

Directions:

- This must be entirely your own work.
- Do not discuss this with any other person except me, Craig, or Nicole.
- Do not use any books, notes, internet sites, etc. except the following: Canonical Forms Notes on WebCT, your notes from lectures in class, and books on the reserve list for this course (QA162 D85 2004 Abstract algebra – Dummit, QA184 O48x 2005 Applied linear algebra – Olver, QA184.2 H36 2007 Handbook of linear algebra – Hogben, QA188 S4713 2002 Matrices: theory and applications – Serre, QA188 H66 1985 Matrix analysis – Horn, QA188 M495 2000 Matrix and analysis and applied linear algebra - Meyer QA188 Z47 1999 Matrix theory: basic results and techniques – Zhang).
- If you have trouble, ask one of us for help during office hours or by appointment (not Oct 20-22 for Leslie). Bring a printout of what you have.
- Do use software such as Mathematica or Sage, but do not use commands that produce Jordan or rational canonical form. For example, the following Mathematica commands may be useful: Eigensystem, Det, RowReduce, Solve, MatrixRank. The command JordanDecomposition can be used to check your answer to #1 but should not be included in your submitted answer.
- Use exact arithmetic, not decimal- rounding error can destroy canonical forms, as you will see if you try both `JordanDecomposition[A]` and `JordanDecomposition[N[A]]` in Mathematica (the latter converts A to a decimal matrix).
- You should organize your work neatly and clearly, showing all steps and including brief explanations, e.g., Step 1 of Algorithm 1 for eigenvalue λ .
- All matrices should be displayed nicely (as is done with `MatrixForm` by Mathematica).
- Proofread your work before submitting it (warning: using the wrong matrix that trivializes the problem will result in a score of 0).
- If you are using Mathematica, the final steps you should do before submitting your work are:
 - Save your solutions.
 - Shut down Mathematica.
 - Reopen your solution file and evaluate each cell in order, checking that it has not changed (when we read your answer we assume linear order).
 - (Fix if necessary.)
 - Print.
- Submit both a paper print-out and an electronic version (the latter by e-mail as an attachment to LHogben@iastate.edu).
- Your matrix A is individually assigned and is given on the one of the following pages in Mathematica input format – I recommend copying and pasting your matrix. (You can ignore the M number; it is record keeping device.) Work only on your own matrix. Possession of work on another student's matrix is academic misconduct.

Questions:

1. (30 points) Use Algorithm 3.1 in the Canonical Forms notes to find (possibly complex) matrices S, J such that S is nonsingular, J is a Jordan matrix, and $S^{-1}AS = J$.
2. Use the method in Section 5 of the Canonical Forms notes to find the Smith Normal Form of $xI - A$ and then exhibit the Rational Canonical Form- Invariant Factors matrix similar to A .

Matrices:

Berdnikov M1

$\{\{2, 8, 2, 1, -9, -2\}, \{2, -11, -2, -3, 10, -1\}, \{7, -15, -4, -6, 15, -4\}, \{7, -10, -2, -5, 10, -5\}, \{5, -15, -3, -5, 14, -3\}, \{4, 8, 2, 1, -9, -4\}\}$

De Silva M2

$\{\{-1, 7, 2, 2, -8, 0\}, \{23, -36, -8, -12, 37, -19\}, \{39, -83, -20, -26, 89, -32\}, \{5, 0, 0, -1, 0, -5\}, \{30, -48, -11, -16, 50, -25\}, \{-9, 33, 8, 10, -36, 6\}\}$

Ekstrand M3

$A = \{\{-6, 4, 2, 1, -5, 6\}, \{7, -7, -2, -3, 6, -6\}, \{0, -3, -2, -2, 3, 1\}, \{11, -6, -2, -5, 6, -9\}, \{12, -9, -3, -5, 8, -10\}, \{-4, 4, 2, 1, -5, 4\}\}$

Estervig M4

$A = \{\{18, -11, -4, -6, 12, -17\}, \{43, -20, -8, -12, 21, -39\}, \{134, -73, -32, -42, 83, -123\}, \{5, 0, 0, -1, 0, -5\}, \{58, -26, -11, -16, 28, -53\}, \{-6, 3, 2, 2, -4, 5\}\}$

