الجمهورية الجزائرية الديمقراطية الشعبية People's Democratic Republic of Algeria
وزارة التعليم العالي والبحث العلمي
Ministry of Higher Education and Scientific Research
اللجنة البيداغوجية الوطنية لميدان العلوم و التكنولوجيا
National Educational Committee for the field of Science and Technology

ACADEMIC MASTER HARMONIZE

National program

2022 update

Domain	Sector	Speciality
Science And Technologies	***Civil Engineering***	***Geotechnical***

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National Educational Committee for the field of Science and Technology

مواءمة
ماستر أكاديمي

تحيين 2022

الميدان	الفرع	التخصص
علوم و تكنولوجيا	هندسة مدنية	جيوتقني

I–Master's identity sheet

Access conditions

Sector	Harmonized Master	Access licenses to the master's degree	Ranking according to license compatibility	Coefficient assigned to the license
Civil engineering	Geotechnical	Civil engineering	**1**	**1.00**
		Hydraulic	**1**	**1.00**
		Public works	**1**	**1.00**
		Mining	**3**	**0.70**
		Other licenses in the ST domain	**5**	**0.60**

II – Half-yearly teaching organization sheets of the specialty

Semester 1 Master: Geotechnics

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**T.D.**	**TP**			**Continuous monitoring**	**Exam**
Fundamental EU Code: UEF 1.1.1 Credits: 8 Coefficients: 4	Continuum mechanics	4	2	1h30	1h30		45:00	55:00	40%	60%
	Advanced soil mechanics	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EU Code: UEF 1.1.2 Credits: 10 Coefficients: 5	Embankments and supports	4	2	1h30	1h30		45:00	55:00	40%	60%
	Foundations	4	2	1h30	1h30		45:00	55:00	40%	60%
	Applied geophysics	2	1	1h30			10:30 p.m.	27:30		100%
Methodological EU Code: UEM 1.1 Credits: 9 Coefficients: 5	Programming add-on	3	2	1h30		1h00	37h300	37:30	40%	60%
	Experimental methods	2	1	1h30			10:30 p.m.	27:30		100%
	Geotechnical testing and site reconnaissance1	4	2	1h30		1h30	45:00	55:00	40%	60%
EU Discovery Code: UED 1.1 Credits: 2 Coefficients: 2	*subject of choice*	1	1	1h30			10:30 p.m.	02:30		100%
	Material of your choice	1	1	1h30			10:30 p.m.	02:30		100%
Transversal EU Code: UET 1.1 Credits: 1 Coefficients: 1	Technical English and terminology	1	1	1h30			10:30 p.m.	02:30		100%
Total semester 1		**30**	**17**	**4:30 p.m.**	**6:00 a.m.**	**2h30**	**375h00**	**375h00**		

Semester 2 Master: Geotechnics

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**T.D.**	**TP**			**Continuous monitoring**	**Exam**
Fundamental EU Code: UEF 1.2.1 Credits: 8 Coefficients: 4	Mechanics of deformable solids	4	2	1h30	1h30		45:00	55:00	40%	60%
	Soil dynamics	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EU Code: UEF 1.2.2 Credits: 10 Coefficients: 5	Soil rheology	4	2	1h30	1h30		45:00	55:00	40%	60%
	Geostatistics	4	2	1h30	1h30		45:00	55:00	40%	60%
	Earth dams	2	1	1h30			10:30 p.m.	27:30		100%
Methodological EU Code: UEM 1.2 Credits: 9 Coefficients: 5	Finite element method	5	3	1h30	1h00	1h30	60:00	65h00	40%	60%
	Geotechnical testing and site reconnaissance 2	4	2	1h30		1h30	45:00	55:00	40%	60%
EU Discovery Code: UED 1.2 Credits: 2 Coefficients: 2	*Material of your choice*	1	1	1h30			10:30 p.m.	02:30		100%
	Material of your choice	1	1	1h30			10:30 p.m.	02:30		100%
Transversal EU Code: UET 1.2 Credits: 1 Coefficients: 1	Compliance with standards and rules of ethics and integrity	1	1	1h30			10:30 p.m.	02:30		100%
Total semester 2		**30**	**17**	**3:00 p.m.**	**7:00 a.m.**	**3:00 a.m.**	**375h00**	**375h00**		

Semester 3 Master: Geotechnics

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**T.D.**	**TP**			**Continuous monitoring**	**Exam**
Fundamental EU Code: UEF 2.1.1 Credits: 8 Coefficients: 4	Dynamics of geotechnical works	4	2	1h30	1h30		45:00	55:00	40%	60%
	Breakdown calculation and limit analysis	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EU Code: UEF 2.1.2 Credits: 10 Coefficients: 5	Rock mechanics	4	2	1h30	1h30		45:00	55:00	40%	60%
	Tunnels and underground structures	4	2	1h30	1h30		45:00	55:00	40%	60%
	Road geotechnics	2	1	1h30			10:30 p.m.	27:30		100%
Methodological EU Code: UEM 2.1 Credits: 9 Coefficients: 5	Soil improvement	4	2	1h30		1h30	45:00	55:00	40%	60%
	Modeling of geotechnical works	2	1			1h30	10:30 p.m.	27:30	100%	
	Geographic Information Systems	3	2	1h30		1h00	37:30	37:30	40%	100%
EU Discovery Code: UED 2.1 Credits: 2 Coefficients: 2	*Material of your choice*	1	1	1h30			10:30 p.m.	02:30		100%
	Material of your choice	1	1	1h30			10:30 p.m.	02:30		100%
Transversal EU Code: UET 2.1 Credits: 1 Coefficients: 1	Documentary research and dissertation design	1	1	1h30			10:30 p.m.	02:30		100%
Total semester 3		**30**	**17**	**3:00 p.m.**	**6:00 a.m.**	**4:00 a.m.**	**375h00**	**375h00**		

EU Discovery materials basket (S1, S2, S3):

1. *Hydrogeology*
2. *Geotechnical hazards and risks*
3. *Finite difference method*
4. *Discrete element method*
5. *Organization of construction sites*
6. *Pathology of geotechnical works*
7. *Market Code*
8. *Geotechnical standards*
9. *Construction law*
10. *PGC of geotechnical works*
11. *Notions on civil and industrial constructions*
12. *Concepts on roads and works of art*
13. *Concepts on hydrotechnical works*

Semester 4

Internship in a company or in a research laboratory culminating in a dissertation and a defense (this table is given for information only).

	VHS	coefficient	Credits
Personal work	550	09	18
Internship in a company or laboratory	100	04	06
Seminars	50	02	03
Other (Framing)	50	02	03
Total Semester 4	750	17	30

This table is given for information purposes only.

Evaluation of the End of Master Cycle Project

- Scientific value (jury assessment) /6
- Writing of the dissertation (jury assessment) /4
- Presentation and response to questions (Jury assessment) /4
- Appreciation of the supervisor /3
- Presentation of the internship report (Jury assessment) /3

III - Detailed program by subject for the S1 semester

Semester: 1
Teaching unit: UEF 1.1.1
Subject 1:Continuum mechanics
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The aim of this course is to introduce the student to the theoretical notions of continuum mechanics.

Recommended prior knowledge:

Algebra, Thermodynamics, Rational mechanics, Fluid mechanics, Resistance of materials.

Material content:

Chapter 1.	General concepts	**(1 week)**
Chapter 2.	Mathematics preliminaries	**(2 weeks)**
Chapter 3.	State of Constraint Theory	**(4 weeks)**
Chapter 4.	Strain state theory	**(4 weeks)**
Chapter 5.	Behavior relationships	**(4 weeks)**

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *P. Germain. Continuum mechanics. Ed. Masson.*
2. *P. Germain, P. Muller. Introduction to continuum mechanics. Ed. Masson.*
3. *J. Salençon. Mechanics of continuous media, Volumes 1, 2 and 3. Ed. Ecole Polytechnique, France.*
4. *J. Coirier, C. Nadot-Martin. Mechanics of continuous media.Ed.Dunod.*
5. *G. Duvaut. Continuum mechanics. Ed. Masson.*
6. *J. Botsis, M. Deville. Continuum mechanics. Ed. Eyrolles.*
7. *R. Temam, A. Miranville. Mathematical and mechanical modeling of continuous media. Ed. Springer.*

Semester: 1
Teaching unit: UEF 1.1.1
Subject 2:Advanced soil mechanics
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The aim of this course is to provide the student with in-depth theoretical and experimental knowledge dealing with the mechanical behavior of granular soils and fine soils in saturated and unsaturated states.

