



University of Tehran
School of Electrical and Computer Engineering

Course:	8101176 – Bio Computing		
Course type:	Required	CE-AI and Robotics	Credit: 3
Level:	Graduate		
Co-requisite(s):	None		
Prerequisite(s):	None		
Prerequisite by topic:	None		
Textbook(s):	[1] Floreano, mattiussi, Bioinspired Artificial Intelligence, 2008 [2] Eric Bonabeau, Marco Dorigo, Guy Theraulaz, Swarm Intelligence: From Natural to Artificial Systems, Oxford University Press, 1999 [3] Bar Cohen, BIOMIMETICS-Biologically Inspired Technologies, 2006		
Coordinator:	Masoud Asadpour, Assistant Professor, School of ECE		
Goals:	Biologically-inspired problem solving has become a hot topic in the last ten years. The approach tries to bring inspirations from biology and animal society to make useful contributions to design of algorithm for solving problems in regular life. This course tries to summarize the related researches to artificial intelligence and robotics field. The students that take this course will learn to look at the engineering problems in a different way than the classical methods. This course will also address to some extent how computer science and robotics can contribute to a better understanding of biological systems.		
Outcome:	Upon successful completion of the course, students will <ol style="list-style-type: none"> 1. Have a basic understanding of biomimetic design 2. Apply Bio-inspired approaches to problems optimization 3. Become familiar with problem solving in swarm of animals and types of problems they solve. 4. Have a basic understanding of the available biological and bio-inspired materials, sensors, actuators, and controllers. 		
Topics:	Part 1 from the book by Prof. Floreano <ol style="list-style-type: none"> 1. Introduction <ul style="list-style-type: none"> ◦ Biomimetics and its application in robotics ◦ Entertainment 		

- Education
 - Health care
 - Telepresence
 - Telesurgery
 - Assistive / rehabilitative robotics
 - Realistic creatures
 - Art
2. Evolutionary Algorithms
 - DNA
 - replication
 - mitosis, meiosis
 - Genetic Algorithm
 - Genetic Programming
 - Evolutionary Programming
 - Evolutionary Strategies
 3. Simulated Annealing
 4. DNA Computing
 5. Cellular Automata
- Part 2: from the book by Prof. Dorigo
1. Swarm Intelligence
 - Self-organization
 - Stigmergy
 - Traffic Control
 - Shortest path problem
 - Minimal spanning tree
 - Travelling salesman problem
 - Ant Colony Optimization (ACO)
 - Division of labor
 - Specialization
 - Clustering
 - Sorting
 - Graph Partitioning
 - Templates
 - Nest Building
 - Cooperative Transport
 2. Particle Swarm Optimization (PSO)
 3. Bee Optimization (BO)
 4. Firefly Algorithm (FA)
 5. Glowworm Swarm Optimization(GSO)
- Part 3: from the book by Prof. Bar Cohen
1. Bio-Inspired Sensors
 - Eye
 - Infrared sensing
 - LVDTs
 - Magneto resistive sensor
 - Piezo resistive sensor
 - Elastic wave sensor
 - Echolocation
 - Artificial Ear
 - Olfaction

	<ul style="list-style-type: none"> ◦ Gustatory system ◦ Electroreception ◦ Tactile sensing ◦ Artificial hair ◦ Magnetic field sensor ◦ Biological clock <p>2. Bio-Inspired Actuators, Components and Materials</p> <ul style="list-style-type: none"> ◦ Sound ◦ Light emission ◦ Muscle ◦ Pneumatic actuators ◦ Hydraulic actuators ◦ Electromagnetic motors ◦ Inchworm motors ◦ Pumps ◦ Drillers/Corers ◦ Spring-loaded actuators ◦ Electroaction ◦ Beak / Trunk / Tube ◦ Gastobotics ◦ Fin ◦ Adhesion ◦ Nests ◦ Defense ◦ Anti-G suits <p>3. Bio-Inspired Locomotion</p> <ul style="list-style-type: none"> ◦ Flight: Wing forms, Take off, Falling/Diving, Gliding, Soaring, Flapping, Hovering, Landing,... ◦ Swimming ◦ Crawling ◦ Rolling ◦ Hopping ◦ Legged locomotion ◦ Animal Gaits ◦ Climbing ◦ Walking on Water <p>4. Locomotion Control (more readings, not included in the final exam)</p> <ul style="list-style-type: none"> ◦ Mathematical Synthesis ◦ Modulated playback ◦ Passive Dynamics ◦ Physics-based heuristics ◦ CPG based methods ◦ Oscillators ◦ Gait optimization <p>5. Bio-inspired Controllers (more readings, not included in the final exam)</p> <ul style="list-style-type: none"> ◦ Reactive control ◦ Deliberative control ◦ Hybrid control
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	<ul style="list-style-type: none"> ◦ Behavior-based control ◦ Potential fields
Computer usage:	4 computer assignments
Assignments:	5 homework assignments
Projects:	None
Grading:	Assignments: 40% Final exam: 60%
Further readings:	[4] Yoseph Bar-Cohen, Cynthia L. Breazeal, Biologically Inspired Intelligent Robots, SPIE Press, 2003 [5] Marco Dorigo and Thomas Stützle, Ant Colony Optimization, The MIT Press, 2004 [6] Maurice Clerc, Particle Swarm Optimization, ISTE Publishing Company, 2006 [7] Abraham, Grosan, Ramos, Swarm Intelligence in Data Mining, Springer, 2006 [8] Parrish, Hamner, Animal Groups in Three Dimensions, Cambridge University Press, 1997 [9] Ginneken, Collective Behavior & Public Opinion, Lawrence Erlbaum Associates Publishers, 2003
Prepared by:	Masoud Asadpour
Date:	February 2013

*EE: Electrical Engineering CE: Computer Engineering IT: Information Technology