RHEOLOGICAL PROPERTIES OF CEMENTED SYSTEMS

1	Course Title:	RHEOLOGICAL PROPERTIES OF CEMENTED SYSTEMS	
2	Course Code:	INS6041	
3	Type of Course:	Optional	
4	Level of Course:	Third Cycle	
5	Year of Study:	1	
6	Semester:	1	
7	ECTS Credits Allocated:	6.00	
8	Theoretical (hour/week):	3.00	
9	Practice (hour/week):	0.00	
10	Laboratory (hour/week):	0	
11	Prerequisites:		
12	Language:	Turkish	
13	Mode of Delivery:	Face to face	
14	Course Coordinator:	Prof. Dr. ALİ MARDANİ	
15	Course Lecturers:		
16	Contact information of the Course Coordinator:	ali.mardani16@gmail.com alimardani@uludag.edu.tr	
17	Website:		
18	Objective of the Course:	The aim of this course is to introduce the rheological properties of building materials to civil engineers. The effect of the choice of components of cementitious systems on rheological behavior will be examined. In addition, within the scope of this course, students will be given the ability to solve the placement problems that may be encountered in the construction site related to fresh concrete. It is aimed that students will perform small-scale laboratory experiments with the help of a rheometer developed for cement-based materials and gain experience by preparing reports with their findings.	
19	Contribution of the Course to Professional Development:	1 To be able to distinguish the basic concepts related to the rheological behavior of cement based materials. 2 To be able to do some experiments used to determine the rheological properties of cement based materials. 3 Making judgments about the flow behavior using rheological parameters of building materials 4 To summarize the factors affecting the rheological behavior. 5 To formulate mathematical models suitable for rheological behavior. 6 To be able to discuss the effects of chemical additives on fresh concrete properties according to their types.	
20	Learning Outcomes:		
		1	To be able to distinguish the basic concepts related to the rheological behavior of cement based materials.
		2	To be able to do some experiments used to determine the rheological properties of cement based materials.
		3	Making judgments about the flow behavior using rheological parameters of building materials
		4	To summarize the factors affecting the rheological behavior.
		5	To formulate mathematical models suitable for rheological behavior.

	6	To be able to discuss the effects of chemical additives on fresh concrete properties according to their types.
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21	Course Content:
	Course Content:

Week	Theoretical	Practice
1	Introduction to fresh state rheology 1.1. Preliminary information 1.2. Rheology of liquids (Basic terms) 1.3. Fresh state behavior of cement based materials 1.4. Machinability terms for cement based composites 1.5. Historical development of rheological measurement and modeling methods	
2	Basic properties of fresh concrete 2.1. Machinability 2.1.1. Definition 2.1.2. The concept of sufficient machinability 2.1.3. Factors affecting workability 2.1.4. Machinability tests	
3	Workability measurement methods 3.1. Direct measurement methods 3.1.1. General properties of rheometers 3.1.2. Rheometer types 3.1.3. Advantages and disadvantages	
4	properties can be associated Working principles and types of rheometers Rheometers suitable for cement paste tests 4.1.2. Rheometers suitable for cement mortar 4.3. Extrusion and capillary rheometers	
5	Usability of rheometers in cement based materials 5.2. Measuring limits of the	
6	Factors affecting rheological parameters Temperature 6.1.2. Ambient humidity 6.2. Experimental effects 6.2.1. Mixer type and mix history (slip history) before test 6.2.3. Mixing time 6.2.4. The geometry of the rheometer and the method used in the measurement	
7	Factors affecting rheological parameters (continued) 7.1. The effects of its components on the rheological behavior 7.1.1. Cement and mineral additives 7.1.2. Aggregate 7.1.3. W / O ratio 7.1.4. Superplasticizers 7.1.5. Fibers 7.1.6. Other contributions	
8	Midterm	

Activites	Number	Duration (hour)	Total Work Load (hour)
Theoretical	14	3.00	42.00
Practicals/Labs	0	0.00	0.00
Self study and preperation	14	8.00	112.00
Homeworks	1	20.00	20.00
Projects	0	0.00	0.00
Field Studies	0	0.00	0.00
Midterm exams	1	2.00	2.00
Others	0	0.00	0.00
Final Exams	1	2.00	2.00
Total Work Load			178.00
Total work load/ 30 hr			5.93
ECTS Credit of the Course			6.00

