1. **Automatic Control and Operational Research**

The scientific areas involved in this Curriculum are Automatic Control (ING-INF/04) and Operational Research (MAT/09). These are fundamental subjects for the Master Courses in Management and Information (Electronics, Computer Science, Telecommunications, Biomedical, Automation) Engineering. Moreover, they are also present in many other Master Courses in Engineering and (as far as MAT/09 is concerned) also in Business Administration and Science. The unifying methodological aspect is the Systems Approach, which provides a very powerful viewpoint to face most problems in modern engineering as well as in many other applied sectors. The basic subjects (system theory, control theory, mathematical optimization, estimation methods, filtering and identification, simulation) provide very useful tools to deal with and solve in a formal and general way complex problems that are often faced with special-purpose procedures, sometimes of empirical type. Main research topics are:

- System and control theory
- Nonlinear control
- Geometric approach to control
- Robotics
- Motion control
- Diagnosis of dynamic systems
- Identification of dynamic systems
- Aerial traffic control
- Electric drives
- Combinatorial optimization
- Graph theory
- Transportation and distribution (logistics) problems
- Network optimization problems
- Cutting and loading problems
- Integration between predictive and prescriptive analytics.

The methodologies of many of these topics are of interest to students in other curricula of the doctorate. For this reason, common events and activities will be organized among the three curricula to encourage interaction among students and the sharing of methodologies, cultural exchange and multidisciplinary education.

2. **Bioengineering**

The Bioengineering curriculum promotes the acquisition of advanced skills of highly interdisciplinary character (from engineering to medical and biological sciences, from mathematics and physics to computer science) to face – by means of innovative tools and solutions - complex problems in the field of the life sciences. The curriculum offers a wide spectrum of research themes, involving electronic, information and industrial aspects of bioengineering:

- Biomedical Imaging, Biomedical Signals and Data Processing
- Biomechanics and Motor Function Control
- Rehabilitation Engineering
- Biomedical Instrumentation and Artificial Organs
- Models of Physiological and Biological Systems
- Computational Neuroscience
- Molecular, Cellular and Tissue Engineering

Strong connections exist between the various themes; frequently, the training and research activities are placed at the intersection of several themes. Each research project will pursue a specific objective: improvement of physiopathological knowledge, progress in diagnostic and therapeutic techniques, advancement in assistive and rehabilitation technologies, optimization of health-care management. The interaction
with the other two curricula - thanks also to common courses and seminars - certainly stimulates the sharing of methodologies, the cultural exchange and the multidisciplinary training necessary for an effective approach to bioengineering problems.

3. Electrical Engineering

The Electrical Engineering curriculum provides a wide scientific and technical-professional training in electrical engineering, with good base knowledge, capacity for technological and design innovation, and specific electrical knowledge. The Ph.D. student must be able to apply the analytical tools and the knowledge concerning the advanced technologies typical of electrical/electromechanical sector also to other engineering leading sectors. The scientific areas involved in this Curriculum are: Electrotechnics (ING-IND/31), Converters, electrical machines and drives (ING-IND/32), Electrical energy systems (ING-IND/33) and Electrical and electronic measurements (ING-INF/07). In particular, the Curriculum in Electrical Engineering aims to develop modern electrical competencies and technologies such as:

- power electronics
- electric drives for automation, robotics, and traction
- unconventional electric machines
- methods of analysis, management and design of the electric power systems
- electricity market
- innovative architectures for the electric distribution
- computer-aided design of electric power systems and components
- rational use of energy and renewable sources
- electromagnetic compatibility
- interactions of electromagnetic fields with biological systems
- electromagnetic characterization of materials
- applied superconductivity
- applied magneto hydrodynamics
- magnetic system engineering plasma engineering.

The activities of the course are customized to each student.

