MALLA REDDY
VISHWAVIDYAPEETH
(Deemed to be University)

SCHOOL OF DIGITAL HEALTH SCIENCES & TECHNOLOGY

Fellowship in Medical Robotics Design and Development

Created in 2025

Academic regulations for fellowship programmes

1. **DEFINITION**

   Fellowship: A fellowship is an advanced, structured programme focused on developing specialized competencies after the completion of a qualifying degree or equivalent experience. It offers structured learning and practical experience in a focused area. The purpose of the fellowship is to develop advanced knowledge, strengthen specialized skills, and prepare participants for professional growth within their chosen field.

2. **AIMS AND OBJECTIVES**

   The aim of the program is to provide program nurtures graduate and postgraduate candidates, building their expertise and skills to drive career excellence and impact in their chosen field.

   Full-Time Candidate: A full-time candidate is an individual who is enrolled exclusively in the fellowship program and is not engaged in any other professional, academic or employment obligations during the training period. These candidates are required to dedicate their time and effort to the structured fellowship programme, meeting the assigned outcomes through full-time participation that ensures immersive training and continuous engagement in all programme activities, including assigned duties, learning sessions, and assessments. Stipends for full-time fellowship candidates will be awarded as per MRV policy.

   Internal Candidate: An internal candidate is an individual currently employed by MRV or its affiliated institutes who wish to enhance their skills through the fellowship during their tenure at the institution. This includes faculty, residents, or staff. Internal candidates are not eligible for a stipend. Applications are subject to institutional approval.

   External Candidate: An external candidate is someone not employed by MRV or its affiliated hospitals and institutes at the time of applying for the fellowship. They may come from other academic institutions, healthcare organizations, or private practice. External candidates are required to complete all fellowship requirements as per MRV guidelines. No stipend will be provided.

   Sponsored Candidate: A sponsored candidate is nominated and financially supported by a recognized institution, organization, or employer such as a government body, healthcare institution, academic organization, or industry partner to pursue a fellowship at MRV. The sponsor typically covers fees or other program-related costs and may require the candidate to fulfill certain obligations, if any, upon completion as required by the sponsor. Employees sponsored by organizations must provide a formal no-objection certificate. Sponsored candidates are not eligible for a stipend.

3. PREREQUISITES

Criteria	Details
Eligibility	To be eligible for admission into the fellowship program at MRV, candidates must meet the following criteria: • Hold a recognized graduate or postgraduate degree with a completion certificate. • The fellowship must align with the candidate's prior qualifications and may require professional registrations. • Detailed eligibility criteria for ach fellowship, including approved qualifications are available on the MRV website.
Duration	• Undergraduate Degrees – Any recognized undergraduate degree – 12 months • Postgraduate Degrees – Any recognized undergraduate degree – 6 months • Super specialty Degrees – Any recognized speciality or advanced degree – 3 months * Duration for any category may be adjusted based on program requirements, as recommended by the Selection Committee.
Mode of Study	Theoretical, Lab-based Development, Simulation Workshops, Clinical Scenario Building, Capstone Project, Practical, Skill, Case-based

4. SELECTION AND COMMENCEMENT OF FELLOWSHIP

Fellowship Committee: The Fellowship Committee is established to uphold principles of transparency, fairness, and meritocracy in the selection process for the MRV Fellowship Program.

Composition of Fellowship Selection Committee

Sr. No.	Role/Position	Description / Designation
1	Chairperson	The Dean of the respective colleges and Schools of Eminence at MRV
2	Subject Expert	A Professor or Associate Professor from the concerned colleges and Schools of Eminence, MRV
3	Guide / Co-Guide	A Professor, Associate Professor, or Assistant Professor from the concerned colleges and Schools of Eminence, MRV
4	Convener	The Fellowship Coordinator of MRV
5	Ex officio Members	The Registrar and the Controller of Examinations,

		MRV

Duties of the Fellowship Selection Committee

- Ensure that the MRV fellowship program commences twice a year in accordance with the academic calendar issued by the university.
- Oversee the preparation and communication of the program schedule, including application deadlines, interview dates, and the start of training through the MRV website and relevant academic departments.
- Thoroughly evaluate all applications to ensure candidates meet the minimum requirements for completion.
- Assess academic credentials, prior qualifications, and overall suitability for the fellowship program.
- Conduct interviews for shortlisted candidates to evaluate knowledge, skills, and overall preparedness.
- Recommend a final list of eligible candidates for approval by the Vice-Chancellor based on the evaluation and interview outcomes.
- Oversee all aspects of the fellowship program from scheduling, implementation, to completion.

5. FEE STRUCTURE

Program Fees: The basic fee structures for each fellowship program are available on the respective program on the MRV website.

6. PROCEDURE FOR SELECTION AND ADMISSION

- **Eligibility Check:** Verify that applicants meet the basic eligibility criteria, including academic qualifications, professional experience, and relevant skills.
- **Document Review:** The Selection Committee reviews all applications for completeness and ensures they satisfy the program's eligibility requirements.
- **Personal or Virtual Interviews:** Shortlisted candidates may be invited for interviews, either in person or virtually. This allows the Committee to assess communication skills, motivation, and overall suitability for the fellowship.
- **Merit-Based Selection:** The Committee selects the most qualified candidates based on a combination of academic performance, professional experience, interview performance, and alignment of the applicant's goals with the objectives of the fellowship.

