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Appendix I to the Edital nº nº 226/2016

THE VICE-RECTOR OF FUNDAÇÃO UNIVERSIDADE FEDERAL DO ABC (UFABC), appointed by the Ordinance UFABC nº 98, on February 11th 2014, published on the Official Gazette of the Federal Government (DOU), Section 2, page 15, February 13th 2014, exercising the power conferred upon him, makes public through the current Appendix, the Program Content, Suggested Bibliography and further information pertaining to the Public Notice no. 226/2016 – Field: Physics/sub-field: High Energy Physics (1 opening) and Gravitation (1 opening), published on the DOU no. 168, on August 31th 2016, section 3, page 50:

1. The two job openings are divided as follows:
1 (one) opening for the sub-field of High Energy Physics;
1 (one) opening for the sub-field of Gravitation.

2. Concerning the examination tests, the program content and suggested bibliography for the sub-field of High Energy Physics

2.1. Written Test: The examination committee will propose an essay topic for each of the desirable candidate profiles: 1) Theory and phenomenology of dark matter; 2) Quantum field theory and its applications to fundamental interactions; 3) Standard Model and Beyond the Standard Model phenomenology. The written test will contain two sections. The first is a written essay on one of the above topics, chosen by the candidate in advance. The second part, which is common to all candidates, will contain general about the following topics:
I) Quantum Field Theory: Relativistic equations for bosonic and fermionic fields; Spin-statistics theorem. Canonical quantization of scalar and fermionic fields; Perturbation theory. Gauge invariance and gauge theories. Spontaneous symmetry breaking.
II) Particle Physics Phenomenology: the Standard Model of particle physics. Strong, weak and electromagnetic interactions. Symmetries and conservation laws in the Standard Model. Spontaneous symmetry breaking e the Higgs mechanism in the Standard Model. Neutrino physics and neutrino oscillations. Theoretical and experimental motivations for physics beyond the Standard Model.

2.2. Test of teaching skills:
a) Electromagnetism: Electric charge and Coulomb's law. Electric field and electric potential. Gauss's law. Electric current, electric resistance and Ohm's law. Magnetic field and Ampère's law. Faraday's law. Induction and inductance. Electric and magnetic fields in matter. Maxwell's laws. Electromagnetic waves.
b) Quantum Mechanics: Black-body radiation. Wave-particle duality. Uncertainty principle. Hilbert space and operators. Postulates of quantum mechanics. Schroedinger equation and applications to simple systems. Angular momentum and spin. Potential barrier and tunneling effects.
c) Special Relativity: Postulates of Special Relativity. Lorentz transformations. Kinematics and dynamics of relativistic systems. Covariant formulation of Maxwell equations.

2.3. Suggested Bibliography:
2.3.1. Written Test:
2.3.1.1. Peskin e Schroeder, An Introduction to Quantum Field Theory (Westview Press, 1995)
2.3.1.2. Quantum Field Theory, Mark Srednicki (Cambridge, 2007)
2.3.1.3. Gauge Theories of the Strong, Weak and Electromagnetic Interactions, Chris Quigg (Princeton Univ. Press, 2013)
2.3.1.4. Quarks and Leptons: An Introductory Course in Modern Particle Physics, F. Halzen and A. Martin (John Wiley & Sons, 1984)

2.3.2 Test of teaching skills:
2.3.2.1. H. Moysés Nussenzveig, Curso de Física Básica (Edgard Blücher Ltda)
2.3.2.2. D. Halliday, R. Resnick, J.Walker, Fundamentos de Física (LTC).
2.3.2.3. R. B. Leighton, M. Sands, R. P. Feynman, The Feynman Lectures on Physics (Addison-Wesley).
2.3.2.4. J. R. Reitz, F. J. Milford e R. W. Christy, *Fundamentos da Teoria Eletromagnética* (Campus).
2.3.2.5. C. Cohen-Tannoudji, B. Diu e F. Laloë, *Quantum Mechanics* (Wiley).
2.3.2.6. W. Rindler, *Introduction to Special Relativity* (Oxford University Press)

2.4. Concerning the examination process, in addition to what is specified by the "**Official Public Notice of General Conditions no. 96/2013 of August, 8th, 2013"**, successful candidates must have potential to lead research projects granted by Brazilian funding agencies and supervise undergraduate, master and Ph.D. students. The candidate must have experience in theoretical research in at least one of the following areas: 1- Theory and phenomenology of dark matter; 2- Quantum field theory and its applications to fundamental interactions; 3-Standard Model and Beyond the Standard Model phenomenology.

