



Syllabus Master's Degree Course in Medicine and Surgery a.y. 2026 - 2027

Medical and surgical robotics

Fourth year, first semester (2 academic credits [CFU])

Teachers

Subject	Academic credits (CFU)	Lecturer
Medical and surgical robotics	2	NICOSIA Giuseppe

Learning outcomes

Subject	Learning outcomes
Medical and surgical robotics	Knowledge and understanding By the end of the course, students are expected to: • Acquire knowledge on the technological development of modern biomedicine, with reference to medical and surgical robotics. • Acquire knowledge on the main technologies and methodologies used in medical and surgical robotic systems, including robot-assisted systems, autonomous robots, and robotic navigation systems. • Understanding the main clinical applications of medical and surgical robotics, including minimally invasive surgery, robotic therapies, and robotic rehabilitation. • Understanding the fundamental principles of engineering and design underlying medical and surgical robotic systems, including mechanics, electronics, controllability, and safety. Applying knowledge and understanding By the end of the course, students are expected to: • Be able to identify and provide appropriate indications for the use of medical and surgical robotic technologies in healthcare, considering the clinical context, the human and technological resources required, and the benefits, limitations, and safety aspects of their use.

Prerequisites

Subject	Prerequisites
Medical and surgical robotics	Attainment of the educational objectives set by prerequisite courses.

Course contents

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Medical and surgical robotics	1. Fundamentals and development of medical and surgical robotics • Development of robotics in modern biomedicine • Classification of medical and surgical robotic systems • Robot-assisted, semi-autonomous, and autonomous systems • Basic architecture and components of medical robotic systems • Fundamental principles of mechanics, electronics, kinematics, sensing, and control • Human–robot interaction, reliability, and safety 2. Robotic navigation and image-guided systems • Principles of robotic navigation and tracking • Image-guided and computer-assisted procedures • Registration and integration of medical imaging with robotic systems • Navigation in minimally invasive and interventional procedures • Accuracy, limitations, and sources of error 3. Robotic surgery and minimally invasive interventions • Principles and applications of robot-assisted surgery • Robotic platforms, surgical interfaces, and instruments • Applications in major surgical specialties • Robotic-assisted minimally invasive procedures • Robotic systems for endovascular and interventional procedures • Clinical indications, patient selection, benefits, limitations, and safety 4. Robotic therapies and rehabilitation • Principles and applications of therapeutic robotics • Robotic systems for neurological and musculoskeletal rehabilitation • Exoskeletons and wearable robotic systems • Robotic assistance in functional recovery • Clinical indications, patient selection, and assessment of outcomes 5. Autonomous, intelligent, and emerging robotic systems • Autonomous and semi-autonomous medical robots • Artificial intelligence and machine learning in medical robotics • Intelligent decision support and robotic assistance • Remote and teleoperated robotic systems • Soft robotics, miniaturized and micro-robotics • Integration of robotics, artificial intelligence, and advanced imaging • Ethical, legal, and safety implications of autonomous systems 6. Clinical evaluation and appropriate use of medical robotics

	• Clinical efficacy, effectiveness, and safety of robotic technologies • Evidence-based evaluation of medical and surgical robotic systems • Comparison with conventional diagnostic and therapeutic approaches • Appropriate indications and patient selection • Professional expertise and technological resources required • Multidisciplinary teamwork and organizational aspects • Cost-effectiveness, sustainability, and future perspectives
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Assessment methods

