Course Syllabus

Description	This course investigates recent work in the areas of nonlinear dynamics and control of robots that walk, run, fly and swim.
Instructor	Prof. Katie Byl (katiebyl@ece.ucsb.edu) Room 5115, Harold Frank Hall
Time/Location	Monday, Wednesday 2:00-3:50pm, in 1437 Phelps
Prerequisites	An undergraduate-level background in both *System Dynamics* and *Controls*.
Office Hours	Tuesday 10am-noon (and/or by appointment), in 5115 HFH.
Required Text/Readings	There is no text for this course. Instead, we will read, analyze and discuss a variety of recent publications relating to robot locomotion. Please be respectful that such publications are *protected by copyright law; any links to publications are for educational use by students within this course, only.*

Grading

Class participation	30%	*(Includes leading at least one class discussion.)*
Homework	35%	*(Lowest HW grade will not be included in average.)*
Final Project	35%	*(With conference-length research paper and talk.)*

Participation Each student will be assigned a particular reading for which (s)he will lead a class discussion. Students are strongly encouraged to meet with me beforehand (either in regular office hours or by appointment) to review their assigned readings. Your grade for class participation will *also* depend on your regular contributions to other class discussions throughout the class.

Homework Homework is due at the start of class. While some collaboration is allowed, direct copying is not (and will be dealt with severely). The lowest homework grade a student receives will *not* be included in calculating the total homework grade contribution.

Projects Details on potential topics for the term project will be discussed in class. Deliverables for the term project include both a conference-length paper (e.g., 6-8 pp.) and a short, in-class presentation (about 15 minutes).

Tentative Schedule

Date	**Topics** (numbering matches HWs)	**Required Readings**†	**Optional Readings**†	Homework **Out**	**Due**
1/4	1: Locomotion overview 1.1 Underactuation and controllability.	[14] [48]	· [45]	·	·
1/6	2: Passive dynamics in walking 2.1 Impedance; robot examples.	[36] [41]	[38] [42]; [12]	·	·
1/11	2.2 Stability analyses and modeling.	[10, 25]	[23, 47, 26]	·	·
1/13	3: Control methods for walking 3.1 Partial Feedback Linearization (PFL).	[11] [49]	· ·	·	1
(1/18)	** *No class. (MLK's Birthday.)* **	–	–	–	–
1/20	3.2 Stability margins. 3.3 Preview control for ZMP.	· [31]	[22] [32]	2	1
1/25	3.4 Hybrid Zero Dynamics (HZD). 3.5 (Manifold control.)	[53] ·	[54] [20]	·	·
1/27	4: Running gaits 4.1 Raibert hoppers; BigDog.	[37] [43]	[27] [44]	3	2
2/1	4.2 Spring-loaded inverted pendulum (SLIP). 4.3 RHex; CPGs.	[24] [2];[29]	[21] [1];[18]	·	·
2/3	5: Dynamics of (flapping) flight 5.1 Blade element method.	[15] [16]	[3, 13] [51, 19, 39]	4	3
2/8	5.2 Passive dynamics. 5.3 Controllability.	[56] [46]	[4, 40] [28]	·	·
2/10	6: Machine learning 6.1 Dynamic Programming.	· [35]	[30] ·	5	4
(2/15)	** *No class. (Presidents' Day.)* **	–	–	–	–
2/17	6.2 Gradient-based methods.	[55]	[50]	6	5
2/22	6.3 Genetic algorithms.	[7]	·	·	·
2/24	7: Kinodynamic planning 7.1 Motion planning for fully-actuated robots.	[6] [17]	[5] [9]	7	6
3/1	7.2 Rapidly-exploring Randomized Trees (RRTs).	[33]	[52, 8, 34]	·	·
3/3	Review; Future directions	*TBA*	*TBA*	·	7
3/8	*Final project presentations.*	·	·	·	·
3/10	*Final project presentations.*	·	·	·	·

† Use "References" (on pages ahead) as a key to the Readings.

References

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