Recommended prior knowledge:

Soil mechanics 1 and 2

Material content:

Chapter 1: Reminder on grainy soils and fine soils(3 weeks)
I-1: Difference between grainy soils and fine soils
I-2: Properties of grainy soils
I-3: Properties of fine soils
I-4: Plasticity and shear resistance
I-5: Short and long term behavior
I-6: Stress path in space ($\sigma - \varepsilon$) and ($p - q$)

Chapter 2: Behavior of granular materials(4 weeks)
II-1: Stress-strain relationship
II-2: Theory of dilatancy
II-3: Critical state and characteristic state
II-4: Influence of lateral stress
II-5: Behavior under cyclic path: contraction, expansion and liquefaction

Chapter 3: Behavior of fine soils(4 weeks)
III-1: clay shear, overconsolidated and normally consolidated domain, drained and undrained shear, pore pressure, failure criterion, total stress envelope.
III-2: State of consolidation and shear resistance
III-3: Relationship between the consolidation pressure of fine soils and Cu

Chapter 4: Behavior of unsaturated soils(4 weeks)
IV-1: Definition of suction
IV-2: Concept of effective stress in unsaturated soils
IV-3: Shear resistance in unsaturated soils
IV-4: Permeability and suction

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *F. Schlosser.**Elements of soil mechanics**. Ed. Presses des ponts, France.*
2. *F. Schlosser.**Soil mechanics exercises**. Ed. Presses des ponts, France.*
3. *J. Costet, G. Sanglerat. Practical course in soil mechanics. Volumes 1 & 2.Ed. Dunod.*
4. *G. Sanglerat, G. Olivari, B. Cambou.Practical problems in soil mechanics and foundations. Volumes 1 & 2. Ed.Dunod.*
5. *G. Philipponnat, B. Hubert. Foundations and earthworks. Ed. Eyrolles.*
6. *D. Cordary.**Ground Mecanic**. Ed. Lavoisier.*
7. *Robert D. Holtz, William D. Kovacs.**Introduction to geotechnics**. Ed.Polytechnic universityfrom Montreal, Canada.*
8. *Braja M. Das.**Advanced Soil Mechanics**. Ed. Taylor & Francis Group.*

9-Delage P., Cui YJ 2001: Mechanical behavior of unsaturated soils. Engineering Techniques, Construction, C302, 19p.

10-Coussy O. and Fleureau JM 2002: Mechanics of unsaturated soils. HermesSciencves publication, Paris, 390p.

Semester: 1
Teaching unit: UEF 1.1.2
Subject 1:Embankments and supports
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The purpose of this course is to enable the student to deepen their knowledge of the analysis of slope stability and the design and calculation of retaining structures.

Recommended prior knowledge:

Soil mechanics 1 and 2, Foundations and geotechnical works.

Material content:

- **First part**:*Stability of slopes and embankments*

Chapter 1.	Stability of slopes in plane failure	**(2 weeks)**
Chapter 2.	Stability of slopes in circular failure	**(3 weeks)**
Chapter 3.	Stability of slopes in any rupture	**(3 weeks)**

- **Second part**:*Worksretaining*

Chapter 4.	Classification of retaining structures	**(1 week)**
Chapter 5.	Actions and requests	**(3 weeks)**
Chapter 6.	Sizing and justifications	**(3 weeks)**

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *F. Schlosser.**Elements of soil mechanics**. Ed. Presses des ponts, France.*
2. *F. Schlosser.**Soil mechanics exercises**. Ed. Presses des ponts, France.*
3. *J. Costet, G. Sanglerat. Practical course in soil mechanics. Volumes 1 & 2. Ed. Dunod.*
4. *G. Sanglerat, G. Olivari, B. Cambou. Practical problems in soil mechanics and foundations. Volumes 1 & 2. Ed. Dunod.*
5. *G. Philipponnat, B. Hubert. Foundations and earthworks. Ed. Eyrolles.*
6. *JL Durville, G.Sap.Slope stability: landslides in soft ground (C254). Ed. Engineering techniques.*
7. *F. Schlosser. Retaining structures: thrusts and stops (C242). Ed. Engineering techniques.*

Semester: 1
Teaching unit: UEF 1.1.2
Subject 2:Foundations
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

This course aims to enable the student to deepen their knowledge of the design and calculation of the surface and deep foundations of structures.

Recommended prior knowledge:

Soil mechanics 1 and 2, Foundations and geotechnical works.

Material content:

Chapter 1.	Typical actions and calculation requests	**(2Weeks)**
Chapter 2.	Superficial foundations	**(5 weeks)**
Chapter3.	Deep foundations	**(5 weeks)**
Chapter 4.	Special foundations	**(3 weeks)**

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *F. Schlosser.**Elements of soil mechanics**. Ed. Presses des ponts, France.*
2. *F. Schlosser.**Soil mechanics exercises**. Ed. Presses des ponts, France.*
3. *J. Costet, G. Sanglerat. Practical course in soil mechanics. Volumes 1 & 2. Ed. Dunod.*
4. *G. Sanglerat, G. Olivari, B. Cambou. Practical problems in soil mechanics and foundations. Volumes 1 & 2. Ed. Dunod*
5. *G. Philipponnat, B. Hubert. Foundations and earthworks. Ed. Eyrolles.*
6. *R.Frank. Shallow foundations (C246). Ed. Engineering techniques.*
7. *R.Frank. Deep Foundations (C248). Ed. Engineering techniques.*
8. *R.Frank. Superficial and deep foundations. Ed. Presses des ponts.*
9. *P. Bousquet. Piles and sheet piles (C140). Ed. Engineering techniques.*
10. *Robert D. Holtz, William D. Kovacs.**Introduction to geotechnics**. Ed.Polytechnic universityfrom Montreal, Canada.*

Semester: 1
Teaching unit: UEM 1.1.2
Subject 3:Applied geophysics
VHS: 10:30 p.m. (Class: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

This course aims to introduce the student to the theoretical and experimental notions of geophysics applied to civil engineering.

Recommended prior knowledge:

Soil mechanics 1 and 2, Mechanics of continuous media.

Material content:

Chapter 1. General information on geophysics and its applications **(3 weeks)**
(Geophysics and geotechnical reconnaissance, measured physical parameters, geophysical prospecting methods, advantages and disadvantages)

Chapter 2. Gravimetric and micro-gravimetric methods **(3 weeks)**

Chapter 3. Electrical methods **(3 weeks)**

Chapter 4. Seismic methods **(3 weeks)**

Chapter 5. Electromagnetic methods **(3 weeks)**

TP program(depending on the availability of test benches specific to geophysical reconnaissance)

Evaluation method:

Review: 100%

Bibliographic references:

1. *J. Dubois, M. Diament, JP Cogné. Geophysics. Ed. Dunod.*
2. *L. Lliboutry. Geophysics and geology. Ed. Elsevier-Masson.*
3. *R. Lagabrielle. Geophysics applied to civil engineering (C224). Ed. Engineering techniques, France.*
4. *M. Chouteau, B. Giroux. Applied geophysics II (GLQ 3202): electrical methods (course notes). Ed. Polytechnic School of Montreal, Canada.*
5. *H. Shout, M. Djeddi. Physical bases of seismic prospecting. Ed. OPU, Algeria.*

Semester:1
Teaching unit: UEM1.1
Subject1:Programming add-on
VHS: 37h30 (Class: 1h30, TP: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:

This course aims to deepen students' knowledge of advanced programming.

Recommended prior knowledge:

General computing, programming language

Material content:

Chapter 1. Reminder of programming techniques and program structuring **(3 weeks)**
Chapter 2. Use ofprocedures and function **(4 weeks)**
Chapter 3. Modular programming **(4 weeks)**
Chapter 4. Application examples **(4 weeks)**

Evaluation method:

Continuous monitoring: 40%; Exam: 60%.

