1 Approximating $F + C^T(M+X)^{-1}C$

Using the result in [Elman,....] we approximate

$$A = F + C^T(M+X)^{-1}C \approx F + Q_s = B, \tag{1}$$

were Q_s is a scaled vector mass matrix. Solving the penalised eigenvalue problem

$$Bx = \lambda Ax,$$

produces the following eigenvalue plots.

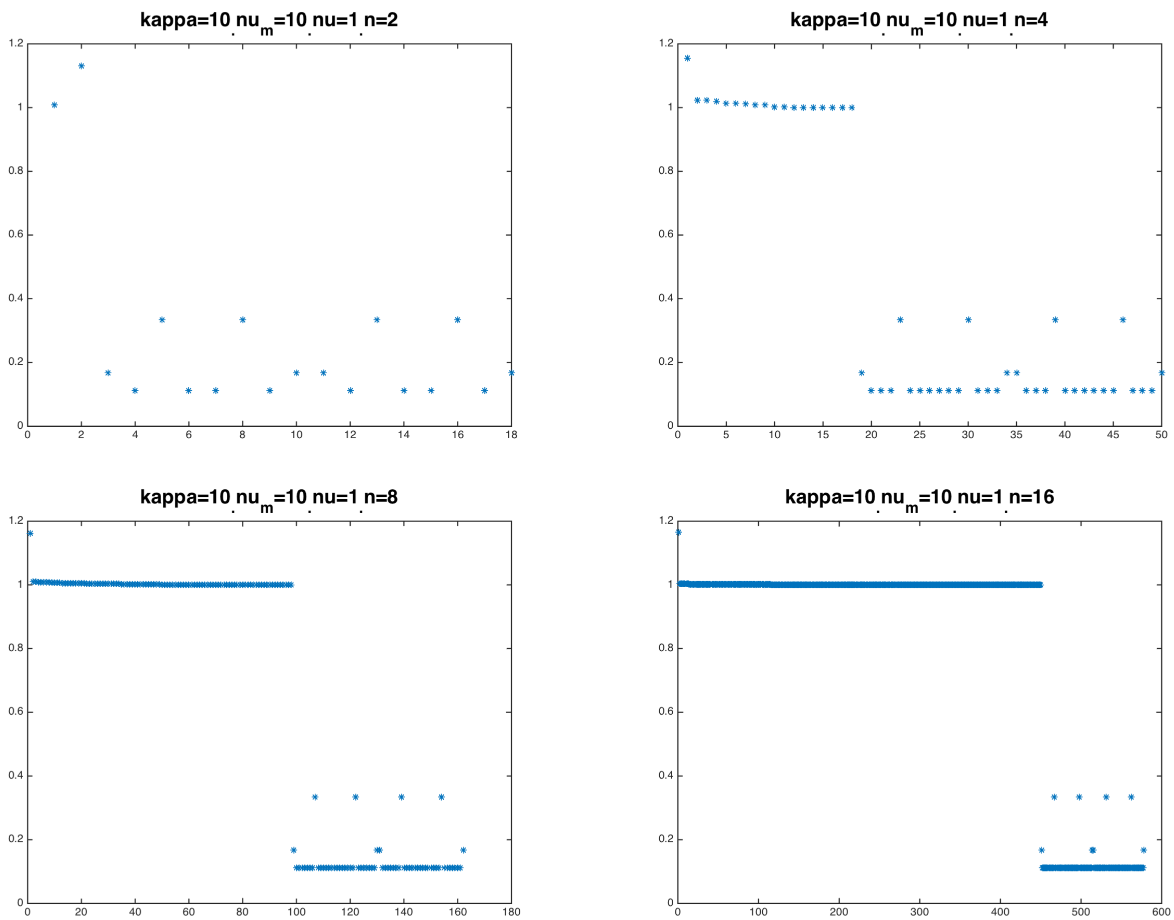

Figure 1: Eigenvalue plot for various values of n

