

# 18.996 Special Topic - Spring 2007

## Kontsevich's proof of Witten's conjecture and related topics

### Course information

**Lectures:**

Monday, Wednesday and Friday, 10-11am, room 2-255.

First lecture: Wednesday, February 7th.

**Two remarkable papers:**

Edward Witten. Two-dimensional gravity and intersection theory on the moduli space. In *Surveys in differential geometry (Cambridge, MA, 1990)*, pages 243-310. Lehigh Univ., Bethlehem, PA, 1991.

Maxim Kontsevich. Intersection theory on the moduli space of curves and the matrix Airy function. *Comm.Math.Phys.*, **147**(1):1-23, 1992.

**Lecturer:**

Gabriele Mondello, room 2-279, phone (617-25)3-3214, e-mail: [gabriele@math.mit.edu](mailto:gabriele@math.mit.edu)

Office hours: by appointment.

## List of topics:

- MODULI SPACE OF RIEMANN SURFACES AND TEICHMÜLLER SPACE:  
complex-analytic and hyperbolic point of view, systems of coordinates, local and global structure, universal families, mapping class group
- TAUTOLOGICAL CLASSES ON THE MODULI SPACE OF RIEMANN SURFACES:  
definitions, examples, intersection theory, conjectures
- EQUIVARIANT CELLULAR MODEL FOR THE TEICHMÜLLER SPACE:  
construction of ribbon graphs from Riemann surfaces via Jenkins-Strebel differential and via hyperbolic geometry, Harer's results on the (virtual) homology of the mapping class group
- MATRIX INTEGRALS AND KONTSEVICH'S MAIN IDENTITY:  
asymptotic expansions of matrix integrals, Wick's lemma and enumeration of (ribbon) graphs, combinatorial psi classes and "symplectic" volume form
- SATO'S GRASSMANNIAN AND SOLUTIONS OF THE KP EQUATION:  
Sato's infinite Grassmannian, boson-fermion correspondence, integrable hierarchies of KP (and KdV) type
- KONTSEVICH'S PROOF AND FURTHER DEVELOPMENTS:  
putting the pieces together in Kontsevich's proof, generalized Witten's conjecture and (time permitting) Virasoro constraints in general.

## Calendar

1.	Wed	2/7	<i>First class</i>
2.	Fri	2/9	
3.	Mon	2/12	
4.	Wed	2/14	
5.	Fri	2/16	
	Mon	2/19	<b>President's holiday</b>
6.	Tue	2/20	<b>(Monday schedule)</b>
7.	Wed	2/21	
8.	Fri	2/23	
9.	Mon	2/26	
10.	Wed	2/28	
11.	Fri	3/2	
12.	Mon	3/5	
13.	Wed	3/7	
14.	Fri	3/9	
15.	Mon	3/12	
16.	Wed	3/14	
17.	Fri	3/16	
18.	Mon	3/19	
19.	Wed	3/21	
20.	Fri	3/23	
	MWF	3/26-30	<b>Spring vacation</b>
21.	Mon	4/2	
22.	Wed	4/4	
23.	Fri	4/6	
24.	Mon	4/9	
25.	Wed	4/11	
26.	Fri	4/13	
	Mon	4/16	<b>Patriots Day</b>
27.	Wed	4/18	
28.	Fri	4/20	
29.	Mon	4/23	
30.	Wed	4/25	
31.	Fri	4/27	
32.	Mon	4/30	
33.	Wed	5/2	
34.	Fri	5/4	
35.	Mon	5/7	
36.	Wed	5/9	
37.	Fri	5/11	
38.	Mon	5/14	
39.	Wed	5/16	<i>Last class</i>