Bibliographic references:

1. *Concepts in programming languages. JC Mitchel, Prentice Hall 1997*
2. *M. BOUMAHRAT, A. GOURDIN"Applied numerical methods" OPU 1993*
3. *VARGA "Matrix iterative analysis"Printice Hall, 1962*
4. *BESTOUGEFF "Computer technology: Digital and non-digital algorithms" Volume 2, Masson, 1975*

Semester:1
Teaching unit: UEM1.1
Subject2:Experimental methods
VHS: 10:30 p.m. (Class: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

This subject provides the student with knowledge of the most recent developments concerning current soil mechanics tests, especially in the laboratory and also in the field.

Recommended prior knowledge:

Soil mechanics 1 and 2.

Material content:

Chapter 1 : Test standards: experimental procedures and techniques for using test results (in-situ and laboratory tests). **(3 weeks)**

Chapter 2 : Permeability tests **(3 weeks)**

Chapter 3: Shear strength and triaxial shear tests **(3 weeks)**

Chapter 4: Settlement calculations and oedometric tests **(3 weeks)**

Chapter 5: In situ tests **(3 weeks)**

Evaluation method:

Review: 100%.

Bibliographic references:

All soil mechanics works

Semester: 1
Teaching unit: UEM 1.1
Subject 3:Geotechnical testing and site reconnaissance
VHS: 45h00 (Class 1h30 and practical work: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The purpose of this course is to introduce the student to the different types of in-situ and laboratory tests carried out in soil mechanics.

Recommended prior knowledge:

Soil mechanics 1 and 2

Material content:

- Surveys and sampling
- In-situ tests (1st part)
- Laboratory tests (part 1)

NBThe teacher will have the free choice to program the different types of in-situ and laboratory tests available in his establishment in addition to those already carried out in the 1st cycle (license) which he will have to divide into two semesters: S1 (for the 1st part) and S2 (for the 2nd part).

Proposal of the content of the subject

I- Surveys and drilling (definition, particularities, core surveys, core drilling techniques, density of surveys, depth of investigation) 2 weeks
II- Sampling and geotechnical characteristics 2 weeks
III- Mechanical tests (driving tests, static penetration tests, piezocone, pressuremeter tests, scissometric tests) 2 weeks
IV- Destructive drilling (instantaneous and delayed logs) 1 week
V- Instruments and monitoring of works 2 weeks
VI- Geotechnical study (mission of the geotechnician, preliminary investigation, the different phases and program of the geotechnical study) 2 weeks
VII- Variability and uncertainties (heterogeneity, soil variability, measurement uncertainties) **2 weeks**
VIII- Choice of investigation techniques. 2 weeks

Evaluation method:

Continuous control:40%; Exam: 60%.

Bibliographic references:

1. *Mr. Cassan (1988),* In situ tests in soil mechanics1. Production and interpretation. Edition Eyrolles.

2 Mr. Rat, (1974),**Soil recognition.Engineering techniques, Ref C224 V1.**

3.P. Reiffsteck**,**D.Lossy**,**J. Benoit, *(2012),***Drilling, surveys and in situ geotechnical tests: Tools for soil and rock reconnaissance. Editor:**Presses Des Ponts.

4.**P. Reiffsteck**,**Mr. Zerhouni**,**Averlan***(2018),***Laboratory tests for soil mechanics and geotechnics: tools forrecognition of soils and rocks.Press of the National School of Bridges and Roads**.

5. Roy E. Hunt (2005), Geotechnical investigation methods: a field guide for geotechnical engineers. CRC Press LLC, 2005.

6. Keith Lawrence H. (1992), Environmental sampling and analysis: A practical guide, Lewis Publisher, Chelsea, Michigan.

*7. AFTES recommendations, (2012)***Characterization of geological, hydrogeological and geotechnical uncertainties and risks. (GT32 R2 F1), 2012.**

*8. G. Philipponnat, B. Hubert, (1998),***Foundations and earthworks. Edition Eyrolles.**

*9. H. Cambefort (1972),***Engineering geotechnics and soil reconnaissance. Edition Eyrolles.**

*10. Geotechnical Union –**Missions***Geotechnical Standards (Standardization Project), 1996.**

*11. Martin Van Staveren (2006),***Uncertainty and ground conditions: A risk management approach.Elsevier.**

Semester:1
Teaching unit: UET1.1
Matter:Technical English and terminology
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Introduce the student to technical vocabulary. Strengthen your knowledge of the language. Help him atunderstand and synthesize a technical document. Allow him to understand a conversation in English held in a scientific framework.

Recommended prior knowledge:

Basic English vocabulary and grammar

Material content:

- Written comprehension :Reading and analysis of texts relating to the specialty.
- Oral comprehension: Based on authentic popular science video documents,note taking, summary and presentation of the document.
- Oral expression: Presentation of a scientific or technical subject,development and exchange of oral messages (ideas and data), Telephone communication, Gestural expression.
- Written expression :Extraction of ideas from a scientific document, Writing a scientific message, Exchange of information in writing,writing CVs, application letters for internships or jobs.

Recommendation:
It is strongly recommended that the person responsible for the subject presents and explains at the end of each session (at most) around ten technical words of the specialty in the three languages (if possible) English, French and Arabic.

Evaluation method:

Review: 100%.

Bibliographic references:

1. *PT Danison.Practical guide to writing in English: uses and rules, practical advice. Organization Editions.*
2. *A. Chamberlain, R. Steele. Practical guide to communication: English. Ed. Didier.*
3. *R. Ernst.Dictionary of applied techniques and sciences: French-English. Ed.Dunod.*
4. *J. Comfort, S. Hick, A. Savage.Basic Technical English.Ed. Oxford University Press.*
5. *EH Glendinning, N. Glendinning.Oxford English for Electrical and Mechanical Engineering.Ed. Oxford University Press.*
6. *TN Huckin, AL Olsen.Technical writing and professional communication for nonnative speakers of English.Ed. McGraw-Hill.*
7. *J. Orasanu.Reading Comprehension from Research to Practice.Ed. Erlbaum Associates.*

Detailed program by subject for semester S2

Semester: 2
Teaching unit: UEF 1.2.1
Subject 1:Mechanics of deformable solids
VHS: 67h30 (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The aim of this course is to introduce the student to the theoretical and experimental notions of the mechanics of deformable solids.

Recommended prior knowledge:

Rational mechanics, Thermodynamics, Mechanics of continuous media.

Material content:

Chapter 1.	Physical mechanisms of deformation and rupture	**(2 weeks)**
Chapter 2.	Rheological classification and experimental characterization	**(3 weeks)**
Chapter 3.	Elasticity and viscoelasticity	**(5 weeks)**
Chapter 4.	Plasticity and viscoplasticity	**(5 weeks)**

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *J. Lemaitre, JL Chaboche. Mechanics of deformable and damaging solids. Ed. Dunod.*
2. *J. Lemaitre, JL Chaboche, A. Benallal, R. Desmorat. Mechanics of solid materials. Ed. Dunod.*
3. *D. François, A. Pineau, A. Zaoui. Elasticity and plasticity. Ed. Lavoisier.*
4. *S. Timoshenko, JM Goodier. Elasticity theory. Ed. Librairie Polytechnique Ch. Béranger.*
5. *J. Salençon. Elastoplasticity. Ed. Ecole polytechnique, France.*
6. *B. Halphen, J. Salençon. Elasto-plasticity. Ed. Presses desponts, France.*
7. *VA Lubarda. Elastoplasticity theory. CRC Press.*
8. *R. Richards Jr. Principles of solid mechanics. CRC Press.*
9. *Robert J. Asaro, Vlado A. Lubarda. Mechanics of solids and materials. Ed. Cambridge University Press.*

Semester: 2
Teaching unit: UEF 1.2.1
Subject 2:Soil dynamics
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The aim of this course is to introduce the student to the dynamic calculation of soils and foundations of geotechnical structures.

Recommended prior knowledge:

Waves and vibrations, Soil mechanics 1 and 2, Foundations and geotechnical structures, Mechanics of continuous media.