3. Concerning the examination tests, the program content and suggested bibliography for the sub-field of Gravitation

3.1. Written Test: The examination committee will propose an essay topic for each of the candidate profiles: **a)** General Relativity; **b)** Cosmology; **c)** Astrophysics. The written test will contain two sections. The first is a written essay on one of the above topics, as chosen by the candidate in advance. The second part will contain general questions about the topics listed below. For the second part the candidate will chose one of the following topics and answer its corresponding questions:

a) General Relativity: Basic principles and fundamentals of General Relativity. Weak gravitational fields. Gravitational waves. Classical tests of General Relativity. Schwarzschild

solution and black holes. Energy-momentum tensor and Einstein's equations for matter and fields.

b) Cosmology: Basic principles and fundamentals of General Relativity. Friedmann cosmological models. Cosmological sources of gravitational waves. The Big Bang model.

Cosmic microwave background radiation. Accelerated universe expansion. Structure formation.

c) Astrophysics: Basic principles and fundamentals of General Relativity. Astrophysical sources of gravitational waves. Structure, composition and evolution of compact objects. Binary compact systems. Astrophysical black holes. Accretion disks.

3.2. Test of teaching skills:

a) Electromagnetism: Electric charge and the Coulomb law. Electric field and electric potential. Gauss law. Electric current, electric resistance and the Ohm law. Magnetic field and the Ampère law. Faraday law. Induction and inductance. Electric and magnetic fields within matter. Maxwell equations. Electromagnetic waves.

b) Quantum Mechanics: Black body radiation. Wave-particle duality. Uncertainty principle. Hilbert space and quantum operators. The postulates of Quantum Mechanics. Schrödinger equation and applications to simple quantum systems. Angular momentum and spin. Potential barrier and quantum tunneling.

c) Special Relativity: The postulates of Special Relativity. Lorentz Transformations. Relativistic kinematics and relativistic dynamics. Covaraint formulation of Maxwell equations.

3.3. Suggested Bibliography

3.3.1. Written Test:

3.3.1.1 J. B. Hartle, Gravity: an introduction to Einstein's general relativity. (Benjamin Cummings).

3.3.1.2. R. M. Wald, General Relativity (Chicago University Press).

3.3.1.3. J. A. Peacock, Cosmological Physics *(*Cambridge University Press).

3.3.1.4. E. Kolb, M. Turner, The early Universe (Addisson Wesley).

3.3.1.5. S. L. Shapiro, S. A. Teukolsky, Black Holes, White Dwarfs and Neutron Stars: The Physics of Compact Objects (Wiley).

3.3.1.6. S. Rosswog, M. Brüggen. Introduction to High-Energy Astrophysics (Cambridge University Press).

3.3.2. Test of teaching skills:

3.3.2.1. H. Moysés Nussenzveig, Curso de Física Básica (Edgard Blücher Ltda).

3.3.2.2. D. Halliday, R. Resnick, J.Walker, Fundamentos de Física (LTC).

3.3.2.3. R. B. Leighton, M. Sands, R. P. Feynman, The Feynman Lectures on Physics (Addison-Wesley).

3.3.2.4. J. R. Reitz, F. J. Milford e R. W. Christy, *Fundamentos da Teoria Eletromagnética* (Campus).

3.3.2.5. C. Cohen-Tannoudji, B. Diu e F. Laloë, *Quantum Mechanics* (Wiley).
3.3.2.6. W. Rindler, *Introduction to Special Relativity* (Oxford University Press).

3.4. Concerning the examination process, in addition to what is specified by the "**Official Public Notice of General Conditions no. 96/2013 of August, 8th, 2013",** successful candidates to the sub-field of Gravitation must show potential to lead research projects funded by national and/or International Grant Agencies, and supervise undergraduate, Master and Ph.D students. The candidates also must have experience in theoretical research at least in one of the following areas: 1) General Relativity: Exact solutions of Einstein equations; numerical methods in General Relativity; gravitational waves; quantum field theory in curved spacetimes; black hole physics and applications of the gauge/gravity duality; 2) Cosmology: cosmological models and cosmological tests; large scale structure formation; 3) Astrophysics: numerical simulations in astrophysics; astrophysics of compact objects; numerical simulations in relativistic astrophysical systems.

Santo André, November 23rd, 2016.

Dácio Roberto Matheus
Vice-Rector