

## Phys 229b, CFT: Problem Set 5

Due: June 12, 2018

Please write up your solutions in  $\text{\LaTeX}$ , and submit via email (dsd@caltech.edu). Feel free to use a computer algebra program (e.g. *Mathematica*).

1. Derive the four-point functions  $\langle \epsilon \epsilon \epsilon \epsilon \rangle$  and  $\langle \sigma \sigma \epsilon \epsilon \rangle$  in the 2d Ising model. Use the degeneracy conditions on  $\sigma, \epsilon$  to write down differential equations for the Virasoro blocks. Solve the equations and fix the coefficients by considering OPE limits.
2. Download and install SDPB from <https://github.com/davidsd/sdpb>. Run the function `bootstrapBound2d` in the notebook `mathematica/Bootstrap2dExample.m` and produce a bound on the lowest-dimension scalar in the  $\phi \times \phi$  OPE in two dimensions.
3. Assume that  $\Delta_\phi = \frac{1}{8}$ . Compute an upper bound on the OPE coefficient of a scalar  $\mathcal{O} \in \phi \times \phi$  with dimension  $\Delta_0$ , as a function of  $\Delta_0$ . You may find it useful to modify the function `singletAllowed2d` to compute an upper bound on an OPE coefficient.