Teaching program

Matériaux

Academic year 2023-2024

Ecole polytechnique de Nantes Université

November 13, 2023

Contents

Part I

Tables of teaching units

Semester 5 - unit *MAT 3*

Accueil

Manager : CROSNIER Olivier

Course		Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Computer aided drawing		1.25		7.5				*0*
• Materials and applications (accueil)			2.5					*0*
1 à 2 ▷ Chimie organique (accueil)			6					*0*
1 à 2 ▷ Mathématiques (accueil)			18					*0*
1 à 2 ▷ Physics (upgrade-refresher training)			6					*0*
1 à 2 ▷ TP Chimie des matériaux (accueil)				20				*0*
TOTAL	min	1.25	8.5	27.5	0	0	0	
	max	1.25	26.5	27.5	0	0	0	

Mathematics and applied computing I — ECTS : 6

Manager : CHAUVET Olivier

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Algorithmic and programming		13.5	10.5			13	*40*
• Linear algebra and complex analysis		26.5				13	*40*
• Numerical processing of experimental data			7.5			4	*20*
TOTAL	0	40	18	0	0	30	

Applied physics I — ECTS : 5

Manager : TESSIER Pierre-Yves

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Sensors, instrumentation and measurements	10	10.5				11	*40*
• General mechanics		11.5				6	*25*
• Optics and materials		16.5				9	*35*
TOTAL	10	38.5	0	0	0	26	

Materials chemistry I — ECTS : 5

Manager : JOUBERT Olivier

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Solid state chemistry I	7.5	9				9	*35*
• Physics and chemistry of polymers		16.5				9	*35*
• Thermodynamics of materials		11.5				6	*30*
TOTAL	7.5	37	0	0	0	24	

Humanities 5 ECTS : 8

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Business knowledge and entrepreneurship	3	13.5				4	*13*
• Physical education and sport 1		21				2	*13*
• Professionnal project 1	1.5	12				4.5	*13*
• Sustainable development and social responsability 1	1.5	13.5					*13*
• Project management 1	4.5		3			2	*13*
• Grammar and professional English 1		40					*35*
TOTAL	10.5	100	3	0	0	12.5	

Organization ECTS : 6

Manager : JOUBERT Olivier

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Chemical bonding		30				15	*50*
• Symmetry	13.75	14.5				14	*50*
TOTAL	13.75	44.5	0	0	0	29	

Sum of semester

		Lect	Tut	PW	Proj	WP	Asst	ECTS
Sum	min	43	268.5	48.5	0	0	121.5	30
	max	43	286.5	48.5	0	0	121.5	
Face-to-face sum		340 à 372						

Semester 6 - unit *MAT 3*

Mathematics and applied computing II — ECTS : 4

Manager : CUENOT Stéphane

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Generalized functions, integral transforms and partial differential equations		23				12	*40*
• Numerical methods 1		22.5				12	*40*
• Probabilities and statistics		13.5				7	*20*
TOTAL	0	59	0	0	0	31	

Mechanics and materials I — ECTS : 8

Manager : BERTRAND Emmanuel

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Mechanics of deformable solid body		31.5	18			25	*45*
• General metallurgy	8.75	23	26			27	*55*
TOTAL	8.75	54.5	44	0	0	52	

Humanities 6 — ECTS : 8

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• History of organizations and Accounting business game	9	10.5	12			5	*15*
• Physical education and sport 2		21				2	*15*
• Soft skills		7.5					*15*
• Socio-economic debates and Tools for shifting		21				10	*15*
• Professional Project 2		4.5					*5*
• Grammar, Toeic and professional English 2		39	2				*35*
TOTAL	9	103.5	14	0	0	17	

Applied physics II — ECTS : 5

Manager : ANGLERAUD Benoit

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Electronics for measurement systems - laboratory			24			12	*25*
• Fundamentals of heat transfer	1.25	10				6	*25*
• Solid state physics 1	6.25	4.5				6	*25*
• Physics and materials - laboratory			24			12	*25*
TOTAL	7.5	14.5	48	0	0	36	

Materials chemistry 2 ECTS : 3

Manager : PAYEN Christophe

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Materials Chemistry II	15	9				12	*55*
• Diffusion in solids		7				4	*20*
• Thermodynamics of materials - 2		11.5				6	*25*
TOTAL	15	27.5	0	0	0	22	

Internship 3rd year ECTS : 2

Manager : CROSNIER Olivier

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Internship 3rd year					8		*0*
TOTAL	0	0	0	0	8	0	

Sum of semester

	Lect	Tut	PW	Proj	WP	Asst	ECTS
Sum	40.25	259	106	0	8	158	30
Face-to-face sum	405.25						

Semester 7 - unit *MAT 4*

Engineering sciences — ECTS : 5

Manager : ANGLERAUD Benoit

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Electrical engineering		13.5	8			11	*40*
• Design of experiments	6.25	5.5				7	*25*
• Numerical methods 2			20			10	*35*
TOTAL	6.25	19	28	0	0	28	

Characterisation methods — ECTS : 5

Manager : COUTURIER Laurent

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Microscopies and spectroscopies	8.75	2.5				6	*25*
• Characterisation methods - laboratory			36			18	*35*
• Radiocrystallography	8.75	12.5				11	*40*
TOTAL	17.5	15	36	0	0	35	

Durability of materials and electric energy storage — ECTS : 3

Manager : CROSNIER Olivier

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Durability : corrosion and electrochemical coating deposition	8.75	9				9	*40*
• Electrochemistry : storage and conversion of decarbonated energy	11.25	11				11	*50*
• Materials indicators for eco-design		4.5				4.5	*10*
TOTAL	20	24.5	0	0	0	24.5	

Physics of materials and applications — ECTS : 4

Manager : CHAUVET Olivier

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Dielectric materials -Magnetic materials	10	4.5				8	*35*
• Solid state physics 2	15	10.5				13	*65*
TOTAL	25	15	0	0	0	21	

Humanities 7 — ECTS : 7

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Business analysis	4.5	6				3	*15*
• Quality, security and environmental approaches (QSE1)		3	3				*10*
• Physical education and sport 3		21				2	*10*
• Negotiations	3	7.5				2	*10*
• Professional project 3		6				6	*10*
• Circular economy	4.5	3				6	*10*
• Professional English 3		19	2				*26.25*
1 opt ▷ Continuous Assessment (bis)							*8.75*
1 opt ▷ French as a Foreign Language for engineering students		18					*8.75*
1 opt ▷ Second foreign language - Spanish		18					*8.75*
1 opt ▷ Second foreign language - Japanese		18					*8.75*
1 opt ▷ Second foreign language - Sign language		18					*8.75*
▷ Training for Toeic		18					*8.75*
TOTAL	12	83.5	5	0	0	19	

Rheology — ECTS : 4

Manager : TANCRET Franck

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Rheology and thermomechanics of polymers	10	14				12	*55*
• Plasticity of metals and metal forming	3.75	13.5				9	*45*
TOTAL	13.75	27.5	0	0	0	21	

Training Pathway S7 — ECTS : 2

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• 3A Internship Assesment							*50*
1 opt ▷ Entrepreneurship S7				32			*50*
1 opt ▷ Transition Engineering and Interdisciplinarity S7				32			*50*
1 opt ▷ Research S7				32			*50*
▷ Ecological and Societal Transition S7				32			*50*
TOTAL	0	0	0	32	0	0	

Sum of semester

	Lect	Tut	PW	Proj	WP	Asst	ECTS
Sum	94.5	184.5	69	32	0	148.5	30
Face-to-face sum	380						

Semester 8 - unit *MAT 4*

Polymers and composites — ECTS : 4

Manager : LESTRIEZ Bernard

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Adhesion, bonding, interfaces	11.25	6				9	*35*
• Composite materials	5	12				9	*35*
• Polymeric materials - laboratory project				17.5		9	*30*
TOTAL	16.25	18	0	17.5	0	27	

Ceramics, glasses and thin solid films — ECTS : 7

Manager : BROUSSE Thierry

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Ceramics and glasses	12.5	8				11	*25*
• Thin film materials	10	6				8	*15*
• Semiconducting materials and devices	13.75	4.5	12			16	*30*
• Ceramics and inorganic materials - laboratory project				32		16	*30*
TOTAL	36.25	18.5	12	32	0	51	

Metallurgy and durability of materials — ECTS : 6

Manager : PAILLARD Pascal

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Fracture-Fatigue-Creep	10	14				12	*30*
• Metallic materials - laboratory project				32		14	*30*
• Physical metallurgy		18				9	*20*
• Welding and foundry	15	3				9	*20*
TOTAL	25	35	0	32	0	44	

Humanities 8 ECTS : 6

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Critical approaches of the firm		9				3	*13*
• Quality, security ant environmental approaches (QSE2)		6					*13*
• Physical education and sport 4		19.5				2	*13*
• Professional Project 4		12				5	*13*
• Sustainable development and social responsability 2		9				10	*13*
• Intercultural explorations		18					*17.5*
1 opt ▷ Continuous Assessment(bis)							*17.5*
1 opt ▷ French as a Foreign Language for engineering students		18					*17.5*
1 opt ▷ Second foreign language - Sign language		18					*17.5*
1 opt ▷ Second foreign language - Spanish		18					*17.5*
1 opt ▷ Second foreign language - Japanese		18					*17.5*
1 opt ▷ Training for Toeic		18					*17.5*
TOTAL	0	91.5	0	0	0	20	

Internship 4th year ECTS : 5

Manager : LOUARN Guy

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Internship 4th year					13		*0*
TOTAL	0	0	0	0	13	0	

Training pathway S8 ECTS : 2

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
1 opt ▷ Entrepreneurship S8				32			*100*
1 opt ▷ Transition Engineering and Interdisciplinarity S8				32			*100*
1 opt ▷ Research S8				32			*100*
1 opt ▷ Ecological and Societal Transition S8				32			*100*
TOTAL	0	0	0	32	0	0	

Sum of semester

	Lect	Tut	PW	Proj	WP	Asst	ECTS
Sum	77.5	163	12	113.5	13	142	30
Face-to-face sum	366						

Semester 9 - unit *MAPI 5 - Composites*

Humanities 9 ECTS : 4

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Designing the tomorrow's management	3	6				3	*30*
• Project management 2		15				3	*35*
• People and team management		10.5				6	*30*
• Professional project 5		12				2	*5*
▷ Training for TOEIC - s9		10					*0*
TOTAL	3	53.5	0	0	0	14	

[MAPI] Scientific and technical advanced courses ECTS : 3

Manager : LOUARN Guy

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• CAD - Thermomecanics		9				5	*25*
• Computer aided design			9			5	*25*
• Meeting management	2.5	2				3	*20*
• Non destructive testing	9.75	1				6	*30*
TOTAL	12.25	12	9	0	0	19	

[MAPI] Internship and industrial project ECTS : 14

Manager : CUENOT Stéphane

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Evaluation internship 4th year						20	*10*
• Project				140		70	*75*
• Bibliographic survey	9			25		13	*15*
TOTAL	9	0	0	165	0	103	

[MAPI] Cursus Composite materials ECTS : 9

Manager : SOBOTKA Vincent

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Mechanical properties of composite materials	15	1.5	12			15	*30*
• Shaping of composite materials	22	13.5	24			30	*50*
• Thermophysical properties of polymers and composites	15	1.5				9	*20*
TOTAL	52	16.5	36	0	0	54	

Sum of semester

	Lect	Tut	PW	Proj	WP	Asst	ECTS
Sum	76.25	82	45	165	0	190	30
Face-to-face sum	368.25						

Semester 9 - unit *MAPI 5 - Métallurgie*

Humanities 9 — ECTS : 4

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Designing the tomorrow's management	3	6				3	*30*
• Project management 2		15				3	*35*
• People and team management		10.5				6	*30*
• Professional project 5		12				2	*5*
▷ Training for TOEIC - s9		10					*0*
TOTAL	3	53.5	0	0	0	14	

[MAPI] Scientific and technical advanced courses — ECTS : 3

Manager : LOUARN Guy

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• CAD - Thermomecanics		9				5	*25*
• Computer aided design			9			5	*25*
• Meeting management	2.5	2				3	*20*
• Non destructive testing	9.75	1				6	*30*
TOTAL	12.25	12	9	0	0	19	

[MAPI] Internship and industrial project — ECTS : 14

Manager : CUENOT Stéphane

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Evaluation internship 4th year						20	*10*
• Project				140		70	*75*
• Bibliographic survey	9			25		13	*15*
TOTAL	9	0	0	165	0	103	

[MAPI] Cursus Métallurgy : processes — ECTS : 5

Manager : BERTRAND Emmanuel

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• From elaboration to final product	24	1				13	*55*
• Current industrial applications in processes	8	0.5				5	*20*
• Thermomechanical treatments	12	0.5				7	*25*
TOTAL	44	2	0	0	0	25	

[MAPI] Cursus Metallurgy : materials ECTS : 4

Manager : COUTURIER Laurent

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Life cycle of metallic materials	8	0.5				5	*20*
• Industrial metallic alloys	26	1				14	*60*
• Current industrial applications in materials	8	0.5				5	*20*
TOTAL	42	2	0	0	0	24	

Sum of semester

	Lect	Tut	PW	Proj	WP	Asst	ECTS
Sum	110.25	69.5	9	165	0	185	30
Face-to-face sum	353.75						

Semester 9 - unit *MAPI 5 - RD*

Humanities 9 ECTS : 4

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Designing the tomorrow's management	3	6				3	*30*
• Project management 2		15				3	*35*
• People and team management		10.5				6	*30*
• Professional project 5		12				2	*5*
▷ Training for TOEIC - s9		10					*0*
TOTAL	3	53.5	0	0	0	14	

[MAPI] Scientific and technical advanced courses ECTS : 3

Manager : LOUARN Guy

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• CAD - Thermomecanics		9				5	*25*
• Computer aided design			9			5	*25*
• Meeting management	2.5	2				3	*20*
• Non destructive testing	9.75	1				6	*30*
TOTAL	12.25	12	9	0	0	19	

[MAPI] Internship and industrial project ECTS : 14

Manager : CUENOT Stéphane

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Evaluation internship 4th year						20	*10*
• Project				140		70	*75*
• Bibliographic survey	9			25		13	*15*
TOTAL	9	0	0	165	0	103	

[MAPI] Cursus R&D of innovative materials ECTS : 3

Manager : CUENOT Stéphane

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• R&D economy	1.5	6				4	*25*
• R&D Project management	12					6	*40*
• Innovation	9					5	*35*
TOTAL	22.5	6	0	0	0	15	

[MAPI] Cursus RD : Scientific and technical advances courses 2 ECTS : 6

Manager : CUENOT Stéphane

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Surface Analysis	8.75	1.5				6	*20*
• Specializes lectures by professionnal lecturers	45					23	*60*
• Design of experiments : advanced course		6				3	*20*
TOTAL	53.75	7.5	0	0	0	32	

Sum of semester

	Lect	Tut	PW	Proj	WP	Asst	ECTS
Sum	100.5	79	9	165	0	183	30
Face-to-face sum	353.5						

Semester 9 - unit *Soudage*

Design and control

ECTS : 6

Manager : PAILLARD Pascal

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• CAD - Thermomecanics		9				5	*15*
• Computer aided design			9			5	*15*
• Design of welded components	28	1.5				15	*40*
• Non destructive testing	9.75	1				6	*15*
• Non destructive testing of welds	3.5		7			6	*15*
TOTAL	41.25	11.5	16	0	0	37	

Materials

ECTS : 5

Manager : PAILLARD Pascal

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Weld analysis			10				*15*
• Welding metallurgy	57.75	1.5				26	*85*
TOTAL	57.75	1.5	10	0	0	26	

Fabrication

ECTS : 8

Manager : PAILLARD Pascal

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Evaluation internship 4th year						20	*15*
• Fabrication, operation and exploitation of welded components	24.5	1.5				9	*30*
• Project - case study - meeting management	2.5	2		52.25		29	*55*
TOTAL	27	3.5	0	52.25	0	58	

Humanities 9

ECTS : 4

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Designing the tomorrow's management	3	6				3	*30*
• Project management 2		15				3	*35*
• People and team management		10.5				6	*30*
• Professional project 5		12				2	*5*
▷ Training for TOEIC - s9		10					*0*
TOTAL	3	53.5	0	0	0	14	

Welding process

ECTS : 7

Manager : PAILLARD Pascal

Course	Lect	Tut	PW	Proj	WP	Asst	*Coef*
• Practical training			35				*20*
• Welding methods	56	1.5				29	*80*
TOTAL	56	1.5	35	0	0	29	

Sum of semester

	Lect	Tut	PW	Proj	WP	Asst	ECTS
Sum	185	71.5	61	52.25	0	164	30
Face-to-face sum	369.75						

Part II

Sheets of courses

3A Internship Assesment

Hours

Lect Tut PW Proj WP Asst

Evaluation

One evaluation : *Rapport*

Manager : Bruno AUVITY

Adhesion, bonding, interfaces

Hours

Lect	Tut	PW	Proj	WP	Asst
11.25	6				9

Evaluation

One evaluation : *DS*

Outline

- Physics-chemistry of adhesion (bonds, thermodynamic work of adhesion), energy of adherence
  - Evaluation of adherence. Mechanical properties of interfaces. Cantilever beam, shear and peel tests
  - Design of bonded joints (the Volkersen approach)
  - Surface preparation. Laws of wetting and impregnation
  - Welding of polymers
  - Adhesives technology
  - o Non-chemical Adhesives
  - o Chemical adhesives (mechanisms of activation and of polymerization)
  - o Exemples of application
  - Controling bonded joints and conclusion.