Material content:

Chapter 1. Characterization of seismic movement **(3 weeks)**
(Elements of seismology, propagation of seismic waves in soils, notions of polarization, historical seismicity of Algeria)

Chapter 2. Behavior of soils under cyclic loading **(3 weeks)**

Chapter 3. Measurement of dynamic soil characteristics **(3 weeks)**

Chapter 4. Seismic response of a soil profile **(3 weeks)**

Chapter 5. Soil liquefaction **(3 weeks)**

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *A. Bouafia. Introduction to soil dynamics. Volumes 1 & 2. Ed. OPU, Algeria.*
2. *A. Pecker. Soil dynamics. Ed. Presses des ponts, France.*
3. *Braja M. Das, GV Ramana. Principles of soil dynamics. Ed. Cengage Learning, USA.*
4. *Braja M. Das. Fundamentals of soil dynamics. Ed. Elsevier.*
5. *Shamsher Prakash. Soil dynamics. Ed. Mc-Graw-Hill.*
6. *A. Verruijt. An introduction to soil dynamics. Ed. Springer.*
7. *FE Richart, JR Hall Jr., RD Woods. Vibrations of soils and foundations. Ed. Prentice-Hall, USA.*
8. *SL Kramer. Geotechnical earthquake engineering. Ed. Prentice-Hall, USA.*

Semester: 2
Teaching unit: UEF 1.2.2
Subject 1:Soil rheology
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The aim of this course is to provide the student with in-depth theoretical and experimental knowledge dealing with the mechanical behavior of soils under homogeneous stresses with a view to calculating foundations and geotechnical structures.

Recommended prior knowledge:

Soil mechanics 1 and 2, Mechanics of continuous media.

Material content:

Chapter 1. In-situ and laboratory behavior **(1 week)**
(Compressibility and permeability characteristics, consolidation-and creep characteristics, shear and rupture characteristics, stress paths, normally consolidated and overconsolidated behaviors)

Chapter 2. Elastic behavior laws **(4 weeks)**
(Linear elasticity, non-linear elasticity, application to hyperbolic models)

Chapter 3. Elasto-plastic behavior laws **(4 weeks)**
(Perfect plasticity, plasticity with work hardening, application to the CAM-CLAY model)

Chapter 4. Elasto-visco-viscoplastic behavior laws **(4 weeks)**
(Taking into account creep, application to the MELANIE-LCPC model)

Chapter 5. Behavioral laws and numerical resolution **(2 weeks)**
(Panorama of soil behavior models implemented in commercial software such as PLAXIS, FLAC, CESAR-LCPC, etc.)

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *JP Magnan, P. Mestat. Soil behavior law and modeling (C218).Ed. Engineering techniques.*
2. *P. Mestat. From soil rheology to structure modeling. Ed. IFSTTAR (formerly LCPC), France.*
3. *Braja M. Das. Advanced soil mechanics. Ed. Taylor & Francis Group.*
4. *Sergei S. Vyalov. Rheological fundamentals of soil mechanics. Ed. Elsevier.*
5. *Mr. J. Keedwell. Rheology and soil mechanics. Ed. Elsevier.*
6. *D. Muir Wood. Geotechnical modeling. CRC Press.*

Semester:3
Teaching unit: UEF 1.2.2
Subject 2:Geostatistics
VHS: 45h00 (Class: 1h30, tutorial: 1h30)
Credits:4
Coefficient:2

Teaching objectives:

The aim of this course is to introduce the student to the theoretical notions of statistical calculation applied to geotechnics.

Recommended prior knowledge:

Statistics, Soil Mechanics.

Material content:

Chapter 1.	Theoretical bases of geostatistics (Random functions, stationarity, covariance, adjustment of a theoretical structure function)	**(3 weeks)**
Chapter 2.	Variogram analysis	**(4 weeks)**
Chapter 3.	Kriging theory	**(4 weeks)**
Chapter 4.	Software and applications	**(4 weeks)**

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *JPChilès, P. Delfiner. Geostatistics: Modeling Spatial Uncertainty. Second Edition. Wiley, 2012.*
2. *C. Lantuéjoul. Geostatistical simulation: Models and Algorithms. Springer, 2002.*
3. *H. Wackernagel. Multivariate geostatistics: an introduction with applications. Springer, 2003.*
4. *R. Webster, M. Olivier. Geostatistics for environmental scientists. Statistics in Practice. Wiley, 2001.*
5. *N. Cressie. Statistics for Spatial Data. Revised Edition. Wiley, 2015*

Semester:2
Teaching unit: UEF 1.2.2
Subject 3:Earth dams
VHS: 10:30 p.m. (Class: 1h30)
Credits:2
Coefficient:1

Teaching objectives:

The purpose of this course is to introduce the student to the design and calculation of earth dams.

Recommended prior knowledge:

Advanced soil mechanics, Foundations, Slopes and retaining, Finite difference method, Finite element method.

Material content:

Chapter I: Design of earth dams (**4 weeks)**
- Different types of earth dams
- Project for an earthen dam
- General profile of an earth dike

Chapter II: Study of infiltrations in an earthen dam (**4 weeks)**
- Infiltration network
- Leak rate by infiltration
- Infiltration through the foundations
- Fox phenomenon

Chapter III: Fight against infiltration in an earth dike**4 weeks)**
- Waterproof screens
- Coating of the upstream facing
- Drains and filters

Chapter IV: Stability of earth dams (**3 weeks)**
- Fellenius method
- Bishop's method

Evaluation method:

Review:100%

Bibliographic references:

1. *AJ Schleiss, H. Pougatsch. Dams – From project to commissioning. Ed. Polytechnic and university presses in French-speaking Switzerland.*
2. *P. Le Delliou. Dams: design and maintenance. Lyon University Press, France.*
3. *L. Vulliet, L. Laloui, J. Zhao. Soil and rock mechanics. Ed. Polytechnic and university presses in French-speaking Switzerland.*

Semester: 2
Teaching unit: UEM 1.2
Subject 1:Finite element method
VHS: 60h00 (Class: 1h30, TD: 1h00, TP: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives:

The aim of this course is to introduce the student to the calculation of geotechnical structures using the finite element method.

Recommended prior knowledge:

Mathematical analysis, Matrix calculation, Resistance of materials, Numerical methods, Soil mechanics 1 and 2.

Material content:

Chapter 1.	General principles	**(3 weeks)**
Chapter 2.	1D finite element method	**(4 weeks)**
Chapter 3.	2D finite element method	**(4 weeks)**
Chapter 4.	3D finite element method	**(4 weeks)**

TP program

Part 1 in Matlab (or other): Manipulation of matrices, Lagrange interpolation, numerical integration using the trapezoid and Simpson methods, practical applications.

Part 2 Use of FE software dedicated to geotechnics (Plaxis or other) and study of a practical case: Presentation of the software, creation and implementation of the calculation model (geometry, soil layer data, boundary conditions, initial conditions, loading, structural elements, calculation phasing, presentation and exploitation of the results), practical applications.

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *G.Dhatt. G. Touzot, E. Lefrançois. Finite element method. Ed. Hermès-Lavoisier.*
2. *J. Chaskalovic. Finite element method for engineering sciences. Ed. Lavoisier.*
3. *JC Craveur. Finite element modeling. Ed. Dunod.*
4. *M. Bonnet, A. Frangi. Analysis of deformable solids using the finite element method. Ed. Ecole polytechnique, France.*
5. *F. Frey, J. Jirousek. Finite element method. Ed. Eyrolles.*

Semester: 2
Teaching unit: UEM 1.2
Subject 2:Geotechnical tests and site reconnaissance 2
VHS: 45h00 (Class: 1h30, practical work: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The purpose of this course is to introduce the student to the different types of in-situ and laboratory tests carried out in soil mechanics.

Recommended prior knowledge:

Soil mechanics 1 and 2

Material content:

- Surveys and sampling
- In-situ tests (2nd part)
- Laboratory tests (part 2)

NBThe teacher has the free choice to program the different types of in-situ and laboratory tests available in his establishment in addition to those already carried out in the 1st cycle (license) which he must divide into two semesters: S1 (for the 1st part) and S2 (for the 2nd part).

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

All soil mechanics works

Semester: 2
Teaching unit: UET 1.2
Subject: Respect forstandards and rules of ethics and integrity.
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

Develop students' awareness of respect for ethical principles and the rules that govern life at university and in the world of work. Raise awareness about respecting and valuing intellectual property. Explain to them the risks of moral evils such as corruption and how to combat them, alert them to the ethical issues raised by new technologies and sustainable development.