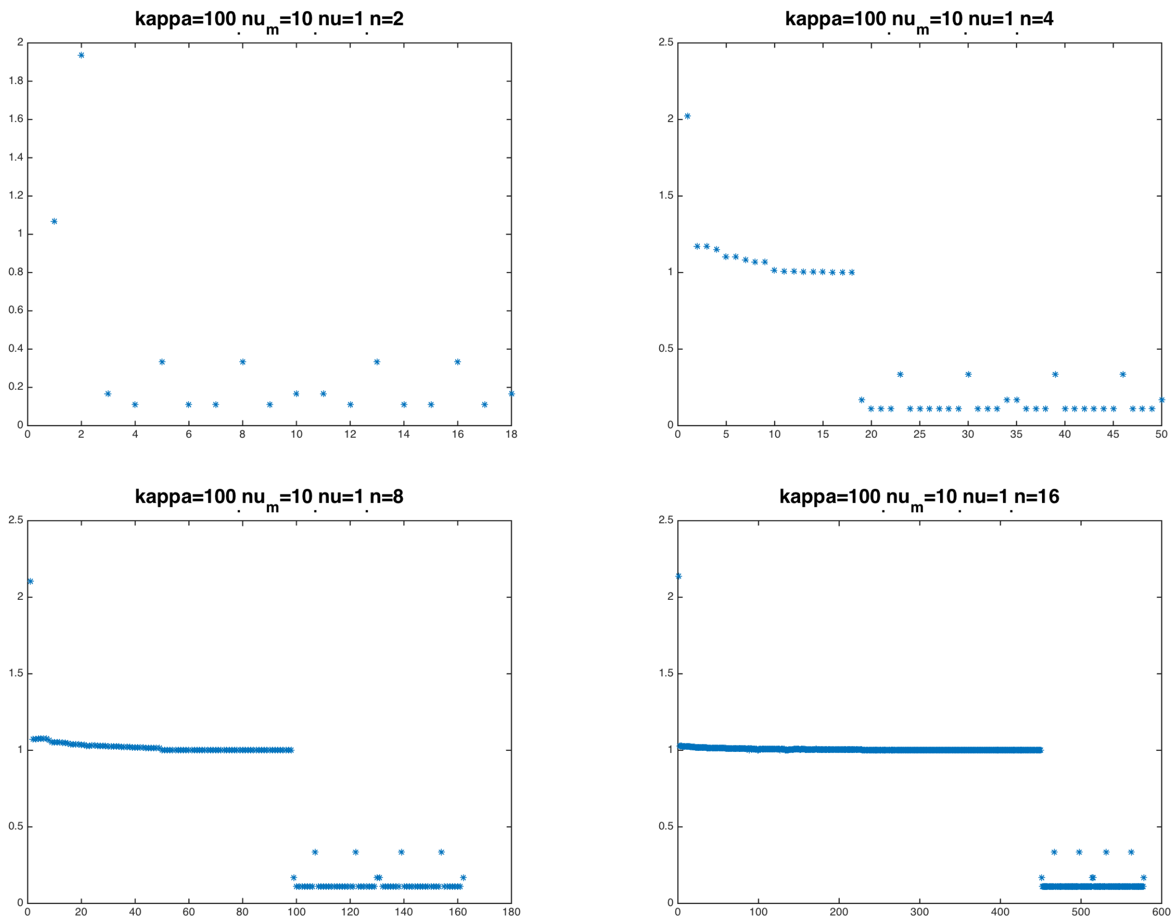

Figure 2: Eigenvalue plot for various values of n

2 Approximating $M + X + CF^{-1}C^T$

Using the result in [Elman,....] we approximate

$$A = M + X + CF^{-1}C^T \approx M + X + X_s = B, \tag{2}$$

were X_s is a scaled vector mass matrix. Solving the generalised eigenvalue problem

$$Bx = \lambda Ax,$$

produces the following eigenvalue plots.

