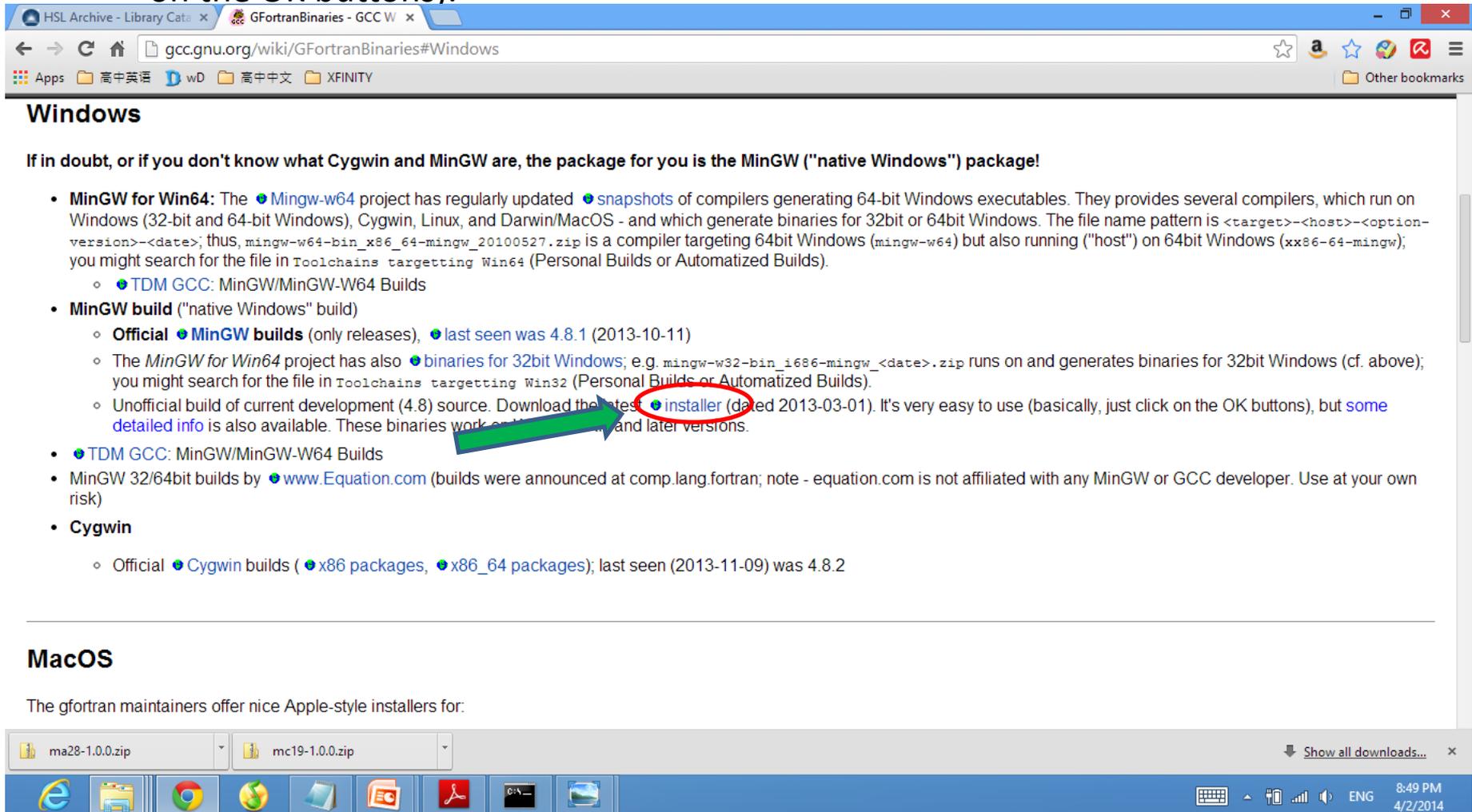


# A Step-by-Step Tutorial for making MA28.dll and running GEBT

- Step 1: Download and install gfortran compiler.
  - 1.1 Go to <http://gcc.gnu.org/wiki/GFortranBinaries#Windows> .
  - 1.2 Click on the “installer” (shown below) for Windows OS. Run the downloaded exe file, follow the instructions to install the gfortran compiler (basically just click on the OK buttons).



