14 Azar 1396
Take-home exam,
Due date 18 Azar, morning

Midterm Exam of String Theory

Bosonic Open String Theory: Consider a D-dimensional open string theory on flat space with n NN modes, m DN modes and d DD modes. For the DD modes assume the two ends of strings are separated by $Y^i,\ i = 1, \cdots, d$.

1) Write out mode expansion of this open string theory.

2) Study the spectrum of this theory using light-cone quantization.

3) Fix the worldsheet diffeomorphisms using the appropriate bc-ghost system.

4) Using the bc-ghost system, show cancellation of the Weyl anomaly leads to $D = 26$, irrespective of values of n, d.

5) Write out the first three low-lying (lightest) states in the spectrum and write the corresponding vertex operators.

6) Construct unoriented version of the above mentioned open string theory:

   6-1) How does NN, DN and DD modes transform under worldsheet parity Ω?

   6-2) Mod out the Hilbert space by Ω to find the spectrum of unoriented open string theory.

7) Compute one-loop partition function of the theory. In particular, discuss the Y^i dependence of the partition function. *Note that for open string case the one-loop worldsheet is annulus (or cylinder), in contrast with the torus in the closed string case.*

8) Compute the one-loop partition function of the unoriented theory (constructed in item 6)). Discuss Y^i dependence of the partition function. *For the unoriented case the worldsheet to consider is a Möbius strip.*

9) Add the most general open string coupling to the worldsheet action. *Hint: this term is a boundary term on the worldsheet.*

10) Compute the one-loop β-function for the worldsheet coupling and work out the (target space) action which yields this β-fucntion equation as its equation of motion.

All the best,
Sheikh-Jabbari.