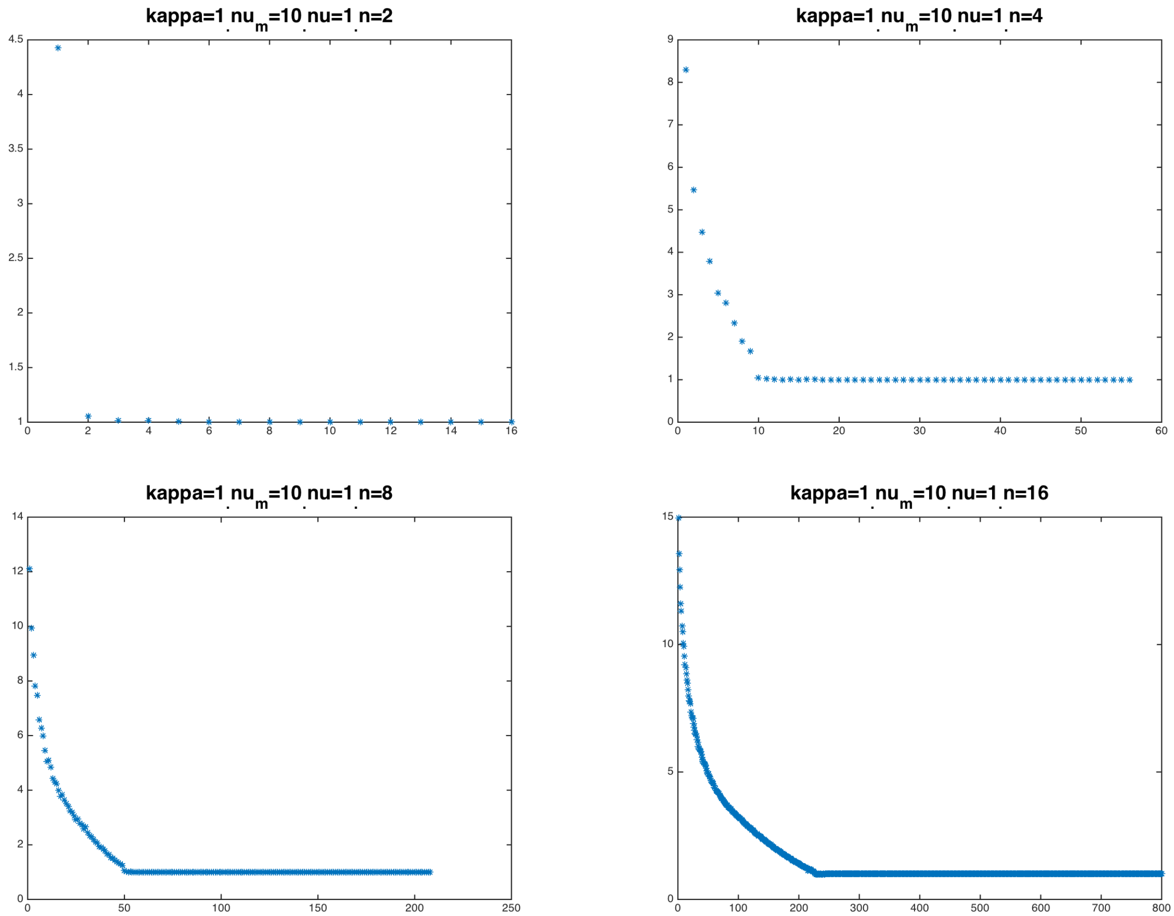

Figure 3: Eigenvalue plot for various values of n

3 Discussion

From the figures, we note that the eigenvalues computed when using the approximation given in (2) seem to spread out as the mesh size, n, gets bigger. However, for the approximation (1) the eigenvalues seem to be clustered nicely. There appears to be a single eigenvalue that is about 1.2 for $\kappa = 10$ and 2 for $\kappa = 100$ that is not clustered. This single eigenvalue does not, however, seem to increase dramatically as the mesh size increases.

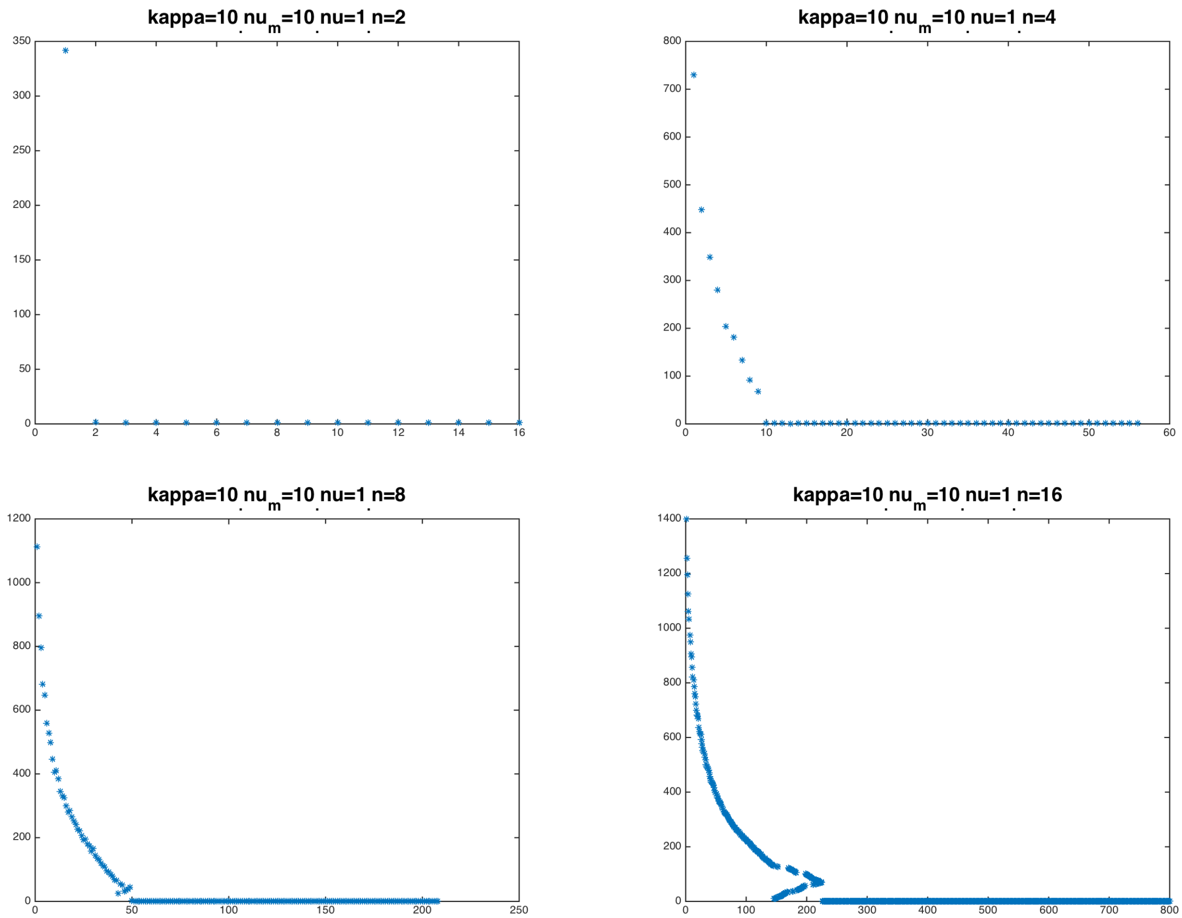

Figure 4: Eigenvalue plot for various values of n