Practical assignment 2. Matrix fundamentals: types and structures

1. Generate a random real matrix A and a random complex matrix B of size 4. For both matrices compute their transpose and complex conjugate transpose. What's the difference in Matlab commands?
2. Generate an identity matrix of size 4. Compute inverse of A (how many ways to compute it to you know?) Check that the product of A and its inverse is an identity matrix.
3. Generate a matrix C by setting one row or column of matrix A to zero. Compute the determinant and inverse of C. Is this matrix singular or nonsingular?
4. Compute characteristic polynomial of A as determinant (find the formula in the lectures) and find its roots. Do the same for the matrices B and C.

```
syms lambda %symbolic lambda
p=det(…)%compute characteristic polynomial as determinant, put the formula in
the brackets
p=vpa(p) %convert to double format
coef=sym2poly(p) %vector of polynomial coefficients
roots(coef) %compute roots of the polynomial
p2=charpoly(A) %check what this command does
```

5. Compute eigenvalues of the matrices A, B and C using `eig` command. Are they real or complex? How the eigenvalues are related to the roots of the characteristic polynomial? What can you say about matrix C?
6. Compute spectral radiuses for the matrices A, B and C.

Types of square matrices

7. Using matrix A, generate a symmetric matrix Asym by multiplying to its transpose. Check that the resulting matrix is symmetric.
8. Using matrix B, generate a Hermitian matrix Aherm by multiplying to its Hermintian transpose. Check that the resulting matrix Hermitian.
9. Check that the following matrices are normal:

$$A = \begin{pmatrix} i & i \\ i & -i \end{pmatrix} \quad B = \begin{pmatrix} 2 & -2 \\ 2 & 2 \end{pmatrix}$$

10. Check that the following matrix is unitary (two ways: by definition and using its inverse):

$$U = \frac{1}{3}\begin{pmatrix} 2 & -2+i \\ 2+i & 2 \end{pmatrix}$$

11. Using matrix A from task 1, generate
    a. Diagonal matrix
    b. Lower triangular matrix
    c. Upper triangular matrix
    d. Tridiagonal matrix
    e. Hessengber matrix