University of Tehran
School of Electrical and Computer Engineering

Course:	**8101641- Special Issue: Modeling and Control of Mobile Robots.**
Course type:	EE*: Com ☐ E ☐ P ☐ B ☒ Con ☒ D ☐ — CE*: SW ☐ HW ☐ IT ☐ MI ☒ — Required: all ☐ — Elective: B, Con, MI ☒ — Credit: 3
Level:	Undergraduate ☐ Graduate ☒
Co-requisite(s):	None.
Prerequisite(s):	Introduction to Robotics (8101187).
Prerequisite by topic:	Nonlinear Control (8101540).
Textbook(s):	[1] Westervelt, E. R., Grizzle, J. W., Chevallereau, C., Choi, J. H., & Morris, B. (2007). *Feedback control of dynamic bipedal robot locomotion*. CRC press. [2] Siegwart, R., Nourbakhsh , E., (2011). *Introduction to autonomous mobile robots*. MIT Press. [3] Bloch, A.M, (2003). *Nonholonomic mechanics and control*. New York: Springer.
Coordinator:	Dr. Nili Ahmadabadi, Professor, School of ECE.
Goals:	To introduce the basics of mobile robots; such as kinematic and dynamic modeling, stability criterion in walking and running, non-holonomic path planning as well as control of legged and wheeled robots. The course also covers systematic design of passive elements to increase energy efficiency and stability in locomotion, and basics for design of passive exoskeletons and exosuits.
Outcome:	Upon successful completion of the course, students will be able to 1. Model wheeled mobile robots 2. Develop path planning software for wheeled mobile robots 3. Design control methods for wheeled mobile robots 4. Model legged robots 5. Develop control methods for legged robots 6. Design energy efficient compliant legged robots 7. Design passive exoskeleton and exosuits
Topics:	1. Introduction to non-holonomic systems 2. Kinematics of wheeled robots 3. Basics of non-holonomic path planning for wheeled robots 4. Quasi-static control of wheeled robots 5. Kinematic modeling of legged robots

	6. Hybrid dynamic modeling of legged robots 7. Foot-ground modeling 8. Gaits in legged locomotion 9. Stability criterion in legged locomotion 10. Control of biped robots by feedback linearization 11. Gait optimization 12. Modeling compliant walking robots 13. Compliance optimization for energy efficiency in walking 14. Introduction to passive exoskeletons and exosuit design
Computer usage:	Implementing the projects using Matlab Software or other robotic simulator softwares; e.g. Webots.
Assignments:	4 to 5 homework.
Projects:	1- Modeling and control of a humanoid biped robots with seven DOFs. 2- Design of compliant robots for efficient walking and running.
Grading:	Assignments: 30% Projects: 30% Midterm exams: 0% Final exam: 40%
Further readings:	Selected papers on control and modeling of walking systems, exoskeletons, exo-suits and passivity in legged systems.
Prepared by:	Dr. Majid Nili Ahmadabadi.
Date:	November, 1, 2017.

*EE: Electrical Engineering		CE: Computer Engineering	
Com	Communications	SW	Software
E	Electronics	HW	Hardware
P	Power	IT	Information Technology
B	Bioelectronics	MI	Machine Intelligence and Robotics
Con	Control		
D	Digital System		