The Finite Element Method

Div. of Solid Mechanics

Course program, vt2, 2013

Course description

The finite element method (FEM) is a numerical method able to solve arbitrary differential equations, i.e. boundary value problems. The method is today the most powerful numerical method within solid mechanics; this since arbitrary geometries and complex material models can be treated. Within the modern industry the finite element method is the key factor in many construction phases. Since the method is a solution method for any partial differential equations it can be used for any problem that is controlled by field equations, for instance heat conduction, diffusion, electromagnetism and solid mechanics.

The emphasis in the course in placed on the understanding of the fundamental principles of FEM and its numerical formulation. During the course the participants implement their own finite element program and thereby gain understanding of the method in detail.

Lectures:

Monday 13-15, MH:B, (18/3,15/4,29/4,6/5,13/5,20/5)
Tuesday 8-10, V:A, (9/4,7/5)
Wednesday 8-10, V:A, (20/3,17/4,24/4,15/5,22/5)
Thursday 8-10, E:A, (21/3,11/4,18/4)

Lectures: Mathias Wallin 
Div. of Solid Mechanics
Mathias.Wallin@solid.lth.se
Tel. 046-222 79 94

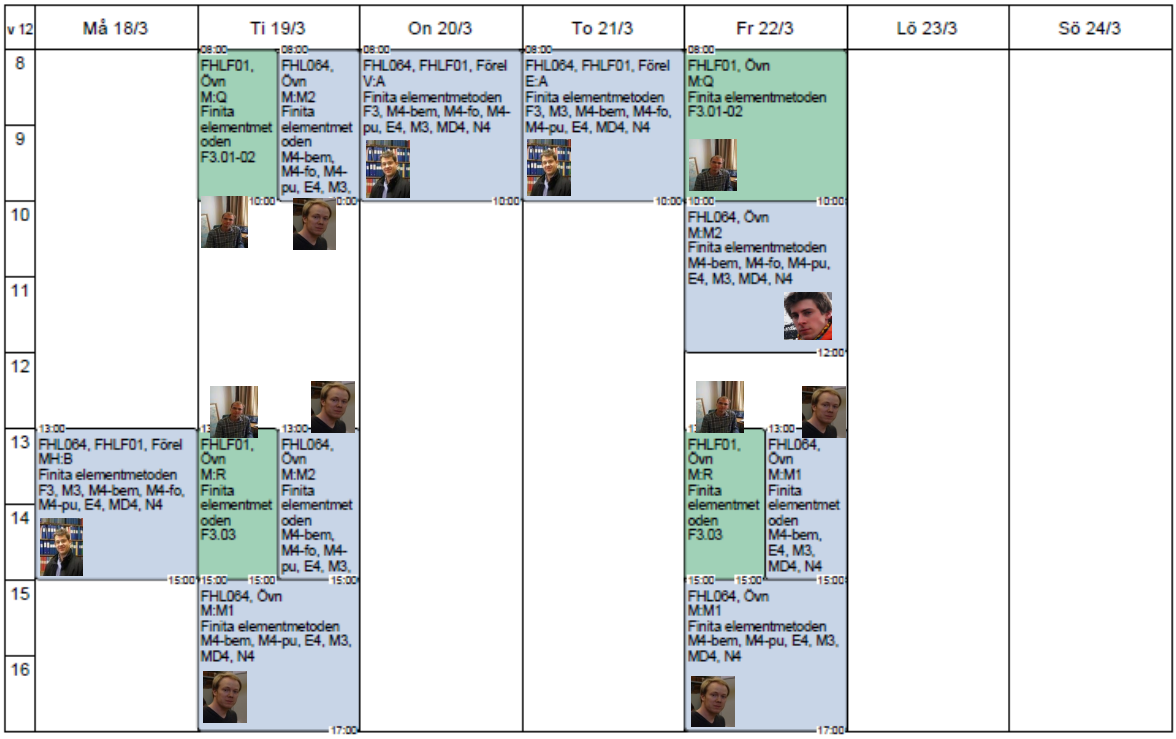
Problem sessions: Eric Borgqvist, Eric.Borgqvist@solid.lth.se 