The screenshot shows a web browser window with the address bar displaying [gcc.gnu.org/wiki/GFortranBinaries#Windows](http://gcc.gnu.org/wiki/GFortranBinaries#Windows). The page content is titled "Windows" and includes the following text:

If in doubt, or if you don't know what Cygwin and MinGW are, the package for you is the MinGW ("native Windows") package!

- **MinGW for Win64:** The [Mingw-w64](#) project has regularly updated [snapshots](#) of compilers generating 64-bit Windows executables. They provides several compilers, which run on Windows (32-bit and 64-bit Windows), Cygwin, Linux, and Darwin/MacOS - and which generate binaries for 32bit or 64bit Windows. The file name pattern is `<target>-<host>-<option-version>-<date>`; thus, `mingw-w64-bin_x86_64-mingw_20100527.zip` is a compiler targeting 64bit Windows (`mingw-w64`) but also running ("host") on 64bit Windows (`xx86-64-mingw`); you might search for the file in `Toolchains` targeting Win64 (Personal Builds or Automatized Builds).
  - [TDM GCC: MinGW/MinGW-W64 Builds](#)
- **MinGW build** ("native Windows" build)
  - **Official** [MinGW builds](#) (only releases), [last seen was 4.8.1](#) (2013-10-11)
  - The *MinGW for Win64* project has also [binaries for 32bit Windows](#); e.g. `mingw-w32-bin_i686-mingw_<date>.zip` runs on and generates binaries for 32bit Windows (cf. above); you might search for the file in `Toolchains` targeting Win32 (Personal Builds or Automatized Builds).
  - Unofficial build of current development (4.8) source. Download the latest [installer](#) (dated 2013-03-01). It's very easy to use (basically, just click on the OK buttons), but [some detailed info](#) is also available. These binaries work on Windows XP and later versions.
- [TDM GCC: MinGW/MinGW-W64 Builds](#)
- MinGW 32/64bit builds by [www.Equation.com](#) (builds were announced at [comp.lang.fortran](#); note - equation.com is not affiliated with any MinGW or GCC developer. Use at your own risk)
- **Cygwin**
  - Official [Cygwin builds](#) ([x86 packages](#), [x86\\_64 packages](#)); last seen (2013-11-09) was 4.8.2

The "installer" link in the second bullet point is circled in red, and a green arrow points to it from the left.

Below the browser window, a Windows taskbar is visible with the Start button, several application icons (including Internet Explorer, File Explorer, Chrome, and a terminal window), and the system tray showing the date and time as 8:49 PM on 4/2/2014.