7. ALLOTMENT OF FELLOWSHIP GUIDE

Assignment of Guides: The allotment of fellowship Guides shall be undertaken by the Selection Committee, ensuring that only eligible and approved faculty members are assigned as Guides or mentors.

Criteria for Allotment are based on:

- Alignment of the fellow's area of interest with the Guide's specialization
- Availability and consent of the Guide
- Existing rotation or merit-based preferences as determined by the Committee

Role and Responsibilities of the Guide:

- Mentoring the fellow to acquire required skills and academic knowledge
- Providing guidance and support to ensure progress throughout the fellowship

- Conducting regular evaluations and offering academic and professional advice and submit periodic report to the Fellowship coordinator
- Supporting the fellow in meeting program requirements and objectives

External Collaborators: External collaborators from recognized institution may serve as fellowship co-Guides in conjunction with a Guide from MRV.

Change of Guide: Fellows may request a change of Guide, subject to approval by the Selection Committee.

8. FELLOWSHIP PROGRAM DESIGN

The fellowship program is designed to provide a structured and comprehensive learning experience that develops relevant skills, knowledge, and professional competencies. Upon completion, they should demonstrate proficiency in core skills, apply their knowledge effectively in professional settings, maintain professional standards, and document their progress.

Logbook Maintenance: Fellows must maintain a logbook throughout the program. The required entries may vary depending on the fellowship. The logbook will be reviewed and evaluated on a daily or weekly basis by the assigned Guide. Regular face-to-face feedback sessions with the Guide will be conducted to monitor progress and provide guidance.

Final Assessment and Exit Examination:

The final assessment by the assigned guides includes the following components:

1. Multiple Choice Questions (MCQs): 25 marks
2. Practical Skills Assessment: Three case scenarios with discussion; each case carries 20 marks (total 60 marks)
3. Logbook Maintenance: 15 marks

The candidate must appear and secure a minimum of 50% marks in each of the above listed components. The total marks are 100, and a minimum aggregate score of 50% is required to successfully complete the fellowship.

Any additional outputs or deliverables may be determined in consultation with the Guide and require prior written approval from the Selection Committee.

9. MINIMUM STANDARD AND CREDITS FOR THE AWARD OF THE FELLOWSHIP

- Fellows must maintain a **minimum of 80% attendance** across all program activities.
- A **minimum overall score of 50%** is required to pass the fellowship.

10. FELLOWSHIP COMPLETION CERTIFICATE

Issued by MRV: Upon successful completion of all training, periodic evaluations, and final examinations, fellows will be awarded a certificate.

The certificate should include details such as:

- Name of the candidate
- Fellowship program details
- Program completion status

Fellowship in Medical Robotics Design and Development

Course Overview

The Fellowship in Medical Robotics Design & Development is an intensive, industry-oriented and research-focused program designed for learners aiming to work at the intersection of robotics, healthcare engineering, surgical technology, sensing systems, and AI-enabled medical devices. The program builds a strong foundation in robotic system design, mechatronics, actuation, control, and computational methods that drive modern medical robotic platforms. It also covers essential areas such as surgical robotics, rehabilitation and assistive systems, human–robot interaction, sensing technologies, haptics, and computer vision approaches used for robotic perception and navigation.

Throughout the fellowship, participants engage in hands-on laboratory work, simulation-based training, prototyping sessions, and iterative design exercises. They also gain practical insight into clinical workflow integration, safety engineering, risk assessment, usability considerations, and regulatory standards required for the development of medical-grade robotic systems. The program culminates in a capstone project where learners design and develop a functional robotic subsystem or application suited for surgical, diagnostic, or therapeutic purposes.

Course Objectives

1. To provide a strong foundation in robotics principles, kinematics, dynamics, control, and their medical applications.
2. To train learners in mechatronic system design, including actuators, motors, sensors, microcontrollers, embedded systems.
3. To introduce the fundamentals of surgical robotics, MRI-compatible robots, catheter robotics, tele-surgery, and robotic systems for minimally invasive procedures.
4. To develop skills in robotic simulation platforms such as ROS, Gazebo, MATLAB/Simulink, and Unity/Unreal simulation environments.
5. To build competencies in computer vision, medical imaging interpretation, AI and ML for perception and autonomous tasks.
6. To train learners in rehabilitation and assistive robotics, exoskeletons, and human–robot interaction (HRI).
7. To provide exposure to design controls, safety testing, biocompatibility, and medical device regulatory pathways (FDA, CE, CDSCO).
8. To create advanced capabilities in designing, prototyping, and testing novel medical robotic systems for clinical use.