Goals

The goals are to be able to handle a bonding problem, from the design to the realization. The students will not be experts, but they will be able to understand all the complexity of bonding problems and to echange with specialists.

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Prerequisites

Polymers rheology, physics-chemistry, synthesis. Basics of mechanics and physics and chemistry of materials.

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know designing bonded joints	·	✓	·	·	·
• To know evaluating the mechanical strength of bonded joints	·	✓	·	·	·
• To know preparing and characterizing a surface before bonding	·	✓	·	·	·
• To know using a technical adhesive	·	✓	·	·	·
• To know controling bonded joints	·	✓	·	·	·

Manager : Bernard LESTRIEZ

Algorithmic and programming

Hours

Lect	Tut	PW	Proj	WP	Asst
	13.5	10.5			13

Evaluation

2 evaluations :

- *DS*
- *CR*

Learning outcomes

Learning outcomes	N	A	M	E	O
• To control a 'basic' programming (graphic, matrix calculation, polynomial, research of extrema, signal processing)	·	·	✓	·	·
• To control the use of procedures "function" pre-programmed or not	·	·	✓	·	·
• To control the graphic display of data (2D, 3D)	·	·	✓	·	·

Manager : Stéphane CUENOT

Bibliographic survey

Hours

Lect	Tut	PW	Proj	WP	Asst
9			25		13

Evaluation

One evaluation : *Rapport*

Outline

The use of documentary research methods - Sources of information in Science and Technology - Query methods - Information exploitation and bibliograhic synthesis

Goals

The aim of this course is to equip students with the skills required to utilise databases and search engines suited to research and development.

Bibliography

Net recherche : le guide pratique pour mieux trouver l'information utile - Armelle Thomas - Sci. et tech. de l'information, 2008

Guide de la recherche documentaire - M Gagnon et F Farley-Chevrier - PUM - 2004

Learning outcomes

Learning outcomes	N	A	M	E	O
• Specifying information requirements and writing a research plan	·	✓	·	·	·
• Using a database and exploiting information	·	·	✓	·	·
• Organizing documentation	·	·	✓	·	·
• Writting a bibliographic essay and creating a reference list	·	✓	·	·	·

Manager : Stéphane CUENOT

Business analysis

Hours

Lect	Tut	PW	Proj	WP	Asst
4.5	6				3

Evaluation

One evaluation : *Etude de cas*

Bibliography

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- S. Robbins, D. DeCenzo, M. Coulter ; Management, l'essentiel des concepts et des pratiques (9ème éd) Ed. Pearson
- https://www.l-expert-comptable.com/dossiers/evaluer-l-entreprise-reprendre-grace-l-analyse-economique.html
- https://www.fao.org/capacity-development/resources/practical-tools/analyse-organizational-performance/fr/

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	·	✓	·	·	·
• TPN-4	✓	·	·	·	·

Manager : Gwenael THOREL

Business knowledge and entrepreneurship

Hours

Lect	Tut	PW	Proj	WP	Asst
3	13.5				4

Evaluation

One evaluation : *Etude de cas*

Bibliography

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? Henri Mintzberg, Structure et dynamique des organisations (Éd. d'organisation)

? http://www.laurentdehouck.fr/enseignements/histoire-des-idees-sur-les-organisations/

? M. Bidan et Y. Livian (2022), les grands auteurs aux frontières du management (Editions EMS)

? M.Crozier ; A quoi sert la sociologie des organisations (Éd. Seli Arslan)

? Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. Communications of the association for Information Systems, 16(1), 1.

? Ramadani, V. (2009). Business angels: who they really are. Strategic Change: Briefings in Entrepreneurial Finance, 18(7?8), 249-258.

? S. Robbins, D. DeCenzo, M. Coulter ; Management, l'essentiel des concepts et des pratiques Ed. Pearson.

? Sarasvathy, S. D. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. Academy of management Review, 26(2), 243-263.

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	✓	·	·	·	·
• TPN-4	✓	·	·	·	·
• TPN-6	✓	·	·	·	·

Manager : Luc OILI

CAD - Thermomecanics

Hours

Lect	Tut	PW	Proj	WP	Asst
	9				5

Evaluation

One evaluation : *CR*

Outline

Tackled issues :

- drawing import from Catia to Comsol
- static analysis (2D & 3D), meshing influence with a point load ;
- differential thermal dilatation
- thermomechanics with stationnary conduction
- elasto-plastic analysis

Goals

To solve multiphysic problems with numerical simulation in mechanics and thermomechanics 2D and 3D.

To manage problems of meshing and modeling choices

Used softwares : Comsol and Catia

Prerequisites

Rigid body mechanics ; Mechanics of deformable solids ; vibrations mechanics; Thermal conduction

Learning outcomes

Learning outcomes	N	A	M	E	O
• To solve multiphysic problems by numerical simulation wiyh Comsol	·	·	✓	·	·
• To manage problems of meshing and singularities	·	·	✓	·	·
• To import models from Catia to Comsol	·	·	✓	·	·

Manager : Jérémie RUPIL

Ceramics and glasses

Hours

Lect	Tut	PW	Proj	WP	Asst
12.5	8				11

Evaluation

3 evaluations :

- *DS1*
- *DS2*
- *Projet*

Outline

Introduction: similarities and differences with metals, polymers, composites

Synthesis and characterization of powders: solid state route, sol-gel, soft chemistry, other syntheses, characterizations (diffraction, microscopy, surface analysis, particle size ...). Techniques for shaping ceramics: compaction, formulation of slurries, sintering with and without a liquid phase, etc ...

Synthesis and shaping glasses

Binders: synthesis, characterization and use ...

Thermomechanical properties of ceramics (elasticity, fracture toughness, effect of porosity, fracture statistics, thermal shock, heat resistance...)

Examples of current applications of ceramics and glasses

Goals

Knowing the main methods of preparation of and characterization of ceramics and glasses as well as their physical, chemical and thermomechanical properties, being able to choose and / or synthesize a ceramic material or glass with specific properties for a given application, to establish a specifications, to perform failure analysis & recommend solutions

Bibliography

J.M. Haussonne, C. Carry, P. Bowen, J. Barton, "Traité des matériaux", vol. 16, "Céramiques et verres - principes et techniques d'élaboration", PPUR.

W.D. Kingery, H. K. Bowen, D.R. Uhlmann, "Introduction to Ceramics", Wiley

D. Munz, T. Fett, "Ceramics: Mechanical Properties, Failure Behaviour, Materials Selection", Springer

Prerequisites

Solid State Chemistry

crystal symmetry

Phase diagrams

Physics of Solids magnetic and dielectric

Bases in mechanics of materials (elasticity, fracture mechanics)

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the main characteristics of ceramics and glasses	·	·	·	✓	·
• Knowledge of methods of preparation of ceramics and glasses and related characterizations	·	·	✓	·	·
• To be able to establish specifications to develop a new material or improve an existing material	·	·	✓	·	·
• To be able to select a material, a powder, a manufacturing method according to an application or environment	·	·	✓	·	·
• To be able to interpret failures and propose remedies for these failures	·	·	✓	·	·

Manager : Thierry BROUSSE

Ceramics and inorganic materials - laboratory project

Hours

Lect	Tut	PW	Proj	WP	Asst
			32		16

Evaluation

2 evaluations :

- *CR*
- *SO*

Outline

28 hours of laboratory work. 4 hours for final oral presentations. 2 supervisors for 16 students. Students work in pairs.

Examples of topics :
Synthesis of materials for Lithium-ion and supercapacitors
Fabrication of a Nernst lamp
Synthesis and characterization of materials for Solid Oxide Fuel Cells (SOFC)

Goals

To undertake a small experimental project in near autonomy dealing with ceramic materials

Prerequisites

To know how to synthesize oxide materials (ceramic, hydrothermal routes, or sol gel methods)

To be able to use the characterization equipments (X-ray diffraction, scanning electron microscopy, electrochemistry equipments, furnaces...)

Learning outcomes

Learning outcomes	N	A	M	E	O
• To be able to manage and execute a small project (task planning and task distribution) in a limited time, taking account of the limited availability of equipments and staff	·	·	✓	·	·
• Be able to use multi-disciplinary knowledge and apply it to metallic materials	·	·	✓	·	·
• To be able to write a final report and give a talk. To be clear, positive and persuasive	·	·	✓	·	·
• To cast a critical eye on one's own work and others. To compare one's work with others	·	·	✓	·	·
• To be able to analyze the causes of failure and adapt one's approach in light of these failures	·	·	✓	·	·

Manager : Olivier CROSNIER

Characterisation methods - laboratory

Hours

Lect	Tut	PW	Proj	WP	Asst
		36			18

Evaluation

2 evaluations :

- *CR*
- *SO*

Outline

Characterization of semi-cristalline polymers using thermal analysis (DSC) - Surface properties of materials

Identification and characterization of polymers using infrared spectroscopy (FTIR) and X-Ray fluorescence (ED-XRF)

Introduction to rheology and viscoelastic behaviors of elastomers and polymers

Characterization of electrochemical generators

Experimental study of materials using X-ray Diffraction (XRD)

Synthesis and forming of ceramics

Powder specific area and grain size determined using the B.E.T. method

Initiation to the usage of a Scanning Electron Microscope (SEM)

Goals

The main objective is to use the main characterization methods used in material science to investigate their properties. These methods will be used by the students in experimental projects, internships, and in their professionnal carrier.

Prerequisites

To know the principles and the basics of the experimental techniques used

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know what kind of information can be obtained from each experimental technique	·	·	✓	·	·
• To know the limits of each technique, and how complementary they can be	·	·	✓	·	·
• To know how to use the different techniques	·	✓	·	·	·
• To be able to write a final report and give an oral presentaion of the obtained results	·	·	✓	·	·

Manager : Laurent COUTURIER

Chemical bonding

Hours

Lect	Tut	PW	Proj	WP	Asst
	30				15

Evaluation

3 evaluations :

- *CC*
- *DS1*
- *DS2*

Outline

Quantum mechanics postulates, deep well and degeneration.; Hydrogen Atom: spherical harmonics, orbital spin.; Many-electron atoms: Periodic classification, electronegativity.; Molecular orbitals: diatomic molecules, the Hückel method. From molecule to solid : Analogy molecular orbital - Bloch orbital (OB), energy diagram, Brillouin zone concepts, valence bands, conduction and Fermi levels. Construction of the band diagram from the LCAO; Parameters influencing the dispersion bands (E (k)) (orbital overlap, distances ...) Construction of a system for 1D OB (infinite chain of hydrogen); Extension to 2D and 3D systems. Structure-property relationship (relationship between the band structure and electronic properties of materials).

Goals

This course is an introduction to the theoretical determination of the electronic structure of solids. It provides the basis for understanding the relationship stucture - properties exposed in the course of Solid State Chemistry and Physics of the solid.

Prerequisites

Concepts of physics and chemical bonding.

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know how to build the periodic table, knowledge and understanding of the periodic changes in the properties of atoms	·	·	✓	·	·
• To be able to apply the Slater method, Linear Combination of Atomic Orbitals and Hückel	·	·	✓	·	·
• To know how to build and used the Bloch orbitals	·	·	✓	·	·
• To know the tools for analyzing the electronic structure of solids	·	✓	·	·	·
• To understand the relationship between structure at the atomic scale and chemical and physical properties of solids.	✓	·	·	·	·

Manager : Olivier CROSNIER

Circular economy

Hours

Lect	Tut	PW	Proj	WP	Asst
4.5	3				6

Evaluation

One evaluation : *Diagnostic*

Bibliography

- AUREZ Vincent, GEORGEAULT Laurent, Economie circulaire, de Boeck
- Cf bibliographie donnée pendant le cours

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-3	✓	·	·	·	·

Manager : Chrystèle GONCALVES

Composite materials

Hours

Lect	Tut	PW	Proj	WP	Asst
5	12				9

Evaluation

One evaluation : *DS*

Outline

PART 1: Composite materials

Reinforcements: glass, carbon, organic fibers

Resins: Thermoplastics, Thermosets

Processing: Contact, Autoclave, Sandwiches, Injection, Compression

PART 2: Mechanic of laminates

- Elastic behavior of a unidirectional composite material
- Behavior of a elastic orthotropic composite . (2D anisotropic behavior, flexibility and stiffness coefficients)
- Composite material outside of its main axes
- Modelling of the mechanical behavior of laminates and sandwiches
- Criteria of breaking classic ; Design Rules

Goals

Having knowledge in the field of reinforced composites, processing and characterization of materials and final product.

Mechanical characterizations : Tests, and modeling, design and examples from the aerospace, naval and automotive.

Prerequisites

Knowledge of polymer chemistry and mechanics of materials

Learning outcomes

Learning outcomes	N	A	M	E	O
• Describe the various components constituting the structural composites	·	·	✓	·	·
• Determine the mechanical tests appropriate for the characterization and modeling	·	·	✓	·	·
• Determine the mechanical properties of a basic structure laminates	·	·	✓	·	·
• Know the failure mechanisms	·	✓	·	·	·
• Determine the rupture limit of laminate material (Tsai-Hill criteria and others)	·	✓	·	·	·

Manager : Guy LOUARN

Computer aided design

Hours

Lect	Tut	PW	Proj	WP	Asst
		9			5

Evaluation

One evaluation : *Travail à rendre*

Manager : Guy LOUARN

Computer aided drawing

Hours

Lect	Tut	PW	Proj	WP	Asst
1.25		7.5			

Outline

Basic rules of technical drawing
Conventional drawings : threads, gears
Perspectives, 3D modelization methods
Practicals : handling of Catia by 3D modelization and 2D drawing of mechanisms

Goals

To understand a technical drawing
To use a drawing software in 3D mode

Bibliography

Memotech-Productique : conception et dessin
par C. Carlier et R. Bourgeois - Editions Casteilla

Learning outcomes

Learning outcomes	N	A	M	E	O
• To understand a technical drawing	·	·	✓	·	·
• To use a drawing software in 3D mode	·	·	✓	·	·

Manager : Jérémie RUPIL

Continuous Assessment (bis)

Hours

Lect Tut PW Proj WP Asst

Evaluation

One evaluation : *CC*

Continuous Assessment(bis)

Hours

Lect Tut PW Proj WP Asst

Evaluation

One evaluation : *CC*

Critical approaches of the firm

Hours

Lect	Tut	PW	Proj	WP	Asst
	9				3

Evaluation

One evaluation : *Exposé*

Bibliography

- Carney, B. M., & Getz, I. (2016). Freedom, Inc: How Corporate Liberation Unleashes Employee Potential and Business Performance. International Creative Management.

- Detchessahar, M. (2019). L'entreprise délibérée: refonder le management par le dialogue. Nouvelle cité.

- Dujarier, M.-A. (2017). Le management désincarné: enquête sur les nouveaux cadres du travail. La découverte.

- Gomez, P.-Y. (2013). Le travail invisible: enquête sur une disparition. Paris: F. Bourin.

- Les statuts juridiques de l'entreprise (Dessine-moi l'éco)

- Rendre le travail visible : la solution pour sortir de la crise (Dessine moi l'éco)

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	✓	·	·	·	·
• TPN-3	✓	·	·	·	·
• TPN-4	✓	·	·	·	·
• TPN-6	✓	·	·	·	·

Manager : Roland BESSENAY

Current industrial applications in materials

Hours

Lect	Tut	PW	Proj	WP	Asst
8	0.5				5

Evaluation

One evaluation : *CR*

Outline

A program of conferences animated by engineers currently working in the mettalic materials industry (topics will depend on the speakers)

Goals

To get an experience of the development of innovative and/or complex metallic alloys based on the development of the technicity of metallic parts through some examples steaming from the current industry

Prerequisites

industrial metallic alloys

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know some examples of the development of innovative and/or complex metallic materials	✓	·	·	·	·
• Be able to extract the important information from an oral presentation and sum them up in a written report	·	·	✓	·	·

Manager : Emmanuel BERTRAND

Current industrial applications in processes

Hours

Lect	Tut	PW	Proj	WP	Asst
8	0.5				5

Evaluation

One evaluation : *CR*

Outline

A program of conferences animated by engineers currently working in the mettalic materials industry (topics will depend on the speakers)

Goals

To get an experience in the innovative and/or complex processes developped based on the technicity of mettalic parts through some examples used in the current industry.

Prerequisites

processes of elaboration, forming and joining

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know some examples of recent and/or complex process development	✓	·	·	·	·
• To be able to extract important information from an oral presentation to sum them up in a written report	·	·	✓	·	·

Manager : Laurent COUTURIER

Design of experiments

Hours

Lect	Tut	PW	Proj	WP	Asst
6.25	5.5				7

Evaluation

One evaluation : *DS*

Outline

Intoduction: experimental strategies, winning strategy
Factorial designs 2p with factors p and two levels
Fractional designs 2k-p
Data analysis
Accuracy
Notions about other types of design of experiments: Tagushi, central composite designs

Goals

To know how to design fractional factorial design of experiments 2p and 2k-p.