Hay M5

$A = \{\{19, -6, -4, -7, 7, -14\}, \{36, -10, -8, -11, 14, -33\}, \{-21, 0, 2, 0, 0, 21\}, \{75, -20, -14, -18, 24, -69\}, \{72, -22, -15, -21, 28, -66\}, \{20, -6, -4, -7, 7, -15\}\}$

Jungjaturapit M6

$\{\{68, -19, -13, -18, 23, -61\}, \{40, -9, -8, -12, 13, -36\}, \{88, -26, -17, -26, 32, -81\}, \{80, -20, -15, -18, 25, -75\}, \{87, -23, -17, -24, 30, -80\}, \{52, -15, -10, -14, 18, -46\}\}$

Lagrange M7

$\{\{29, -17, -7, -11, 19, -22\}, \{24, -24, -11, -15, 30, -20\}, \{13, -24, -7, -14, 27, -9\}, \{62, -48, -20, -25, 54, -54\}, \{53, -51, -21, -29, 60, -45\}, \{30, -17, -7, -11, 19, -23\}\}$

Li M8

$\{\{36, -45, -13, -18, 49, -28\}, \{25, -34, -11, -16, 40, -20\}, \{76, -114, -31, -46, 125, -64\}, \{55, -70, -21, -25, 77, -48\}, \{55, -77, -23, -32, 87, -46\}, \{28, -35, -10, -14, 38, -21\}\}$

Liao M9

$\{\{-9, 0, 2, 1, -1, 10\}, \{11, -2, -2, -3, 2, -10\}, \{-14, 1, 1, 2, -1, 13\}, \{15, -2, -2, -4, 2, -13\}, \{18, -3, -3, -5, 3, -16\}, \{-8, 0, 2, 1, -1, 9\}\}$

Lois M10

{{23, -3, -4, -6, 4, -21}, {13, -1, -2, -4, 1, -11}, {85, -6, -16, -22, 11, -79}, {18, -1, -3, -4, 2, -17}, {30, -2, -5, -8, 3, -27}, {7, -2, -1, -2, 2, -6}}

Martinez M12

{{97, -53, -22, -30, 60, -88}, {103, -53, -23, -32, 61, -94}, {279, -150, -63, -86, 171, -257}, {67, -35, -15, -19, 40, -62}, {156, -82, -35, -48, 94, -143}, {57, -32, -13, -18, 36, -51}}

Nowak M13

{7, -18, -4, -7, 19, -4}, {7, -36, -8, -11, 38, -4}, {24, -93, -21, -30, 99, -15}, {25, -62, -14, -20, 66, -19}, {18, -67, -15, -21, 71, -12}, {10, -18, -4, -7, 19, -7}}

Osborne M14

{{18, -45, -10, -14, 48, -14}, {38, -87, -20, -28, 93, -30}, {91, -226, -52, -70, 243, -73}, {17, -39, -9, -12, 42, -14}, {54, -126, -29, -40, 135, -43}, {3, -6, -1, -2, 6, -2}}

Ponce M15

{{-8, 6, 2, 1, -7, 8}, {6, -9, -2, -3, 8, -5}, {3, -8, -3, -4, 8, -1}, {9, -8, -2, -5, 8, -7}, {10, -12, -3, -5, 11, -8}, {-6, 6, 2, 1, -7, 6}}

Ross M16

{{39, -35, -10, -14, 38, -36}, {39, -28, -8, -12, 29, -35}, {137, -114, -35, -46, 125, -125}, {5, 0, 0, -1, 0, -5}, {53, -37, -11, -16, 39, -48}, {17, -15, -4, -6, 16, -16}}

Sanyatit M11

{{25, -17, -7, -11, 19, -20}, {38, -26, -11, -15, 30, -34}, {17, -24, -9, -14, 27, -13}, {86, -48, -20, -27, 54, -78}, {79, -51, -21, -29, 58, -71}, {28, -17, -7, -11, 19, -23}}

Stuart M17

{{39, -24, -10, -15, 27, -30}, {39, -30, -14, -19, 38, -34}, {20, -31, -9, -18, 35, -15}, {95, -62, -26, -32, 70, -85}, {84, -65, -27, -37, 77, -74}, {40, -24, -10, -15, 27, -31}}

Troll M18

{{61, -39, -16, -22, 44, -51}, {47, -29, -14, -20, 37, -41}, {87, -66, -24, -38, 75, -77}, {98, -63, -27, -32, 72, -89}, {100, -68, -29, -40, 81, -89}, {49, -32, -13, -18, 36, -40}}