II Civil Engineering
NUMERICAL ANALYSIS
Academic year 2012-2013

Exam Questions – February 2013

Item No.	*Chapter [– Sub-Chapter]:* Topic[†]
1	*Object of Numerical Analysis:* Object. Problem conditioning; condition number; examples.
2	*Object of Numerical Analysis:* Algorithm stability. Conclusions on problem conditioning and algorithm stability. Example: Three-term recursion formula.
3	*Computer representation of numbers:* Integer representation. Formats; storage rule. - *Reals, floating-point representation*: Representation model. Representation in a binary computer.
4	*Computer representation of number - Reals, floating-point representation:* Format structure; IEEE Formats (754-85 Standard).
5	*Computer representation of numbers:* Fortran intrinsic functions returning format parameters (CVF).
6	*Computer representation of numbers – IEEE Formats:* Special values; denormalization. Representation range (reals).
7	*Computer representation of numbers:* 754-2008 Standard: Basic arithmetic formats; Representation; Set of representable data; Encodings (in a binary interchange formats).
8	*Computer representation of numbers – Rounding error measure:* ULP; Machine-ε; Unit rounding error.
9	*Errors, sources and propagation:* Error; Relative error. Significant digits; Correct representation with m significant digits.
10	*Errors, sources and propagation:* Error sources. Rounding error; Truncation case. Wilkinson form of the error. Examples for base $\beta = 2$.
11	*Errors, sources and propagation – Error propagation:* Propagated error. Multiplication; Division; Function evaluation.
12	*Errors, sources and propagation – Error propagation:* Loss of signification error. Addition and subtraction. Propagation of errors in a sum.
13	*Errors, sources and propagation – Error propagation:* Summation; Examples. Conclusions regarding the numbers used in computation, and the format needed for their representation.
14	*Nonlinear equations:* Method and method analysis. Order of convergence. Relation between absolute errors $\boldsymbol{e}_n$ and $\boldsymbol{e}_0$: case $p > 1$.
15	*Nonlinear equations – Order of convergence:* Relation between absolute errors $\boldsymbol{e}_n$ and $\boldsymbol{e}_0$: case $p = 1$. Linear convergence. Variant to convergence order; Assymptotic error constant.

Item No.	*Chapter [– Sub-Chapter]:* Topic[†]
16	*Roots of an equation f(x) = 0:* Bisection method. Secant method. Remarks on secant method.
17	*Roots of an equation f(x) = 0 – Newton method:* Method; Convergence. Error estimation. Comparison with Secant method.
18	*Fixed-Point method:* Method. Convergence: contractive mapping; Theorems 1 & 2; Case g = differentiable; case $\|g'(x)\|>1$.
19	*Fixed-Point method - Error propagation:* Isaacson & Keller Theorem (without proof). Conclusions; rational number of iterations.
20	*Fixed-Point method – Implementation:* Error evaluation. XTOL choice. Algorithm: the divergence test.
21	*Fixed-Point method:* Geometrical interpretation. The stationary process (graphical interpretation).
22	*Fixed-Point method:* The stationary process of period 2; stationary process in general.
23	*Fixed-Point method:* Explicit Fixed-point procedures. Case $\Phi(x) = m =$ constant. Higher order Fixed-point methods. Example: Newton method.
24	*Multiple roots:* Definition; Computing problems; Newton method; Modified Newton method. Determination of the multiplicity order.
25	*Root of a polynomial:* Polynomial evaluation; Deflation; Newton method for polynomials.
26	*Root of a polynomial:* Strategies & Algorithms: Deflation & root refinement; POL. Direct iteration in the original polynomial; Pol_Direct & Pol_Direct 2011.
27	*Root of a polynomial:* Complex roots (elements); Laguerre Method; IMSL implementation. Stability of the roots.
28	*Systems of non-linear equations:* Definitions. Vector norm. Matrix norm; Matrix norm induced by vector norm; spectral radius.
29	*Systems of non-linear equations:* Fixed-point method. Convergence: main theorem; jacobian. Second order convergence.
30	*Systems of non-linear equations:* Explicit fixed-point procedure; Iteration with constant matrix **A** (updated). Practical iteration scheme.
31	*Systems of non-linear equations:* Newton Method; Convergence; Practical iteration scheme. Newton-like methods.
32	*Linear systems of equations:* General considerations. Gauss elimination: method; multipliers and elimination; pivoting (notion). Triangular factorization of system matrix; determinant computation.
33	*Linear systems of equations – Gauss elimination:* Number of operations in Gauss elimination. Matrix inversion, number of operations; comparison with Gauss elimination.

Item No.	*Chapter [– Sub-Chapter]:* Topic†
34	*Linear systems of equations – Gauss elimination:* Pivoting in Gauss elimination: partial & complete pivoting. Solution steps by LU decomposition; Number of operations.
35	*Linear systems of equations:* Direct evaluation of LU factors; methods. The possibility of LU factorization.
36	*Linear systems of equations – Cholesky method:* Symmetric and positive definite matrices: definition, properties. Cholesky method; solution steps; number of operations; matrix storage. Factorization without square roots.
37	*Error analysis & Solution stability:* Perturbation in the RHS ***b***. Condition number; properties; matrix conditioning. $Cond(\mathbf{A})_{*}$; computation formula. Example of ill-conditioned matrices.

† *Chapter/Sub-chapter* and Topic refer to the content taught in Course lectures & Lab classes.

January 20, 2013

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