Bibliography

« La méthode des plans d'expériences », J.Goupy, Dunod, Paris 1988.
« Introduction à la méthode des plans d'expériences par la méthode Tagushi », M.Pillet, Les éditions d'organisation université, 1991.
« Plans d'expériences pour surfaces de réponse », J. Goupy, Dunod, Paris 1999

Prerequisites

matrix calculations
Basic Statistics

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know how to design a design of experiments 2p, how to perform it and how to solve it	·	·	✓	·	·
• To know how to design a fractional design of experiments 2k-p, how to perform it and how to solve it	·	·	✓	·	·

Manager : Thierry BROUSSE

Design of experiments : advanced course

Hours

Lect	Tut	PW	Proj	WP	Asst
	6				3

Evaluation

One evaluation : *CC*

Outline

Multilinear regression, quality evaluation models
Analysis of variance
Transmission of errors, accuracy in the predicted responses
Optimality criterion
Study on the model of second degree
Canonical analyzes R and RT
Different types of experimental designs

Goals

To know the analysis of variance and canonical analysis practice.
To know the different types of experimental designs and their characteristics

Bibliography

« Plans d'expériences pour surfaces de réponse », J. Goupy, Dunod, Paris 1999

Prerequisites

Advanced notions on complete and fractional factorial designs.
Matrix calculations.
Statistics

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the principles of analysis of variance	·	✓	·	·	·
• To practice canonical analysis R and RT	·	✓	·	·	·

Manager : Thierry BROUSSE

Design of welded components

Hours

Lect	Tut	PW	Proj	WP	Asst
28	1.5				15

Evaluation

One evaluation : *DS*

Outline

Design of joints for welding and brazing
- Principles of welding design
- Behavior of welded structures under different types of load
- Design of welded structures under essentially static
- Behaviour of welded structuresunder cyclic load
- Design of the welded under cyclic load
- Design of welded pressure equipment
- Design of structures in aluminium alloys

Goals

Know to calculate and to design welded structures subjected to different types of solicitation: static or dynamic mechanics, thermal

Bibliography

MANFRED A., Conception des charpentes métalliques, Presses Polytechniques et Universitaires Romandes, 2002

BLONDEAU R., Métallurgie et mécanique du soudage, Lavoisier , Hermès science, 2001

MANFRED A., Construction métallique: notions fondamentales et méthodes de dimensionnement, Presses Polytechniques et Universitaires Romandes, 2001

MOREL J., Guide de calcul des structures métalliques : CM 66 additif 80 - Eurocode 3, Eyrolles, 1997.

Construction métallique et mixte acier-béton : calcul et dimensionnement selon les Eurocodes 3 et 4 - Tome 1, Eyrolles, 1996.

Construction métallique et mixte acier-béton : conception et mise en oeuvre - Tome 2, Eyrolles, 1996

Prerequisites

Course on mechanics of fracture and strength of materials (3rd and 4th year)

Learning outcomes

Learning outcomes	N	A	M	E	O
• To understand the behavior of welded structures under different types of load	·	·	✓	·	·
• To calculate and size welds	·	·	✓	·	·
• To design of welded structures	·	·	✓	·	·

Manager : Pascal PAILLARD

Designing the tomorrow's management

Hours

Lect	Tut	PW	Proj	WP	Asst
3	6				3

Evaluation

One evaluation : *Grille d'évaluation*

Bibliography

Partie don :

L'entreprise une affaire de don (Collectif, 2016)

Recevoir pour donner (Collectif, 2016)

Partie Jeux sérieux :

Theory of Fun for Game Design, Raph Koster, O'Reilly Media; Second edition, ISBN ? 978-1449363215

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	·	·	✓	·	·
• TPN-2	·	·	✓	·	·
• TPN-3	·	·	✓	·	·
• TPN-4	·	·	✓	·	·
• TPN-5	·	·	✓	·	·

Manager : Roland BESSENAY

Dielectric materials -Magnetic materials

Hours

Lect	Tut	PW	Proj	WP	Asst
10	4.5				8

Evaluation

One evaluation : *DS*

Outline

This course will cover the following topics. Electric polarization and dielectric constant - Dielectric loss - Capacitance - Dielectric breakdown - Piezoelectricity - Pyro and ferroelectricity - Applications of dielectric materials - Magnetostatics - Ferromagnetism - Hard ferromagnets - Soft magnetic materials - Magnetic properties of superconducting materials.

Goals

The aim of the course is to provide students with a general overview of the various properties and of the numerous applications of magnetic or dielectric materials. Manufacturing process are also introduced

Bibliography

"Matériaux de l'électronique - Volume II, P. Robert, Traité d'électricité de l'EPFL, PPR" « Magnétisme - Fondements, Matériaux et Applications », Presses Universitaires de Grenoble - « Matériaux magnétiques en génie électrique », Lavoisier et Hermès science

Prerequisites

Background in electromagnetism and materials sciences (chemistry, physics, process engineering)

Learning outcomes

Learning outcomes	N	A	M	E	O
• Knowing physical quantities in order to characterize or choose a material	·	·	✓	·	·
• Knowing the possible roles of magnetic or dielectric materials in industrial devices	·	·	✓	·	·
• Evaluating energy losses in a magnetic or dielectric material	·	✓	·	·	·
• Knowing and understanding shape anisotropy and microstructural effects on the properties of magnetic or dielectric materials	·	·	✓	·	·

Manager : Christophe PAYEN

Diffusion in solids

Hours

Lect	Tut	PW	Proj	WP	Asst
	7				4

Evaluation

One evaluation : *DS*

Outline

Atomic jumps and statistical physics
Fick's equations
Influence of time and temperature on diffusion
Meachanisms and associated diffusion coefficients
- autodiffusion
- vacancies diffusion
- heterodiffusion : in dilute alloy and interdiffusion
Diffusion in ionic solids
Diffusion and cristalline defects
Reactive diffusion

Goals

Get the basics of solid state diffusion : equations that drive the diffusion and the phenomenon mechanisms.

Sensitize the students to the ubiquity of this phenomenon in materials science (often being underlying in more complex phenomena) and then to the fact that they will have to often use it again in the following of their formation.

Bibliography

Phase transformations in Metals and Alloys, Third Edition, D. A. Porter, K. E. Easterling and M. Y. Sherif, CRC Press Taylor & Francis Group

Diffusion in Solids, Field Theory, Solid-State Principles, and Applications, M. E. Glicksman, Wiley Inter-Science

Prerequisites

Mathematics and physics basics

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know how to use the Fick's equations in order to solve a diffusion problem.	·	✓	·	·	·
• To understand the influence of time and temperature on the diffusion phenomenon.	·	✓	·	·	·
• To understand that diffusion is a phenomenon that governs numerous other more complex phenomena in materials science.	✓	·	·	·	·
• To master the diffusion terminology in order to be able to get from scientific literature the appropriate data to solve a diffusion problem.	·	·	✓	·	·

Manager : Laurent COUTURIER

Durability : corrosion and electrochemical coating deposition

Hours

Lect	Tut	PW	Proj	WP	Asst
8.75	9				9

Evaluation

One evaluation : *DS*

Presentation

A set of lectures, supervised work and industrial presentations covering the mechanisms, thermodynamics and kinetics of corrosion, as well as the ways to fight against it or to avoid it, notably through surface treatments and electrochemically obtained coatings.

Outline

1. Thermodynamics of corrosion:
- Oxidation, electronegativity, Gibbs free energy
- High temperature oxidation (Ellingham)
- Electrochemical potential (Nernst, Pourbaix)
2. Kinetics of aqueous corrosion:
- Kinetics controlled by charge transfer (Butler-Volmer, Tafel, Evans...)
- Kinetics controlled by diffusion
- Passivation and depassivation
3. Industrial case studies and mechanisms:
Uniform, pitting, crevice, galvanic, intergranular, stray current corrosions; stress-corrosion cracking
4. Implementation of surface treatments and coatings:
- Preparation treatments: pickling, degreasing, polishing
- Chemical deposition (displacement deposition, electroless plating), electrolytic deposition and coating by immersion in liquid metals
5. Applications of surface treatments and coatings:
- Protection against corrosion: thickness, undercoats, other physico-chemical properties (hardness, wear resistance...)
- Other uses: MEMS, sensors...

Goals

Provide the future materials engineer with:
- physical and chemical notions leading to the understanding and characterisation of corrosion phenomena;
- an illustration of industrial practice in terms of corrosion control and expertise;
- the scientific and technological knowledge allowing to implement strategies of protection against corrosion, notably involving coating processes by electrochemical routes.

Bibliography

- Dieter Landoldt ; Corrosion et chime de surface des matériaux ; PPUR, 1993
- Mars G. Fontana ; Corrosion Engineering ; Mc Graw-Hill, 1987, www.corrosiondoctors.org/
- MODERN ELECTROPLATING, Fifth Edition, Edited by MORDECHAY SCHLESINGER & MILAN PAUNOVIC, Published by John Wiley & Sons, Inc., Hoboken, New Jersey, 2010, ISBN 978-0-470-16778-6

Prerequisites

Thermodynamics, bases in chemistry and general metallurgy

Learning outcomes

Learning outcomes	N	A	M	E	O
• Knowing how to apply electrochemical law to corrosion characterisation	·	·	✓	·	·
• Being able to take corrosion into account in engineering design (corrodability, corrosion rate)	·	·	✓	·	·
• Being able to diagnose corrosion damage	·	✓	·	·	·
• Being capable of choosing a surface treatment / a coating to fight against corrosion	·	·	✓	·	·
• Knowing how to implement a surface treatment / a coating	·	·	✓	·	·

Manager : Franck TANCRET

Ecological and Societal Transition S7

Hours

Lect	Tut	PW	Proj	WP	Asst
			32		

Evaluation

One evaluation : *Evaluation*

Manager : Emilie GADOIN

Ecological and Societal Transition S8

Hours

Lect	Tut	PW	Proj	WP	Asst
			32		

Evaluation

One evaluation : *Evaluation*

Manager : Emilie GADOIN

Electrical engineering

Hours

Lect	Tut	PW	Proj	WP	Asst
	13.5	8			11

Evaluation

2 evaluations :

- *DS*
- *CR*

Presentation

Basis of electrical engineering. The production and the network of electrical energy is presented. The main industrial electrical machines are also described.

Laboratory : practical works and skills concerning electrical engineering ; Pratical performing of electrical circuit using industrial machine (tranformers, motors) ; study of electrical apparatus behaviour. Calculation of electrical powers (DC and RF).

Outline

Course :

Materials being used in electrical engineering regarding their electrical properties

single and three phase networks ; electrical powers ; electrical security ; electrical transformer ; alternator ; Direct current motor ; AC current motor

Laboratory :

single transformer ; no-load and short circuit test ;electrical load measurements ; single phase engine operation ; variable three phase transfomer ; DC current engine operation ; yield measurement ; motor speed control ; characteristics of asynchronous engine

Goals

the aim is to acquire the basis of electrical engineering, of electrical security and also to give the knowleges which allow the choice of material regarding its electrical properties and its potential application in an electrical machine.

Practical basis of electrical engineering ; electrical measurements ; electrical security

Bibliography

titre : Matériaux de l'Electrotechnique
auteurs : P. Robert
éditeur : Presses Polytechniques Romande date : 1998 ISBN: 2-88074-419-9
titre : Les Bases de l'Electrotechniqueauteurs : I. BERKES
éditeur : Vuibert date : 1998 ISBN: 2-7117-8879-2
titre : Electrotechnique Industrielle
auteurs : G. SEGUIER, F. NOBLET
éditeur : Lavoisier date : 2006 ISBN 2-7430-0791-5
titre : Electrotechnique
auteurs : T. WILDI
éditeur : Deboeck, Université date : 2005 ISBN 2-8041-4892-0
titre : Electrotechnique
auteurs : MERAT
éditeur : Nathan date : 1997 ISBN 2-09-177992-7

Prerequisites

Electricity, Magnetism, Electromagnetism

Learning outcomes

Learning outcomes	N	A	M	E	O
• knowing of materials involved in electrical engineering	·	✓	·	·	·
• be able to describe the operating principles of electrical machines	·	✓	·	·	·
• be able to evaluate the different electrical powers and the power factor of an electrical circuit	·	·	✓	·	·
• be able to evaluate and to measure the yield of an electrical system	·	·	✓	·	·
• knowing and be able to follow the bases of electrical safety	·	✓	·	·	·
• be able to choose electrical components to make an electrical circuit and to control an electrical machine	·	✓	·	·	·
• be able to operate different electrical machines	·	·	✓	·	·
• be able to define and use a control and regulation system to operate an electrical machine	·	✓	·	·	·
• be able to make electrical assembly using industrial electrical machines	·	✓	·	·	·

Manager : Benoit ANGLERAUD

Electrochemistry : storage and conversion of decarbonated energy

Hours

Lect	Tut	PW	Proj	WP	Asst
11.25	11				11

Evaluation

2 evaluations :

- *CC*
- *DS*

Outline

The first part is devoted to the basics of electrochemistry in liquid medium in particular addressing the concepts of thermodynamic stability of species as a function of potential and pH. The second part deals with the electrochemical generators using the previous bases. Batteries, fuel cells and supercapacitors are detailed.

Goals

Acquire theoretical and practical knowledge on the different systems of electrochemical conversion and storage of energy.

Prerequisites

Concepts of general chemistry

Learning outcomes

Learning outcomes	N	A	M	E	O
• Know the basics of electrochemistry	·	·	✓	·	·
• Know the different systems of electrochemical storage and conversion of energy	·	·	✓	·	·

Manager : Olivier JOUBERT

Electronics for measurement systems - laboratory

Hours

Lect	Tut	PW	Proj	WP	Asst
		24			12

Evaluation

One evaluation : *CR*

Outline

Microproject - Sensors and measurement chain - Experimental study of analog filtering - Sampling, Data acquisition and digital signal processing

Goals

Learn techniques of measurements on electronic systems with analog and digital signal processing. Realize a project of conception and realization of a measurement chain going from the sensor up to the acquisition of datas

Bibliography

Acquisition de données - Du capteur à l'ordinateur - G. Asch - Dunod ; Electronique des systèmes de mesures - Mise en oeuvre des procédés analogiques et numériques - Tran Tien Lang - Masson ; Les capteurs en instrumentation industrielle - G. Asch - Dunod

Prerequisites

Course of "Sensors, Instrumentation and Measurements" in S5

Learning outcomes

Learning outcomes	N	A	M	E	O
• Build a project management with time constraint and with precise technical specifications: organize work and schedule, know how to cooperate, know how to work in a team, manage stress, make choices, adapt oneself to the available facilities.	·	✓	·	·	·
• Conceive, realize and test a measurement chain with a temperature regulation including a sensor, a bridge for signal conditioning, assemblies of operational amplifiers assuring functions of analog signal processing and control of the analog signal and LED for display and alert.	·	✓	·	·	·
• Be able to use a data acquisition system to realize the signal sampling and the calculation of the signal frequency spectrum.	·	·	✓	·	·
• Be able to measure the gain and the phase shift of a linear quadripole. Be able to evaluate the bandwidth.	·	·	✓	·	·

Manager : Pierre-Yves TESSIER

Entrepreneurship S7

Hours

Lect	Tut	PW	Proj	WP	Asst
			32		

Evaluation

One evaluation : *Evaluation*

Manager : John KINGSTON

Entrepreneurship S8

Hours

Lect	Tut	PW	Proj	WP	Asst
			32		

Evaluation

One evaluation : *Evaluation*

Manager : John KINGSTON

Evaluation internship 4th year

Hours

Lect	Tut	PW	Proj	WP	Asst
					20

Evaluation

One evaluation : *Un rapport écrit de*

Outline

Examples of projects :

Developing a method for the fabrication of graphene thin films for applications in photovoltaics

Hydrogen induced strain fields in thin films

Nanowire synthesis and characterisation. For application including treatment of wastewater and sensors development.

Study friction stir welding (FSW) of aluminium alloy 6061

Metallurgical investigation of corrosion behavior of brazed aluminium alloys used for heat exchanger application

Goals

To undertake a materials-related project of at least 12 weeks abroad in a research institute or a company

Prerequisites

Level corresponding to the end of the 4th year Materials

Learning outcomes

Learning outcomes	N	A	M	E	O
• Know how to apply for an internship in a foreign research institute or a foreign company	·	·	✓	·	·
• Be able to use multi-disciplinary knowledge and apply it to a particular materials-related project	·	·	✓	·	·
• Be able to communicate daily with foreign colleagues	·	·	✓	·	·
• To be able to write a final report in English.	·	·	✓	·	·

Manager : Bernard LESTRIEZ

Fabrication, operation and exploitation of welded components

Hours

Lect	Tut	PW	Proj	WP	Asst
24.5	1.5				9

Evaluation

One evaluation : *DS*

Outline

Introduction to assurance quality in welded fabrication
- Process quality control
- Deformations and residual stresses
- Means of production, jigs and fixtures
- Hygiene and security
- Defects and acceptance criteria
- Productivity and economic aspects

Goals

Fabrications welded from standardization to implementation in a manufacturing issues

Bibliography

Fumée de soudage : efficacité des différents systèmes de protection du soudeur et de son environnement en soudage, Edition du CETIM, 2005

BLONDEAU R., Procédés et applications industrielles du soudage, Lavoisier , Hermès science, 2001

Prerequisites

Not applicable

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know and to know how to apply the standardisation in the field of welding	·	·	✓	·	·
• To know the impact of welding on health	·	·	✓	·	·
• To know the impact of welding on the quality of the welded construction	·	·	✓	·	·
• To know the overriding settings on increasing productivity in welded construction	·	✓	·	·	·

Manager : Pascal PAILLARD

Fracture-Fatigue-Creep

Hours

Lect	Tut	PW	Proj	WP	Asst
10	14				12

Evaluation

2 evaluations :

- *DS1*
- *DS2*

Outline

Part I: Fracture mechanics
- Fracture mechanims (brittle, ductile, inter- or transgranular, fractography...)
- Mechanical approach (stress intensity factor, toughness, measurements...)
- Energetic approach (energy balance, G, Gc, measurements, relations with K1c)
- Elasto-plastic fracture (small-scale yielding, J-integral, work of fracture)

Part II: Fatigue of materials
- Initiation of fatigue cracks (mechanisms, triaxial criteria...)
- Propagation of fatigue cracks (mechanisms, Paris' law, fractography)
- S-N curves, fatigue limit, parametric study of fatigue
- Accumulation of damage (Palmgren-Miner, non-linear accumulation...)
- Low cycle fatigue (cyclic loading curves, Coffin-Manson law...)