Jonas Engqvist, Jonas.Engqvist@solid.lth.se 

Marcus Alexandersson 

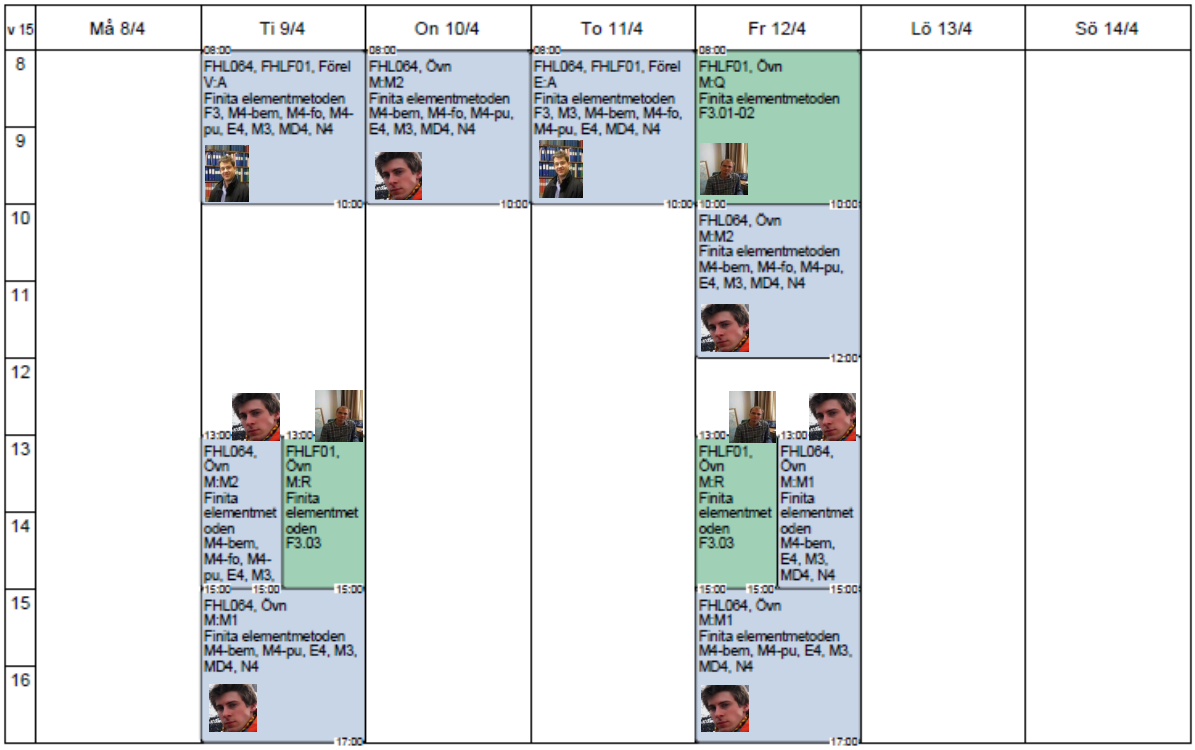
WEEK 1

FHLF01, FHL064



WEEK 2

FHLF01, FHL064



WEEK 3

FHLF01, FHL064

v 16	Må 15/4	Ti 16/4	On 17/4	To 18/4	Fr 19/4	Lö 20/4	Sö 21/4
8		08:00–10:00 FHLF01, Övn M:Q Finita elementmetoden F3.01-02 	08:00–10:00 FHL064, FHLF01, Förel V:A Finita elementmetoden F3, M4-bem, M4-fo, M4-pu, E4, M3, MD4, N4 	08:00–10:00 FHL064, FHLF01, Förel E:A Finita elementmetoden F3, M3, M4-bem, M4-fo, M4-pu, E4, MD4, N4 	08:00–10:00 FHLF01, Övn M:Q Finita elementmetoden F3.01-02 		
9							
10		08:00–10:00 FHL064, Övn M:M2 Finita elementmetoden M4-bem, M4-fo, M4-pu, E4, M3, 			10:00–12:00 FHL064, Övn M:M2 Finita elementmetoden M4-bem, M4-fo, M4-pu, E4, M3, MD4, N4 		
11							
12							
13	13:00–15:00 FHL064, FHLF01, Förel MH:B Finita elementmetoden F3, M3, M4-bem, M4-fo, M4-pu, E4, MD4, N4 	13:00–15:00 FHLF01, Övn M:L1 Finita elementmetoden F3.03 	13:00–15:00 FHL064, Övn M:M2 Finita elementmetoden M4-bem, M4-fo, M4-pu, E4, M3, 		13:00–15:00 FHLF01, Övn M:R Finita elementmetoden F3.03 	13:00–15:00 FHL064, Övn M:M1 Finita elementmetoden M4-bem, E4, M3, MD4, N4 		
14							
15		15:00–17:00 FHL064, Övn M:M1 Finita elementmetoden M4-bem, M4-pu, E4, M3, MD4, N4 			15:00–17:00 FHL064, Övn M:M1 Finita elementmetoden M4-bem, M4-pu, E4, M3, MD4, N4 		
16							

