Course Syllabus
«A Dual Ontology of Nature, Life, and Person»

Professor	Gianfranco Basti	**Phone**	+39 339 5760314
Affiliation	Pontifical Lateran University	**E-mail**	basti@pul.it

Title:

A Dual Ontology of Nature, Life, and Person

Short Description:

The course – given partly in distance learning modality (7 units), and partly in onsite modality (8 units) – is conceived as a formal counterpart of the other one "From Modern Transcendental of Knowing to the Post-Modern Transcendental of Language". It aims at offering to graduate students both of philosophical and scientific – mainly of physics, mathematics, and computer science – departments, a philosophical interpretation of the "paradigm shift" we are living both in fundamental physics, and in theoretical computer science. This shift leaded the scientific community to awarding the Nobel Prizes in Physics to the Authors of momentous discoveries in these two related realms, respectively in 2015 and in 2016. These changes, however, concern - and in many senses, primarily - the mathematical and the logical basis of the topological (operator algebra) modeling of quantum physics, and of quantum computing, as far as interpreted in the framework of Category Theory (CT). Therefore, we illustrate the foundations of the topological (operator algebra) approach to quantum physics and computation, by introducing some elementary notions of Category Theory, as a universal language for logic and mathematics in many senses wider than set-theory. We show, over all, the relevance of categorical semantic duality in logic and computer science because of the famous Stone theorem that has also an immediate philosophical relevance for the foundation of a coalgebraic first-order modal semantics of propositional (Boolean) logic. On the other hand, because the topologies of Stone spaces are the same of the *C**-algebras in quantum physics, the functorial categorical duality coalgebra-algebra can be usefully applied to the non-commutative coalgebraic modeling of the thermal quantum field theory (QFT) of dissipative systems, developed independently by theoretical physicists. Particularly, in CT framework, it is possible to formalize the core principle of thermal QFT, consisting in the "doubling of the states (phases) of the Hilbert space" (or "doubling of the degrees of freedom (DDF)"), in order to satisfy the Hamiltonian character (closeness) of the system. In this way, the minimum free-energy function, differently from QM, can be used as a selection function among states, so to justify a dynamic, "observer-independent", choice of the orthonormal basis of the Hilbert space, and then, in quantum computing, the semantic character of the associated qubit. Effectively, we demonstrate that the notion of "QV-foliation", where each "sheet" corresponds to one of the infinitely many "spontaneous symmetry breakdowns (SSBs)" of the QV according to the Goldstone Theorem, can be modeled in CT logic using the construction of the "infinite state black-box machine" for dealing with computations on infinite data streams. All this justifies the experimental evidence that thermal QFT applies for modeling in cognitive neuroscience the "deep learning" of our dissipative brains entangled with their environments (notion of "intentional extended mind"), using the QV-foliation as a powerful tool of memory. This inspired our group also for developing a new architecture in nanotechnology of optical quantum computer, for modeling infinite data stream computations. Finally, because of the coalgebraic nature of modal logics in CT, all this justifies the construction of the formal ontology for a "semiotic" post-modern naturalism and epistemological realism, which concern the same metaphysics of the human person as free-agent, perfectly consistent with the notion of person as an autonomous communication agent of neuroethics, where the conscious component of our self-controlling ability is a small part (effectively, an iceberg top) of it.

Course Units:

Unit	Topic
1	Premise: the actual paradigm shift in fundamental (quantum physics) and in theoretical computer science
2	Some elements of the classical Von Neumann formalization of quantum mechanics (QM)

Unit	Topic
3	The commutative Hopf algebra and coalgebra (Hopf bialgebra) in the standard formalism of QM
4	Some elements of the GNS-construction, and the passage to a topological modeling of quantum field theory (QFT)
5	A topological model of near-to-equilibrium system in quantum thermodynamics within the statistical mechanics
6	The Stone Theorem and some elements of a non-commutative topological modeling of quantum computations
7	The III Principle of Thermodynamics and the notion of quantum vacuum (QV): the thermal QFT of dissipative systems
8	Some elements of Category Theory (CT), and the notion of categorical dual equivalence in mathematics and logic
9	The irreducible quantum vacuum (QV) fluctuations and the coalgebraic modeling of a thermal QFT system
10	The doubling of the Hilbert space and the categorical duality between *q*-deformed Hopf coalgebras/algebras
11	The Stone theorem and the coalgebraic semantics of Boolean algebras: its relevance in logic and computer science
12	The QV foliation in thermal QFT and in quantum computing: the "infinite state black-box machine" construction
13	Application to cognitive neuroscience. The "dissipative brain": quantum entanglement and intentional consciousness
14	A taxonomy of the different formal ontologies, and the semiotic naturalism in cosmology and metaphysics
15	Conclusion: A dual ontology of the human person as a conscious communication agent, and the neuroethics

Examinations:

Preparation of a written work of at least 20 pages on some sources of the course bibliography, and previously agreed with the professor.