Part III : Creep of materials
- Deformation mechanisms (dislocation creep, diffusion creep...)
- Models and constitutive laws
- Damage and strengthening mechanisms
- Lifetime extrapolation methods (Monkman-Grant, Rabotnov-Kachanov, Larson-Miller, Wilshire...)

Goals

Provide the future materials engineer with a culture on (thermo)mechanical failure modes of materials (fracture by crack propagation, fatigue, creep), in liaison with their nature and microstructure, as well as knowledge and tools allowing to address the phenomena in terms of experiment (characterisation) and application (mechanical design, durability, control, expertise...).

To be noted that thermal shock is dealt with in another course.

Bibliography

- J. B. Leblond, "Mécanique de la rupture fragile et ductile" (Hermes)
- D. Miannay, "Mécanique de la rupture" (EDP Sciences)
- C. Bathias, A. Pineau, "Fatigue des matériaux et des structures" (Hermes)

Prerequisites

- Basics of continuum mechanics (stresses and strains, elasticity)
- Bases in materials science (microstructures, tensile testing)
- Bases on plasticity criteria (Tresca, von Mises)
- Basics of physical metallurgy (plastic slip in crystals, strain hardening, diffusion)

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the basics of fracture mechanics and the different types of fracture behaviours of materials	·	·	✓	·	·
• To know the behaviour of materials submitted to fatigue and the main damage mechanisms	·	·	✓	·	·
• To be able to apply mechanical design to a structure with the presence of defects and/or submitted to fatigue	·	✓	·	·	·
• To be able to perform a failure analysis from a fracture surface	·	·	✓	·	·
• To know the behaviour of materials during creep and the associated mechanisms	·	·	✓	·	·

Manager : Franck TANCRET

French as a Foreign Language for engineering students

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				

Evaluation

One evaluation : *CC*

French as a Foreign Language for engineering students

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				

Evaluation

One evaluation : *CC*

From elaboration to final product

Hours

Lect	Tut	PW	Proj	WP	Asst
24	1				13

Evaluation

One evaluation : *Oral*

Outline

Extractive metallurgy
- Semi-wrought products processes
- Finished products processes
- Assembly processes

Goals

To know how metallic materials ar produced, from ore to material.
- To know how metallic materials are shaped into half-wrought material or finished product.
- To know which properties can be reached.

Manager : Laurent COUTURIER

Fundamentals of heat transfer

Hours

Lect	Tut	PW	Proj	WP	Asst
1.25	10				6

Evaluation

One evaluation : *DS*

Outline

Introduction (Different forms of energy, Energy conversion, Heat transfer). Conduction (Fourier's law, Heat equation, solution for stationnary regime). Convection (Forced and Natural Convection, Laminar and Turbulent regimes, Correlations). Radiation (Physical aspects, Emission-absorption of opaque surfaces, Radiosity method).

Goals

The objectives of this course is (i) to introduce the fundamentals of this subject, (ii) to establish the relationship of these origins to the behavior of thermal systems. It should develop methodologies which facilitate application of the subject to a broad range of practical problems and it should give necessary tools to perform engineering analysis of a system or process

Bibliography

J.F Sacadura, "Initiation aux transferts thermiques", Editions TEC&DOC, 2000. F.P. Incropera, D.R. De Witt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, 1996.

Prerequisites

General Thermodynamics

Learning outcomes

Learning outcomes	N	A	M	E	O
• Basic knowledge of heat transfer modes	·	·	✓	·	·
• Knowing to do an energy balance for a system	·	✓	·	·	·

Manager : Ahmed GUELED

General mechanics

Hours

Lect	Tut	PW	Proj	WP	Asst
	11.5				6

Evaluation

One evaluation : *DS*

Outline

Mathematical reminders
- Mechanical action modelling
- Mass centre, moments of inertia
- Physical behaviour laws (Newton, Coulomb)
- Study cases

Goals

To position and parametrize a system of rigid bodies
- To modelize mechanical actions
- To solve a static problem (to find efforts and positions)

Bibliography

Mécanique générale par JC. Bône - Editions Dunod
- Engeneering Mechanics par McLean & Nelson - Editions Schaum

Learning outcomes

Learning outcomes	N	A	M	E	O
• To position and parametrize rigid bodies	·	·	✓	·	·
• To modelize mechanical actions	·	·	✓	·	·
• To determine unknown forces and positions	·	·	✓	·	·

Manager : Jérémie RUPIL

General metallurgy

Hours

Lect	Tut	PW	Proj	WP	Asst
8.75	23	26			27

Evaluation

4 evaluations :

- *DS*
- *TP*
- *CC1*
- *CC2*

Outline

Introduction

Mechanical properties of metals (Tensile curves, effect of physical parameters (temperature, crystal structure...), practical realization of a tensile test, hardness and Charpy impact tests)

Thermodynamic of metallic systems (Relationship between Gibbs free energy and phase diagrams)

Phase of metallic alloys (Crystal structures, solid solutions)

Solidification (homogeneous and heterogeneous nucleation, growth, cellular and dendritic microstructure, segregation, ingot solidification)

Solid state transformation (Energy barrier, nucleation and growth in diffusive transformations)

Goals

To be able to interpret a phase diagram and predict solidification microstructure

To know the main transformations in the liquid and solid state and in metallic materials

To know how to caraterize the mechanical properties of a metallic material

To understand the mechanisms of solidification of an alloy

Bibliography

Métallurgie, du minerai au matériau, Jean Philibert, Alain Vignes, Yves Bréchet, Pierre Combrade, Dunod, 2002

Publication : 2002Métallurgie : Élaboration, structures-propriétés, normalisation de Jean Barralis et Gérard Maeder, Afnor-Nathan, 2005

Matériaux : Tome 1, Propriétés, applications et conception de Michael-F Ashby, David-R-H Jones, Yves Bréchet et Joël Courbon, Dunod, 2008

Matériaux : Tome 2, Microstructures, mise en oeuvre et conception de Michael-F Ashby, David R. H. Jones, Joël Courbon et Michel Dupeux, Dunod, 2008

Prerequisites

Thermodynamics, Strength of Materials, Solid State Chemistry

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the mechanisms of solidification in metallic alloys and the main chemical and microstructural characteristics of alloys solidification	·	·	✓	·	·
• To know the main solid state phase transformations mechanisms in metallic alloys (diffusive, displacive) and microstructures associated with these transformations	·	·	✓	·	·
• To be able to predict the microstructure of a binary alloy using a phase diagram	·	·	✓	·	·
• To be able to predict the microstructure of a steel using a CCT or TTT diagrams	·	·	✓	·	·
• To know the thermodynamical basis of phase diagrams	·	·	✓	·	·
• To know the role of carbon as interticial element in steels	·	·	✓	·	·

Manager : Emmanuel BERTRAND

Generalized functions, integral transforms and partial differential equations

Hours

Lect	Tut	PW	Proj	WP	Asst
	23				12

Evaluation

2 evaluations :

- *DS1*
- *DS2*

Presentation

This EC follows the EC?Linear algebra, complex analysis? of semester 5 and aims to give to the future Materials engineer mathematical tools required for his partice, whether for the description of physical phenomena , their modeling or the modeling of systems, or even the data analysis.

Outline

1. Functional analysis

Dirac distribution, Convolution product , Fourier series, Fourier transformation Laplace transform of functions and distributions

2. Differential analysis

Supplements on differential equations, on partial differential equations (PDE),

Goals

At the end of this EC, the student will be able to implement the basic concepts and elementary calculations based on functional anaylsis (distributions, convolutions, Fourier or Laplace transforms) or differential analysis for applications in materials science in general, in data and signal processing on the other hand.

Bibliography

L. Schwartz ; « Cours d'analyse » ; Hermann

R. Petit ; « L'outil mathématique » ; Dunod

R. Roddier ; « Distributions et transformations de Fourier » ; Ediscience

J. Dixmier ; « Cours de Mathématiques » ; Gauthiers-Villars

G. Gasquet et P. Witomski ; « Analyse de Fourier et applications » ; Masson

Prerequisites

- same as for "linaear algebra, complex analysis"

Learning outcomes

Learning outcomes	N	A	M	E	O
• MAT-1: Apply mathematical tools and statistical methods	·	·	✓	·	·
• MAT-11: Apply analytical, statistical, numerical mathematical tools to solve complex problems already formalized	·	·	✓	·	·
• MAT-10: Explain, model and solve a complex problem, even if it is not fully defined	·	✓	·	·	·

Manager : Olivier CHAUVET

Grammar and professional English 1

Hours

Lect	Tut	PW	Proj	WP	Asst
	40				

Evaluation

2 evaluations :

- *CC*
- *DS*

Grammar, Toeic and professional English 2

Hours

Lect	Tut	PW	Proj	WP	Asst
	39	2			

Evaluation

3 evaluations :

- *CC*
- *Tutorat*
- *Toeic*

History of organizations and Accounting business game

Hours

Lect	Tut	PW	Proj	WP	Asst
9	10.5	12			5

Evaluation

One evaluation : *Soutenance + CC*

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	✓	·	·	·	·
• TPN-2	·	✓	·	·	·
• TPN-3	✓	·	·	·	·
• TPN-4	·	✓	·	·	·

Manager : Chrystèle GONCALVES

Industrial metallic alloys

Hours

Lect	Tut	PW	Proj	WP	Asst
26	1				14

Evaluation

One evaluation : *Oral*

Outline

I/ Iron based alloys
- I.1/ Iron-carbon based alloys : steels and cast irons
- I.2/ Stainless steels
- II/ Light alloys
- II.1/ Precipitation hardening aluminum alloys
- II.2/ Non-precipitation hardening aluminum alloys
- II.3/ Magnesium based alloys
- III/ Titanium based alloys (and Zr)
- IV/ Nickel based alloys (and Co)
- V/ Copper based alloys

Goals

To know the different families of metallic alloys currently used in industry, their properties ranges and their principal use.

To learn how one may design the alloys microstruture to adapt their properties to a specific use.

Prerequisites

general metallurgy, physical metallurgy, metallic materials microprojects, thermodynamics, corrosion, plasticity, mechanics

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the principal families of industrial metallic materials, their main properties and their main applications	✓	·	·	·	·
• To know and to know how to use the designations of the different metallic alloys used in industriy	·	·	✓	·	·
• To understand the link between the microstructures and the properties of these metallic alloys	·	·	·	✓	·
• Be able to suggest thermomechanical treatments to adapt the properties of a metallic material to a specific use	·	·	✓	·	·

Manager : Emmanuel BERTRAND

Innovation

Hours

Lect	Tut	PW	Proj	WP	Asst
9					5

Evaluation

One evaluation : *Soutenances projets*

Learning outcomes

Learning outcomes	N	A	M	E	O
• Connaitre les étapes du processus d'innovation et leurs acteurs	✓	·	·	·	·

Manager : Emmanuel CHENE

Intercultural explorations

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				

Evaluation

One evaluation : *CC*

Internship 3rd year

Hours

Lect	Tut	PW	Proj	WP	Asst
				8	

Evaluation

One evaluation : *Validation*

Manager : Olivier CROSNIER

Internship 4th year

Hours

Lect	Tut	PW	Proj	WP	Asst
				13	

Evaluation

One evaluation : *Rapport écrit*

Manager : Bernard LESTRIEZ

Life cycle of metallic materials

Hours

Lect	Tut	PW	Proj	WP	Asst
8	0.5				5

Evaluation

One evaluation : *SO*

Outline

Deterioration phenomena and how to avoid them
- Microstructures aging and associated properties drop
- Corrosion mechanisms and means to avoid them / limit their effects
- Wear phenomena
- Metallic alloys recycling

Goals

Be able to understand and anticipate the properties evolution of in use materials.

To know the requirements due to metals recycling and be able to take them into account in the developpement of new materials and/or processes.

Learning outcomes

Learning outcomes	N	A	M	E	O
• Be able to use materials that may deteriorate during use and plan counteractions	·	·	✓	·	·
• Be able to anticipate metallic alloys recycling by imposing a well though use and management of these materials during their whole life cycle	·	·	✓	·	·
• Do a literature review and make of speech of it	·	·	·	✓	·

Manager : Emmanuel BERTRAND

Linear algebra and complex analysis

Hours

Lect	Tut	PW	Proj	WP	Asst
	26.5				13

Evaluation

2 evaluations :

- *DS1*
- *DS2*

Presentation

This EC aims to provide the future Materials Science engineer with the mathematical tools essential for the description of physical phenomena, their modeling or the modeling of systems. It is spread over the two semesters of the 1st year of the engineering cycle.

Outline

1) Elements on linear algebra

Algebric structures, linear applications, matrices, determinants and linear systems, eigenvectors eigenvalues and eigen spaces, diagonalisation and tiangularisation

2) Functions of a complex variable

Holomorphic functions, standard functions, integration in the complex plane, analytic functions, method of residues

Goals

At the end of this EC, students will have good skills in basic mathematical techniques such as linear algebra and analysis in the complex plane for applications in materials science.

Bibliography

L. Schwartz ; « Cours d'analyse » ; Hermann
R. Petit ; « L'outil mathématique » ; Dunod
N. Boccara ; « Fonctions analytiques » ; Ellipses
J. Dixmier ; « Cours de Mathématiques » ; Gauthiers-Villars
P. Benoist-Gueutal et M. Courbage ; « Mathématiques pour la physique » ; Eyrolles

Prerequisites

- notions of linear algebra, resolution of linear systems
- notions concerning sequences and series
- master of differential and integral calculus for the functions of the real variable
- master of linear differential equations of 1st and 2nd order with constant coefficients
- notions on functions with several variables, differential, partial derivatives, multiple integrals

Learning outcomes

Learning outcomes	N	A	M	E	O
• MAT-1: Apply mathematical tools and statistical methods	·	·	✓	·	·
• MAT-11:Apply analytical, statistical, numerical mathematical tools to solve complex problems already formalized	·	·	✓	·	·
• MAT-10: Explain, model and solve a complex problem, even if it is not fully defined	·	✓	·	·	·

Manager : Olivier CHAUVET

Materials Chemistry II

Hours

Lect	Tut	PW	Proj	WP	Asst
15	9				12

Evaluation

2 evaluations :

- *CC*
- *DS*

Outline

Chapter III - Solid State Chemistry
III.1 Crystal structures
III.2 Ionic bond
III.3 Ionocovalency
III.4 Electronic structure of solids
III.5 Metallic bond
Chapter IV - Defects in solids
IV.1 Types of defects
IV.2 Effect of defetc on optical properties
IV.3 Mobility of defects - Ionic conductivity in solids
Chapter V - Materials Synthesis and Processing
V.1 Modern ceramics overview
V.2 Synthesis routes (powder)
V.3 Introduction to ceramic sintering

Goals

Analyze simple crystal structures.

Describe, in connection with the chemical compositions, crystal structures and properties of materials, the main types of chemical bond (ionic, covalent and metallic) and electronic structures (insulators, semiconductor, metal).

Study the influence of defects on the properties of materials.

Describe the main methods for preparing non-metallic inorganic materials (powder synthesis and ceramic sintering).

Bibliography

Chimie des solides - J.F. Marucco - EDP Sciences
Solid State Chemistry - L. Smart and E. Moore - Chapman et Hall
Chimie Inorganique - Huheey, Ketter et Ketter - De Boeck Université
J. M Haussonne, C. Carry, P. Bowen, and J. Barton. Céramiques et verres: principes et techniques d'élaboration. Presses Polytechniques et Universitaires Romandes

Prerequisites

Courses: "Materials Chemistry I", "Symetry in solids". Level : semester 5

Learning outcomes

Learning outcomes	N	A	M	E	O
• Analyzing simple crystal structures	·	·	✓	·	·
• traduire	·	✓	·	·	·
• traduire	✓	·	·	·	·
• traduire	✓	·	·	·	·

Manager : Christophe PAYEN

Materials and applications (accueil)

Hours

Lect	Tut	PW	Proj	WP	Asst
	2.5				

Presentation

This lecture proposes a general description of materials science and engineering (main families and examples of materials, of properties, of processes...), in liaison with the teaching cursus over the three years, the profiles of teachers and the skills necessary for a materials engineer.

Outline

- Materials and Mankind
  - The main families of materials
  - The main categories of properties
  - The main families of processes
  - Case studies
  - Research and innovation
  - The skills of a materials engineer
  - The teaching cursus

Goals

- (Re-)discover materials science and engineering, to give all students a common culture of the domain, whatever is their academic background.

- Being aware of the structure of the cursus (fundamental and engineering sciences => sciences of the materials specialty => industrial practice), which allows to cover globally the domain and the skills of a materials engineer.

- Discover the contribution of the school to the domain through its research.

Prerequisites

Physics and chemistry (beginning of first cycle).

