AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: Finite Elements

Academic year: 2016/2017 Code: ZZP-2-409-ZF-s ECTS credits: 5

Faculty of: Management

Field of study: Management Specialty: Financial Management

Study level: Second-cycle studies Form and type of study: Full-time studies

Lecture language: English Profile of education: Academic (A) Semester: 4

Course homepage: —

Responsible teacher: prof. dr hab. Błachut Jan (jblachut@zarz.agh.edu.pl)

Academic teachers: prof. dr hab. Błachut Jan (jblachut@zarz.agh.edu.pl)

Module summary

The module provides exposure to rapidly grown numerical tool (Finite Elements, FE) right across engineering fields. The FE is in use by small and large companies.

Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Skills			
M_U001	Knows pracrical applications, limitations, benefits and comparisons with current/Rother implementations and methodologies	ZP2A_U01	Test
Knowledge			
M_W001	Descriptions of Finite Element Technology	ZP2A_W01	Test
M_W002	Fundamental definitions regarding the FE modelisation, interpretation of results	ZP2A_W02	Test
M_W003	Description of theory behind typical implementation of the FE	ZP2A_W03	Test

FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Others	E-learning
Skills												
M_U001	Knows pracrical applications, limitations, benefits and comparisons with current/Rother implementations and methodologies	-	+	-	-	-	-	-	-	-	-	-
Knowledge												
M_W001	Descriptions of Finite Element Technology	+	-	-	-	-	-	-	-	-	-	-
M_W002	Fundamental definitions regarding the FE modelisation, interpretation of results	+	-	-	-	-	-	-	-	-	-	-
M_W003	Description of theory behind typical implementation of the FE	+	-	-	-	-	-	-	-	-	-	-

Module content

Lectures

1.Introduction. What is FEM? Stiffness matrix concepts, Examples of applications. 1 – D Rod Element: Derivation of FE equations using equilibrium and virtual work principles. Assembly of Elements: Global stiffness matrix, Example of application.
2Application of 1-D elements. Stress Analysis of a Tapered Rod: Stress distribution, Average nodal stress, Stress at Gauss points. Pin-jointed Frames: Transformation matrices, Local to global transformation of the FE stiffness matrices.
3.Finite Element Approximations. Shape functions, C0 and C 1 continuity elements, Shape functions of 2- and 3-D finite elements. Beam Elements: Stiffness matrix, Limitation of stress analysis by beam FEs. Examples of application.
4.Strain and Stress Tensor Components. Constitutive Equations: Material models, Strength of material, Failure criteria. 2-D Plane Stress and Strain Plate Elements: Stiffness matrix of 4-noded quadrilateral elements, Edge loads, and Examples of applications.
5.Geometric Non-linearity and Buckling of Structures. Beams, pin-jointed bars, eigenvalues, procedures for modelling and analysis.
6.Elasto-plastic analysis. Material nonlinearity, plastic limit design, strain hardening, implementation of the non-linear elasto-plastic analysis by FEM, non-linear load-deflection curve, examples.

Auditorium classes

1.Modern Finite Element technology, principles, capabilities and limitations

2.Mathematics and physics behind the FE
3.Approximation concepts. shape functions
4.Stiffness, strain, stress, and deflections
5.Non-linearities: geometrical and material

Method of calculating the final grade

Passing the module will be based on:
1. Written paper (80%): (a) multi-choice part, (b) descriptive part, © solving a typical FE problem
2. Class activities: FE jargon – tested, problem solving (20%) – during semester

Prerequisites and additional requirements

Prerequisites and additional requirements not specified

Recommended literature and teaching resources

T.R. Chandrupatha, A.D. Belegundu, “Introduction to Finite Elements”, Prentice Hall, 4th Edition, 2010.

Scientific publications of module course instructors related to the topic of the module

1. L. Dong, J. Błachut, “Analysis and collapse of thick composite torispheres”, Proc. Inst. Mech. Engrs., Part E, Vol. 212, 1998, 103-117.
2. J. Błachut, “Modelling and analysis of multi-ply torispheres from draped carbon fabric”, Computers and Struct., Vol. 76, 2000, 1-9.
3 J. Błachut, “Experimental perspective on the buckling of pressure vessel components”, Applied Mechanics Reviews, Transactions of The ASME, Vol. 66, 010803-1 010803-24, 2014.
4. J. Blachut, “Buckling of Sharp Knuckle Torispheres UnderExternal Pressure”, Thin-Walled Structures Vol. 30, Nos 1–4, pp. 55–77, 1998
5. J. Blachut, I.B. Iflefel, “Experimental and Numerical Investigation of Plain and Gouged Dents in Steel Pipes Subjected to Pressure and Moment Loading”, Journal of Pressure Vessel Technology, Trans of the ASME, MAY 2008, Vol. 130 / 021203-1.

Additional information

1.Apart from one written paper there will be two additional dates, within the semester, for those who failed the written paper. The maximum mark of 80% will apply to all three attempts.
2.All students can sit the paper irrespective of tutorial attendance.
3.Marks will be allocated for each student and for every tutorial class.
4.Incidental absence from tutorial will result: (i) if excused – average mark from the remaining weeks will be entered, and (ii) if not excused – a zero mark for absent tutorial session is to be entered.
5.It is up to individual students to catch up with the material missed due to absence. Lecture and tutorial material is to be available to all students.
6.In all other situations, not mentioned above, the University Good Practice will be applied.
7.Presence at the lectures is not compulsory but it is highly recommended.

Student workload (ECTS credits balance)

Student activity form	Student workload
Participation in lectures	28 h
Participation in auditorium classes	28 h
Preparation of a report, presentation, written work, etc.	14 h
Contact hours	2 h
Preparation for classes	52 h
Examination or Final test	1 h
Summary student workload	125 h
Module ECTS credits	5 ECTS