## Department of Engineering Science and Mathematics, LTU

# M0031M Linjär algebra och differentialekvationer <br> (Linear Algebra and Differential Equations)-Period 1, 2014 

Contact teacher: Norbert Euler, Examiner: Lech Maligranda

## 35 Lectures

## Literature:

1) D. C. Lay, Linear Algebra and its Applications, 4th Edition 2003
2) A. Dunkels at all, Derivator, integraler och sånt, Studentlitteratur 2000
3) N. Euler, Elementary Ordinary Differential Equations, Online Access will be provided.
4) A. Gilat, MATLAB: an Introduction with Applications, 4th Edition. 2008

## A. Complex Numbers (Dunkels)

$\begin{array}{lll}\text { L1. Definition of complex number and calculation rules (algebraic properties, } \\ \text { conjugate number, modulus=absolute value, triangle inequality) }\end{array} \quad 9.1-2$
L3. Algebraic equations (quadratic equations, polynomials and algebraic equations) 9.5-6
L4. Equation $z^{n}=w$ and function $e^{z}$ 9.7-8
L5. Reserve

## B. Linear Algebra (Lay)

L6. Vector spaces and subspaces 4.1
L7. Null spaces, column spaces, and linear transformations 4.2
L8. Linearly independent sets. Bases 4.3
L9. Coordinate system 4.4
L10. The dimension of a vector space. Rank 4.5-6
L11. Change of basis 4.7
L12. Eigenvectors and eigenvalues. The characteristic equation 5.1-2
L13. Diagonalization, eigenvectors and linear transformations 5.3-4
L14. Inner product, length. Orthogonality and orthogonal sets 6.1-2
L15. Orthogonal projections. The Gram-Schmidt process 6.3-4
L16. Least-squares problems 6.5-6
L17. Inner product spaces 6.7
L18. Diagonalization of symmetric matrices 7.1
L19. Reserve
L20. Reserve
L21. Reserve

## C. Differential Equations (Dunkels et al and Euler)

L22. Introduction to differential equations 10.1-5 (Dunkels et al)
L23. Solutions of linear equations and the Wronskian
L24. IVP, BVP and separable 1-st order differential equations
L25. Linear 1-st order differential equations
L26. Linearizable 1-st order differential equations
L27. Linear homogeneous 2-nd order differential equations
L28. Nonhomogeneous equations: undetermined coefficients
L29. Nonhomogeneous 2-nd order: undetermined coefficients
L30. Nonhomogeneous 2-nd order: variation of parameters
L31. The 2-nd order Cauchy-Euler equation
L32. Linear equations: nonconstant coefficients
L33. Higher-order equations: homogeneous
L34. Higher-order nonhomogeneous: undetermined coefficients
L35. Repetition
1.1-1.3 (Euler)
2.1-2.2 (Euler)
2.3 (Euler)
2.4 (Euler)
3.1-3.2 (Euler)
3.3.1 (Euler)
3.3.1 (Euler)
3.3.3 (Euler)
3.4 (Euler)
3.5 (Euler)
4.1- 4.2 (Euler)
4.3.1 (Euler)

| $===============$ | $===================$ |
| ---: | :--- |
| M | $=031 \mathrm{M}-$ Exercises |
| Complex Numbers (Dunkels et al) |  |

9.11.1: 9.1acg, 9.2b, 9.3a, 9.4, 9.6, 9.7, 9.9, 9.11, 9.13 (9.1bd, 9.2a, 9.3b, 9.4c, 9.8, 9.12)
9.11.2: $9.16 \mathrm{abe}, 9.17,9.18,9.20,9.21$ (9.16cf, 9.22)
9.11.3: 9.25a, 9.29, 9.30acef (9.25b, 9.26, 9.30dg)
9.11.4: $9.32 \mathrm{ac}, 9.33,9.34,9.35,9.36,9.37,9.39 \mathrm{acd}, 9.41,9.44 \mathrm{ac}, 9.45 \mathrm{ab}, 9.46,9.50$ (9.32b, 9.38, 9.39b, 9.42, 9.44b, 9.45c, 9.47, 9.48)

