 ore); SSD: ING-INF/04

The next-generation power system needs to be smart and sustainable to simultaneously deal with the ever-growing global energy demand and achieve environmental goals. Environmental concerns as well as the technical and economic (the energy trilemma) are driving significant changes in power systems. This course explores the main concepts behind smart grids and low-carbon networks, two prominent changes in power systems, and the impact of new loads (e.g., electric vehicles and heat pumps) on the power system. The potential benefits to the next-generation power grid of demand-side flexibility will be discussed. In this context, the role of buildings is crucial, due to their large share of primary energy usage and their increasing capability to integrate also distributed generation and storage systems. Among the various approaches adopted within the energy management literature, Model Predictive Control (MPC) has received particular attention and it is expected to become a common solution for use in building energy management. MPC-based energy management frameworks for buildings in a smart grid scenario will be described. Each lesson consists in lectures, numerical examples, simulation and analysis of case studies.

20. Numerical methods for fractional calculus and matrix functions

CFU 3 (30 ore); SSD: MAT/08

- Fundamentals of Fractional Calculus: Riemann-Liouville differential and integral operators Caputo's approach, Mittag-Leffler functions
 - Theory of Fractional Differential Equations
 - Numerical Solution of Fractional Differential Equations
- Numerical schemes for systems of FDEs, Numerical schemes for multi-term FDEs
- Numerical computation of matrix functions

21. Themes and methods of contemporary architectural research

CFU 3 (30 ore); SSD: ICAR/14

The main educational objective of "Themes and methods of contemporary architectural research" course is to provide the PhD student the theoretical basis for the formation of a critical knowledge of the main themes that feed the contemporary architectural research. The course will be articulated into lessons and exercises complementary to each other. Through the lessons the knowledge will be transmitted and the comprehension skills will be developed; through the exercises the acquisition of the ability to apply knowledge and understanding will be verified. The course will be divided into two parts, corresponding to two blocks of lessons and exercises, complementary to each other. The first part of the course will address to general issues concerning the ontology of architecture and its special cognitive status of discipline that lies between the epistemological model of the scientific disciplines and that of the artistic disciplines.

In the second part of the course will be proposed a thematic deepening on three central themes for the contemporary architectural debate, concerning the relationship between "Architecture and City", the relationship between "Architecture and Ancient", the relationship between "Architecture and Construction".

22. La ricerca storica e lo studio dell'antico

CFU 3 (30 ore); SSD: ICAR/18, L-ANT/07

L'architettura antica si presenta quasi sempre allo stato di rudere. Il suo studio, finalizzato alla formulazione di attendibili ipotesi di ricostruzione del testo architettonico, deve naturalmente basarsi su metodologie di indagine integrata che fanno dell'analisi di dettaglio della consistenza materica del rudere la base conoscitiva imprescindibile. Sono presi in considerazione quindi, oltre alle osservazioni derivate dall'analisi autoptica e dai risultati del rilievo architettonico, anche le eventuali testimonianze iconografiche provenienti da altre fonti, come la pittura vascolare, gli affreschi, i bassorilievi, le immagini su monete ecc. L'edificio e i suoi dettagli costruttivi e morfologici, nonché, quando presente, la sua scultura architettonica vanno poi confrontati con altre architetture coeve, in modo da inserirlo nel corretto contesto storico-geografico di appartenenza.

Il corso si prefigge quindi di illustrare alcune ricerche architettoniche concluse o in atto che possano efficacemente illustrare il metodo di ricerca sopra citato. In particolare, verranno affrontati, in altrettante lezioni, i seguenti casi studio:

- il teatro ellenistico di Mitilene
- il tempio di Roma e Augusto a Leptis Magna
- la Curia di Leptis Magna
- l'Arco di Traiano a Leptis Magna
- l'anfiteatro di Sabratha
- il cd. "tempio romano" di Agrigento
- la ricostruzione dell'impianto urbano di Kos
- la scultura architettonica
- la rappresentazione della città attraverso le fonti iconografiche
- l'impianto urbano e l'agorà di Byllis in Albania

23. Historical research and study of the city and contemporary architecture

CFU 3 (30 ore); SSD: ICAR/18

The course is divided into an institutional part of the program and in an experimental part, implemented in the modalities of the Laboratory, within which will be provided some exercises aimed at strengthening the student's critical skills starting from a basic training about the methods and materials for historical research in the second half of the twentieth century.

The course aims to provide students with a correct study methodology aimed at acquiring a historical-critical knowledge of the history of contemporary architecture, from the origins of modern architecture to current architectural trends, with particular attention to the widespread ideas of Italian tendency. and, in particular, to the figure of Aldo Rossi and the masters who revolve around the editors of the Casabella of Rogers, also and above all in relation to the worldwide resonance that they had within the architectural debate after World War II.

24. Analysis and representation techniques for architectural research

CFU 3 (30 ore); SSD: ICAR/17

The course aims to stimulate a critical attitude in the study of the city and architecture, providing to the young researcher a repertoire of analysis techniques and representation models to support research.

The techniques of survey of the existing, laser scanner and photo-modeling, are joined to those of the inexistent, graphic analysis and graphic reconstruction, providing the tools and methods for a research of architectures in praesentia that can be studied and analyzed also metrically, that those in absentia designed and never realized.