Curriculum with Part-wise Syllabus & Modules

Part 1: Foundations of Robotics & Medical Applications

Module	Topics Covered
Introduction to Robotics in Medicine	History and evolution of medical robotics; robotic-assisted surgery; diagnostic robotics; rehabilitation robotics; tele-robotics; emerging global trends
Robotics Fundamentals (Kinematics, Dynamics & Control)	Forward & inverse kinematics; Jacobians; manipulability; rigid-body dynamics; PID control; impedance/admittance control; trajectory generation
Mechatronics for Medical Devices	Actuators, servomotors, BLDC motors; microcontrollers (Arduino, STM, Raspberry Pi); embedded systems; power and control circuits; safety design
Sensors, Sensing Systems & Medical Integration	Force/torque sensors, encoders, IMUs, optical sensors, haptics, biosensors; wearable sensing; integration challenges in sterile hospital environments; MRI-compatible sensing
Simulation Platforms for Robotics	ROS (Robot Operating System), Gazebo, MATLAB Robotics Toolbox, PyBullet; simulation of surgical tools; digital twins for medical robotics
Regulatory, Ethical & Safety Considerations	FDA/CE classifications, IEC standards for medical robots, reliability engineering, risk analysis (FMEA), sterilization & biocompatibility, cybersecurity in robotic systems

Part 2: XR Development, Simulation Engineering & Clinical Applications

Module	Topics Covered
Advanced Surgical Robotics	Robotic surgery systems (e.g., da Vinci), catheter navigation robots, robotic ultrasound, micro-robots, endoscopic robotics, image-guided & MRI-compatible robots. Inspired by Maryland Robotics Center research areas
Computer Vision & AI for Robotic Perception	Image segmentation, feature detection, depth estimation, stereo vision, tracking, SLAM; using medical images (CT/MRI) for robotic navigation; AI pipelines for automation
Tele-robotics & Remote Surgery	Haptic feedback, latency reduction, remote operation systems, communication protocols, safety layers, real-time control challenges
Rehabilitation & Assistive Robotics	Exoskeletons (upper/lower limb), prosthetics, neuro-robotics, gait training systems, soft robotics, human-robot collaboration. Similar themes appear in MassRobotics & IIT Guwahati innovation labs
Prototype Development & Testing	Designing robotic mechanisms; CAD modelling; 3D printing; bench testing; phantom models; integrating controllers & sensors; verification & validation
Capstone Project	Students design and prototype a medical robotic device or subsystem—options include catheter robot, surgical trainer robot, rehabilitation robot, robotic gripper, tele-operable arm, or AI-driven medical sensing robot. Final presentation + viva + design dossier

Program Outcomes

SR.N.	Program Outcome	Detailed Description
1	**Mastery of Robotics Fundamentals**	Demonstrate in-depth knowledge in kinematics, dynamics, control, mechatronics and their medical applications
2	**Ability to Design and Develop Medical Robotic Systems**	Build robotic mechanisms, sensor modules, and embedded systems tailored for clinical procedures
3	**Proficiency in Simulation & Prototyping Tools**	Use ROS, MATLAB, Gazebo, CAD & simulation platforms for modelling, simulation and testing
4	**Competency in Surgical Robotics Concepts**	Understand and apply principles of robotic-assisted surgery, image-guided robotics, and tele-surgery
5	**Expertise in Sensors & HRI**	Integrate sensors, haptics, and wearable devices for robust robotic perception and human–robot interaction
6	**Ability to Apply AI & Vision in Robotic Systems**	Use AI/ML algorithms and computer vision techniques for autonomous or semi-autonomous operations
7	**Understanding of Regulatory and Safety Frameworks**	Comply with medical device standards, safety testing, risk assessment, and validation processes
8	**Leadership in Medical Robotics Innovation**	Lead research, development, and deployment of clinical robotics solutions in hospitals or technology organizations

Course Outcomes

	Course Outcome	Detailed Description
1	**Explain Robotic Technologies in Healthcare**	Understand fundamentals of medical robotics, surgical systems, rehabilitation platforms, and sensing devices
2	**Apply Kinematics, Control & Mechatronics**	Design and control robotic links, joints, actuators, and embedded systems for medical devices
3	**Work with Robotics Simulation Environments**	Use ROS, MATLAB, and Gazebo to simulate robotic arms, surgical tools, and clinical workflows
4	**Integrate Sensors & Haptic Systems**	Build real-time sensing modules and haptic feedback systems for robotic applications
5	**Use AI & Computer Vision for Robotic Perception**	Implement algorithms for detection, segmentation, motion tracking, and robotic navigation
6	**Design Safe & Compliant Medical Robots**	Apply design control processes, perform risk analysis, and adhere to medical regulatory pathways
7	**Prototype & Test Robotic Systems**	Use CAD, 3D printing, and actuator

		integration to prototype and validate robotic mechanisms
8	**Deliver a Working Medical Robotics Project**	Develop a functional robot prototype or subsystem demonstrating innovation, clinical relevance, and safety

Recommended Books & E-Resources
Textbooks:

- Springer Handbook of Robotics – Siciliano & Khatib
- Medical Robotics – Jacob Rosen, Blake Hannaford
- Robotics: Modelling, Planning and Control – Siciliano
- Biomechatronics – D. Howard
- Introduction to Robotics: Mechanics and Control – Craig

Platforms:

- ROS Tutorials, MATLAB Robotics Toolbox, Unity Robotics Hub