9	The effects of cement and mineral additives on rheological parameters (2.Lab. Study) 9.1. Effect of cement type and amount 9.2. Effect of type and amount of mineral additives 9.2.1. Fly ash 9.2.2. Silica fume 9.2.3. ÖYFC 9.2.4. Limestone powder 9.2.5. Other mineral additives	
10	The effects of chemical additives and fibers on rheological properties (3.Lab. Study) 10.1. Lignin based superplasticizers 10.2. Naphthalene and melamine formaldehyde based superplasticizers 10.3. Polycarboxylate based superplasticizers 10.4. Air-entraining additives 10.5. Set adjusting additives 10.6. The effects of fibers on rheological properties 10.7. Limits regarding fiber type	
11	Basic parameters derived from rheological measurements 11.1. Flow curves 11.2. Threshold shear stress, instantaneous viscosity and plastic viscosity 11.3. Deformation softening behavior and pseudoplasticity 11.4. Deformation hardening and dilatant behavior	
12	Commonly used rheological models 12.1. Bingham and Herschel Bulkley models 12.2. Other models; 12.2.1. Cement paste 12.2.2. Mortar 12.2.3. Concrete 12.3. Comparison of parameters obtained from rheological models	
13	Models developed for special conditions 13.1. Pumping 13.2. Spraying 13.3. Mold surface fresh concrete interaction 13.4. Vibration compression	
14	Time dependent change of rheological properties in cement based materials 14.1. Thixotropic and reopectic behavior 14.2. Factors affecting thixotropy 14.3. Methods of thixotropy measurement 14.3.1. Hysteresis fields and measurement methods 14.3.2. Delayed viscosity and threshold shear stress measurements	

22	Textbooks, References and/or Other Materials:	-Banfill, P.F.G. (editor) The rheology of fresh cement and concrete, Liverpool, (1990), 373p. - Tattersall, G.H., Banfill, P.F.G. The rheology of fresh concrete, Pitman, (1983), 356pp. - Bartos, P.J.M, Marrs, D.L., Cleland, D.J. (editors) Production methods and workability of concrete, Spon, (1996), 541pp. - Barnes, H.A., Hutton, J.F., Walters, K. An introduction to rheology, Elsevier, (1989), 199pp. - Barnes, H.A. A handbook of elementary rheology, Institute of Non Newtonian Fluid Mechanics, University of Wales, (2000), 200pp.
23	Assesment	

TERM LEARNING ACTIVITIES	**NUMBER**	**WEIGHT**
Midterm Exam	1	20.00
Quiz	0	0.00
Home work-project	1	20.00
Final Exam	1	60.00
Total	3	100.00

Contribution of Term (Year) Learning Activities to Success Grade	40.00
Contribution of Final Exam to Success Grade	60.00
Total	100.00
Measurement and Evaluation Techniques Used in the Course	Measurement and evaluation are performed according to the Rules & Regulations of Bursa Uludağ University on Undergraduate Education.

24 ECTS / WORK LOAD TABLE

25 CONTRIBUTION OF LEARNING OUTCOMES TO PROGRAMME QUALIFICATIONS

	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6	PQ7	PQ8	PQ9	PQ10	PQ11	PQ12	PQ13	PQ14	PQ15	PQ16
ÖK1	5	0	4	0	0	4	0	0	0	0	0	0	0	0	0	0
ÖK2	5	0	0	3	0	4	0	0	0	0	0	0	0	0	0	0
ÖK3	5	0	4	0	3	0	0	0	0	0	0	0	0	0	0	0
ÖK4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ÖK5	0	0	0	0	0	0	5	5	0	4	0	0	0	0	0	0
ÖK6	0	0	0	0	0	0	4	5	0	4	0	0	0	0	0	0

LO: Learning Objectives PQ: Program Qualifications

Contribution Level:	1 very low	2 low	3 Medium	4 High	5 Very High