WEEK 4

v 17	Må 22/4	Ti 23/4	On 24/4	To 25/4	Fr 26/4	Lö 27/4	Sö 28/4
8		08:00–10:00 FHLF01, Övn M:Q Finita elementmetoden F3.01-02 	08:00–10:00 FHL064, FHLF01, Förel V:A Finita elementmetoden F3, M4-bem, M4-fo, M4-pu, E4, M3, MD4, N4 		08:00–10:00 FHLF01, Övn M:Q Finita elementmetoden F3.01-02 		
9							
10	10:00–12:00 FHL064, Övn M:M2 Finita elementmetoden M4-bem, M4-pu, E4, M3, MD4, N4 	08:00–10:00 FHL064, Övn M:M2 Finita elementmetoden M4-bem, M4-fo, M4-pu, E4, M3, 			10:00–12:00 FHL064, DatorÖvn M:Ida, M:Ina4 Finita elementmetoden M4-bem, M4-fo, M4-pu, E4, M3, MD4, N4 		
11							
12							
13		13:00–15:00 FHLF01, DatorÖvn M:Em1-5 Finita elementmetoden F3 	13:00–15:00 FHL064, Övn M:M2 Finita elementmetoden M4-bem, M4-fo, M4-pu, E4, M3, 		13:00–15:00 FHLF01, DatorÖvn M:Ida, M:Em4-5 Finita elementmetoden F3 	13:00–15:00 FHL064, Övn M:M1 Finita elementmetoden M4-bem, E4, M3, MD4, N4 		
14							
15		15:00–17:00 FHL064, Övn M:Em1-3 Finita elementmetoden M4-bem, M4-fo, M4-pu, E4, M3, MD4, N4 			15:00–17:00 FHL064, Övn M:M1 Finita elementmetoden M4-bem, M4-pu, E4, M3, MD4, N4 		
16							