Recommended prior knowledge:

Ethics and professional conduct (the foundations)

Content of the material:

A.The respect of the rulesethics and integrity,

1. **Reminder on the MESRS Charter of Ethics and Professional Conduct:**Integrity and honesty. Academic freedom. Mutual respect. Requirement for scientific truth, objectivity and critical thinking. Equity.Rights andobligationsof the student,the teacher, administrative and technical staff,

2. Integrity and responsible research
- Respect for ethical principles in teaching and research
- Responsibilities in teamwork: Professional equality of treatment. Conduct against discrimination. The search for the general interest. Inappropriate conduct in the context of collective work
- Adopt responsible conduct and combat abuses: Adopt responsible conduct in research. Scientific fraud. Conduct against fraud. Plagiarism (definition of plagiarism, different forms of plagiarism, procedures to avoid unintentional plagiarism, detection of plagiarism, sanctions against plagiarists, etc.). Falsification and fabrication of data.

3. Ethics and professional conduct in the world of work:
Legal confidentiality in business. Loyalty to the company. Responsibility within the company, Conflicts of interest. Integrity (corruption in the workplace, its forms, its consequences, methods of combating and sanctions against corruption)

B- Intellectual property

I- Fundamentals of intellectual property

1- Industrial property. Literary and artistic property.
2- Rules for citing references (books, scientific articles, communications in a congress, theses, dissertations, etc.)

II- Copyright

1. **Copyright in the digital environment**

Introduction. Copyrightdatabases, software copyright. Specific case of free software.

2. Copyright in the Internet and e-commerce

Domain name law. Intellectual property on the internet. E-commerce site law. Intellectual property and social networks.

3. Patent

Definition. Rightsin a patent. Usefulness of a patent. Therepatentability. Patent applicationin Algeria and around the world.

III- Protection and valorization of intellectual property

How to protect intellectual property. Violation of rights and legal tool. Vvaluation of intellectual property. Protection of intellectual propertyin Algeria.

C. Ethics, sustainable development and new technologies

Link between ethics and sustainable development, energy saving, bioethics and new technologies (artificial intelligence, scientific progress, Humanoids, Robots, drones,

Evaluation method:

Review: 100%

Bibliographic references:

1. Charter of university ethics and professional conduct,https://www.mesrs.dz/documents/12221/26200/Charte+fran__ais+d__f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce
2. Orders No. 933 of July 28, 2016 setting the rules relating to the prevention and fight against plagiarism
3. The ABCs of Copyright, United Nations Educational, Scientific and Cultural Organization (UNESCO)
4. E. Prairat, On teaching ethics. Paris, PUF, 2009.
5. Racine L., Legault GA, Bégin, L., Ethics and engineering, Montreal, McGraw Hill, 1991.
6. Siroux, D., Deontology: Dictionary of Ethics and Moral Philosophy, Paris, Quadrige, 2004, p. 474-477.
7. Medina Y., Ethics, what will change in the company, Editions d'Organisation, 2003.
8. Didier Ch., Thinking about the ethics of engineers, Presses Universitaires de France, 2008.
9. Gavarini L. and Ottavi D., Editorial. of professional ethics in training and research, Research and training, 52 | 2006, 5-11.
10. Caré C., Morality, ethics, deontology. Administration and education, 2nd quarter 2002, n°94.
11. Jacquet-Francillon, François. Concept: professional ethics. Letélémaque, May 2000, n° 17
12. Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.
13. Galloux, JC, Industrial property law. Dalloz 2003.
14. Wagret F. and JM., Patent of invention, trademarks and industrial property. PUF 2001
15. Dekermadec, Y., Innovating through patents: a revolution with the internet. INSEP 1999
16. AEUTBM. The engineer at the heart of innovation. Belfort-Montbéliard University of Technology
17. Fanny Rinck etléda Mansour, literacy in the digital age: copying and pasting among students, University of Grenoble 3 and University of Paris-Ouest Nanterre la Défense Nanterre, France
18. Didier DUGUEST IEMN, Cite your sources, IAE Nantes 2008
19. Similarity detection software: a solution to electronic plagiarism? Report of the Working Group on Electronic Plagiarism presented to the CREPUQ Subcommittee on Pedagogy and ICT

20. EmanuelaChiriac, Monique Filiatrault and André Régimbald, Student guide: intellectual integrity plagiarism, cheating and fraud… avoiding them and, above all, how to properly cite your sources, 2014.
21. Publication of the University of Montreal, Plagiarism prevention strategies, Integrity, fraud and plagiarism, 2010.
22. Pierrick Malissard, Intellectual property: origin and evolution, 2010.
23. The website of the World Intellectual Property Organizationwww.wipo.int
24. http://www.app.asso.fr/

Detailed program by subject for the S3 semester

Semester:3
Teaching unit: UEF 2.1.1
Subject 1:Dynamics of geotechnical works
VHS: 45h00 (Class: 1h30, tutorial: 1h30)
Credits:4
Coefficient:2

Teaching objectives:

This course aims to introduce the student to the dynamic calculation of geotechnical structures and their interaction with their environment.

Recommended prior knowledge:

Advanced soil mechanics, Foundations, Embankments and retaining walls, Soil dynamics.

Material content:

Chapter 1.	General information on soil-structure interaction	**(1 week)**
Chapter 2.	Behavior of foundations under vibrating machines	**(4 weeks)**
Chapter 3.	Seismic bearing capacity of foundations	**(4 weeks)**
Chapter 4.	Seismic stability of retaining structures	**(3 weeks)**
Chapter 5.	Seismic stability of slopes and embankments	**(3 weeks)**

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *A. Bouafia. Introduction to soil dynamics. Volumes 1 & 2. Ed. OPU, Algeria.*
2. *A. Pecker. Soil dynamics. Ed. Presses des ponts, France.*
3. *Braja M. Das, GV Ramana. Principles of soil dynamics. Ed. Cengage Learning, USA.*
4. *Braja M. Das. Fundamentals of soil dynamics. Ed. Elsevier.*
5. *Shamsher Prakash. Soil dynamics. Ed. Mc-Graw-Hill.*
6. *SL Kramer. Geotechnical earthquake engineering. Ed. Prentice-Hall, USA.*

Semester:3
Teaching unit: UEF 2.1.1
Subject 2:Breakdown calculation and limit analysis
VHS: 45h00 (Class: 1h30, tutorial: 1h30)
Credits:4
Coefficient:2

Teaching objectives:

The aim of this course is to introduce the student to the theoretical notions of calculation at the breakdown of structures and their limit analysis.

Recommended prior knowledge:

Mechanics of continuous media, Mechanics of deformable solids, Mechanics of soils.

Material content:

Chapter 1. Concept of limit loads and usual failure criteria **(3 weeks)**

Chapter 2. Static approach from the inside **(3 weeks)**

Chapter 3. Kinematic approach from the outside **(3 weeks)**

Chapter 4. Practical applications **(6 weeks)**

- Structures (beams, frames, thin plates and slabs)
- Geotechnical structures (stability of excavations, lateral earth thrusts, bearing capacity of foundations)

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *J. Salençon. Breakdown calculation and limit analysis. Ed. Presses des ponts, France.*
2. *J. Salençon. Yield design. Ed. Wiley-ISTE.*
3. *P. De Buhan. Plasticity and calculation at breakage. Ed. Presses des ponts, France.*
4. *J. Lemaitre, JL Chaboche. Mechanics of deformable and damaging solids. Ed. Dunod.*
5. *J. Lemaitre, JL Chaboche, A. Benallal, R. Desmorat. Mechanics of solid materials. Ed. Dunod.*

Semester: 3
Teaching unit: UEF 2.1.2
Subject 1:Rock mechanics
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The aim of this course is to introduce the student to the theoretical and experimental notions of rock mechanics applied to civil engineering works.

Recommended prior knowledge:

Soil mechanics 1 and 2, Foundations and geotechnical works, Mechanics of continuous media.

