# PhD in Information and Communication Technology for Health

# Università degli Studi di Napoli Federico II

# Module Title: High Field Magnetic Resonance Imaging

# Lecturer: Giuseppe Ruello

## University of Napoli Federico II

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## CV: Giuseppe Ruello is an Associate Professor at the Department of Electrical and Information Technology Engineering, University of Naples Federico II, Italy. He received the Laurea degree (cum laude) in Telecommunication Engineering in 1999, and the Ph.D. degree in Information Engineering in 2003, both from the University of Naples Federico II, Naples, Italy. In 2019 he was a Fulbright Scholar at the Department of Radiology, New York University, USA. In 2002 and in 2004-2005 he was visiting scientist at the Department of Signal Theory and Communications of the Universitat Politecnica de Catalunya of Barcelona (Spain). His main research interests include SAR remote sensing, modelling of electromagnetic scattering from natural surfaces, fractal models, SAR raw signal simulation, modelling of electromagnetic field propagation in urban environment, modelling of electromagnetic field propagating in Magbetiv resonance scanners.

# More lecturers (TBC):

## At least one professor from the Department of Radiology, New York University, USA is expected to teach high field MRI challenges and present the actual research activity at NYU. Eventual contributions are expected from the Department of Physics of University of Napoli Federico II. Names of the lecturers will be disclosed once their presence is confirmed

# Dates and Locations

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| --- | --- | --- | --- |
| Date | Hours | Room | Lecturer |
| Sept., 14 2020 | 9.30-11.30 | TEAMS/ room TBD | G. Ruello |
| Sept., 15 2020 | 9:30-12:30 | TEAMS/ room TBD | G. Ruello |
| Sept., 16 2020 | 9.30-11.30 | TEAMS/ room TBD | G. Ruello |
| Sept., 21 2020 | 9.30-12.30 | TEAMS/ room TBD | G. Ruello |
| Sept., 22 2020 | 9.30-11.30 | TEAMS/ room TBD | NYU Prof. TBC |
| Sept., 23 2020 | 9.30-12.30 | TEAMS/ room TBD | NYU Prof. TBC |

# Content

**I Lesson - Introduction**: Physical basis of the Magnetic Resonance Phenomenon. The Bloch equation and the Larmor frequency. Effect of static field B0 and RF field B1 on the magnetization of the hydrogen nucleus.

**II Lesson – The MRI signal**: The relaxation phenomenon. The spin-spin and the spin-lattice relaxations. Reciprocity. Signal to noise ratio in MRI. Intrinsic SNR and ultimate intrinsic SNR.

**III lesson – Image formation**: Gradient fields and their use for localization. Definition and comprehension of the k-space for image creation purposes.

**IV Lesson – Electromagnetic methods**: Electromagnetic description in canonical and actual problems. Numerical and analytical approaches. Advantages and limitations of the presented methodologies.

**V Lesson – High field MRI**: Why High field MRI. Challenges in Ultra high field MRI. Field inhomogeneity and patient safety. Solutions to control the field distribution in the scanner.

**VI Lesson – High permittivity materials in MRI and Conclusions**: Introduction of high permittivity materials (HPM) in MRI. Experimental evidences and actual knowledge on the underlying phenomena. Discussion, concluding remarks and learning assessment.

# ECTS Credits: 3

# Notes

Doctoral Students are requested (starting from Lesson I) to bring their own notebook with Matlab installed.

Doctoral Students with noticeable experience on this Module topics can participate as Tutors.

Participants to the Module (including those interested to the Tutorship positions) are requested to e-mail to prof. Giuseppe Ruello the following: Student name, name of the PhD course and cycle.

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Info: **Prof. GIUSEPPE RUELLO -** tel. 081 7683512– ruello@unina.it