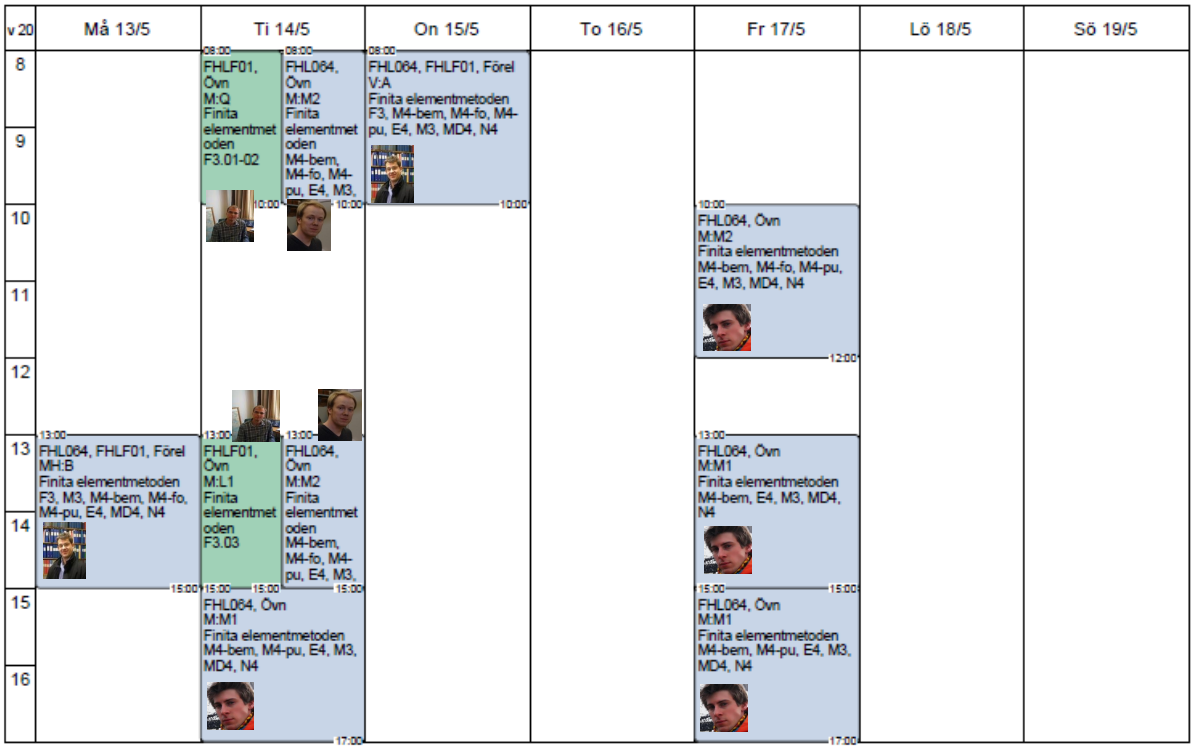
WEEK 5

v 18	Må 29/4	Ti 30/4	On 1/5	To 2/5	Fr 3/5	Lö 4/5	Sö 5/5
8							
9							
10					10:00 FHL064, Övn M:M2 Finita elementmetoden M4-bem, M4-fo, M4-pu, E4, M3, MD4, N4  12:00		
11							
12							
13	13:00 FHL064, FHLF01, Förel MH:B Finita elementmetoden F3, M3, M4-bem, M4-fo, M4-pu, E4, MD4, N4  15:00				13:00 FHL064, Övn M:M1 Finita elementmetoden M4-bem, E4, M3, MD4, N4  15:00		
14							
15					15:00 FHL064, Övn M:M1 Finita elementmetoden M4-bem, M4-pu, E4, M3, MD4, N4  17:00		
16							