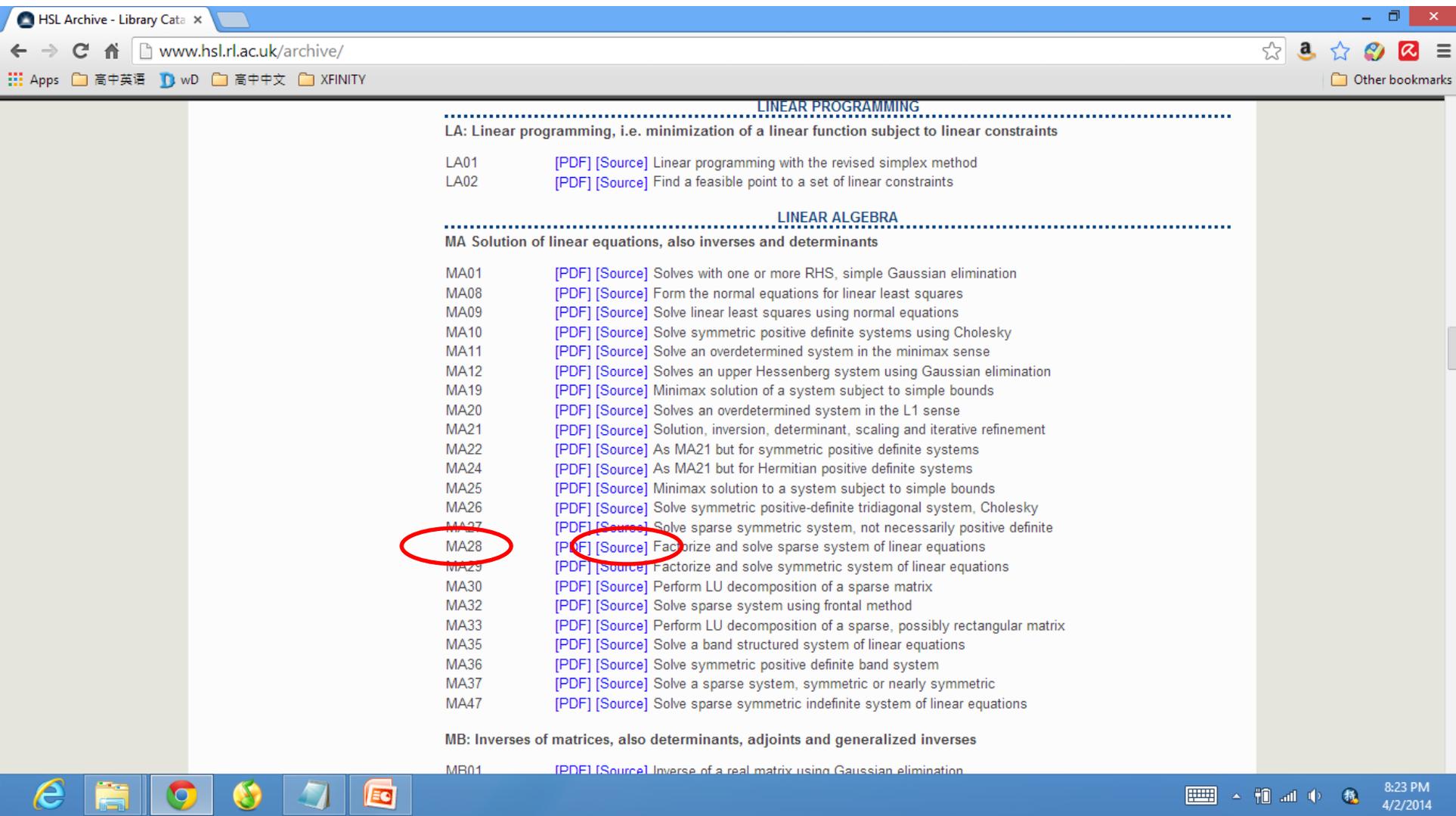
## Step 2: Download MA28 and MC19

- 2.1 Create a new folder “MA28” as working directory.
- 2.2 Go to: <http://www.hsl.rl.ac.uk/> .
  - 2.2.1 Click “HSL Archive” on the left column, see figure below.

The screenshot shows the HSL Mathematical Software Library website. The browser address bar displays [www.hsl.rl.ac.uk](http://www.hsl.rl.ac.uk/). The page header includes the Facilities Council logo and the text "Excellence with Impact - part of Research Councils UK". The main heading is "The HSL Mathematical Software Library". A search bar is located at the top of the main content area. The left sidebar contains a navigation menu with the following items: "STFC home", "HSL home", "HSL 2013", "HSL Archive" (highlighted with a red circle and a green arrow), "Academic access", "The Numerical Analysis Group", and "Contact us". The main content area features the text "Over 50 years of getting the right answer" and a paragraph describing the library's history and offerings. Below this, there is a section titled "New: HSL 2013 Released" with a list of major new packages: HSL\_MA97, HSL\_MC80, HSL\_MI28, and HSL\_MI29. The bottom of the page shows a Windows taskbar with the time 8:21 PM and date 4/2/2014.

## Step 2: Download MA28 and MC19 (continued)

- 2.2.2 Scroll down on the Archive page to “LINEAR ALGEBRA”.
- 2.2.3 Click on “Source” of MA28 and MC19, respectively.