Material content:

Chapter 1. General information on rocks and rock masses **(4 weeks)**
(Genesis of rocks, physical and thermal properties of rocks - Discontinuities of the rock mass: typology, description and geometric representation of joints - Classification of rocks and rock masses)

Chapter 2. Mechanical behavior of rocks and rock masses **(6 weeks)**
(In-situ and laboratory characterization - Rock matrix: mechanical properties, strength criterion and mode of failure – Discontinuities: characteristics and resistance of rock joints, flow in the joints – Rock masses: RQD/RMR/QS/GSI classification)

Chapter 3. Stability of rock slopes **(3 weeks)**
(Modes of failure of rock slopes, role of water, stability in limit equilibrium, mowing, stabilization techniques)

Chapter 4. Stability of rock cavities **(2 weeks)**
(State of constraints, calculation methods, case of stratified masses, calculation of the swelling pressure on the covering)

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *JL Durville. Rock mechanics: General (C350). Ed. Engineering techniques.*
2. *JL Durville, H. Héraud. Description of rocks and rock massifs (C352). Ed. Engineering techniques.*
3. *P. Duffaut, F. Homand. Textbook of rock mechanics. Volumes 1 & 2. Ed. Presses des ponts, France.*
4. *RE Goodman. Introduction to rock mechanics. Ed. John Wiley and Sons, New York.*
5. *E. Hoek. Practical Rock engineering. Ed.https://www.rocscience.com*

Semester:3
Teaching unit: UEF 2.1.2

Subject 2:Tunnels and underground structures
VHS: 45h00 (Class: 1h30, tutorial: 1h30)
Credits:4
Coefficient:2

Teaching objectives:

The aim of this course is to introduce the student to the design and calculation of tunnels and other underground structures.

Recommended prior knowledge:

Advanced soil mechanics, Mechanics of deformable solids, Rock mechanics, Finite difference method, Finite element method.

Material content:

Chapter 1. Definition and classification of underground works **(2 weeks)**
Chapter 2. Tunnel design and construction techniques **(3 weeks)**
Chapter 3. Tunnel calculation and sizing methods **(4 weeks)**
Chapter 4. Pathology and tunnel reinforcement techniques **(2 weeks)**
Chapter 5. Practical application (Calculation of a road or railway tunnel) **(4 weeks)**

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *Mr. Panet. Calculation of tunnels using the convergence-confinement method. Ed. Presses des ponts, France.*
2. *A. Bouvard-Lecouanet, G. Colombet, F. Esteulle. Underground structures: design – construction – maintenance. Ed. Presses des ponts, France.*
3. *L. Vulliet, L. Laloui, J. Zhao. Soil and rock mechanics. Ed. Polytechnic and university presses in French-speaking Switzerland.*
4. *F.Martin. Rock mechanics and underground work: courses and corrected exercises. Ed. BG Consulting Engineers, ENS Cachan, France.*

Semester: 3
Teaching unit: UEF 2.1.2
Subject 3:Road geotechnics
VHS: 45h (Class: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

The purpose of this course is to enable the student to carry out a geotechnical study applied to the design of road and motorway pavements.

Recommended prior knowledge:

Ground Mecanic

Material content:

Chapter 1.	Soil classification according to GTR	**(1 week)**
Chapter 2.	Road earthworks	**(2 weeks)**
Chapter3.	Soil compaction	**(4 weeks)**
Chapter 4.	Soil bearing capacity	**(4 weeks)**
Chapter 5.	Sizing of flexible and rigid pavements	**(4 weeks)**

Proposal of the content of the subject

Chapter I: General information on the roads**(3 weeks)**

1- Presentation of the route
2- Pavement types
3- Creation of a flexible roadway
4- Road materials

Chapter II: Sizing of pavements**(3 weeks)**

1- Definition of the dimensioning of a roadway
2- CBR method
3- Improved CBR method

Chapter III: Road earthworks**(3 weeks)**

1- Cubature of earthworks
2- Measurement of cubatures
3- Land movement

Chapter IV: GTR classification of soils**(3 weeks)**

1- Definitions
2- Soil classification
3- Classification settings
4- GTR classification table

Chapter IV: Soil compaction**(3 weeks)**

Evaluation method:

Review: 100%

Bibliographic references:

1. *LCPC-SETRA. Guide to road earthworks: Creation of embankments and subgrade layers. Technical guide, France. Ed.IFSTTAR(ex. LCPC), France.*
2. *R. Coquand. Roads. Ed. Eyrolles.*
3. *P. Carillo. Design of a road project. Technical guide. Ed. Eyrolles.*

Semester:3
Teaching unit: UEM2.1
Subject 1:Soil improvement
VHS: 60h00 (Class: 1h30, practical work: 1h30)
Credits:4
Coefficient:2

Teaching objectives:

The purpose of this course is to introduce the student to the different techniques of soil stabilization and reinforcement of geotechnical structures.

Recommended prior knowledge:

Soil mechanics, Geotechnical tests 1 & 2, Road geotechnics.

Material content:

1. General information on the stabilization, reinforcement and repair of geotechnical structures.
2. Chemical stabilization of soils (Treatment with hydraulic binders).
3. Reinforcement of geotechnical works (Preloading, Supports, Nailing, Reinforced earth, Geotextiles, Ballasted columns, Injections (jet grouting, soil mixing, etc.) Dynamic compaction).
4. Criteria for choosing methods.

Practical work program:

TP No. 1: Atterberg limits of reinforced soils.
TP No. 2: Proctor test of reinforced soils.
TP No. 3:CBR test of reinforced floors.
TP No. 4: Simple compression test of reinforced soils.
TP No. 5: Simple box shear test for reinforced floors.
TP No. 6: Triaxial shear test of reinforced soils.
TP No. 7: Soil-fiber shear test.
TP No. 8: Soil-geotextile shear test.

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliography

1.Bell FG, (1993): Engineering treatment of soils. E & FN Spon. 302 pp.
2.GTS, Technical Guide (2000): "Treatment of soils with lime and/or hydraulic binders. Application to the production of embankments and subgrade layers", LCPC-SETRA (Paris-Bagneux) Jan. 2000, 240p.
3. Mouroux P. et Al. (1989) "*Economical construction on expansive soils***".**Manuals and methods, BRGM. France.

4. Roads (2004); Treatment of soils with lime and/or hydraulic binders for the execution of embankments and subgrade layers. Technical document, Routes n°89, September 2004, Paris, France.
5. Davidovici, V and Lambert, S. (2013). Foundations and soil improvement processes, Application guide for seismic EC8: Provisions for soil reinforcement by ballasted columns in seismic zones, AFPS (2012). sl: Eyrolles, 2013. ISBN: 978-2-212-13831-3.
6. Dhouib, A., Magnan JP and Guilloux, A. (2004c). Recognition methods and application to soils and improvement techniques. Proceedings of the International Symposium on In-Place Soil Improvement (ASEP-GI 2004). Edition Presses de l'ENPC- LCPC, 2004c, Vol. 2.
7.Dhouib, A. and Blondeau, F. (2005). Ballasted columns: Implementation techniques, areas of application, behavior, justification, control, areas of research and development. Presses de l'Ecole Nationale des Ponts et Chaussées - ISBN 2- 85978- 401-2, 2005 (ENPC), Paris.
8.Schlosser S. and UnterreinerP.: Soil reinforcement by inclusions. Engineering techniques, C245.
9. AFPS technical guide (2012): Processes for improving and reinforcing soils under seismic actions – Presse de Pont, Paris, 231 pages.
10.Magnan JP (1983): Theory and practice of vertical drains. Technical Edition and Documentation – Lavoisier. Paris.
11.Queyroi D., Chaput D., Pilot G. (1985): Improvement of foundation soils, choice of execution methods. Technical information note from the Ministry of Urban Planning, Housing and Transport. Editions du LCPC - 53p.
12.Technical guide:recommendations for detailed inspection, monitoring and diagnosis of backfill walls reinforced with geosynthetic elements. Central laboratory of bridges and roads July 2003.
13.Holtz, R.D., (2001): Geosyntetic For Soil Reinforcement, The Ninth Spencer J. Buchanan Reading, College Station, University Drive
14. Retaining structures: General design guide. SETRA-Technical Studies Service for Roads and Highways - December 1998.
15.Works in Reinforced Earth (1979)*:*Recommendations and Rules of the Art.Document LCPC-SETRA (1979).
16.Clouterre Recommendations (1991)for the design, calculation, execution and control of supports made by soil nailing.Presses de l'ENPC, 1991, Paris.
17.Le-Kouby A.,:Reinforcement of dikes using the DeepSoilMixing technique. Summary of test results from experimental sites in Val d'Orléans. IFSTTAR – GERS – Laboratory Soils, Rocks and Geotechnical Structures – November 19, 2014.
18.Corté JF., Poupelloz B., and Washkowski E., (1984): Reinforcement by injections of the foundations of engineering structures. Report from LCPC laboratories, May 1984.