## Linear Algebra (Lay)

| 4.1: | $1,3,5,9,12,15,21$ ( $7,10,13,18,22)$ |
| :---: | :---: |
| 4.2: | $1,3,5,7,9,15,17,19,21,23,25,28,31,33(2,4,8,11,16,18,22,24,32)$ |
| 4.3: | $1,3,5,9,11,13,15,19,26,31,33$ (7, 16, 23, 25, 32, 34) |
| 4.4: | $1,3,5,9,10,11,13,17,21,27,32(4,7,12,14,22,31)$ |
| 4.5: | $1,3,7,11,13,15,21,23,27$ ( $5,9,16,19,22,25)$ |
| 4.6: | $1,4,5,7,8,9,25,28,29,32$ (3, 6, 11, 13, 17, 21, 27) |
| 4.7: | $1,3,5,7,13$ (2, 6, 8, 11, 14) |
| 5.1: | $1,3,5,7,10,13,17,19,25,26,31$ (4, 8, 14, 21, 23, 32) |
| 5.2: | $1,9,15,18,20,23,24(3,11,17,21)$ |
| 5.3: | $1,3,5,7,13,19,23,31(4,9,11,17,24,25,32)$ |
| 5.4: | $1,3,5,7,9,11,15,17,20,25,29(2,4,6,10,13,21,27)$ |
| 6.1: | $1,3,5,7,11,13,16,17,22,24,25,28,31$ (12, 14, 15, 23, 27, 29) |
| 6.2: | $1,5,7,9,11,13,15,17,21,26-30(3,10,12,14,16,20,32)$ |
| 6.3: | $1,3,7,9,11,13,15,17,19,24(2,5,10,12,14,18)$ |
| 6.4: | $3,4,6,11,22(2,9,16,17)$ |

```
6.5: }\quad3,5,9,13,15,19,20,25 (4, 6, 11, 14, 16, 24)
```

6.6: $\quad 1,3$
6.7: $\quad 1,3,5,9,12,14,18,21,23,25 \quad(2,4,6,13,17,22,24,26)$
7.1: $\quad 1-6,8,13,17,19,21,23,28,30(11,22,24)$

## Differential Equations (Euler)

1.1.1: $1 \mathrm{a}, \mathrm{b}, \mathrm{c}, \mathrm{d}, \mathrm{h}, \mathrm{i}, \mathrm{j} ; 2 ; 3 \mathrm{a}, \mathrm{c}, \mathrm{f}, \mathrm{h} ; 4 ; 5 \mathrm{a}, \mathrm{c}, \mathrm{f}$
1.2.1: $\quad 1 ; 2 ; 3 ; 4$ a, c, e; 5
2.2.1: 1 a, b, c, f, h, i; 2 a, c, e; $3 ; 4$
2.3.1: 1 a, c, d, g; 2 a, c; 3
2.4.4: $1 ; 2$ а, с, е; $3 ; 4 ; 5 ; 6 ; 7 ; 8$
3.2.1: 1 a, c, d, e, f; $2 \mathrm{a}, \mathrm{b}, \mathrm{c}, \mathrm{e} ; 3 ; 4$
3.3.2: 1 a, c, e, f, h, j, k, m, p, r; 2 a, c, f, h; 3 a, c, f, h; 4
3.3.4: 1 a, b, c, d, e, g; 2; 3; 4; 5; 7 a, c; 8 a, c
3.4.1: 1 a, c, d, e, g; 2; 3; 4; 5
3.5.1: $\quad 1$ a, b, d, f; 2; 3; 5
4.2.1: 1 a, b, d, f, h; 2 a, c, f, h; 3 a, d, f; $4 ; 5$
4.3.2: 1 a, d, e, h, l, o; 2 a, d, e; $3 ; 4$

## MATLAB Exercises

## Important Note:

Hand-in deadline for your MATLAB results: 17 October 2014!

## Exercises from Gilat, Edition 3:

1.10: $\quad 1,2,4,5,6,16$
2.11: $\quad 1,4,14$
3.9: $\quad 7,9,18$
6.13: $\quad 3$

## or

Exercises from Gilat, Edition 4:
1.10: $1,2,4,5,6,20$
2.11: $1,7,29$
3.9: $\quad 11,15,32$
7.13: 2

NOTE: For the Matlab exercises from Gilat, Edition 5, please see the next page!

Exercises from Gilat, Edition 5:
1.10: $\quad 1,2,4,5,6,20$
2.11: $\quad 1,7,33$
3.9: $\quad 11,15,33$
7.13: 1