The course aims to analyze and graphically return the different components of architecture and the city, and with the tools of drawing and modeling investigate the historical / evolutionary process or the ideation / composition process too. These are fundamental cognitive moments for the study of

an architecture or a part of the city and at the same time to analyze the complex personality of its author.

Practical exercises alternate with lectures encouraging young researchers to use the techniques of analysis and graphic representation, articulating and stimulating their critical skills in reading an architecture and / or the city or a portion of it.

25. L'architettura delle forme strutturali

CFU 3 (30 ore); SSD: ICAR/12

Il corso si articola in una prima parte in cui sono individuate le Forme della Costruzione, ovvero i principi formali che costituiscono il fondamento delle forme strutturali; quindi la conoscenza degli elementi che le costituiscono ed infine le rispettive regole di composizione. I principi formali si riconoscono essenzialmente nel sistema murario, nel sistema trilitico e nel sistema a traliccio, declinati in differenti possibili variazioni che dipendono dall'uso di materiali e tecniche. Allo stesso tempo si riconoscono altri principi riferiti ai sistemi di copertura: la copertura piana, il tetto, la volta, la cupola.

Il corso si avvia con un breve excursus storico, nel quale si mostrano le origini di tali principi, il loro consolidarsi e svilupparsi attraverso il progressivo potenziamento della tecnica. Particolare attenzione si rivolge alle esperienze del Novecento più significative, quando tali principi assumono una rilevanza decisiva nell'assolvere alle necessità della cosiddetta "architettura delle tecniche", cioè al progetto di grattacieli, fabbriche, edifici commerciali, edifici religiosi, ecc.

Non si trascura la costante riflessione che questo tema ha sviluppato, soprattutto nel Novecento, accompagnando la pratica del progetto. Questo aspetto costituirà la parte teorica dell'intero corso.

L'elenco dei corsi da erogare nell'A. A. 2019-2020, e quindi da bandire nel 2019, è il seguente:

1. How to write a technical paper and to present it effectively to an educated audience
CFU 3 (30 ore); L-LIN/12
2. Fundamentals of surface roughness analysis for tribology
CFU 3 (30 ore); SSD: ING-IND/13
3. Optical measurements in fluid dynamics
CFU 3 (30 ore); SSD: ING-IND/12
4. Residual stress evaluation by X-ray diffractometry
CFU 2 (20 ore); SSD: ING-IND/14
5. Advanced opto-acoustics methods for experimental mechanics
CFU 2 (20 ore); SSD: ING-IND/14
6. Collective and swarm intelligence
CFU 3 (30 ore); SSD: ING-IND/13
7. Design of experiment for research and process optimization
CFU 3 (30 ore); SSD: ING-IND/16
8. Theory and applications of stochastic processes
CFU 3 (30 ore); SSD: ING-INF/03

9. Emerging methodologies and technologies for the Cyber Security
CFU 3 (30 ore); SSD: ING-INF/03
10. Supervision and monitoring of renewable energy systems
CFU 3 (30 ore); SSD: ING-IND/31
11. Lab-on-chip devices
CFU 3 (30 ore); SSD: ING-INF/01
12. Matlab Recipes for Measurement Data Processing
CFU 3 (30 ore); SSD: ING-INF/07
13. Design and optimization of nearly Zero Energy Buildings and Districts
CFU 3 (30 ore); SSD: ING-IND/33
14. Middleware and architecture for Industry 4.0
CFU 3 (30 ore); SSD: ING-INF/05
15. Modeling of Smart Material Systems
CFU 3 (30 ore); SSD: ING-INF/04
16. Software-Based Methods for Modern Control Systems Design
CFU 3 (30 ore); SSD: ING-INF/04
17. Adaptive technologies for the Mitigation of Urban Heat Island and Climate Change Effects
CFU 3 (30 ore); SSD: ICAR/10
18. Advanced numerical modelling and nonlinear analysis of existing buildings under seismic actions
CFU 3 (30 ore); SSD: ICAR/09
19. Lab-and-field data acquisition and processes in Hydraulics
CFU 3 (30 ore); SSD: ICAR/01
20. Multidisciplinary approach to solving complex environmental problems
CFU 2 (20 ore); SSD: ING-IND/22, ICAR/03 and ICAR/02
21. Teorie e metodi del progetto per l'antico CFU 3 (30 ore)
22. Teorie della ricerca architettonica contemporanea CFU 3 (30 ore)
23. Teorie e metodi del progetto per la città CFU 3 (30 ore)
24. Teorie e metodi del progetto per il territorio CFU 3 (30 ore)
25. Teorie e metodi del progetto per le strutture: modellazione e sperimentazione CFU 3 (30 ore)

Inoltre, fa parte dei corsi riconosciuti dalla Scuola di Dottorato il seguente corso:

Human performance in production systems; 3 CFU; SSD: ING-IND/17

tenuto nell'ambito di un progetto di collaborazione tra il Politecnico di Bari e l'Università UNINOVE di San Paolo (Brasile).

La seduta si scioglie alle 10,45. Del che è redatto il presente verbale, che viene letto e approvato seduta stante.

Il Direttore
prof. ing. Pietro De Palma



Il Segretario
prof. ing. Alfredo Grieco