The screenshot shows a web browser window with the address bar displaying [www.hsl.rl.ac.uk/archive/](http://www.hsl.rl.ac.uk/archive/). The page content is organized into sections:

- LINEAR PROGRAMMING**
  - LA: Linear programming, i.e. minimization of a linear function subject to linear constraints
  - LA01 [PDF] [Source] Linear programming with the revised simplex method
  - LA02 [PDF] [Source] Find a feasible point to a set of linear constraints
- LINEAR ALGEBRA**
  - MA Solution of linear equations, also inverses and determinants
  - MA01 [PDF] [Source] Solves with one or more RHS, simple Gaussian elimination
  - MA08 [PDF] [Source] Form the normal equations for linear least squares
  - MA09 [PDF] [Source] Solve linear least squares using normal equations
  - MA10 [PDF] [Source] Solve symmetric positive definite systems using Cholesky
  - MA11 [PDF] [Source] Solve an overdetermined system in the minimax sense
  - MA12 [PDF] [Source] Solves an upper Hessenberg system using Gaussian elimination
  - MA19 [PDF] [Source] Minimax solution of a system subject to simple bounds
  - MA20 [PDF] [Source] Solves an overdetermined system in the L1 sense
  - MA21 [PDF] [Source] Solution, inversion, determinant, scaling and iterative refinement
  - MA22 [PDF] [Source] As MA21 but for symmetric positive definite systems
  - MA24 [PDF] [Source] As MA21 but for Hermitian positive definite systems
  - MA25 [PDF] [Source] Minimax solution to a system subject to simple bounds
  - MA26 [PDF] [Source] Solve symmetric positive-definite tridiagonal system, Cholesky
  - MA27 [PDF] [Source] Solve sparse symmetric system, not necessarily positive definite
  - MA28 [PDF] [Source] Factorize and solve sparse system of linear equations**
  - MA29 [PDF] [Source] Factorize and solve symmetric system of linear equations
  - MA30 [PDF] [Source] Perform LU decomposition of a sparse matrix
  - MA32 [PDF] [Source] Solve sparse system using frontal method
  - MA33 [PDF] [Source] Perform LU decomposition of a sparse, possibly rectangular matrix
  - MA35 [PDF] [Source] Solve a band structured system of linear equations
  - MA36 [PDF] [Source] Solve symmetric positive definite band system
  - MA37 [PDF] [Source] Solve a sparse system, symmetric or nearly symmetric
  - MA47 [PDF] [Source] Solve sparse symmetric indefinite system of linear equations
- MB: Inverses of matrices, also determinants, adjoints and generalized inverses**
  - MB01 [PDF] [Source] Inverse of a real matrix using Gaussian elimination

The browser's taskbar at the bottom shows the time as 8:23 PM on 4/2/2014.

# Step 2: Download MA28 and MC19 (continued)

## – 2.2.4 Check “Personal License” .

The screenshot shows a web browser window with the URL [www.hsl.rl.ac.uk/download/MA28/1.0.0/a/](http://www.hsl.rl.ac.uk/download/MA28/1.0.0/a/). The page header features the Science & Technology Facilities Council logo and the text "Excellence with Impact - part of Research Councils UK". The main content area is titled "HSL package download request". Under the heading "I want a:", there are two radio button options: "Personal Licence (allows use without redistribution)" and "Incorporation Licence (allows redistribution as part of your software)". The "Personal Licence" option is selected and circled in red. Below this, it states "This method of obtaining HSL software is strictly intended for:" followed by a bulleted list: "Personal use." and "Without redistribution in source or binary form." A note says "If you do not meet these criteria and wish to discuss alternative licencing arrangements, or have any other questions, please contact [hsl@stfc.ac.uk](mailto:hsl@stfc.ac.uk)." The form is divided into sections: "The Software" (requesting MA28 v1.0.0), "The Agreement" (terms and conditions), and "HSL ARCHIVE LICENCE VERSION 1.0 MAY 2011". A link for "printer friendly version" is also present. The browser's taskbar at the bottom shows various application icons and the system clock indicating 8:24 PM on 4/2/2014.

**Science & Technology Facilities Council**  
Excellence with Impact - part of Research Councils UK

HSL Home : [Contact HSL](#)

### STFC home

The Science and Technology Facilities Council

### HSL home

About the HSL Mathematical Software Library

### HSL 2013

Our current release

### HSL Archive

Older packages at no cost

### Academic access

Free access for teaching and research

### The Numerical Analysis Group

The research group behind HSL

### Contact us

Our contact details

## HSL package download request

I want a:

- Personal Licence (allows use without redistribution)
- Incorporation Licence (allows redistribution as part of your software)

This method of obtaining HSL software is **strictly** intended for:

- Personal use.
- Without redistribution in source or binary form.