<table>
<thead>
<tr>
<th>Position n.</th>
<th>Financial support</th>
<th>Description</th>
<th>Curriculum</th>
<th>Positions linked to research subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PhD Scholarship</td>
<td>Totally funded by the University of Bologna general budget</td>
<td>Electrical Engineering</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>PhD Scholarship</td>
<td>Totally funded by the University of Bologna general budget</td>
<td>Electrical Engineering</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>PhD Scholarship</td>
<td>Totally funded by the University of Bologna general budget</td>
<td>Electrical Engineering</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>PhD Scholarship</td>
<td>financed in full from the central budget under the &quot;Departments of Excellence&quot; initiative</td>
<td>Biomedical Engineering Bioengineering</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>PhD Scholarship</td>
<td>Totally funded by the University of Bologna general budget</td>
<td>Automatic Control and Operational Research</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>PhD Scholarship</td>
<td>partly financed from the central budget and co-financed by the &quot;Guglielmo Marconi&quot; Department of Electrical Energy and Information Engineering</td>
<td>Automatic Control and Operational Research</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>PhD Scholarship</td>
<td>financed in full by MIUR under the &quot;Departments of Excellence&quot; initiative</td>
<td>Automatic Control and Operational Research</td>
<td>Innovative mobile systems for smart and green agriculture Abstract: The activity of the PhD candidate is framed within the “Excellent Department Project” dealing with Cyber Physical Systems for precision farming. The specific activity pertains the development of new prototypes, representing new generation tractors, for field monitoring and intervention, with a special emphasis toward full electric solutions. The activity</td>
</tr>
</tbody>
</table>
deals with many integration aspects of cyber physical technologies all instrumental to develop efficient tractors able to overcome the limits of actual solutions (mainly in terms of power consumption, total weight, reconfigurability, maintenance and operative costs). The technical emphasis will be on the development of new mechatronic solutions, sizing of full electric locomotion systems, recharging systems based on wireless power transfer principles, development of new generation implements, and autonomous navigation systems. The starting design concept is a modular locomotion system, easily reconfigurable for accomplishing both massive field monitoring activities and typical field interventions such as spraying and mowing. Part of the activity will be conducted at the school of agriculture, in collaboration with the department DISTAL, where a lab field will be set-up and extensively used for development and testing.

<table>
<thead>
<tr>
<th></th>
<th>PhD Scholarship</th>
<th>financed by the Department of Electrical Energy and Information Engineering &quot;Guglielmo Marconi&quot;.</th>
<th>Biomedical Engineering</th>
<th>Bioengineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>High level apprenticeship position</td>
<td>High level PhD apprenticeship position with MediCon Ingegneria s.r.l. Measurement &amp; digital Control s.r.l. (the PhD candidate must enter into the contract by 31/12/2019 and adhere to it until 31/10/2022, with the exception of period of suspension resulting in the postponement of the legal duration of the course).</td>
<td>Biomedical Engineering</td>
<td>Bioengineering</td>
</tr>
<tr>
<td></td>
<td>Research Grant</td>
<td>Provided by the Department of Electrical Energy and Information Engineering “Guglielmo Marconi” with funds from the implementation agreement with the Bologna Local Health Authority. The grant has a duration of 12 months, renewable up to a maximum of 36 months. The gross percipient amount is € 21,169.19.</td>
<td>Automatic Control and Operational Research</td>
<td>Analytics and Optimization for Healthcare Processes</td>
</tr>
<tr>
<td>10</td>
<td>Research Grant</td>
<td>provided by the Department of Electrical Energy and Information Engineering “Guglielmo Marconi” with funds from a framework cooperation agreement between the University of Bologna and ATERSIR - Agenzia Territoriale dell'Emilia-Romagna per i Servizi idrici e rifiuti (Emilia-Romagna Territorial Agency for Water and Electrical Engineering)</td>
<td>Fault diagnosis of electric machines and drives</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Research Grant</td>
<td>provided by the Department of Electrical Energy and Information Engineering “Guglielmo Marconi” with funds from a framework cooperation agreement between the University of Bologna and ATERSIR - Agenzia Territoriale dell'Emilia-Romagna per i Servizi idrici e rifiuti (Emilia-Romagna Territorial Agency for Water and Electrical Engineering)</td>
<td>Fault diagnosis of electric machines and drives</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Type</td>
<td>Research Area</td>
<td>Grant Details</td>
<td></td>
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<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>PhD Scholarship</td>
<td>Waste Services) The research grant shall have a duration of 12 months renewable up to a maximum of 36 months and a gross percipient amount of €19,947.89.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Research Grant</td>
<td>Electrical Engineering funded under the three-year High Competence Plan for research, technology transfer and entrepreneurship (POR FSE funds – Resolution n. 462 of 25/03/2019). The assignment of this scholarship is subject to the declaration of residence or domicile of the scholarship holder in Emilia-Romagna.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Research Grant</td>
<td>Automatic Control and Operational Research provided by the Department of Electrical Energy and Information Engineering “Guglielmo Marconi” with funds from a framework cooperation agreement between the University of Bologna and Finmeccanica. The research grant shall have a duration of 36 months and a gross percipient amount of €58,101.00.</td>
<td>Autonomous Guidance, Navigation and Control for multirotor UAVs.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Research Grant</td>
<td>Automatic Control and Operational Research provided by the Department of Electrical Energy and Information Engineering “Guglielmo Marconi” with funds from UE Project H2020 ERC OPT4SMART Distributed Optimization Methods for Smart Cyber-Physical Networks (GA n. 638992). The research grant shall have a duration of 12 months renewable up to a maximum of 36 months and a gross percipient amount of €24,425.00.</td>
<td>Design and Analysis Methods for Dynamic Optimization of Complex Systems</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>PhD Scholarship</td>
<td>Electrical Engineering FibrAVirt: Atrial Fibrillation mechanism understanding and therapy optimization through a personalized virtual heart financed by the Department of Electrical Energy and Information Engineering “Guglielmo Marconi” with funds from the “Insulation stressed with fast rise time repetitive voltages from high voltage power.</td>
<td>Detection of partial discharges in electrical apparatus energized from power converters.</td>
<td></td>
</tr>
</tbody>
</table>
The above positions shall be awarded on the basis of both the final ranking list, as drawn by the Admission Board, and the Curriculum for which the applicant has expressed his/her preference in the statements made at the time of filling in the application and indicated on the cover page of the research project submitted (NB. A sub-ranking list for each Curriculum shall be drawn up). If the curriculum is not specified by the applicant it will be assigned by the evaluation committee based on the project and the titles of the applicant. Possible remaining positions linked to specific Curricula shall be proposed to eligible applicants, irrespective of the Curriculum chosen.

