NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	M.Tech. in Electronics & Instrumentation Engineering (Robotics and Artificial Intelligence)
Semester:	II
Course Code:	6ME872ME25
Course Title:	Underwater Robotics
Course Type:	Elective
Year of introduction:	2025-26

L	T	Practical component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLOs):

After successful completion of the course, student will be able to –

1. identify the applications of underwater robotics (BL3)
2. develop the mathematical model of underwater robot (BL3)
3. select a suitable controller for underwater robot (BL5)
4. build a program for autonomous navigation and obstacle avoidance. (BL6)

Unit	Contents	Teaching Hours (Total 30)
Unit I	**Introduction to Underwater Robotics** Basics of underwater navigation, definitions of underwater vehicle, types of underwater vehicles, classification, sensorial systems, introduction to underwater localization, anatomy of underwater vehicle, degree of freedom, underwater motions.	05
Unit II	**Modelling of underwater robot** Rigid body kinematics, rigid body dynamics, hydrodynamic effect, effect of gravity underwater, concept of buoyancy, buoyant force estimation, importance of buoyancy, thrusters as underwater actuators, basic anatomy of thrusters, thrust force estimation, thruster's dynamic, common AUV design and strategies.	08
Unit III	**Kinematic control** Introduction to kinematic control, forward kinematic model, kinematic model with thruster's configuration, drag minimization algorithm, joint limit constraints, inverse kinematic model, drag force estimation and consideration in control scheme, control block diagram, task planning control algorithm.	08

Unit IV	**Dynamic control** Dynamic model of underwater vehicle, concept of dynamic controller, Earth fixed frame-based controller, vehicle fixed frame-based controller, mixed frame-based controllers, comparisons of different controller, sliding mode control, adaptive control, AI based control design, underwater image processing and decision making, dynamic task planning for AUV.	09

Self – Study:	The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.
Suggested Readings/References:	1. Gianluca Antonelli, Underwater Robots, Springer 2. Steven W. Moore, Underwater Robotics : Science, Design and Fabrication, Marine Advanced Technology Edu 3. Junzhi Yu, Zhengxing Wu, Jian Wang, Bionic Gliding Underwater Robots: Design, Control, and Implementation, CRC press
Suggested List of tutorials:	1. Hydrodynamic design of underwater robot 2. Operation of thrusters 3. Simulation of 1DOF and 2DOF UWR 4. Simulation of 3DOF and 4DOF UWR 5. Simulation of 6DOF UWR 6. Navigation planning of UWR 7. Localization of UWR 8. Underwater image acquisition and analysis 9. Underwater manipulation

L = Lecture, T = Tutorial, P = Practical, C = Credit

w.e.f. the academic year 2025 – 26 and onwards