AM 527b, Winter 2007

Introduction to the Bosonic String

Time & Place: to be determined

Instructor: Dr. Alex Buchel , office MC 264 , Ext: 88794 , E-mail: **abuchel@uwo.ca**

Office hours: by appointment

Course webpage: **http://abuchel.apmaths.uwo.ca/∼public/strings2007/**

Prerequisites:

The course is geared for M.Sc. and Ph.D. students enrolled in Collaborative Ph.D. Program in Theoretical Physics. Required previous course work: Quantum Field Theory (AM516 or equivalent).

Course outline:

I. A first look at strings:

a. Action principles

b. The open string spectrum

c. Closed and unoriented strings

II. Conformal field theory:

a. Massless scalars in two dimensions

b. The operator product expansion

c. Ward identities and Noether's theorem

d. Conformal invariance

e. Free CFTs

f. The Virasoro algebra

g. Mode expansions

h. Vertex operators

III. The Polyakov path integral:

a. Sums over world-sheets

b. The Polyakov path integral

c. Gauge fixing

d. The Weyl anomaly

e. Scattering amplitudes

f. Vertex operators

g. Strings in curved spacetime

IV. The string spectrum:

a. Old covariant quantization

b. BRST quantization

c. BRST quantization of the string

d. The no-ghost theorem

V. The string S-matrix:

a. The circle and the torus

b. Moduli and Riemann surfaces

c. The measure for moduli

VI. Tree-level amplitudes:

a. Riemann surfaces

b. Scalar expectation values

c. The *bc* CFT

d. The Veneziano amplitude

e. Chan-Paton factors and gauge interactions

f. Closed string tree amplitudes

g. General results

VII. One-loop amplitudes:

a. Riemann surfaces

b. CFT on the torus

c. The torus amplitude

d. Open and unoriented one-loop graphs

VIII. Toroidal compactification and T-duality:

a. Toroidal compactification in field theory

b. Toroidal compactification in CFT

c. Closed strings and T-duality

d. Compactification of several dimensions

e. Orientifolds

f. Open strings

g. D-branes

h. T-duality of unoriented theories

IX. High order amplitudes (if time permits):

a. General tree-level amplitudes

b. Higher genus Riemann surfaces

c. General amplitudes

d. String field theory

e. Large order behavior

f. High energy and high temperature

g. Low dimensions and noncritical strings

Text:

The primary text is the book:

"String theory. Vol. 1: An introduction to the bosonic string."

J. Polchinski (Santa Barbara, KITP) . 1998. 402pp.

Cambridge, UK: Univ. Pr. (1998) 402 p.

The book is on reserve in Allyn & Betty Taylor Library (1 day loan). Additional resources will be posted on/linked to the course webpage.

Course evaluation:

Course grade will be based on a number of homework assignments (to be specified). There will be no final exam.

Feedback to the instructor regarding the quality, speed, and content of presentation is especially appreciated during the semester!