Course Number: 28922

Course Name: Underwater Engineering

Course Type: Theory	Type & Max Unit: Constant 3
Prerequisite: Nothing	Corequisite: Nothing.
Level: Graduate	First Presentation: 2003-2
Group: Marine Engineering	Last Edition: 2018-1

Objectives:

The main idea of presenting this course is to introduce to the graduate students of Marine Engineering about underwater technology such as Manned Submersible Vehicles and Unmanned Submersible Vehicles, Remotely Operated Vehicles, Autonomous Underwater Vehicles, underwater Hydrodynamics and Control, Underwater Pipe Laying, Underwater Cable Laying, Underwater survey etc.

Topics:

- Introduction to the course and introduction to the sea and ocean, underwater minerals, underwater oil and gas, underwater source of food and nutrition, underwater diving methods for underwater resources investigations etc.
- Other underwater operations such as structures, pipe laying, cable laying and investigations, underwater vehicles including Manned Submersible Vehicles, Unmanned Submersible Vehicles, Remotely Operated Vehicles, Autonomous Underwater Vehicles, underwater Hydrodynamics and Control methods.
- Underwater hydrodynamics based on the classical methods and difficulties in identification of hydrodynamics coefficients, underwater control and mission control for underwater vehicles based on the classical control theories and the difficulties, switching to data based and experimental based methods for hydrodynamics and controls using Neural Networks.
- How a nerve cell functions and how to model a nerve cell mathematically, Artificial Neuron and Propagation Function including Synaptic Weight and Synaptic Bias and Neuron Activation Function such as Bias, Linear and Nonlinear, Sigmoid, Hyperbolic Tangent, etc. and then extending the results to the networks of multi neurons in multi layers, namely Neural Network. Definition of Feed Forward Neural Networks suitable for statics and time irrelevant system identifications and introducing Feed Back Neural Networks using recurrent from hidden layers or output layer to all previous layers, namely Jordan and Elman network and it combinations suitable for dynamics and time relevant system and control purposes.
- Supervised Learning and Unsupervised Learning in Neural Networks trainings, how to collect rich data from experiments to be needed for Supervised Learning, Errors between data and network output, least square of error and optimizing it by learning procedure using Error Back Propagation to tune up Synaptic Weights and Bias Value for every neurons in the network, learning rate and learning momentum, decomposing a MIMO system to several SISO systems to ease up training and convergence of learning procedure and then composing back to early MIMO one, cutting of external recurrent loops to make a Dynamic System to Static one to speed

up convergence in training and then turning on recurrent loops for Dynamics Simulation, other training consequences such as training in state variables, their derivatives, Example By Example Learning and Batch Learning, Simulation of the trained network to accomplish its performances, Unsupervised Learning suitable for training Neural Network for control application, decomposing to Supervised Learning with imitating a very simple controller data such as On-Off controller and then composing the controller using Unsupervised Learning to optimize Neural Network Controller. Running different examples in Supervised and Unsupervised Learning, Static and Dynamic Networks, Control Networks, SISO and MIMO systems.

- Term projects in dynamics modeling and control and other identification method.

References:

1- Sandhya Samarasinghe, “Neural Networks for Applied Sciences and Engineering”, First Edition, Taylor & Francis Group, 2007.
2- Thor I. Fossen, “Guidance and Control of Ocean Vehicles”, First Edition, John Wiley & Sons, 1994.
3- Hassan Sayyaadi, “Personal Notes and Comments”, Professor of the School of Mechanical Engineering, Sharif University of Technology, Tehran, Iran, Since 2002.