# EE 703: Digital Message Transmission (Autumn 2020) <br> Instructor: Saravanan Vijayakumaran <br> Indian Institute of Technology Bombay 

Assignment 5: 20 points

1. For the 16-QAM constellation shown below calculate $E_{b}$ in terms of $A$. Assume that the transmitted symbol is corrupted by adding $N=N_{c}+j N_{s}$ where $N_{c}$ and $N_{s}$ are independent zero-mean Gaussian random variables with variance $\frac{N_{0}}{2}$. If all the constellation points are equally likely to be transmitted, calculate the following in terms of $E_{b}$ and $N_{0}$.
(a) [5 points] The exact error probability of the optimal decision rule.
(b) [5 points] The union bound on the exact error probability.
(c) [5 points] The intelligent union bound on the exact error probability.
(d) [5 points] The nearest neighbor approximation of the exact error probability.