If you do not meet these criteria and wish to discuss alternative licencing arrangements, or have any other questions, please contact [hsl@stfc.ac.uk](mailto:hsl@stfc.ac.uk).

The Software

You are requesting to download the **all available precisions** variant of **MA28 v1.0.0**.

This package includes all HSL dependencies required to compile the software. However, for some packages you may additionally require your own BLAS and LAPACK libraries and/or the MeTiS graph partitioning package.

The Agreement

Please read the licence below, complete the registration information at the bottom, and accept the terms of the licence in order to download the software. IN THE FOLLOWING TERMS AND CONDITIONS YOU ARE REFERRED TO AS THE "LICENSEE".

### HSL ARCHIVE LICENCE VERSION 1.0 MAY 2011

[printer friendly version](#)

## Step 2: Download MA28 and MC19 (continued)

- 2.2.5 Fill in the information at the bottom of the webpage, click “Accept”.

accordingly the Contracts (Rights of Third parties) Act 1999 shall not apply to this Agreement.  
7.9 This agreement shall be interpreted and construed in accordance with the laws of England and Wales. The English Courts will have exclusive jurisdiction to deal with any dispute which has arisen or may arise out of or in connection with this Agreement, however STFC may enforce the Licensee's obligation of confidence in the courts of any jurisdiction having competence to issue an injunction directly enforceable against the Licensee.

Please fill in the following information completely. Your application may be rejected if you do not.

About you

Name

Email

Company

Domain

City

Country

About your application

Please give a short description of your intended application

Please tick this box if you are able to supply us with data for testing and improving HSL. We are particularly interested in large scale or numerically challenging problems.

By clicking "Accept" and downloading the software you are offering to enter into a legally binding agreement governed by the terms and conditions set out above. Your request will be automatically approved, and you will be sent a personalised download link to your given email address. It will be valid for 7 days. The sending of such a download link constitutes STFC's acceptance of your offer and creates a contract between you and STFC.

## Step 2: Download MA28 and MC19 (continued)

- 2.2.7 You will receive a personalised download link in the email you provided in the previous step in few minutes. Click the link to download the zip file to the working folder “..\MA28” created in the Step 2.1.
  - 2.2.8 Unzip these two files, you will have two folders, “mc19-1.0.0” and “ma28-1.0.0”.
  - 2.2.9 Copy “mc19d.f” from ..\MA28\mc19-1.0.0\src to ..\MA28 (the working folder), rename it as “mc19.f”.
  - 2.2.10 Copy “ma28d.f” from ..\MA28\ma28-1.0.0\src to ..\MA28 (the working folder), rename it as “ma28.f”.
  - 2.2.11 Copy “ddeps.f” from ..\MA28\mc19-1.0.0\src to ..\MA28 (the working folder), rename it as “ddep.f”.
  - 2.2.12 Copy “MakeMA28” from ..\GEBT4 (your download package from [analyswift.com](http://analyswift.com)) to ..\MA28 (the working folder).
- 2.3 Now you have all the files needed for compiling MA28.dll. The working folder “..\MA28” should look like this (see figure on the next slide):

## Step 2: Download MA28 and MC19 (continued)

- 2.3.1 Working directory “..\MA28”.

The screenshot shows a Windows File Explorer window titled "MA28". The address bar indicates the path: Computer > Windows (C:) > Qi\_Research > MA28. The window displays a list of files and folders with columns for Name, Date modified, Type, and Size. The file "ma28-1.0.0" is selected.