Learning outcomes

Learning outcomes	N	A	M	E	O
• Knowing and being able to apply materials sciences	✓	·	·	·	·
• Take environmental issues into account	✓	·	·	·	·
• Take society issues into account	✓	·	·	·	·
• Building a realistic and consistent professional and personal project	✓	·	·	·	·

Manager : Franck TANCRET

Materials indicators for eco-design

Hours

Lect	Tut	PW	Proj	WP	Asst
	4.5				4.5

Evaluation

One evaluation : *CR*

Manager : Laurent COUTURIER

Mechanical properties of composite materials

Hours

Lect	Tut	PW	Proj	WP	Asst
15	1.5	12			15

Evaluation

2 evaluations :

- *DS*
- *CR*

Bibliography

Matériaux Composites, J-M Berthelot, Ed. Tec & Doc, Lavoisier, Paris, 2005.
Matériaux Composites, F. Gay, Hermès Science Publications, 2005.
Généralités sur les matériaux composites, L. Gornet, Ecole Centrale de Nantes, 2008

Learning outcomes

Learning outcomes	N	A	M	E	O
• -	·	·	✓	·	·
• -	·	·	✓	·	·
• -	·	✓	·	·	·
• -	·	✓	·	·	·

Manager : Vincent SOBOTKA

Mechanics of deformable solid body

Hours

Lect	Tut	PW	Proj	WP	Asst
	31.5	18			25

Evaluation

4 evaluations :

- *Cours-TD : 2DS*
- *TP: CR*
- *Cours-TD : CR*
- *TP : SO*

Outline

I. General introduction
II. Basic concepts and concepts in Mechanics
Material continuity concept, concept of REV (Representative Elementary Volume)
Kinematics of the deformable solid
Deformation
Stress concept
1D elasticity material behavior
Characterization of materials: tensile, bending, twisting tests
Generalization to the 3D case
III. Introduction to beam theory
Fundamental assumptions
Simplifications in beam theory
IV. Practical method of solving a problem with beam theory
From external mechanical loading to internal stresses
Dimensioning in tension / compression
Determining the characteristics of a section
Simple bending
V. Resolution approached by the finite element method
Basic principle of the method
Digital applications in CATIA V5
VI. Theory of beams: Torsion, shear and combined stresses
Shear-Twist
Combined loadings
VII. Basic relations for solving a 3D problem
Local equilibrium equation
Behavioral relation
Yield strength criteria

Goals

Introduce the notions of displacement, stress state and deformation (tensors) in a material.

Introduce the deformation measurement by strain gauge.

Knowledge of the fundamental relations of the mechanics of deformable solids: linear elasticity, local equilibrium assumption, deformation/displacement relation.

Knowledge of Mohr's graphical analysis of stress and strain states in elasticity theory.

Know how to analytically solve a problem for a structure formed of "beam" type solids: calculation of internal loadings, stresses, deformations and displacements.

Mechanical dimensioning through the use of strength criterions.

Bibliography

S. TIMOSHENKO & J. GOODIER, Théorie de l'élasticité, éd. Béranger, 1961
P. GERMAIN, Cours de Mécanique des Milieux Continus, éd. Masson, 1973
J. DUC & D. BELLET, Mécanique des solides réels - Elasticité, Cepadues , 1977
Résistance des matériaux par Giet & Géminard - Editions Dunod
Résistance des matériaux par Kerguignas & Caignaert - Editions Dunod
Résistance des Matériaux par A. Bazergui - Editions Polytech. Montréal

Prerequisites

Deformable solid mechanics
Notions of tensor algebra

Learning outcomes

Learning outcomes	N	A	M	E	O
• Know the concepts of state of deformation and stress state expressed by their respective tensors and their respective properties	·	·	✓	·	·
• Know graphical analyzis of elastic strains measurments (strain gage, strain rosette) to determine components of strain and stress tensors	·	✓	·	·	·
• To determine stresses, deformations and displacements in a structure. To size through the use of strength criterions	·	·	✓	·	·

Manager : Jérémie RUPIL

Meeting management

Hours

Lect	Tut	PW	Proj	WP	Asst
2.5	2				3

Evaluation

One evaluation : *CC*

Outline

To organize a meeting: material aspects, objectives, communication
Methodology of problem solving in groups.
Tools for group problem solving: tools for sorting, selection, analysis, presentation, etc ...

Goals

To know the principles of the organizing a meeting, conducting meetings and solving problems in groups.To know the principles of the organizing a meeting, conducting meetings and solving problems in groups.

Prerequisites

Communication.
Negotiation.
Group work.
Mathematical tools and basic statistics.

Learning outcomes

Learning outcomes	N	A	M	E	O
• To organize a meeting	·	✓	·	·	·
• To lead a meeting	·	✓	·	·	·
• To solve problems in group	·	✓	·	·	·

Manager : Thierry BROUSSE

Metallic materials - laboratory project

Hours

Lect	Tut	PW	Proj	WP	Asst
			32		14

Evaluation

2 evaluations :

- *CR*
- *S0*

Outline

28 hours of laboratory work. 4 hours for final oral presentations. 2 supervisors for 16 students. Students work in pairs.

Examples of topics:
TRIP effect in 304L stainless steel
Intergranular corrosion in cemented 304L stainless steel
Inoculation during wire-arc additive manufacturing of an aluminum alloy
Effect of grain size in on martensitic transfomation in a low alloyed steel
Heterogeneous welding of stainless steels

Goals

To undertake a small experimental project in near autonomy dealing with metallic materials

Prerequisites

To be able to use the laboratory equipments (tensile apparatus, optical microscope, hardness tester, scanning electron microscope, X-ray diffractometer, electrochemistry equipments, furnaces...)

Learning outcomes

Learning outcomes	N	A	M	E	O
• To be able to manage and execute a small project (task planning and task distribution) in a limited time, taking account of the limited availability of equipments and staff.	·	·	✓	·	·
• Be able to use multi-disciplinary knowledge and apply it to metallic materials	·	·	✓	·	·
• To be able to write a final report and give a talk. To be clear, positive and persuasive.	·	·	✓	·	·
• To cast a critical eye on one's own work and others'. To compare one's work with others'.	·	·	✓	·	·
• To be able to analyse the causes of failure and adapt one's approach in light of these failures	·	·	✓	·	·

Manager : Emmanuel BERTRAND

Microscopies and spectroscopies

Hours

Lect	Tut	PW	Proj	WP	Asst
8.75	2.5				6

Evaluation

One evaluation : *Examen*

Outline

Image analysis 101
- Optical microscopy
- Electron microscopy
- Electron-matter interactions
- Microscopes technology
- SEM specificity
- TEM specificity
- Associated characterization techniques
- X-Rays : production and matter interaction
- X-Rays spectroscopy techniques (EDS/WDS, XRF, XAS, XPS)
- Electron spectroscopy techniques (EELS, Auger)
- Crystalline orientations identification (EBSD, ACOM)

Goals

To provide the basics of optical microscopy, electron microscopy (scanning and transmission) and associated techniques (spectroscopies and diffractions), applied to materials science. To present and understand the capabilities and the limits of each technique.

Bibliography

Scanning Electron Microscopy and X-ray Microanalysis, J.I. Goldstein, C.E. Lyman, D.E. Newbury, E. Lifshin, P. Echlin, L. Sawyer, D.C. Joy, J.R. Michael, Spinger, 2003.

Caractérisation microstructurale des matériaux, Analyse par les rayonnements X et électroniques, C. Esnouf, Presses polytechniques et universitaires romandes, 2011.

Prerequisites

light reflection, refraction and diffraction; optical lenses; Gaussian optics; electrons; photons; X-rays; thermoelectric effect; magnetic and electric fields; structure of matter; microstructure of materials; crystal diffraction; periodic table; atom model; energy levels of electron shells

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the main characteristics of microscopy techniques: resolution, depth of field and contrast	·	·	✓	·	·
• To know the principle of optical and electron (scanning and transmission) microscopy. To know the main characteristics associated with these techniques, as well as the specimen preparations needed	·	·	·	✓	·
• To know the advantages and limitations of the different observation modes in electron microscopy	·	·	✓	·	·
• To be able to chose one of the presented techniques depending on the nature of what you want to observe or measure within the material you are studying	·	·	✓	·	·
• To know the basics of the physical principle of the presented spectroscopy techniques and the main characteristics of each of them	·	·	✓	·	·
• To know how an electron microscope is working from the gun to the sample	·	✓	·	·	·
• To know how it is possible to determine the cyrstallographic structure of a grain and its orientation using electron microscopy	✓	·	·	·	·

Manager : Laurent COUTURIER

Negotiations

Hours

Lect	Tut	PW	Proj	WP	Asst
3	7.5				2

Evaluation

One evaluation : *Vidéo*

Bibliography

Stimec A. ; « La négociation » ; Dunod
Fisher, Ury ; « Comment réussir une négociation » ; Seuil

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	·	✓	·	·	·
• TPN-2	·	✓	·	·	·
• TPN-4	✓	·	·	·	·

Manager : John KINGSTON

Non destructive testing

Hours

Lect	Tut	PW	Proj	WP	Asst
9.75	1				6

Evaluation

One evaluation : *DS*

Outline

Organization and use of non-destructive testing and non destructive analysis in a company, relationship with quality assurance system.

Non-destructive testing, description of the main techniques and their application fields: visual checks (including interference holography, radar imaging , etc. ..), penetrant testing, Foucault current testing, magnetic measurements, radiography, ultrasonic and acoustic emissions, infrared thermography.

Goals

To know the main methods of non-destructive testing for metals and alloys, ceramics, glasses, polymers and composites, and being able to advocate on a given part.

To know the different ways of organizing controls within a company.

Bibliography

Techniques de l'ingénieur

Non-Destructive Testing, B. HULL, Springer-Verlag, New-York, 1988

Prerequisites

Solid state chemistry, solid state physics

Materials characterization techniques

Design and use of polymers and composites

Design and use of metals and alloys

Design and use of céramqiues and glasses

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the main methods of non-destructive testing	·	·	✓	·	·
• To know the main methods for organizing NDT in companies	✓	·	·	·	·
• To advocate NDT methods on a given part	·	·	✓	·	·

Manager : Thierry BROUSSE

Non destructive testing of welds

Hours

Lect	Tut	PW	Proj	WP	Asst
3.5		7			6

Evaluation

One evaluation : *CR*

Outline

Overview of the NDT applied to welding
- Penetrant testing
- Magnetic particle testing
- Eddy current
- Ultrasound (classic, TOFD, Phased Arrays)
- X-ray and Gamma Graphy

Goals

Knowledge of non-destructive controls applied to the weld

Bibliography

ALTHOUSE A.D., BRAMAT M., MAYER, VILLENEUVE M., Technologie des métaux, contrôles et essais des soudures, De Boeck Edition 2008

Caractérisation ultrasonore par TOFD de défauts de soudures, Publication du CETIM, 2004

Prerequisites

Physics courses

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the various technics of controls and their application in the field of welding	·	·	✓	·	·
• To know the limits of the different technics	·	·	✓	·	·
• How to use the technics of conventional controls	·	✓	·	·	·

Manager : Pascal PAILLARD

Numerical methods 1

Hours

Lect	Tut	PW	Proj	WP	Asst
	22.5				12

Evaluation

2 evaluations :

- *DS*
- *CR*

Manager : Stéphane CUENOT

Numerical methods 2

Hours

Lect	Tut	PW	Proj	WP	Asst
		20			10

Evaluation

One evaluation : *CR*

Outline

2D and 3D modeling of a physical problem (Drawing), Create and manage a 2D meshing, Optimize the meshing for a given structure, Taking into account the boundary conditions of a problem, Post-processing and visualization, Convergence of a numerical solution in function of meshing, Relationship meshing-time of calculation, Modeling of multi-physic problems

Goals

To know how to use a modeling software of finite element methods. Modeling a (multi)physical problem. To manage the convergence relationship of the numerical solution in function of meshing. To manage the relationship meshing-time of calculation

Prerequisites

To know the numerical methods, Matlab programming concept

Learning outcomes

Learning outcomes	N	A	M	E	O
• To manage the steps of modeling of a simple problem (drawing, boundary conditions, physical properties, meshing, resolution)	·	·	✓	·	·
• To control the convergence of a numerical solution (meshing, calculation time)	·	·	✓	·	·
• To know the different steps of modeling of a multi-physic problem	·	✓	·	·	·

Numerical processing of experimental data

Hours

Lect	Tut	PW	Proj	WP	Asst
		7.5			4

Evaluation

One evaluation : *CR*

Outline

Excel: presentation of graphic tools, tables of number and data treatment, import of raw data, solver
Matlab: presentation of graphic tools

Goals

To know how to use Excel and Matlab for graphic display and simple data analysis

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know how to present Excel and Origin data	·	·	✓	·	·
• To control data processing (curves analysis) with Excel	·	·	✓	·	·
• To know how to adjust experimental data with theoretical curves (parameters optimization)	·	✓	·	·	·

Manager : Laurent COUTURIER

Optics and materials

Hours

Lect	Tut	PW	Proj	WP	Asst
	16.5				9

Evaluation

One evaluation : *1 DS*

Presentation

Interaction between light and matter with optical applications.

Outline

propagating waves ; phase and group velocity, dispersion relation, index number ; propagation of electromagnetism waves ; polarization ; refractive index ; transmission, reflection and absorption factors ; electromagnetism energy ; photon concept, radiating pressure ; guided waves ; metallic wave guides ; introduction to optical fibers ; ligh propagation in anisotropic materials ; birefringence ; materials for optics ; optical filters ; laser and applicartions

Goals

This course is dealing with the basis of the interaction between matter and light. Particularly, the phenomena involved betwwen matter and the visible light are presented : the reflection, absorption and transmission factors are calculated. The understanding of the mecanisms involved in the the polarization of the light by birefringent materials and in the light propagation through optical fibers is also studied. The different concepts developed lead to the choice of materials for optics.

Bibliography

titre : Manuel d'Optique
auteurs : G. Chartier
éditeur : Hermès date : 1997 ISBN 2 86 601634 3
titre : Optique
auteurs : J.P. Pérez
éditeur : Dunod date : 2000 ISBN 2 10 004890 2
titre : Fibres optiques Théories et applications
auteurs : S. Ungar
éditeur : Bordas-Dunod date : 1989 ISBN 2 04 018763 4
titre : Ondes élastiques dans les solides ; Tome 1 : Propagation libre et guidée ; Tome 2 : Génération, Interaction acousto-optique, Applications
auteurs : D. Royer
éditeur : Masson date : 1996 - 1999 ISBN 2 2258 5422 X et 2 2258 34415
titre : Electromagnétisme
auteurs : J.P. Pérez
éditeur : Dunod date : 2002 ISBN 2 10 005574 7
auteurs : E. Hecht
titre : Optique
éditeur : Série Schaum - Mac Graw Hilldate date : 1985 ISBN 2 7042 1021 7
titre : Lasers
auteurs : P.W. Milonni
éditeur : Wiley-Interscience date : 1988 ISBN 0 47 162731 3

Prerequisites

Electricity, Magnetism, Electromagnetism, wave physics, geometric optics

Learning outcomes

Learning outcomes	N	A	M	E	O
• be able to choose a material for optics regarding its properties	·	·	✓	·	·
• be able to calculate the absorption, reflection and transmission factors of light for a chosen material	·	·	✓	·	·
• be able to describe and understand the effect of a electromagnetic wave in a material	·	·	✓	·	·
• knowing the basis of matter-wave interaction	·	✓	·	·	·
• Knowing of light propagation and guiding	·	✓	·	·	·

Manager : Benoit ANGLERAUD

People and team management

Hours

Lect	Tut	PW	Proj	WP	Asst
	10.5				6

Evaluation

One evaluation : *DS*

Bibliography

- Le chaos Management / Tom Peters / Intereditions
- Manager dans la complexité / Dominique Genelot / Insep Editions
- Les responsables porteurs de sens / Vincent Lenhardt / Insep Editions
- De la performance à l'excellence / Jim Collins / Village Mondial
- Comment leur dire / Gérard Collignon / Intereditions
- Communiquer, motiver, manager en personne/ Taibi Kahler / Intereditions
- Vidéos d'Edgar Morin sur la complexité / Youtube
- Management et communication : 100 exercices / Denis Cristol / ESF editeur

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	✓	·	·	·	·
• TPN-2	✓	·	·	·	·
• TPN4	✓	·	·	·	·
• TPN-6	✓	·	·	·	·

Manager : Anouk GREVIN

Physical education and sport 1

Hours

Lect	Tut	PW	Proj	WP	Asst
	21				2

Evaluation

One evaluation : *Contrôle continu*

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	·	✓	·	·	·
• TPN-2	·	✓	·	·	·
• TPN-3	✓	·	·	·	·
• TPN-4	✓	·	·	·	·
• TPN-5	·	✓	·	·	·
• TPN-3	✓	·	·	·	·
• TPN-7	✓	·	·	·	·
• TPN-12	✓	·	·	·	·
• TPN-19	✓	·	·	·	·

Manager : Jérôme BEZIER

Physical education and sport 2

Hours

Lect	Tut	PW	Proj	WP	Asst
	21				2

Evaluation

One evaluation : *Contrôle continu*

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	·	✓	·	·	·
• TPN-2	·	✓	·	·	·
• TPN-3	✓	·	·	·	·
• TPN-4	✓	·	·	·	·
• TPN-5	·	✓	·	·	·
• TPN-3	✓	·	·	·	·
• TPN-7	✓	·	·	·	·
• TPN-12	✓	·	·	·	·
• TPN-19	✓	·	·	·	·

Manager : Jérôme BEZIER

Physical education and sport 3

Hours

Lect	Tut	PW	Proj	WP	Asst
	21				2

Evaluation

One evaluation : *Contrôle continu*

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	·	✓	·	·	·
• TPN-2	·	✓	·	·	·
• TPN-3	✓	·	·	·	·
• TPN-4	✓	·	·	·	·
• TPN-5	·	✓	·	·	·

Manager : Jérôme BEZIER

Physical education and sport 4

Hours

Lect	Tut	PW	Proj	WP	Asst
	19.5				2

Evaluation

One evaluation : *Contrôle continu*

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	·	✓	·	·	·
• TPN-2	·	✓	·	·	·
• TPN-3	✓	·	·	·	·
• TPN-4	✓	·	·	·	·
• TPN-5	·	✓	·	·	·

Manager : Jérôme BEZIER

Physical metallurgy

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				9

Evaluation

One evaluation : *DS sur table*

Outline

Introduction

Dislocations (dislocation theory, slide plane and directions, Frank-Read source, Schmid factor)

Hardening mechanisms (strain hardening, solid solution hardening, precipitation hardening, grain size hardening)

Punctual defects (voids, self-intersticials, thermal activation)

Restauration and recrystallization (cold-work, restauration, recrystallization, grain coarsening)

Grain boundaries (Classification, nucleation, embitterment)

Diffusion (origin of diffusion coefficient in metals, Kirkendall effect)

Diffusion-plasticity interactions (PLC effect, dynamic recrystallization)

Goals

To understand phenomena occuring during thermal treatments, cold or hot froming in metallic alloys.