Bibliography:

- Course Textbooks:

Basti, G. (2017a) "The Post-Modern Transcendental of Language in Science and Philosophy". In: Epistemology and Transformation of Knowledge in Global Age, Zlatan Delic (Ed.), InTech, Rijeka, 2017, pp. 35-62 (Available also online: DOI:10.5772/intechopen.68613. https://www.intechopen.com/books/epistemology-and-transformation-of-knowledge-in-global-age/the-post-modern-transcendental-of-language-in-science-and-philosophy)

Basti G. (2017b). *An ontology for our information age. A paradigm shift in science and philosophy,* Aracne Edition, Rome. (available in ebook format since Fall 2017).

Abramsky, S., & Tzevelekos, N. (2011). Introduction to categories and categorical logic. In B. Coecke (Ed.), *New structures for physics. Lecture Notes in Physics, vol. 813* (pp. 3-94). Berlin-New York: Springer

- Other texts (many of them will be downloadable in the online course viewer):

Abramsky, S. (2005). A Cook's Tour of the Finitary Non-Well-Founded Sets (original lecture: 1988). In S. Artemov, H. Barringer, A. d'Avila, L. C. Lamb, & J. Woods (A cura di), *Essays in honor of Dov Gabbay. Vol. I* (p. 1-18). London: Imperial College Pubblications.

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Basti, G. (2012). *Philosophy of Nature and of Science. Vol. I: The Foundations. Translated by Ph. Larrey*. Retrieved May 31, 2016, from http://www.irafs.org/courses/materials/basti_fil_nat.pdf

Basti, G. (2013). A change of paradigm in cognitive neurosciences Comment on: "Dissipation of 'dark energy' by cortex in knowledge retrieval" by Capolupo, Freeman and Vitiello, *Physics of life reviews*, 5 (2013b), 97-98.

Basti, G. (2017c). The quantum field theory (QFT) dual paradigm in fundamental physics and the semantic information content and measure in cognitive sciences, in *Representation and Reality: Humans, Other Organisms, and Intelligent Machines* (Springer "Studies on Applied Philosophy Epistemology", vol.28), G. Dodig-Crnkovic & R. Giovagnoli (Eds.), Springer Verlag: Berlin-New York, pp. 177-210.

Basti G., Capolupo A, Vitiello G, (2017). Quantum field theory and coalgebraic logic in theoretical computer science, *Progress in Biophysics and Molecular Biology*, Preprint in: <https://doi.org/10.1016/j.pbiomolbio.2017.04.006>.

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Del Giudice, E., Pulselli, R., & Tiezzi, E. (2009). Thermodynamics of irreversible processes and quantum field theory: an interplay for understanding of ecosystem dynamics. *Ecological Modelling, 220*, 1874-1879

Deutsch, D. (1985). Quantum theory, the Church-Turing principle and the universal quantum computer. *Proc. R. Soc. Lond. A, 400*, 97–117.

Goranko, V., & Otto, M. (2007). Model theory of modal logic. In P. Blackburn, F. J. van Benthem, & F. Wolter (A cura di), *Handbook of Modal Logic* (p. 252-331). Amsterdam: Elsevier

Hawking, S., & Mlodinow, L. (2010). *The grand design. New answers to the ultimate questions of life.* London: Bantam Press.

Krauss, L. M. (2012). *A universe from nothing. Why there is something rather than nothing. Afterward by Richard Dawkins.* New York: Free Press

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Rutten, J. J. (2000). Universal coalgebra: a theory of systems. *Theoretical computer science, 249*(1), 3-80.

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Umezawa, H. (1993). *Advanced field theory: micro, macro and thermal concepts.* New York: American Institute of Physics.

Umezawa, H. (1995). H. Umezawa, Development in concepts in quantum field theory in half century. *Math. Japonica, 41*, 109–124.

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Van Benthem, J. (2010). *Modal Logic for Open Minds.* Stanford, CA: CLSI Publications.

Vattimo, G. (1985). *La fine della modernità.* Milano: Garzanti.

Venema, Y. (2007). Algebras and co-algebras. In P. Blackburn, F. J. van Benthem, & F. Wolter (A cura di), *Handbook of modal logic* (p. 331-426). Amsterdam, North Holland: Elsevier.

Vitiello, G. (2004). The dissipative brain. In G. G. Globus, K. H. Pribram, & G. Vitiello (A cura di), *Brain and Being - At the boundary between science,philosophy,language and arts* (p. 317-330). Amstedam: John Benjamins Pub. Co.

Vitiello, G. (2007). Links. Relating different physical systems through the common QFT algebraic structure. *Lecture Notes in Physics, 718*, 165-205.

Von Neumann, J. (1955). *Mathematical foundations of quantum mechanics.* Princeton, NJ: Princeton UP.Basti G. (2017).