Name	Date modified	Type	Size
ma28-1.0.0	4/2/2014 8:35 PM	File folder	
mc19-1.0.0	4/2/2014 8:34 PM	File folder	
ddep.f	8/18/2011 2:37 AM	F File	94 KB
ma28.f	8/18/2011 2:37 AM	F File	41 KB
ma28-1.0.0	4/2/2014 8:35 PM	Compressed (zipp...	210 KB
MakeMA28	3/7/2011 12:01 PM	File	1 KB
mc19.f	8/18/2011 2:41 AM	F File	5 KB
mc19-1.0.0	4/2/2014 8:34 PM	Compressed (zipp...	103 KB
Tutorial	4/3/2014 12:02 AM	Microsoft Office P...	844 KB

9 items

12:03 AM  
4/3/2014

## Step 2: Download MA28 and MC19 (continued)

### – 2.3.2 Change variable type in mc19.f

Before compiling MA28.dll, some variables need to be modified in “mc19.f” from “REAL” to “DOUBLE PRECISION”. There are totally **four** changes needed

- Line 8 Change from “REAL” to “DOUBLE PRECISION”
- Line 18 Change from “REAL” to “DOUBLE PRECISION”
- Line 20 Change from “ALOG” to “LOG”
- Line 44 Change from “ALOG” to “LOG”, see Figure below (Change 4, Line 44, does not shown)

```
1 C COPYRIGHT (c) 1977 AEA Technology.
2 C#####DATE 09 MAR 1989
3 SUBROUTINE MC19AD(N,NA,A,IRN,ICN,R,C,W)
4 INTEGER N,NA,IRN(*),ICN(*)
5 DOUBLE PRECISION A(*)
6 C IRN(K) GIVES ROW NUMBER OF ELEMENT IN A(K).
7 C ICN(K) GIVES COL NUMBER OF ELEMENT IN A(K).
8 REAL R(N),
9 R(I) IS USED TO RETURN LOG(SCALING FACTOR FOR ROW I).
10 C(J) IS USED TO RETURN LOG(SCALING FACTOR FOR COL J).
11 C W(I,1), W(I,2) HOLD ROW, COL NON-ZERO COUNTS.
12 C W(J,3) HOLDS - COL J LOG DURING EXECUTION.
13 C W(J,4) HOLDS 2-ITERATION CHANGE IN W(J,3).
14 C W(I,5) IS USED TO SAVE AVERAGE ELEMENT LOG FOR ROW I.
15 INTEGER LP,IFAIL
16 COMMON/MC19BD/LP,IFAIL
17 INTEGER I,I1,I2,ITER,J,K,L,MAXIT
18 REAL E,E1,
19 EXTERNAL MC19SD
20 INTRINSIC ALOG,DABS,
21 DATA MAXIT/100/,SMIN/0.1/
22 C MAXIT IS THE MAXIMAL PERMITTED NUMBER OF ITERATIONS
23 C SMIN IS USED IN A CONVERGENCE TEST ON (RESIDUAL NORM)**2
24 C
25 C CHECK SCALAR DATA
26 IFAIL=1
27 IF(N.LT.1)GO TO 230
28 IFAIL=2
29 IFAIL=0
30 C
31 C INITIALISE FOR ACCUMULATION OF SUMS AND PRODUCTS
32 DO 5 I=1,N
33 C(I)=0.
34
```

Fortran source file

length: 4144 lines: 174

Ln: 7 Col: 36 Sel: 0|0

UNIX

ANSI as UTF-8

INS



## Step 3: Compile "MA28.dll"

- 3.1 Launch a command window in the working directory "..\MA28".
- 3.2 Type command "make -f MakeMA28" in the command line, click "enter".
- 3.3 A "MA28.dll" file will be generated in your working folder. Copy this "MA28.dll" to "..\GEBT4" folder.

The screenshot shows a web browser window with the URL [www.hsl.rl.ac.uk/archive/](http://www.hsl.rl.ac.uk/archive/). The page content includes a list of linear algebra topics and a table of resources. A command prompt window is overlaid on the page, showing the execution of the 'make' command to compile MA28.dll.