### Admission requirements

Please, see art. 2 of the Call for applications

### Mandatory documents to be attached to the application

Please, see art. 3 of the Call for applications

### Further qualifications that may be attached to the application, if in possession of the applicant

(only qualifications attested by documents drawn up in Italian, English, French, German and Spanish shall be considered as valid and assessed by the Admission Board)

<table>
<thead>
<tr>
<th>Qualifications</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract of the second cycle master’s degree thesis. Undergraduate applicants can submit the draft of the thesis approved by their supervisor (please, note that abstracts cannot exceed 5,000 characters, including spaces and formula possibly used. The above figure does not include: the title of thesis, the outline, and images such as graphs, diagrams, tables etc. - where present);</td>
<td>- No more than 2 reference letters signed by Italian and international academics and professionals in the research field, which do not form part of the Admission Board, attesting the suitability of the applicant and his/her interest for the scientific research. Please, note that the above letters cannot be uploaded by applicants. When filling the online application form on <a href="http://studenti.unibo.it">http://studenti.unibo.it</a>, applicants will be only allowed to provide the email accounts of the requested academic/professional. The latter shall receive an email from the University of Bologna providing for the instructions for uploading. Only letters in pdf format submitted before the expiry date and time of the Call shall be accepted.</td>
</tr>
<tr>
<td>Multi-annual research project, with special emphasis on the activities to be completed during the first-year course. The proposal must meet the following requirements:</td>
<td>- It must indicate in the cover page the research topic of the PhD Programme covered by the research project proposal and for which the applicant is applying. In the case that the curriculum is not indicated in the application, the Commission will operate this choice on the basis of the project contents and of the qualifications of the applicant at the time of the publication of the evaluation of the qualifications;</td>
</tr>
<tr>
<td>Postgraduate vocational training programmes/specialisation programmes relevant to the PhD Programme.</td>
<td>- It cannot exceed 20,000 characters, including spaces and formula possibly used. This figure does not include: the title of project, the outline, references and images (such as graphs, diagrams, tables etc - where present);</td>
</tr>
<tr>
<td>Teaching activity and support to training activities carried out at university level.</td>
<td>The research projects that successful applicants shall carry out during their doctoral career may possibly differ from the project proposed at the application stage. This shall be defined together with the supervisor and approved by the Academic Board.</td>
</tr>
<tr>
<td>Research activity of any kind - whether basic, applied, translational, etc. - carried out in any capacity, including when covered by research grants, and as a staff member of research projects.</td>
<td>- Publications in extenso (monographs, articles published on scientific journals, volume’s chapters) (max 3).</td>
</tr>
<tr>
<td>Documents attesting the knowledge of foreign languages</td>
<td>- Minor Publications in extenso (conference papers, etc.) (max 2).</td>
</tr>
<tr>
<td>Study periods completed by students outside their countries of origin (e.g. Erasmus programme or other similar mobility programmes).</td>
<td>- Professional Master courses completed in Italy (1st or 2nd level) relevant to the PhD Programme.</td>
</tr>
<tr>
<td>Other qualifications attesting the suitability of the applicants (scholarships, prizes, etc.)</td>
<td>- Postgraduate vocational training programmes/specialisation programmes relevant to the PhD Programme.</td>
</tr>
</tbody>
</table>