Subject	Assessment methods
Medical and surgical robotics	The final assessment of acquired knowledge is conducted by an oral exam. The grade is expressed on a scale of thirty, up to a maximum of 30/30 cum laude (with honors). The oral examination consists of an interview during which questions will cover at least three different topics from the course curriculum. The assessments aim to evaluate: i) the level of knowledge on features and clinical applications of medical and surgical robotic systems (knowledge and understanding); ii) the ability to apply this knowledge to identify and provide appropriate indications for the clinical use of medical and surgical robotic technologies (applying knowledge and understanding); iii) the ability to apply the acquired knowledge to critically and independently assess benefits, limitations, and safety aspects medical and surgical robotics (making judgements); iv) clarity of presentation and the use of medical-scientific language (communication skills); v) the ability to critically appraise emerging robotic technologies and to independently update their knowledge in this evolving field (learning skills). The assessment of learning can also be conducted remotely if the conditions necessitate it. To ensure equal opportunities and in compliance with current laws, interested students may request a personal interview in order to plan any compensatory and/or dispensatory measures based on educational objectives and specific needs. Students can also contact the CInAP (Centro per l'integrazione Attiva e Partecipata – Servizi per le Disabilità e/o i DSA) referring teacher within their department (https://www.cinap.unict.it/content/referenti). For the assignment of the final grade, the following parameters will be considered: • Score 29-30 with honors: The student demonstrates an in-depth knowledge of the topics, promptly and correctly integrates and critically analyzes presented situations, independently solving even highly complex problems. They possess excellent communication skills and command medical-scientific language proficiently. • Score 26-28: The student has a good understanding of the topics, is able to integrate and critically and logically analyze presented situations, can fairly independently solve complex problems, and presents topics clearly using appropriate medical-scientific language.

	• Score 22-25: The student has a fair understanding of the topics, although it may be limited to the main areas. They can integrate and critically analyze presented situations, although not always in a linear fashion, and present topics fairly clearly with moderate language proficiency. • Score 18-21: The student has minimal knowledge of the topics, possesses modest ability to integrate and critically analyze presented situations, and presents topics sufficiently clearly, although their language proficiency may be underdeveloped. • Exam not passed: The student lacks the minimum required knowledge of the core content of the course. Their ability to use specific language is minimal or nonexistent, and they are unable to independently apply acquired knowledge.
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Examples of common questions and/or exercises

Subject	Examples of common questions and/or exercises
Medical and surgical robotics	What are the main types of medical and surgical robotic systems? What are the fundamental principles of mechanics, sensing, and control underlying medical robotic systems? What are the main applications of robotics in minimally invasive surgery? Discuss their potential advantages and limitations compared with conventional approaches. What are the main clinical applications of robotic systems in rehabilitation? Describe the role of exoskeletons and wearable robotic systems. What is the role of artificial intelligence in medical and surgical robotics? Describe the main potential applications and limitations. What are the main safety issues associated with the use of medical and surgical robotic systems? A patient with a neurological disorder presents with significant impairment of lower-limb motor function. Discuss whether robotic rehabilitation could be considered in this patient and what factors should be considered when selecting a robotic system A patient is a candidate for a minimally invasive procedure for which both conventional and robot-assisted approaches are available. What factors should guide the choice of the most appropriate approach? Discuss the potential risks associated with increasing autonomy in surgical robotic systems. What level of human supervision should be maintained? A new robotic technology is reported to improve procedural accuracy. What evidence would you require before considering its routine clinical use? Critically compare robot-assisted surgery with conventional minimally invasive surgery, considering clinical outcomes, safety, limitations, and resource requirements. Discuss the main ethical and medico-legal implications of autonomous robotic systems in healthcare.

	Explain to a patient, using clear and non-technical language, the main advantages and limitations of a robot-assisted surgical procedure. A new autonomous robotic system has been developed for a surgical procedure. What aspects do you assess for the clinical use of it?
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Reference texts

Subject	Textbooks
Medical and surgical robotics	Achim Schweikard, Floris Ernst, "<i>Medical Robotics</i>", Springer, 2016. Any additional educational material (slides, videos, handouts, etc.) will be distributed or indicated during the lessons.

Course format

Subject	Course format
Medical and surgical robotics	Teaching will be primarily delivered through in-person lectures, combining theoretical instruction with practical exercises. If teaching is conducted in blended or remote mode, appropriate adjustments will be made to ensure alignment with the objectives and content outlined in the Syllabus.

Attendance

Subject	Textbooks
Medical and surgical robotics	Mandatory attendance.

Course schedule

Subject	Course schedule
Medical and surgical robotics	Students may refer to the recommended textbooks, slides, videos and handouts to identify the correspondence between the topics covered in the syllabus and the relevant chapters.