**Linear Algebra Topics:**

- simple Gaussian elimination
- linear least squares
- ng normal equations
- nite systems using Cholesky
- em in the minimax sense
- system using Gaussian elimination
- subject to simple bounds
- stem in the L1 sense
- nt, scaling and iterative refinement
- ositive definite systems
- sitive definite systems
- subject to simple bounds
- nite tridiagonal system, Cholesky
- em, not necessarily positive definite
- ystem of linear equations
- c system of linear equations
- a sparse matrix

**Table of Resources:**

Resource ID	Format	Source	Description
MA32	[PDF]	[Source]	Solve sparse system using frontal method
MA33	[PDF]	[Source]	Perform LU decomposition of a sparse, possibly rectangular matrix
MA35	[PDF]	[Source]	Solve a band structured system of linear equations
MA36	[PDF]	[Source]	Solve symmetric positive definite band system
MA37	[PDF]	[Source]	Solve a sparse system, symmetric or nearly symmetric
MA47	[PDF]	[Source]	Solve sparse symmetric indefinite system of linear equations
<b>MB: Inverses of matrices, also determinants, adjoints and generalized inverses</b>			
MB01	[PDF]	[Source]	Inverse of a real matrix using Gaussian elimination
MB04	[PDF]	[Source]	Given a matrix and its inverse, finds inverse of leading submatrix
MB05	[PDF]	[Source]	Given a matrix and inverse of its leading submatrix, finds its inverse
MB10	[PDF]	[Source]	Generalized inverse of a rectangular matrix

**Command Prompt Output:**

```
C:\Windows\System32\cmd.exe
Microsoft Windows [Version 6.2.9200]
(c) 2012 Microsoft Corporation. All rights reserved.

C:\Qi_Research\MA28>make -f MakeMA28
gfortran -O3 -c ddep.f
gfortran -O3 -c ma28.f
gfortran -O3 -c mc19.f
gfortran -O3 -shared ddep.o ma28.o mc19.o -o MA28.dll

C:\Qi_Research\MA28>
```

## Step 4: Running GEBT

- 4.1 The best way to run GEBT is in the command window. Launch a command window in the “..\GEBT4” folder.
- 4.2 Type “gebt ‘input\_file\_name.dat’” in the command line, then click “enter”. In this example, the input file is “Cantilever1.dat”, which is included in the download package.

The screenshot displays a Windows desktop environment. In the background, a web browser window is open to the HSL Archive website. In the foreground, a file explorer window shows the contents of the 'GEBT4' folder, including various DAT files, F90 files, and configuration files. Overlaid on the file explorer is a command prompt window titled 'C:\Windows\System32\cmd.exe'. The command prompt shows the execution of the 'gebt' command with 'Cantilever1.dat' as input. The output indicates that the beam analysis was completed successfully, with the results saved in 'Cantilever1.dat.out' and the program running for approximately 0.73 seconds.

```
C:\Windows\System32\cmd.exe
Microsoft Windows [Version 6.2.9200]
(c) 2012 Microsoft Corporation. All rights reserved.

C:\Qi_Research\GEBT4>gebt Cantilever1.dat
The inputs are echoed in Cantilever1.dat.ech

Finished reading inputs for the beam analysis.
ITERATION= 1
Finished the beam analysis.
The results can be found in Cantilever1.dat.out

Finished outputting results for the beam analysis.
GEBT finished successfully
Program runs 0.733862996 seconds
C:\Qi_Research\GEBT4>
```

Type	Size
AM DAT File	3 KB
AM DAT File	3 KB
PM DAT File	3 KB
PM DAT File	3 KB
PM F90 File	12 KB
0 PM F90 File	17 KB
PM DAT File	3 KB
PM Configuration sett...	48 KB
PM DAT File	2 KB
PM DAT File	3 KB
AM Configuration sett...	9 KB
PM Adobe Acrobat D...	37 KB
46 ... Application	111 KB
AM Microsoft Office P...	132 KB
2 PM Adobe Acrobat D...	263 KB
PM F90 File	25 KB
10/26/2011 6:06 PM F90 File	4 KB
7/19/2011 9:07 AM F90 File	23 KB
7/29/2010 6:56 PM DAT File	3 KB
2/10/2010 2:14 PM Configuration sett...	5 KB
7/29/2010 6:44 PM DAT File	8 KB

## Step 5: Running PostGEBT

- 5.1 Two new files, “Cantilever1.dat.ech” and “Cantilever1.dat.out” for this case, will be generated which showed the analysis information and results, respectively.
- 5.2 Now you can run PostGEBT to visualize the results.