### Admission exams (art. 4 of the call for applications)

<table>
<thead>
<tr>
<th>Examination type</th>
<th>Schedule</th>
<th>Examination results publication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualifications and research project evaluation</td>
<td>Non-presential.</td>
<td>The results of the qualifications and research project evaluation shall be available online starting from the 01/06/2019 at the page <a href="http://studenti.unibo.it">http://studenti.unibo.it</a> (please, select: “summary of the requests in progress” - “see detail” and open the pdf file “risultati valutazione titoli e progetto”)</td>
</tr>
</tbody>
</table>
In case that the oral examination cannot be completed in one day due to the large number of applicants, the oral exam schedule shall be made available at the webpage http://studenti.unibo.it together with the results of the qualifications and research project evaluation. The results of the oral examination shall be available on the webpage http://studenti.unibo.it starting from 28/06/2019 (please, select "summary of the requests in progress" - "see detail" and open the pdf file "risultati prova orale").

Applicants can ask to take the exam remotely using Skype. For further details please refer to the relevant provision laid down in art. 4 of the Call for applications.

### Evaluation criteria

Points will be allocated to applications out of a total of 100 on the basis of the following weighting:

1. **Qualifications and research project**
   - Minimum for admission to the oral exam: 30 points
   - Maximum: 50 points
   Only qualifications relating to the last 5 calendar years prior to the calendar year of publication of the Call for applications shall be taken into consideration, with the exception of the University Degree (Diploma di laurea). Please, note that qualifications must be consistent with the PhD Programme.
   Points relating to qualifications and to the research project shall be allocated on the basis of the consistency with the curriculum chosen (or assigned by the Commission if the applicant does not indicate this) and of the following criteria:
   - Graduation final mark. Undergraduates shall be evaluated on the basis of the Weighted Average Mark (WAM): max 15 points
   - Publications: max 5 points
   - other qualifications: max 15 points
   Points relating to the research project shall be allocated on the basis of the following criteria:
   - scientific value and ground-breaking nature of the proposal: max 5 points
   - description and structure of the proposal: max 5 points
   - proposal feasibility: max 5 points.

2. **Oral examination**
   - Minimum for inclusion in the final ranking list: 30 points
   - Maximum: 50 points
   The oral test is aimed at verifying the candidate's aptitude for scientific research and his/her general preparation on topics related to the PhD Programme, with particular reference to the curriculum chosen (or assigned by the Commission case it was not indicated by the candidate). During the oral examination, knowledge of English language shall be assessed.
   Points relating to the oral examination shall be allocated on the basis of the coherence of the curriculum chosen (or assigned by the Commission in case it was not indicated by the candidate) and of the following criteria:
   - knowledge of the English language: max 5 points
   - research project presentation: max 25 points
   - general knowledge of issues connected to the PhD Programme: max 20 points
Possible evaluation sub-criteria will be available on the Unibo website, selecting the relevant PhD Programme → “PhD programme information” at the bottom of the page in the section "Notices".

### Final ranking list and enrolment (arts.6 and 7 of the Call for applications)

After the publication of the results of the oral exam, the final ranking list will be available on the Unibo website, selecting the relevant PhD Programme → “PhD programme information” at the bottom of the page in the section “Notices”.
Following the publication of the final ranking list, successful applicants must enroll on http://studenti.unibo.it by the deadline indicated on the Unibo website, selecting the relevant PhD Programme → “PhD programme information”.