Know dislocation theory, hardening mechanisms, diffusion at microscopic scale, restauration and recrystallization.

To be able to address the problems of deformation in metals and thermomechanical treatments, considered at the microstructure scale and at the atomic scale. This lecture comes after the General Metallurgy lecture given in the 3rd year.

Bibliography

Métallurgie, du minerai au matériau. J. Philibert, A. Vignes, Y. Bréchet, P. Combrade. Masson Editeur. 1998.

Les défauts ponctuels dans les métaux. Y. Quéré. Masson Editeur. 1967.

La diffusion dans le solides. J. Philibert. Les éditions de physique. 1985.

Eléments de métallurgie physique. Y. Adda, J.M. Dupouy, J. Philibert, Y. Quéré. La documentation française. 6 tomes. 1987-1991.

Physical Metallurgy Principles. R. Abbaschian, L. Abbaschian, R. E. Reed-Hill. Cencage Learning. 2009.

Prerequisites

structure of matter; crystallography; stress; strain; microstructure of materials; basics of statistical thermodynamics; potential barrier; concentration; chemical potential; mathematics of 1st year level

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the main types of defect in crystalline materials : vacancies, dislocations, subsitutional solute, interstitial solute, grain boundaries	·	·	✓	·	·
• To know the principle of diffusion at the atomic scale (diffusion mechanisms)	·	·	✓	·	·
• To know the mechanisms of deformation and hardening (including work-hardening) associated with the dislocation theory	·	·	✓	·	·
• To know the mechanisms of twinning, recrystallization and recovery in deformed materials	·	·	✓	·	·
• To understand phenomena occuring in a metallic alloy during thermal treatments, cold or hot working	·	·	✓	·	·

Manager : Emmanuel BERTRAND

Physics (upgrade-refresher training)

Hours

Lect	Tut	PW	Proj	WP	Asst
	6				

Presentation

General physics upgrade to prepare the courses of S5

Outline

unit system
- uncertainty calculation
- Mathematics tools
- Electrostatics (Coulomb law, Poisson and Laplace Law, Gauss therorem)
- Magnetostatics (Biot and Savart, Laplace, Lorentz laws, Ampere theorem)
- Electrical current effects (Joule and Ohm laws)
- basis of Electromagnetism (Maxwell laws, propagation equations of electrical and magnetical fields)
- electrical analogue signal (DC and rf signals, periodical signals, sinusoidal signals)
- Electricity networks, Kirchhoff laws, linear dipoles, general theorems (Norton Thevenin, Millman...)
- Transfer functions (Bode diagramm)

Goals

refresher training of the basis of general physics (electricty, optics, electronics) in order to homogenize the knowledges of students ocming from different schooling.

Bibliography

titre : Electromagnétisme
- auteurs J.P. Pérez
- éditeur : Dunod date : 2002 ISBN 2-1000-5574-7
- titre : Electronique linéaire
- auteurs Blot
- éditeur Dunod date 1993 ISBN 2-1000-1777-5
- titre : Physique 1ère année Cours et exercices corrigés
- auteurs : M.N. Sanz, A.E. Badel, F. Clausset
- éditeur : Dunod date 2002 ISBN 2 10 005373 6

Prerequisites

Basis of Physics : Optics, electronics, electricity.

Learning outcomes

Learning outcomes	N	A	M	E	O
• be able to to present numerical results in the right format	·	·	✓	·	·
• be able to make uncertainty calculation	·	·	✓	·	·
• be able to to apply the laws and equations of general electricity	·	·	✓	·	·
• knowing the main electrical properties of materials	·	·	✓	·	·
• knowing of electrical current effects on materials	·	✓	·	·	·
• be able to determine electrical transfer function of a linear quadripole	·	·	✓	·	·
• be able to calculate the electrical complex impedance of a linear dipole made of resistors, self inductance and capacitors	·	·	✓	·	·
• be able to draw and interprate the bode diagramm of a first order electrical circuit	·	·	✓	·	·
• be able to use the electrical laws : Kirchhoff, voltage and current divider bridges, Millman	·	·	✓	·	·

Manager : Benoit ANGLERAUD

Physics and chemistry of polymers

Hours

Lect	Tut	PW	Proj	WP	Asst
	16.5				9

Evaluation

One evaluation : *DS*

Outline

1. MACROMOLECULAR CHEMISTRY

chain polymerisation, Copolymerisations; Step-growth polymerisation

2. PHYSICO-CHEMISTRY OF POLYMERS IN SOLUTION

Configuration and chain conformation, molar mass distribution ; Experimental characterisation techniques

3. CONDENSED STATE PHYSICS OF POLYMERS

Amorphous polymers, semicrystalline polymers, rubbery state; Mechanical properties in the solid state.

Goals

Understand by simple representations, the macromolecular chemistry.

Know the main characterization tools of polymers.

Anticipate the behavior of polymeric materials by the analysis of their chemical structures and spatial structures

Know the major industrial polymers and their properties

Prerequisites

Basic knowledge of organic chemistry

Learning outcomes

Learning outcomes	N	A	M	E	O
• Describe the synthesis routes of polymers	✓	·	·	·	·
• Know the caracterisation tools of polymer materials	·	·	✓	·	·
• Know the different macromolecular structures (homo and copolymers) and their properties	·	·	✓	·	·
• Knowing thermomechanical behavior of different polymers	·	✓	·	·	·
• Describe the key mechanisms of aging and recycling of polymers	✓	·	·	·	·

Manager : Guy LOUARN

Physics and materials - laboratory

Hours

Lect	Tut	PW	Proj	WP	Asst
		24			12

Evaluation

One evaluation : *CR*

Presentation

Practical works of physics

Outline

Study of glass dispersion ; determination of glass optical index ; Study of laser light ; HeNe laser tuning ; study of a laser diode ; Study of light polarization ; Retardation plates ; temperature measurement ; study of different temperature sensors ; ultrasonic inspection of materials

Goals

The aim of these practical courses is to to teach the basis of measurement methods in physics : measure of light power, measure of optical index, use of heat sensors, caracterisation of birefringence materials.

Bibliography

titre : Manuel d'Optique
auteurs : G. Chartier
éditeur : Hermès date : 1997 ISBN 2 86 601634 3
titre : Optique
auteurs : J.P. Pérez
éditeur : Dunod date : 2000 ISBN 2 10 004890 2
titre : Fibres optiques Théories et applications
auteurs : S. Ungar
éditeur : Bordas-Dunod date : 1989 ISBN 2 04 018763 4
titre : Ondes élastiques dans les solides ; Tome 1 : Propagation libre et guidée ; Tome 2 : Génération, Interaction acousto-optique, Applications
auteurs : D. Royer
éditeur : Masson date : 1996 - 1999 ISBN 2 2258 5422 X et 2 2258 34415
titre : Electromagnétisme
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auteurs : E. Hecht
titre : Optique
éditeur : Série Schaum - Mac Graw Hilldate date : 1985 ISBN 2 7042 1021 7
titre : Lasers
auteurs : P.W. Milonni
éditeur : Wiley-Interscience date : 1988 ISBN 0 47 162731 3

Prerequisites

Electricity, Magnetism, Electromagnetism, wave physics, geometric optics

Learning outcomes

Learning outcomes	N	A	M	E	O
• be able to determine the mechanical properties of a material using ultrasonic waves	·	·	✓	·	·
• be able to make ultrasonic material inspection	·	✓	·	·	·
• be able to choose, use and calibrate temperature sensors	·	·	✓	·	·
• be able to describe and put in light the effects of an anisotropic material on light polarization	·	✓	·	·	·
• be able to determine and to measure laser light properties	·	✓	·	·	·

Manager : Benoit ANGLERAUD

Plasticity of metals and metal forming

Hours

Lect	Tut	PW	Proj	WP	Asst
3.75	13.5				9

Evaluation

One evaluation : *DS*

Presentation

A set of lectures and supervised work allowing to cover plasticity of metals and alloys from the point of view of mechanics (plasticity criteria, flow rule...), materials (constitutive laws...) and forming processes by plastic deformation. To be noted that creep is detailed in another course.

Outline

Part I: Mechanical aspects of plasticity
- Continuum mechanics (reminders, invariants, deviator, generalised variables)
- Plastic flow rule, plasticity criteria (Tresca, von Mises, Hill)
- Constitutive laws for metals at low and high temperatures

Part II: Technological aspects of plasticity: forming processes
- Chapters: Rolling, forging, extrusion, wire drawing, sheet drawing...

Goals

Provide the future materials engineer a set of basic skills and knowledge allowing to understand the plastic behaviour of metals and alloys, the mechanical design of structures and the implementation of forming processes by plastic deformation.

Bibliography

G.E. Dieter, "Mechanical metallurgy" (McGraw-Hill)

B. Jaoul, J. Friedel, C. Crussard, "Etude de la plasticité et application aux métaux" (Presses Mines ParisTech)

Prerequisites

Bases in continuum mechanics (stress and strain tensors, principal stresses, Mohr's circle, elasticity...)

Bases of general metallurgy (microstructure of polycristalline materials)

Learning outcomes

Learning outcomes	N	A	M	E	O
• Being able to perform simple continuum mechanics calculations applied to plasticity (plasticity criteria, plastic flow rule, plastic constitutive laws)	·	✓	·	·	·
• To know the main families of forming processes by plastic deformation ; to be able to choose a process for a given part	·	✓	·	·	·

Manager : Franck TANCRET

Polymeric materials - laboratory project

Hours

Lect	Tut	PW	Proj	WP	Asst
			17.5		9

Evaluation

2 evaluations :

- *Rapport*
- *SO*

Outline

1) Thermomechanical properties of thermoplastics
- Elaboration and creep behaviour of the pressure sensitive adhesive
- Rheological study of complex fluids
- Tensile tests - Role of the temperature - Relaxation test
- Charpy (impact) test - Role of the temperature
- Reverse engineering: thermoforming

2) Elaboration and characterization of an epoxy-glass composite material
- Monitoring the curing reaction by scanning differential calorimetry
- Monitoring the curing reaction by infra-red spectroscopy
- Fabrication of the epoxy-glass composite
- Thermal analysis
- Flexion test

Goals

The objectives are to know characterizing the rheological and mechanical properties of polymer materials, looking at the influence of their composition and external factors (time, temperature). The objectives are also to be able to process manually an epoxy-glass fiber composite material, knowing monitoring its curing reaction and designing its curing cycle.

Prerequisites

An introduction to polymers and composite materials

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know monitoring the curing of a thermoset	·	·	✓	·	·
• To know determining the curing cycle of a thermoset	·	✓	·	·	·
• To know characterizing the rheological properties of a complex (non-newtonian) fluid	·	·	✓	·	·
• To know characterizing the thermomechanical properties of polymer and polymer-based composite materials	·	·	✓	·	·
• To know characterizing the adhesion properties of pressure-sensitive adhesives	·	·	✓	·	·

Manager : Bernard LESTRIEZ

Practical training

Hours

Lect	Tut	PW	Proj	WP	Asst
		35			

Evaluation

One evaluation : *CC*

Outline

Oxy-fuel welding
- Welding with covered electrode
- GMA welding
- GTA welding

Goals

Practice of different welding processes

Bibliography

RAS

Prerequisites

Theoretical course on welding processes of the 4th and 5th years

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know practice of different welding processes	·	✓	·	·	·
• To understand the influence of welding parameters	·	✓	·	·	·

Manager : Pascal PAILLARD

Probabilities and statistics

Hours

Lect	Tut	PW	Proj	WP	Asst
	13.5				7

Evaluation

One evaluation : *CC*

Outline

Introduction: probability and statistics for engineers
Single variable descriptive statistics
Discrete probabilities: definitions, Bayes formula
Random variables, discrete distributions, continuous distributions
Inferential statistics: estimates, confidence intervals
Inferential statistics: statistical tests, chi-2 test, parametric tests
Linear regression: simple regression, multiple regression
Multivariable statistics: principal component analysis, factorial analysis

Bibliography

A. Mansour: Probabilités et statistiques pour les ingénieurs, Hermes, Lavoisier, 2007
G. Saporta: Probabilités, analyse de données et statistiques, Technip, Eyrolles, 2006
G. Demengel; Probabilités, statistique inférentielle, fiabilité, outils pour les ingénieurs, Ellipses, 1997

Learning outcomes

Learning outcomes	N	A	M	E	O
• To be able to use simple statistical tools to describe and analyze data	·	·	✓	·	·
• To give estimates and confidence intervals	·	·	✓	·	·
• To perform simple statistical tests of adjustments and parametric tests	·	✓	·	·	·
• To implement multivariable analysis (PCA, FAC) and extracting the information	✓	·	·	·	·
• To use probability and statistical tools to solve a problem of engineering	·	✓	·	·	·

Manager : Guy LOUARN

Professional English 3

Hours

Lect	Tut	PW	Proj	WP	Asst
	19	2			

Evaluation

3 evaluations :

- *CC*
- *Tutorat*
- *DS*

Professional Project 2

Hours

Lect	Tut	PW	Proj	WP	Asst
	4.5				

Evaluation

One evaluation : *CV rendu*

Manager : Sylvaine GAUTIER

Professional Project 4

Hours

Lect	Tut	PW	Proj	WP	Asst
	12				5

Evaluation

One evaluation : *Oral*

Outline

Path : 4 sessions of 3h TD

1 / Portfolio "Exploration Project Professional" : my "professionnel journey" those last years - changes - choices - motivations...

2 / My professionnal project : what I intended, the way to go, anticipate steps (especially the choice of option at the end of the fourth year)

3 and 4 / I introduce myself, my skills, my project : simulations and role plays

Goals

Clarify the professional project and be able to present it orally in different circumstances (professional network meetings, hiring individual or collective interview , student lounge, video resume, ..)

Bibliography

"Le Carnet de Route universitaire et professionnel" - SUIO de l'Université de Nantes - 2008

Prerequisites

Professionnal project 1 (S5)

Discovery of firms and professions (S6)

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	✓	·	·	·	·
• TPN-2	✓	·	·	·	·
• TPN-3	✓	·	·	·	·
• TPN-5	✓	·	·	·	·
• TPN-6	✓	·	·	·	·
• TPN-7	✓	·	·	·	·

Manager : Sylvaine GAUTIER

Professional project 3

Hours

Lect	Tut	PW	Proj	WP	Asst
	6				6

Evaluation

One evaluation : *Profil linkedin+rdv*

Bibliography

Grant : Givers & Takers TED

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-2	·	·	✓	·	·
• TPN-6	·	✓	·	·	·
• TPN-7	·	✓	·	·	·

Manager : John KINGSTON

Professional project 5

Hours

Lect	Tut	PW	Proj	WP	Asst
	12				2

Evaluation

One evaluation : *Présence*

Bibliography

Ressources : Évolueront selon les thématiques choisies par les intervenants - en lien avec les TPN et les objectifs de ce module.

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	✓	·	·	·	·
• TPN-2	✓	·	·	·	·
• TPN-3	✓	·	·	·	·
• TPN-5	✓	·	·	·	·
• TPN-6	✓	·	·	·	·
• TPN-7	✓	·	·	·	·

Manager : Sylvaine GAUTIER

Professionnal project 1

Hours

Lect	Tut	PW	Proj	WP	Asst
1.5	12				4.5

Evaluation

One evaluation : *Contrôle continu*

Bibliography

- DE LASSUS René, L'analyse transactionnelle : une méthode révolutionnaire pour bien se connaître et mieux communiquer, Marabout (Savoir pratique n3516), 2013, 288 p., ISBN 2501085493

- DE LASSUS René, La communication efficace par la PNL, Marabout (Bien-être - Psy), 2019, 288 p., ISBN 2501089499

- DE LASSUS René, L'ennéagramme : les 9 types de personnalités, Marabout (Poche Psy n3568), 2019, 288 p., ISBN 2501084950

- DE MONICAULT Frédéric / RAVARD Olivier, 100 questions posées à l'entretien d'embauche, Jeunes Editions (Guides J), 2004 (3e édition), 182 p., ISBN-10 : 2844724221 / ISBN-13 : 978-2844724229

- LEONARD Thomas J., The portable coach, Simon & SCHUSTER, 1999, 336 p., ISBN-10 : 0684850419 / ISBN-13 : 9780684850412

- ROSENBERG Marshall B., Les mots sont des fenêtres (ou bien ce sont des murs) : initiation à la communication non-violente, La Découverte, 2016, 320 p., ISBN 2707188794

- www.16personalities.com

- www.acnv.com

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-2	·	✓	·	·	·
• TPN-6	·	✓	·	·	·

Manager : Sylvaine GAUTIER

Project

Hours

Lect	Tut	PW	Proj	WP	Asst
			140		70

Evaluation

One evaluation : *Rapports + so*

Outline

From September to January, students conduct a mentored advanced project. To this end, they can use all equipement available in the department of materials science and engineering. Projects are funded by private companies, and they have to be aligned with the corporate strategic plan. Students have to organize working meetings, to present the final results to the project's leadership, and to complete a post-project review report.