Semester:3
Teaching unit: UEM2.1

Subject 2:Modeling of geotechnical works
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits:2
Coefficient:1

Teaching objectives:

Acquire practical notions for the dimensioning of foundations, supports and protective structures with one of the following software: Plaxis, Geo5, Flac, Z-SOIL, COMSOL, Etc...

Recommended prior knowledge:

Soil mechanics, Geotechnical tests 1 & 2, MEF, ….

Material content:

Evaluation method:

Continuous control: 100%

Bibliographic references:

Instructions for using the software used for the practical work.

Semester: S3
Teaching unit:UEM2.1
Subject 3: Geographic Information Systems
VHS: 37h30 (Class: 1h30, TP: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:

This course aims to allow the student to become familiar with geographic information systems and their application to geotechnics.

Recommended prior knowledge:

Topography, Computer Science, Mathematics

Material content:

Chapter 1. General information on GIS **(3 weeks)**
Chapter 2. Geographic information in GIS **(3 weeks)**
Chapter 3. Coordinate systemsand map projections (3 weeks)
Chapter 4. Databases in GIS **(3 weeks)**
Chapter 5. Processing in GIS **(3 weeks)**

TP program:
TP1: The components of a GIS
Basic GIS Design, GIS Software Overview
TP2:Methods of representing geographic data in a GIS
Vector mode, Raster mode, Digital terrain model DEM
TP 3:Import and displayDatas
Data georeferencing, Projection system.
TP3:Data in GIS
Attribute data, Spatial data
TP5:Applications
Spatial analysis

Evaluation method:

Continuous monitoring: 40%; Examination: 60%.

Bibliographic references:

1. PORNON, Henri. GIS: the geographical dimension of the information system. Dunod, 2015.
2. CHANG, Kang-Tsung. Introduction to geographic information systems. Boston: McGraw-Hill, 2008.
3.DENÈGRE, Jean and SALGÉ, François. Introduction to geographic information systems. What do I know?, 2004, vol. 2, no. 3122, p. 5-11.
4. GIS Software Guides.

Semester: 3
Teaching unit: UET 2.1
Subject 1:Documentary research and dissertation design
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Give the student the necessary tools to search for useful information to better use it in their end-of-studies project.Help them go through the different stages leading to the writing of a scientific document. Tell himthe importance of communication and itlearn to present the work carried out in a rigorous and educational manner.

Recommended prior knowledge:
Writing methodology, Presentation methodology.

Content of the subject:

Part I-: Documentary research:

Chapter I-1: Definition of the subject (02 Weeks)
- Subject title
- List of keywords relating to the subject
- Gather basic information (acquisition of specialized vocabulary,meaning of terms, linguistic definition)
- The information sought
- Take stock of your knowledge in the field

Chapter I-2:Select information sources (02 Weeks)
- Type of documents (Ldrunk, Theses, Memoirs, Periodical articles, Conference proceedings, Audiovisual documents, etc.)
- Type of resources (Libraries, Internet, etc.)
- Evaluate the quality and relevance of information sources

Chapter I-3:Locate documents (01 Week)
- Research techniques
- Search operators

Chapter I-4: To process information (02 Weeks)
- Work organization
- Starting questions
- Summary of documents retained
- Links between different parties
- Final plan of the documentary research

Chapter I-5: Presentation of the bibliography (01 Week)
- Systems for presenting a bibliography (The Harvard system, The Vancouver system, The mixed system, etc.)
- Presentation of documents.
- Citation of sources

Part II: Memory Design

Chapter II-1: Plan and stages of the dissertation (02 Weeks)

- Identify and delimit the subject (Summary)
- Problem and objectives of the dissertation
- Other useful sections (Acknowledgments, Table of abbreviations, etc.)
- The introduction (The writing of*the introduction last)*
- State of the specialized literature
- Formulation of hypotheses
- Methodology
- Results
- Discussion
- Recommendations
- conclusion and perspectives
- Table of contents
- The bibliography
- Annexes

Chapter II-2: Writing techniques and standards (02 Weeks)

- Formatting.Numbering of chapters, figures and tables.
- Cover Page
- Typography and punctuation
- Writing. Scientific language: style, grammar, syntax.
- Spelling.Improved general language skills in terms of comprehension and expression.
- Back up, secure, archive your data.

Chapter II-3:Workshop : Critical study of a manuscript **(01 Week)**

Chapter II-4: Oral presentations and defenses (01 Week)

- How to present a Poster
- How to present an oral communication.
- Defense of a dissertation

Chapter II-5: How to avoid plagiarism? **(01 Week)**

(Formulas, sentences, illustrations, graphs, data, statistics,...)

- The quote
- The paraphrase
- Indicate the complete bibliographic reference

Evaluation method:

Review: 100%

Bibliographic references:

1. *M. Griselin et al., Guide to written communication, 2nd edition, Dunod, 1999.*
2. *JL Lebrun, Practical guide to scientific writing: how to write for the international scientific reader, Les Ulis, EDP Sciences, 2007.*
3. *HAS.Mallender Tanner, ABC of technical writing: instructions for use, user manuals, online help, Dunod, 2002.*
4. *M. Greuter, Write your dissertation or internship report well, L'Etudiant, 2007.*
5. *Mr. Boeglin, reading and writing in college. From the chaos of ideas to structured text. The Student, 2005.*
6. *M. Beaud, the art of the thesis, Editions Casbah, 1999.*
7. *M. Beaud, the art of the thesis, The discovery, 2003.*

8. *M. Kalika, Master's thesis, Dunod, 2005.*

IV- Detailed programs by subject From Some Discoveries (S1, S2, S3)

Semester:
Teaching unit: UED XX
Matter:Hydrogeology
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The aim of this course is to introduce the student to the control of groundwater circulation and its impact on the stability of geotechnical structures.

Recommended prior knowledge:

Geology, General hydraulics, Soil mechanics.

Material content:

Chapter 1.	Behavior of reservoir aquifer systems	**(4 weeks)**
Chapter 2.	Behavior of aquifer systems in pipeline	**(4 weeks)**
Chapter 3.	Flow networks	**(4 weeks)**
Chapter 4.	Water flow control	**(3 weeks)**

Evaluation method:

Review: 100%

Bibliographic references:

1. *E.Gilli. C. Mangan, J. Mudry. Hydrogeology: objects, methods, applications. Ed. Dunod.*
2. *G. Castany. Hydrogeology: principles and methods. Ed. Dunod.*

Semester:
Teaching unit: UED XX
Matter:Geotechnical hazards and risks
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The purpose of this course is to introduce students to the understanding of certain geotechnical risks, their analysis and evaluation in order to better manage crisis situations and make appropriate decisions.

Recommended prior knowledge:

Knowledge acquired in probability and statistics, MDS.

Material content:

Chapter 1. Introduction to geotechnical risks **(1 week)**

Chapter 2 General risk analysis methodology **(4 weeks)**

Chapter 3. Remote sensing applied to the natural environment **(4 weeks)**

Chapter 4. Data analysis and processing methodology **(4 weeks)**

Chapter 5. Alert and crisis management systems **(2 weeks)**

Proposed content of the subject:

Chapter 1. Introduction to geotechnical risks **(1 week)**

Chapter 2. Analysis of different geotechnical risks**(3 weeks)**

Chapter 3. General risk analysis methodology **(3 weeks)**

Chapter 4. Remote sensing applied to the natural environment **(3 weeks)**

Chapter 5. Data analysis and processing methodology **(3 weeks)**

Chapter 6. Alert and crisis management systems **(2 weeks)**

Evaluation method:

Review: 100%

Bibliographic references:

1. *Mr. Merad. Decision support and risk management expertise. Ed. Lavoisier.*
2. *JP Louisot. Risk Management and strategy. Ed. AFNOR.*
3. *JL Wybo. Risk management and crisis prevention. Ed. Lavoisier.*

4-Techniques and Methods: Removal of swelling: Analysis and treatment of disorders created by drought. Guide 3, IFSTTAR Edition, July 2017.

