Course Number : AR508
Course Name : Marine Robotics
Credit Distribution : 3-0-0-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

Students will be introduced to the main topics in the theoretical and practical design of marine robots such as autonomous underwater and surface vehicles (AUVs, ASVs). Students will be introduced to the theoretical principles underlying their design including aspects of guidance, navigation, and control, modelling and simulation. The module aims to provide the students with the skills required to design, build and deploy simple marine robotic systems.

2. Course Modules with quantitative lecture hours:

Types of Marine robots and applications: Introduction to the types of marine robots, Classification based on applications, Approach for deployment, operation and maintenance of marine robots such as surface vehicles and underwater vehicles (ASVs, AUVs, ROVs, underwater gliders and floats). **(4 hours)**

Vehicle design: Mechanical design of marine robots, structures, materials, pressure hull, Vehicle parameters and performance metrics including pressure, buoyancy, stability, ballasting, propulsion, power, speed, range, and cost of transport (COT). **(8 hours)**

Vehicle mathematical modelling: Classification of models, Rigid body Kinematics, frame transformations between body, flow, and non-accelerating frames, Euler angles, quaternions, Rigid-Body Kinetics, Equations of motion (Linear and nonlinear), Hydrostatics, maneuvering model, coupled motion model, environmental disturbances. **(8 hours)**

Navigation: Marine Sensors and navigational strategies for localization using dead-reckoning, SLAM and uncertainty/probabilistic approaches, and Observer-based design. **(6 hours)**

Guidance: Path planning algorithms and path following strategies include line of sight guidance strategies, pure pursuit guidance, constant bearing guidance, and trajectory tracking. **(6 hours)**

Control: Modelling and control using PID controllers, open-loop stability, and state feedback control, maneuverability system architectures, and actuator models. **(6 hours)**

Final project: Student project towards modelling of a marine robot using MATLAB. **(4 hours)**

3. Textbooks:

1. Handbook of Marine Craft Hydrodynamics and Motion Control 2nd Edition, Wiley.
2. Beard, R. W. and T. W. McLain. Small Unmanned Aircraft. Theory and Practice. Princeton University Press.
3. Moore S.W., Bohm H., and Jensen V. Underwater Robotics: Science, Design, and Fabrication.

4. References:

1. Triantafyllou MS, Franz S. Hover. Maneuvering and control of marine vehicles. Lecture Notes, Department of Ocean Engineering Massachusetts Institute of Technology Cambridge, Massachusetts USA.
2. Antonelli, G. Underwater robots. In Encyclopedia of Systems and Control (pp. 2384-2388). Cham: Springer International Publishing.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None