Goals

Students will actively engage in funded research projects. They will have to demonstrate initiative in shaping the project at each stage.

Bibliography

Pas de bibliographie

Prerequisites

All 3rd and 4th year courses

Learning outcomes

Learning outcomes	N	A	M	E	O
• Using scientific and technical skills to fix a technological problem.	·	·	·	✓	·
• Defining and analyzing the needs associated with a particular industrial problem.	·	·	✓	·	·
• Designing novel materials or process	·	·	✓	·	·
• Shaping and conducting a project. Conducting worshops and presenting results	·	·	·	✓	·
• Organizing a project schedule and a work plan.	·	·	✓	·	·

Manager : Stéphane CUENOT

Project - case study - meeting management

Hours

Lect	Tut	PW	Proj	WP	Asst
2.5	2		52.25		29

Evaluation

One evaluation : *CC*

Outline

Shipbuilding case studies
- Offshore construction case studies
- Energy case studies

Goals

Here it is a question of having examples in the form of case studies of practical applications related to welded fabrication. Interventions are given by industrialists in the sector.

Prerequisites

All courses in welding processes, welding metallurgy, design and manufacturing

Learning outcomes

Learning outcomes	N	A	M	E	O
• understand the choices of welding processes for a given application	·	·	✓	·	·
• know how to choose a material for a given application	·	·	✓	·	·
• Choose designs for a given application	·	·	✓	·	·
• Understand and implement manufacturing for a given application	·	·	✓	·	·

Manager : Pascal PAILLARD

Project management 1

Hours

Lect	Tut	PW	Proj	WP	Asst
4.5		3			2

Evaluation

One evaluation : *DS*

Project management 2

Hours

Lect	Tut	PW	Proj	WP	Asst
	15				3

Evaluation

One evaluation : *Contrôle continu*

Bibliography

Partie analyse du travail : PIERRE VERMERSCH, 1994 « L'entretien d'explicitation », ESF éditeur

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	✓	·	·	·	·
• TPN-2	·	✓	·	·	·
• TPN-3	·	✓	·	·	·
• TPN-4	✓	·	·	·	·
• TPN-5	·	✓	·	·	·

Manager : John KINGSTON

Quality, security and environmental approaches (QSE1)

Hours

Lect	Tut	PW	Proj	WP	Asst
	3	3			

Evaluation

One evaluation : *QCM+exercices*

Bibliography

Ressources documentaires disponibles sur madoc :

o Le Code du travail numérique

o Code de l'environnement LEGIFRANCE

o Les aventures de Napo vidéos d'animation INRS pour sensibilisation à la sécurité au travail

o Publications et outils de l'INRS Institut national de recherche et de sécurité

o AIDA : Site web des textes réglementaires du Ministère en charge de l'environnement

o Les fiches sur le fonctionnement des principales institutions de la République, l'organisation de l'Union européenne et les relations internationales

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	✓	·	·	·	·
• TPN-3	·	✓	·	·	·
• TPN-4	✓	·	·	·	·
• TPN-5	✓	·	·	·	·

Manager : John KINGSTON

Quality, security ant environmental approaches (QSE2)

Hours

Lect	Tut	PW	Proj	WP	Asst
	6				

Evaluation

One evaluation : *QCM+exercices*

Bibliography

Références ou ressources documentaires disponibles sur madoc :

- Les fiches sur le fonctionnement des principales institutions de la République, l'organisation de l'Union européenne et les relations internationales
- Publications et outils de l'INRS Institut national de recherche et de sécurité
- Rapports détaillés des accidents industriels sur la base de donnée ARIA
- Outils MARP de Techniques de l'Ingénieur.

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	✓	·	·	·	·
• TPN-3	·	✓	·	·	·
• TPN-4	✓	·	·	·	·
• TPN-5	✓	·	·	·	·

Manager : John KINGSTON

R&D Project management

Hours

Lect	Tut	PW	Proj	WP	Asst
12					6

Evaluation

One evaluation : *Projet+exposés*

Outline

Introduction to innovation projects. Possible fundings. Industrial property protection strategies. How to effectively plan and execute a project ? Risk analysis. Communication in project management.

Goals

This course is designed to provide a broad introduction to project management and to intellectual property.

Bibliography

Manager par projets. [Valentine CHAPUS-GILBERT NATHAN / Les échos.fr]

L'Auto qui n'existait pas - Management des projets et transformation de l'entreprise. [Christophe MIDLER DUNOD]

La méthode APTE (Analyse fonctionnelle). [Bertrand DE LA BRETESCHE PETRELLE]

Pratique de l'AMDEC. [Jean FAUCHER DUNOD / L'usine Nouvelle]

Prerequisites

Pre-professional work experience (internship)

Learning outcomes

Learning outcomes	N	A	M	E	O
• Knowing about industrial property protection strategies and about the principal funding opportunities for research and innovation in France and in EU.	✓	·	·	·	·
• Conducting a simple needs assessment	·	✓	·	·	·
• Planning and organizing a simple project	·	✓	·	·	·
• Understanding the role of a project leader and anticipating project risks	✓	·	·	·	·

Manager : Emmanuel CHENE

R&D economy

Hours

Lect	Tut	PW	Proj	WP	Asst
1.5	6				4

Evaluation

One evaluation : *Etude de cas*

Outline

CHAPTER 1 : Innovation: engine of the economic growth
CHAPTER 2 : The modes of evaluation and financing of the innovation

Goals

Understand the relations and interaction between economy and innovation

Bibliography

GUELLEC D, "Economie de l'innovation", Repères La Découverte
LACHMANN J., "le finacement des stratégies de l'innovation", Paris, Economica
BETBEZE J.P (2005), "Financer la R&D", Conseil d'analyse économique

Prerequisites

The basic concepts in economy

Learning outcomes

Learning outcomes	N	A	M	E	O
• Know the links between economy and innovation	✓	·	·	·	·
• Know the economic problems of the economy of the innovation following countries and periods	·	✓	·	·	·

Manager : Emmanuel CHENE

Radiocrystallography

Hours

Lect	Tut	PW	Proj	WP	Asst
8.75	12.5				11

Evaluation

One evaluation : *DS*

Outline

The first part deals with general information on radiation such as x-ray production and collection of diffraction data. The second part concerns the laws of diffraction and a third on the methods of diffraction by single crystal and powders.

Goals

The study of diffraction (X-rays, neutrons or electrons) and highlighting the relationship between the directions of diffraction and the lattice, and between the diffracted intensity and pattern. Applications.

Prerequisites

Courses of symmetry

Learning outcomes

Learning outcomes	N	A	M	E	O
• Know how to extract information from the X-ray, neutron and electron diffraction data	·	✓	·	·	·
• Know the expression of the intensity of a diffraction peak, of the structure factor and know how to determine the reflection condictions	·	·	✓	·	·
• To be able to give the diffraction conditions in the direct and reciprocal spaces	·	·	✓	·	·

Manager : Olivier JOUBERT

Research S7

Hours

Lect	Tut	PW	Proj	WP	Asst
			32		

Evaluation

One evaluation : *Evaluation*

Manager : Antoine GOULLET

Research S8

Hours

Lect	Tut	PW	Proj	WP	Asst
			32		

Evaluation

One evaluation : *Evaluation*

Manager : Antoine GOULLET

Rheology and thermomechanics of polymers

Hours

Lect	Tut	PW	Proj	WP	Asst
10	14				12

Evaluation

2 evaluations :

- *DS1*
- *DS2*

Outline

A - Viscoelasticity
- Creep-Recovery and relaxation tests
- Maxwel and Kelvin-Voigt models
- Dynamic mechanical measurements

B - Rheology of complex fluid : typical behaviours

C - Polymers rheology
- Time - Temperature Superposition (WLF law)
- Thermomechanical behaviour of polymer in the solid state

o Mechanical spectroscopy (structure-property relationships)

o Determination of long-term mechanical properties (cycle life)

o Determination of short-term properties (quality check)
- Thermomechanical behaviour of polymers in the liquid state

Goals

It is an introduction to the rheological behaviours of visco-elastic materials in their day-to-day life and processing situation; it is also a more exhaustive study of polymers and the influence of their composition and external factors (time and temperature).

Bibliography

Mc GRUM N.G., BUCKLEY C.P., BUCKNALL C.B. - Principles of polymer engineering 2nd ed. Oxford University Press (1997).

Les techniques de l'ingénieur :

CARROT C., GUILLET J. -Viscoélasticité linéaires des polymères fondus (AM 3 620) et Viscoélasticité non linéaires des polymères fondus (AM 3630).

KRAWCZAK P., - Essais mécaniques des plastiques (AM 3 510) (AM 3 511) (AM 3 512).

CHATAIN M., - Comportement physique et thermomécanique des plastiques (A 3 110).

Prerequisites

An introduction to polymers

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the thermomechanical behaviour of polymers in general, in the solid and melt states	·	·	✓	·	·
• To know the effect of the chemical nature of a polymer on its thermomechanical behaviour	·	·	✓	·	·
• To know how to measure the thermomechanical behaviour of a polymer depending on its usage and processing method	·	✓	·	·	·
• To know how to chose a polymer for an application of a processing method	·	✓	·	·	·
• To know how to use viscoelastic models to predict the behaviour of a viscoelastic material in certain conditions	·	✓	·	·	·

Manager : Bernard LESTRIEZ

Second foreign language - Japanese

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				

Evaluation

One evaluation : *CC*

Second foreign language - Japanese

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				

Evaluation

One evaluation : *CC*

Second foreign language - Sign language

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				

Evaluation

One evaluation : *CC*

Second foreign language - Sign language

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				

Evaluation

One evaluation : *CC*

Second foreign language - Spanish

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				

Evaluation

One evaluation : *CC*

Second foreign language - Spanish

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				

Evaluation

One evaluation : *CC*

Semiconducting materials and devices

Hours

Lect	Tut	PW	Proj	WP	Asst
13.75	4.5	12			16

Evaluation

2 evaluations :

- *DS*
- *TP*

Manager : Pierre-Yves TESSIER

Sensors, instrumentation and measurements

Hours

Lect	Tut	PW	Proj	WP	Asst
10	10.5				11

Evaluation

One evaluation : *1 DS*

Outline

Continuous and discrete signals, Continuous and discrete systems - sampling, Signal processing, amplification, filtering, control and conversion - A/D converter. Semiconductor devices : diodes and transistors. Measurement chain - sensors - conditioning systems - amplifier for instrumentation - Examples

Goals

Describe different principles of the transduction of sensors related to the physical properties of materials. Describe the signal conditioning of sensors. Give the basic knowledge onto the structure and the functioning of a measurement chain and acquisition of data. Give basic notions of continuous and digital signal processing.

Bibliography

Acquisition de données - Du capteur à l'ordinateur - G. Asch - Dunod ; Electronique des systèmes de mesures - Mise en oeuvre des procédés analogiques et numériques - Tran Tien Lang - Masson ; Les capteurs en instrumentation industrielle - G. Asch - Dunod

Prerequisites

Calculation of a function of transfer of a quadripole in sinusoidal regime - Diagram of Bode - Calculation of a gain and a phase shift - Theorems and basic techniques of calculation on circuits in linear regime : Kirchoff, Thévenin, Norton, voltage dividing bridge, Millman, Equivalent Impedance

Learning outcomes

Learning outcomes	N	A	M	E	O
• Conceive the elements of a measurement chain and acquisition of datas including the sensors and their integration in bridges, conditioning systems, the amplification systems and analog filtering, the analog multiplexers, sampling and the digital-analog conversion	·	✓	·	·	·
• Know the basic principles leading to a specific function of transduction in a sensor related to material properties and/or to geometrical effects.	·	✓	·	·	·
• Set the conditions of sampling of a continuous signal of time: sampling frequency (Shannon criterion) and number of samples and know tools allowing to estimate the frequency spectrum of a continuous signal or a discrete signal.	·	·	✓	·	·
• Know the basic features about operational amplifier used for processing and the control of the analog signals (amplifier, comparator, trigger, converter).	·	·	✓	·	·
• Know the electric basic characteristics of junction diodes (recovery, switching, LED, photodiodes) and know how to evaluate the behavior of an electrical assembly with ideal diodes.	·	·	✓	·	·

Manager : Pierre-Yves TESSIER

Shaping of composite materials

Hours

Lect	Tut	PW	Proj	WP	Asst
22	13.5	24			30

Evaluation

3 evaluations :

- *CR1*
- *CR2*
- *TP*

Bibliography

J.-P. Pascault, H. Sautereau, J. Verdu, R.J.J. Williams ; « Thermosetting polymers» ; Marcel Dekker Inc., ISBN 0-8247-0670-6.

Heat Transfers in Polymer Composite Materials: Forming Processes, ISTE Ltd.(nov. 2015), ISBN-13: 978-1848217614.

« Pam Rtm : Users Guide » ; ESI-Group, http ://www.esi-group.com

Learning outcomes

Learning outcomes	N	A	M	E	O
• -	·	✓	·	·	·
• -	·	·	✓	·	·
• -	·	·	✓	·	·
• -	·	✓	·	·	·

Manager : Vincent SOBOTKA

Socio-economic debates and Tools for shifting

Hours

Lect	Tut	PW	Proj	WP	Asst
	21				10

Evaluation

One evaluation : *Exposé débat*

Bibliography

De nombreuses références seront proposées dans chacun des 6 thèmes (liens vidéos, articles et livres) ; quelques livres de base peuvent cependant servir à tous les thèmes :

- BRAQUET Laurent et MOUREY David, Comprendre les fondamentaux de l'économie, De Boeck, 2015, 475 p., ISBN 978-2-8041-9021-7
- BIASUTTI Jean-Pierre et BRAQUET Laurent, Les débats économiques d'aujourd'hui, Ellipses, 2019, 278p, ISBN 9782340-031210
- DESCAMPS Christian, L'analyse économique en questions, Vuibert, 2005, ISBN 2-71117-7413-9
- SINAÏ Agnès, Penser la décroissance, Sciences Po Les presses, 2018, 210 p, ISBN 9782724613001
- SINAÏ Agnès, Economie de l'après-croissance, Sciences Po Les presses, 2018, ISBN 9782724617559
- PIKETTY Thomas, Capital et idéologie, Seuil, 2019, ISBN 978-2-02-133804-1
- COHEN Daniel, Le monde est clos et le désir infini, Albin Michel, 2015, ISBN 978-2226240293

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-3	✓	·	·	·	·
• TPN-4	✓	·	·	·	·
• TPN-1	·	✓	·	·	·
• TPN-2	·	✓	·	·	·
• TPN-3	·	✓	·	·	·
• TPN-8	✓	·	·	·	·
• TPN-9	✓	·	·	·	·
• TPN-10	·	✓	·	·	·
• TPN-11	✓	·	·	·	·

Manager : Chrystèle GONCALVES

Soft skills

Hours

Lect	Tut	PW	Proj	WP	Asst
	7.5				

Evaluation

One evaluation : *Examen:cas pratique*

Bibliography

- La confiance en gestion : un regard pluridisciplinaire (Boissieu & Oguchi, 2011)
- Trust Rules: How the World's Best Managers Create Great Places to Work (Lee, 2017)
- Give and Take: A Revolutionary Approach to Success (Grant, 2013)
- L'entreprise une affaire de don (Collectif, 2016)
- La théorie des jeux - Science étonnante
- Jeu sur l'évolution de la confiance
- The Office (NBC, 2005)
- Mad Men (HBO, 2007)

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-1	✓	·	·	·	·
• TPN-2	✓	·	·	·	·
• TPN-4	✓	·	·	·	·
• TPN-6	✓	·	·	·	·
• TPN-5	✓	·	·	·	·
• TPN-6	✓	·	·	·	·
• TPN-7	✓	·	·	·	·
• TPN-12	✓	·	·	·	·
• TPN-13	✓	·	·	·	·
• TPN-20	✓	·	·	·	·
• TPN-21	✓	·	·	·	·

Manager : Roland BESSENAY

Solid state chemistry I

Hours

Lect	Tut	PW	Proj	WP	Asst
7.5	9				9

Evaluation

One evaluation : *DS*

Outline

Chapter I - Atoms A: Chemical elements - Periiodic Table
B: Orbitals
C: Interactions - Chemical bond a: electronegativity, b: oxidation state, c: Diffeernt types of chemical bond
Chapter II - Coordination chemistry
A- Structural descrption, ligands and coordination
B - Molecular orbital theory : octahedral complexes, s interactions, p interactions
C - Crystal field theory - 1: Crystal field splitting 2 - Jahn Teller effect

Goals

Firmly establish the background of solid state chemistry. Precisely know the orbitals and their occupancy. Acquire important basic knowledges: electronegativity, oxidation state, different types of chemical bond. Establish energy diagramms for orbitals in a complex.

