Program for the graduate course 'Introduction to string theory'

Projected schedule: 30 hours, distributed in 20 lectures of about 90 minutes
Program and Lecture Notes available at

http://gesalerico.ft.uam.es/paginaspersonales/angeluranga/firstpage.html

Program

Introduction and general properties

- 0. Introduction I: String theory at the perturbative level
- 0'. Introduction II: String theory beyond perturbation theory

Closed bosonic string theory

- 1. Closed bosonic string theory: Quantization, spectrum and basic properties
- 2. Modular invariance
- 3. Toroidal compactification of closed bosonic string theory, T-duality
- App. I: Group theory

Superstrings in ten dimensions

- 4. Type II superstrings: Quantization, spectrum and basic properties
- 5. Heterotic superstrings: Quantization, spectrum and basic properties
- 6. Open superstrings
- 7. Type I superstring

Compactification

- 8. Toroidal compactification of superstrings
  App.2: Some topological tools: Homology, cohomology and fiber bundles
- 9 Calabi-Yau compactification and Heterotic String phenomenology
- 10. Orbifold compactification

Duality and Branes in string theory

- 11. Non-perturbative states in string theory

- 12 D-branes: Definition, effective action and basic properties
- 13. String theory duality. M-theory
- 14. Non-perturbative effects in (weakly coupled) string theory
- 15. D-branes and gauge field theories
- 16. Brane-Worlds
- 17. Non-BPS states in String Theory

Comment
A further appendix on Supersymmetry is under work

Some important topics NOT covered in this course

- Conformal field theory
- Computation of scattering amplitudes in string theory
- Computation of string theory spacetime effective actions
- Supergravity

Potentially useful bibliography

The best reference is of course provided by the lecture notes, where I have condensed the topics and discussions relevant for this course, taken from diverse references below. However it is always interesting to look at complementary viewpoints.

- B. R. Greene, 'The elegant universe: Superstrings, hidden dimensions, and the quest of the ultimate theory', New York, USA: Norton (1999) 448
  General public introductory book, useful in getting intuitive understanding of string theory.

- M. E. Peskin, 'Superstring spectroscopy', SLAC Summer Inst.1986:64.
  Lightning review of string theory in the mid-80's with few technicalities, but very precise intuitive descriptions of the constructions.

- M. E. Peskin, 'Introduction to string and superstring theory, 2', Santa Cruz TASI 86:27.
  Lightning review of string theory in the mid-80's with more detailed and technical discussion than previous.

- J. Polchinski. 'String theory', Vols. 1, 2 Cambridge Univ. Pr. (1998)
  Complete reference book for string theory, standard textbook on the topic. Quite up-to-date except for few topics. Also, quite technical, but very precise and modern treatment.

- M. B. Green, J.H. Schwarz, E. Witten, 'Superstring theory, vols 1,2' Cambridge, Uk: Univ. Pr. (1987) (Cambridge Monographs On Mathematical Physics
  Previous standard textbook in string theory. Treatment is not as modern as in Polchinski, and in general discussions are more difficult to follow. However, treatment of some specific topic is extremely precise, modern and useful (for instance, differential geometry and Calabi-Yau compactification).

- D. Lust, S. Theisen, 'Lectures on string theory', Lect.Notes Phys.346:1-346,1989.
  Detailed discussion of string theory in the mid 80's, with special emphasis on some specific topics like toroidal and orbifold compactifications, etc. Discussion in centered on heterotic theories.

- C. V. Johnson, 'D-brane primer', hep-th/0007170
  Extended review of D-brane properties and applications in string theory, also with and introduction to basic string and superstring theories.

  Other reviews of string theory

- T. Mohaupt, 'Introduction to string theory', hep-th/0207249

- R. J. Szabo, 'BUSSTEPP lectures on string theory: An Introduction to string theory and D-brane dynamics', hep-th/0207142.

- E. Kiritsis, 'Introduction to superstring theory', hep-th/9709062

- E. Kiritsis, 'Introduction to nonperturbative string theory', hep-th/9708130