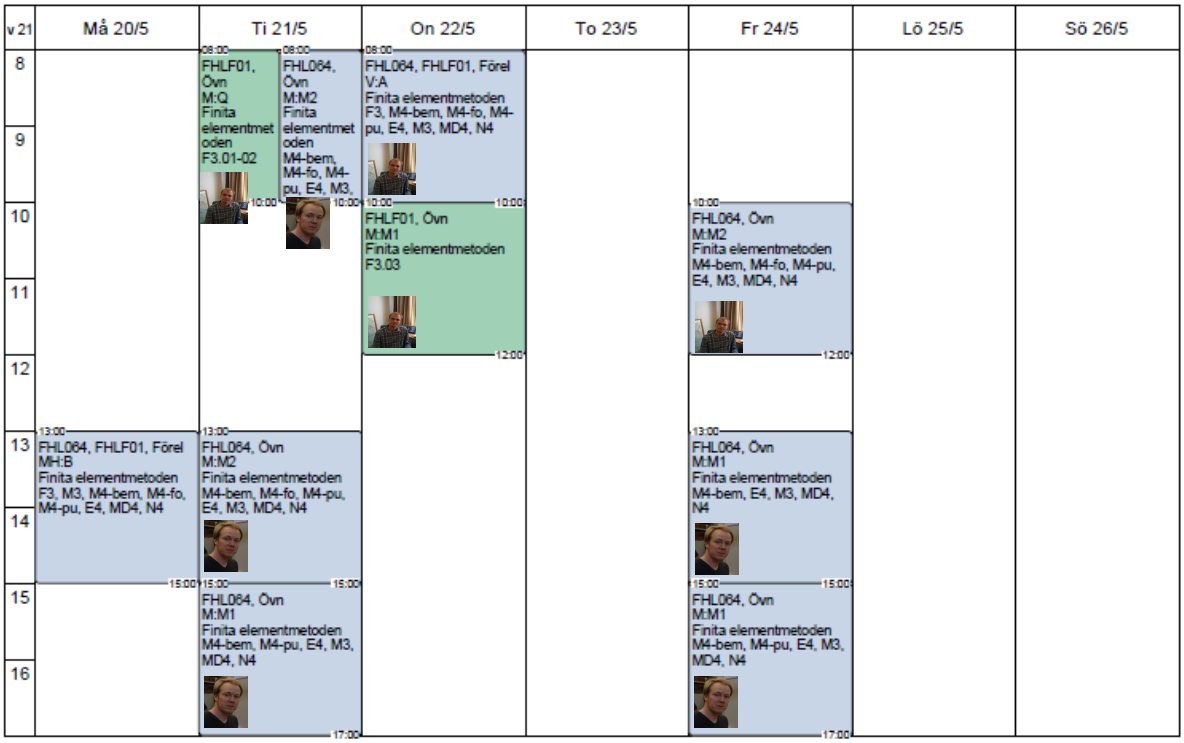
WEEK 6

v 19	Må 6/5	Ti 7/5	On 8/5	To 9/5	Fr 10/5	Lö 11/5	Sö 12/5
8		08:00 FHL064, FHLF01, Förel V:A Finita elementmetoden F3, M4-bem, M4-fo, M4-pu, E4, M3, MD4, N4  10:00	08:00 FHLF01, Övn M:X1b Finita elementmetoden F3.01-02  10:00	08:00 FHL064, Övn M:M2 Finita elementmetoden M4-bem, M4-fo, M4-pu, E4, M3,  10:00			
9							
10							
11							
12		 					
13	13:00 FHL064, FHLF01, Förel MH:B Finita elementmetoden F3, M3, M4-bem, M4-fo, M4-pu, E4, MD4, N4  15:00	13:00 FHLF01, Övn M:L1 Finita elementmetoden F3.03 15:00	13:00 FHL064, Övn M:M2 Finita elementmetoden M4-bem, M4-fo, M4-pu, E4, M3, 15:00				
14							
15		FHL064, Övn M:M1 Finita elementmetoden M4-bem, M4-pu, E4, M3, MD4, N4  17:00					
16							

WEEK7



WEEK 8



EXAM WEEK
Wed: 5/6: Vic: 1A-D, Vic 2A 14-19

Course literature

Ottosen, Niels Saabye and Petersson, Hans:
Introduction to the Finite Element Method, Prentice Hall.

Wallin, Mathias: **"Introduction to the Finite Element Method- Exercises"**, Solid Mechanics, 2012. The exercises can be downloaded from the course website.

The course book can be bought at KFS.

Additional notes on transient problems is available at the course home-page.

CALFEM-manual, computer program for learning the finite element method, Structural mechanics and Solid Mechanics, Lund 1999.

The Matlab-toolbox CALFEM can be downloaded from our homepage (www.solid.lth.se).

Assignment

The course includes a mandatory assignment. The assignment is performed in groups of two, or individually. **The assignment shall be handed in not later than May 27 at 16.00**. The assignment will be graded with up to 5 points which can be added to the points obtained at the exam June 5. Note that the bonus points is only valid at the exam June 5, 2013. A report that is handed in after May 27 will be given 0 points. The report must be approved not later than June 12.

Submission

You should submit your report in PDF format to FHLF01@solid.lth.se or FHL064@solid.lth.se. In addition to your report you should also attach your m-files in the email. Moreover, a paper version should also be handed in to the division of Solid Mechanics.

Examination

The examination of the course consists of a final examination and an assignment. The total points for passing the exam is 30. Total points is 60.

The exam takes place
June 5, 13-19, Vic1A-D, VIC 2A

Preliminary lecture schedule

Lecture 1	18/3	Introduction to FE-analysis, Chap. 1 and Chap. 2
Lecture 2	20/3	Chap. 3
Lecture 3	21/3	Chap. 4
Lecture 4	9/4	Chap. 5 **FHL064**
Lecture 5	11/4	Chap. 6, Chap 7 (1D)
Lecture 6	15/4	Chap. 7 (3D), Chap 8
Lecture 7	17/4	Chap. 9
Lecture 8	18/4	Chap. 10 + Transient heat flow, Chap 11
Lecture 9	24/4	Chap. 12, Chap. 13
Lecture 10	29/4	Chap. 15 and 16
Lecture 11	6/5	Chap. 19
Lecture 12	7/5	Chap. 20
Lecture 13	13/5	Variational principles. **FHLF01**
Lecture 14	15/5	Chap. 17. **FHL064**
Lecture 15	20/5	Guest lecture. Jan Granlund
Lecture 16	22/5	Reserv

Exercises

Exercise 1	Chap. 2
Exercise 2	Chap. 3
Exercise 3	Chap. 4.
Exercise 4	Chap. 5, Chap. 6
Exercise 5	Chap. 7, Chap. 8
Exercise 6	Chap. 9 (not 9.4 and 9.5)
Exercise 7	Chap. 10
Exercise 8	9.4, 9.5 and Chap. 11
Exercise 9	Chap. 12, Chap. 13
Exercise 10	Chap. 15, Chap. 16
Exercise 11	Chap. 19
Exercise 12	Chap. 20
Exercise 13	Chap. 17 / Variational principles.
Exercise 14	Consultation