Bibliography

Chimie des solides - J.F. Marucco - EDP Sciences
Solid State Chemistry - L. Smart and E. Moore - Chapman et Hall
Chimie Inorganique - Huheey, Ketter et Ketter - De Boeck Université

Prerequisites

Basic knowledge in chemistry - Content of previous courses in semester 5 : Chemical Bond and Symmetry

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know chemical elements, their classification and their main characteristics	·	·	✓	·	·
• To know basic knowledge in solid state chemistry : electronegativity, oxidation states, the types of chemical bond	·	·	✓	·	·
• To know the different types of chemical bond	·	·	✓	·	·
• Draw an orbital diagramm in coordination chemistry	·	·	✓	·	·

Manager : Olivier JOUBERT

Solid state physics 1

Hours

Lect	Tut	PW	Proj	WP	Asst
6.25	4.5				6

Evaluation

One evaluation : *DS*

Manager : Olivier CHAUVET

Solid state physics 2

Hours

Lect	Tut	PW	Proj	WP	Asst
15	10.5				13

Evaluation

2 evaluations :

- *CC (quizz+DM)*
- *Examen final*

Presentation

This EC aims to give the future engineer the keys to understand, model and evaluate the physical properties of functional materials according to the environment, excluding mechanical properties. Emphasis is placed on the link between the microscopic / crystalline structure and the physical properties (electronic, thermal, magnetic, optical). Some applications associated with these properties are described but the technological systems are not treated.

Outline

Introduction
The classical free electron gas: Drude's model- metals
The quantum free electrons: the Drude Sommerfeld model- metals
The quasi free electrons- conductors and insulators
Phonons and thermal properties
Electronic transport properties of solids
Magnectif properties of solids
Elements on magnetic spectroscopies

Goals

At the end of this EC, the future engineer will be able to:
? Understand the origin of physical properties and the link between them for the major classes of materials, in connection with their microscopic structure
? Know the order of magnitude of the physical properties of the different classes of materials
? Being able to choose a material for a given application
? Have some notions of magnetic spectroscopies

Bibliography

C. Kittel: Introduction à la physique du solide, Dunod, Paris
M. Gerl, JP. Issy, Traité des matériaux: physique des matériaux, tome 8, Presses Polytechniques et Universitaires Romandes, Lausanne
N.W. Ashcroft, N.D. Mermin, Solid State Physics, Saunders, Philadelphie

Prerequisites

Basis of quantum mechanics
Basis of quantum chemistry
Structure of solids

Learning outcomes

Learning outcomes	N	A	M	E	O
• MAT-3: describe and solve a physics problem	·	·	✓	·	·
• MAT-6: Being able to apply physics and / or chemistry in the field of material science	·	·	✓	·	·
• MAT-8:Make the link between the different scientific fields, Take into account their interactions, and be able to synthesize them on complex cases of material science	·	✓	·	·	·
• MAT-13: Choose and use the materials characterizations; interpret, analyze and use the results	✓	·	·	·	·

Manager : Olivier CHAUVET

Specializes lectures by professionnal lecturers

Hours

Lect	Tut	PW	Proj	WP	Asst
45					23

Evaluation

One evaluation : *DS*

Manager : Stéphane CUENOT

Surface Analysis

Hours

Lect	Tut	PW	Proj	WP	Asst
8.75	1.5				6

Evaluation

One evaluation : *DS*

Outline

1) Introduction on the need for specific techniques of surface characterization from examples in the field of physics and the chemistry of materials
2) Electron Spectroscopy - XPS / ESCA, AES
3) Rutherford Backscattering Spectrometry - RBS
4) Secondary Ions Mass Spectrometry - SIMS
5) Comparison of techniques - Strategies of analysis approach

Goals

Overview of surface analysis techniques, their principles and their main characteristics and specifications. Know how to choose a surface analysis technique based on a specific problem.

Bibliography

Analyse structurale et chimique des matériaux - J.P. Eberhart (Dunod) ; Surfaces, interfaces et films minces - B. Agius, M. Froment et co-auteurs (Dunod) ; Semiconductor material and device characterization - Dieter K. Schroder (John Wiley and Sons)

Prerequisites

General knowledge of the different categories of materials: glasses, ceramic, polymers, metals, semiconductors. Electron orbital in atoms. Solid-state physics and chemistry.

Learning outcomes

Learning outcomes	N	A	M	E	O
• Be able to choose a technique of surface analysis of a material according to a specific problem	·	✓	·	·	·
• Be able to interpret spectra of XPS, AES, RBS, SIMS analysis	·	✓	·	·	·

Manager : Pierre-Yves TESSIER

Sustainable development and social responsability 1

Hours

Lect	Tut	PW	Proj	WP	Asst
1.5	13.5				

Evaluation

One evaluation : *Grille d'évaluation*

Bibliography

- Travaux du GIEC
- Global carbon project

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-3	✓	·	·	·	·

Manager : Laurence CHARPENTIER

Sustainable development and social responsability 2

Hours

Lect	Tut	PW	Proj	WP	Asst
	9				10

Evaluation

One evaluation : *Soutenance + Rapport*

Bibliography

- Travaux du GIEC
- Global carbon project

Learning outcomes

Learning outcomes	N	A	M	E	O
• TPN-3	·	✓	·	·	·
• TPN-5	·	✓	·	·	·

Manager : Laurence CHARPENTIER

Symmetry

Hours

Lect	Tut	PW	Proj	WP	Asst
13.75	14.5				14

Evaluation

One evaluation : *DS*

Outline

I INTRODIUCTION -THE MOLECULAR SYMMETRY - THE CRYSTALLOGRAPHY
II ORIENTATION SYMMETRY
III GROUP THEORY
IV SPACE GROUP SYMMETRY - THE CRYSTALLOGRAPHY

Goals

Introduce the principles of group theory and the base of geometrical crystallography from the study of symmetry operations, enumeration and construction of point groups, calculations in different spaces, and the construction of space groups.

Bibliography

"La théorie des groupes en physique et chimie quantiques", J. HLADIK, Ed. MASSON 1995, ISBN : 2 225 84752 3.

"Cristallographie géométrique et radiocristallographie", J.J. Rousseau, Ed. MASON 1995, ISBN 2 225 84990 0

Prerequisites

Mathematics, Level equivalent to a second academic year

Learning outcomes

Learning outcomes	N	A	M	E	O
• Know how to recognize and count the symmetry operations of a molecule, an object or a crystal.	·	·	✓	·	·
• Know how to determine a point group of a molecule	·	·	✓	·	·
• Know how to build a character table	·	·	✓	·	·
• Know how to represent direct and reciprocal lattices and solving some calculations	·	·	✓	·	·
• Recognize the elements of symmetry of a space group and place them in a unit cell	·	·	✓	·	·

Manager : Olivier JOUBERT

Thermodynamics of materials

Hours

Lect	Tut	PW	Proj	WP	Asst
	11.5				6

Evaluation

One evaluation : *1 DS*

Outline

Work, heat, thermal capacities - First law - Entropy, second and third laws. Free Gibbs energy - Chemical potentials - Phase transition of matter, allotropic transformations - Variations of enthalpy, entropy and free Gibbs energy for a chemical reaction - Thermodynamic tables - Interfacial tension - Lattice energy - Oxidation of metals in air or oxygen gas.

Goals

This course will consider classical thermodynamics and its practical application in the field of material science and engineering

Bibliography

"Thermodynamique des matériaux", Gérard Lesoult, Traité des matériaux vol. 5, Presses polytechniques et universitaires Romandes - "Thermodynamique des matériaux" : équilibres de phases et métastabilité", P. Desré, F. Hodaj, EDP Sciences

Prerequisites

Introductory thermodynamics
Mathematics

Learning outcomes

Learning outcomes	N	A	M	E	O
• Calculating thermodynamic quantities for physical transformations or chemical reactions	·	·	✓	·	·
• Calculating heat and temperature changes	·	·	✓	·	·
• Using Free Gibbs energy	·	·	✓	·	·
• Using interfacial tension	·	✓	·	·	·

Manager : Christophe PAYEN

Thermodynamics of materials - 2

Hours

Lect	Tut	PW	Proj	WP	Asst
	11.5				6

Evaluation

One evaluation : *DS*

Outline

Chemical equilibrium (equilibrium constant, activity, phase rule and degrees of freedom, van't Hoff equation, Le Chatelier's principle) - Ellingham diagrams - Reactive atmospheres - Reducing or oxidizing agents - Introduction to electrochemical devices (free Gibbs enthalpy and emf, Nernst equation).

Goals

This course will consider classical thermodynamics and its practical application in the field of material sciences and engineering.

Bibliography

"Thermodynamique des matériaux", Gérard Lesoult, Traité des matériaux vol. 5, Presses polytechniques et universitaires Romandes - "Thermodynamique des matériaux" : équilibres de phases et métastabilité", P. Desré, F. Hodaj, EDP Sciences

Prerequisites

Course : "Thermodynamics of materials - 1" - Level : Semester 5

Learning outcomes

Learning outcomes	N	A	M	E	O
• Knowing the factor which allow to control a reaction	·	·	✓	·	·
• Knowing the factor which allow to control a reaction	·	·	✓	·	·
• Using Nernst equation	·	·	✓	·	·
• Using Ellingham diagrams	·	·	✓	·	·

Manager : Christophe PAYEN

Thermomechanical treatments

Hours

Lect	Tut	PW	Proj	WP	Asst
12	0.5				7

Evaluation

One evaluation : *SO*

Goals

To know thermal, mechanical or thermomechanical treatments employed in industry to modify properties of metallic parts and understand how these treatments modify microstructures and properties of metallic alloys.

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the main termal treatments employed on metals and their consequences	·	·	✓	·	·
• To understant the consequences of thermal treatments on micristructures of metals	·	·	·	✓	·

Manager : Laurent COUTURIER

Thermophysical properties of polymers and composites

Hours

Lect	Tut	PW	Proj	WP	Asst
15	1.5				9

Evaluation

One evaluation : *DS*

Bibliography

D.W. Van Krevelen ; « Properties of polymers » ; Elsevier, Third completely revised edition

Learning outcomes

Learning outcomes	N	A	M	E	O
• -	·	·	✓	·	·
• -	·	·	✓	·	·
• -	·	·	✓	·	·

Manager : Vincent SOBOTKA

Thin film materials

Hours

Lect	Tut	PW	Proj	WP	Asst
10	6				8

Evaluation

One evaluation : *DS*

Outline

1- Panorama of the applications 2- Process overview 3-Notion of physics of surfaces 4- Kinetic theory of gases 5- Thermal Evaporation 6-Laser ablation 7-Ion sputtering 8-Examples

Goals

Give the fields of thin film applications and give a knowledge about the panorama of the techniques of thin film synthesis.

Bibliography

Thin films - R.A. Powell, S.M. Rossnagel - Academic Press

Prerequisites

Notions of thermodynamics: Maxwell-Boltzman distribution, Clapeyron law - Saturation vapor pressure - Notion of crystallography: Crystalline Bravais lattice

Learning outcomes

Learning outcomes	N	A	M	E	O
• Have a knowledge of the main fields of application of thin films and have a knowledge of the panorama of the techniques of thin film deposition	·	·	✓	·	·
• Have a knowledge of the surface mechanisms leading to the growth of a thin film	·	·	✓	·	·
• Be able to choose a technique of thin film deposition according to a given application.	·	✓	·	·	·
• Know the principle of the cathodic sputtering, the thermal evaporation, the plasma laser deposition and of the chemical vapor deposition	·	·	✓	·	·
• Able to evaluate the evaporated or sputtered flux of atoms and able to estimate the deposition rate and the rate of contamination by residual gas.	·	·	✓	·	·

Manager : Pierre-Yves TESSIER

Training for Toeic

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				

Evaluation

One evaluation : *CC*

Training for Toeic

Hours

Lect	Tut	PW	Proj	WP	Asst
	18				

Evaluation

One evaluation : *CC*

Transition Engineering and Interdisciplinarity S7

Hours

Lect	Tut	PW	Proj	WP	Asst
			32		

Evaluation

One evaluation : *Evaluation*

Manager : Bruno AUVITY

Transition Engineering and Interdisciplinarity S8

Hours

Lect	Tut	PW	Proj	WP	Asst
			32		

Evaluation

One evaluation : *Evaluation*

Manager : Bruno AUVITY

Weld analysis

Hours

Lect	Tut	PW	Proj	WP	Asst
		10			

Evaluation

One evaluation : *CC*

Outline

It is a mini project in the laboratory comprising macrographic and micrographic observations of weld seams and mechanical characterizations (shock, tensile tests, bends).

Goals

This involves carrying out the expertise of weld seams in order to validate the welding parameters. It is a question of characterizing the quality of cords

Prerequisites

The courses in metallurgy, characterization of materials and behavior of materials during welding must be acquired.

Learning outcomes

Learning outcomes	N	A	M	E	O
• Weld characterization	·	·	✓	·	·
• Interpret the presence of faults	·	·	✓	·	·
• Give solutions in case of faults	·	·	✓	·	·

Manager : Pascal PAILLARD

Welding and foundry

Hours

Lect	Tut	PW	Proj	WP	Asst
15	3				9

Evaluation

One evaluation : *DS*

Outline

Foundry and Economics
- History of the Foundry
- Foundry processes
- Metallurgical changes
- Foundry defects
- Casting alloys
- Welding processes
- The electric arc
- Welding deformation
- Health and security
- Welding metallurgy

Goals

Panorama of processes foundry and the methods of jointing by welding
- Behaviour of metallic materials during forming

Bibliography

DOUR G., Aide mémoire Fonderie, DUNOD, 2004
- MURRY G., Aide mémoire Métallurgie, DUNOD, 2004
- WEMAN K., Aide mémoire Procédés de soudage, DUNOD, 2004

Prerequisites

Courses of Metallurgy and Phisical Metallurgy in 3rd and 4th years

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the foundry processes	·	·	✓	·	·
• To know the welding processes	·	·	✓	·	·
• To understand the effect of forming process (foundru and welding) on metallic materials	·	·	✓	·	·

Manager : Pascal PAILLARD

Welding metallurgy

Hours

Lect	Tut	PW	Proj	WP	Asst
57.75	1.5				26

Evaluation

One evaluation : *DS*

Outline

Behavior of steels during fusion welding
- Cracking in welded joints
- Heat treatment of welded joints
- Structural steels (non-alloy)
- High strength steels
- Applications of construction and high strength steels
- Creep and creep-resisting steels
- Steels for cryogenic applications
- Stainless and refractory steel
- Fonts and cast steels
- Copper and copper alloys
- Nickel and nickel alloys
- Aluminium and aluminium alloys
- Titanium and titanium alloys

Goals

Acquire the basic principles of the metallurgy of welding of all types of structural steels, stainless steels, aluminum alloys, titanium alloys, copper alloys ...

Bibliography

KOU S., Welding Metallurgy, John Wiley, 2005

BOUCHER C., L'aluminium et ses alliages, Publications du soudage et de ses applications, 2000

GRANJON H., Bases métallurgiques du soudage, Publications du soudage et de ses applications, 1995

GRANJON H., Bases métallurgiques du soudage, Soudure Autogène, 1989

ALTHOUSE A.D., BRAMAT M., MAYER, VILLENEUVE M., Technologie des métaux, contrôles et essais des soudures, De Boeck Edition 2008

Prerequisites

Courses of Metallurgy and Physical Mettalurgy en 3rd ant 4th years

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the influence of welding on the metallurgical modifications of alloys	·	·	✓	·	·
• To choose a welding process based on the alloy to weld	·	·	✓	·	·
• To understand damages of materials likely to appear during the welding operation and to propose remedies	·	·	✓	·	·
• To choose a metallic material for a given application	·	·	✓	·	·

Manager : Pascal PAILLARD

Welding methods

Hours

Lect	Tut	PW	Proj	WP	Asst
56	1.5				29

Evaluation

One evaluation : *DS*

Outline

Oxyfuel processes

Current sources

Processes with electric arc without gas protection (Metal arc welding with covered electrode, submerged arc welding,...)

Methods for gas shielded arc (GTAW, GMAW, Plasma,...)

High density of energy (Laser, electron beam) processes

Electric resistance welding processes

Other welding processes: aluminothermy, diffusion, explosion,...

Cutting and preparation of the edges

Brazing

Mechanization and automation of welding

Goals

Understand in detail the developments in all welding processes, including terminology, standards, accepted abbreviations, equipment, applications, procedures and common problems

Bibliography

ALTHOUSE A.D, PAQUET C., BRAMAT M., VILLENEUVE M., Coupage et procédés oxygaz, De Boeck Edition 2008.

PAQUET C., BRAMAT M., VILLENEUVE M., Procédés spéciaux de soudage et coupage, De Boeck Edition 2008.

ALTHOUSE A.D., BRAMAT M., MAYER, VILLENEUVE M., Technologie des métaux, contrôles et essais des soudures, De Boeck Edition 2008.

PAQUET C., LEVESQUE L., BRAMAT M., Procédés de soudage à l'arc, De Boeck Edition 2008.

JORION A., THIEBAULT A., La soudure à l'arc, Edition SAEP, 2007.

CRETIN S., JUBIN L., MACQUET P., Soudage robotisé en construction mécanique : technologies de production, Publication du CETIM, 2005

Prerequisites

Course of Welding and Cast Process of 4th year

Learning outcomes

Learning outcomes	N	A	M	E	O
• To know the different welding processes	·	·	✓	·	·
• To know the possible applications with different welding processes	·	·	✓	·	·
• To choose a welding process based on a given application	·	·	✓	·	·

Manager : Pascal PAILLARD