5-Federal Roads Office OFROU: Risk analysis for national road tunnels ASTRA Edition; 2014.

6-Kergomard C.: Aero-space remote sensing: an introduction. Courses at the Ecole Nationale Supérieure de Paris.

7-AFTES Recommendations: Characterization of geological, hydrogeological and geotechnical uncertainties and risks. GT32R2F1, July –August 2012.

8-Methodological guide: Risk management in large public infrastructure projects. Edition: Infrastructure Quebec.

9-Engineering Techniques: “Safety and risk management” file. (www.techniques-entreprises.fr/traite/securite_et_gestion_des_risks/T1112)

Semester
Teaching unit: XX
Matter:Finite difference method
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The aim of this course is to introduce the student to the calculation of geotechnical structures using the finite difference method.

Recommended prior knowledge:

Mathematical analysis, Matrix calculation, Resistance of materials, Soil mechanics.

Material content:

Chapter 1.	General principles	**(3 weeks)**
Chapter 2.	Fine difference methods in 1D	**(4 weeks)**
Chapter 3.	Finite difference method in 2D	**(4 weeks)**
Chapter 4.	Study of some real cases	**(4 weeks)**

TP program

Part 1 under Matlab (or other): Implementation of the finite difference method for a simple case (Bending of a beam, Consolidation problem).

Part 2 Use of geotechnical FD software (Flac or other) and study of a practical case: Modeling of the problem, Discretization of the domain, Meshing, Introduction of boundary and initial conditions, Resolution and exploitation of the results.

Evaluation method:

Continuous control: 40%; Exam: 60%

Bibliographic references:

1. *A. Curnier. Numerical methods in solid mechanics.Ed.French-speaking polytechnic and university presses.*
2. *M. Deville, M. Rappaz. Numerical modeling in materials science and engineering. Ed.French-speaking polytechnic and university presses.*
3. *M. Rappaz, M. Bellet, M. Deville.Treatment of materials 10. Ed.French-speaking polytechnic and university presses.*
4. *G. Allaire.Numerical analysis and optimization: an introduction to modeling. Ed. Ecole polytechnique, France.*

Semester:
Teaching unit: UED XX
Matter:Pathology of geotechnical works
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The aim of this course is to present to the student the main pathological cases linked to geotechnical structures, the techniques for their diagnosis and the possible means of repair.

Recommended prior knowledge:

Material content:

It covers the following points:

- Analysis of the causes of disorders (execution errors, site instability, structural defects, modification of the characteristics of the foundation soil, modification of the environment).
- Causes linked to structures (constituent materials, undersizing, faulty execution)
- Causes linked to problematic soils (expansive soils, collapsible soils and liquefiable soils).
- Pathologies of superficial and deep foundations.
- Pathology of retaining structures.
- Means of prevention and repair of damaged structures.

Proposal for the new content of the subject:

- Definition of pathology and general information on the diagnosis and causes of pathologies,
- Pathologies of superficial and deep foundations,
- Pathology of retaining structures,
- Pathology of tunnels and underground works,
- Pathology of drainage works,
- Pathology of roads and roads,
- Means of prevention and repair of damaged structures.

Bibliography

1. *Mr. Lor. (2015), Pathology, diagnosis, prevention and maintenance of structures (C7100 V1). Ed. Engineering techniques.*
2. *J. Delefosse. Reinforced concrete pathologies – Physico-chemical actions, special cases and specific works (C6200 V2). Ed. Engineering techniques.*
3. *A. Plumier. (2011)*, Pathologies and structural repairs of constructions. Courses at the University of Liège.
4. *L. Logeais (2012)*, Foundation pathology – Fondasol. Monitor Edition.
5. **Pathology of superficial foundations: diagnosis, repair and prevention – individual houses and similar buildings**. CSTB Editions 2015.
6. **Guide to civil engineering inspection of road tunnels.**From disorder towards diagnosis – book 1 – Catalog of disorders – book 2 – CETU Guides – 2015.
7. **Removal and swelling of clays: Analysis and treatment of disorders created by drought**. Technique and Methods – Guide 3 – IFSTTAR Technical Quide 2017.

Repair and strengthening of foundations.*STRRES Guides No. 1*– National Federation of Public Works (FNTP).

Evaluation method:

Review: 100%

Bibliographic references:

1. *Mr. Lor. Pathology, diagnosis, prevention and maintenance of structures (C7100 V1). Ed. Engineering techniques.*
2. *J. Delefosse. Reinforced concrete pathologies – Physico-chemical actions, special cases and specific works (C6200 V2). Ed. Engineering techniques.*

Semester:
Teaching unit: UED XX
Matter:Rules of the public markets
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Recommended prior knowledge:

Material content:

Evaluation method:

Review: 100%

Bibliographic references:

Semester:
Teaching unit: UED XX
Matter:Geotechnical standards
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The purpose of this course is to present to the student the different geotechnical standards in force in Algeria and to raise awareness of compliance with regulatory requirements in geotechnical projects (design, calculation, execution, contractual relations, etc.).

Recommended prior knowledge:

Soil mechanics 1 and 2, Foundations and geotechnical works.

Material content:

It covers the following points:

- Test standards: experimental procedures and techniques for using test results (in-situ and laboratory tests).
- Sizing and calculation standards (foundations, retaining structures, screens, etc.).
- Standards for execution, monitoring and control of geotechnical works.
- Overview of European standards (Eurocode 7), American standards (ASTM: Geotechnical Engineering Standards), etc.

Evaluation method:

Review: 100%

Bibliographic references:

1. *Algerian standards published under the aegis of the Algerian Institute of Standardization (IANOR, 2010).*
2. *European standards :https://www.icab.fr/guide/eurocode/eurocode7.html*
3. *American standards:*https://www.astm.org/Standards/geotechnical-engineering-standards.html

Semester:
Teaching unit: UED XX
Matter:Construction law
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Recommended prior knowledge:

Material content:

Evaluation method:

Review: 100%

Bibliographic references:

Semester:
Teaching unit: UED XX
Matter:PGC of geotechnical works
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The purpose of this course is to introduce the student to the general processes of constructing foundations and geotechnical structures.

Recommended prior knowledge:

Soil mechanics 1 and 2, Foundations and geotechnical works.

Material content:

It covers the following points:

- Design.
- Regulatory sizing principles.
- Construction techniques.

Evaluation method:

Review: 100%

Bibliographic references:

Any document dealing with geotechnical works.

Semester:
Teaching unit: UED XX
Matter:Notions on civil and industrial constructions
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

This course aims to introduce the student to civil and industrial construction.

Recommended prior knowledge:

Construction materials, Resistance of materials, Reinforced concrete, Metal framework.

Material content:

It covers the following points:

- Design.
- Regulatory sizing principles.
- Construction techniques.

Evaluation method:

Review: 100%

Bibliographic references:

Any document dealing with civil and industrial constructions

Semester:
Teaching unit: UED XX
Matter:Concepts on roads and works of art
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The aim of this course is to introduce the student to engineering routes and structures.

Recommended prior knowledge:

Construction materials, Resistance of materials, Reinforced concrete, Metal framework.

Material content:

It covers the following points:

- Design.
- Regulatory sizing principles.
- Construction techniques.

Evaluation method:

Review: 100%

Bibliographic references:

Any document dealing with roads and structures

Semester:
Teaching unit: UED XX
Matter:Concepts on hydrotechnical works
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The purpose of this course is to introduce the student to hydrotechnical works.

Recommended prior knowledge:

Construction materials, Resistance of materials, Reinforced concrete, Metal framework.

Material content:

It covers the following points:

- Design.
- Regulatory sizing principles.
- Construction techniques.

Proposal of the content of the subject

Part I : Retaining works

1- General information on dams
- Definition of a dam
- Goals of a play-off
- Works constituting a dam
- Types of dams

2-Choice of the site of a dam
- Topography
- Hydrology
- Geotech

3-Calculation of concrete gravity dams
- Forces applied to the dam
- Rollover stability
- Sliding stability
- Drainage of concrete dams

Part II: Port works

1- General information on port structures
2- Exterior and interior works of ports
3- Constitution and dimensioning of an embankment dike

Evaluation method:

Review: 100%

Bibliographic references:

Any document dealing with hydrotechnical works.