



الجمهورية الجزائرية الديمقراطية الشعبية
République Algérienne Démocratique
et Populaire
وزارة التعليم العالي والبحث العلمي
Ministère de l'Enseignement Supérieur
et de la Recherche Scientifique

اللجنة البيداغوجية الوطنية
لميدان العلوم و التكنولوجيا
Comité Pédagogique
National du Domaine
Sciences et Technologies



OFFRE DE FORMATION L.M.D.

OFFRE DE FORMATION MASTER PROFESSIONNALISANT

Ce Master a été développé dans le cadre du Projet Erasmus+ SM Weld
N° Réf : 561786-EPP-1-2015-1-SE-EPPKA2-CBHE-JP, et sera suivi
attentivement par les partenaires Européens, Algériens et Tunisiens

2018 - 2019

Etablissement	Faculté / Institut	Département
USTHB	Génie Mécanique et Génie des Procédés	Construction Mécanique et Productique

Domaine	Filière	Spécialité
Sciences et Technologie	Génie Mécanique	Ingénierie du Soudage



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عرض تكوين ماستر مهني

2018-2019

المؤسسة	الكلية/ المعهد	القسم
جامعة هواري بومدين للعلوم و التكنولوجيا	كلية الهندسة الميكانيكية وهندسة الطرائق	البناءات الميكانيكية و الإنتاج

الميدان	الفرع	التخصص
علوم و تكنولوجيا	الهندسة الميكانيكية	هندسة التلحيم

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I – Fiche d'identité du Master

1 - Localisation de la formation :

Faculté (ou Institut) :Génie Mécanique et Génie des Procédés

Département : Construction Mécanique et Productique

2- Partenaires extérieurs:

Autres établissements partenaires :

Ce Master rentre dans le cadre d'un Projet ERASMUS+ en cours (Octobre 2015 à Octobre 2018) dénommé :SMWeldetintitulé: "South MediteranianWelding Center for Education, Training and Quality Control" Sous le code: 561786-EPP-1-2015-1-SE-EPPKA2-CBHE-JP

Par conséquent toutes les universités et entreprises membres du Projet SMWeld sont automatiquement partenaires de ce Master.

Partenaires Européens:

- 1. KTH - Institut Royal de Technologie de Stockholm, Suède**
- 2. UC-UNIVERSIDADE DE COIMBRA, Portugal**
- 3. ULE-UNIVERSIDAD DE LEON, Espagne**
- 4. UDJ - UNIVERSITATEA DUNAREA DE JOS, Roumanie**

Partenaires Maghrébins

- 5. USTHB- Université des Sciences et de la Technologie Houari Boumediene, Algérie**
- 6. UPMC1 – Université des Frères Mentouri Constantine 1, Algérie**
- 7. ENIM- Université de Monastir – Ecole Nationale des Ingénieurs de Monastir, Tunisie**
- 8. US – Université de Sfax - Ecole Nationale d'Ingénieurs de Sousse, Tunisie**

Entreprises et autres partenaires socio-économiques :Plusieurs entreprises et organismes Algériens, Européens et Tunisiens sont aussi partenaires :

- 9 Entreprise Nationale des Véhicules Industriels, SNVI, Rouiba, Algérie**
- 10 Société des Matériels de Gerbage et de Manutention, GERMAN, Constantine, Algérie**
- 11 Yamani Institut de Technologie, Zeralda, Algérie**

Partenaires internationaux :

- 12 EUROPEAN FEDERATION FOR WELDING JOINING AND CUTTING AISBL, Belgique**
- 13 GSI - Gesellschaft fürSchweißtechnik International mbH, Allemagne**
- 14 INSTITOUTO ANAPTIXIS EPICHEIRIMATIKOTITAS ASTIKI ETAIREIA, Grèce**
- 15 R&G InfoTech Consulting AB, Suède**
- 16 SOCOMININ, Tunisie**
- 17 CHAMBRE DE COMMERCE, Tunisie**
- 18 Technoprest-Technologies Prestation, Tunisie**

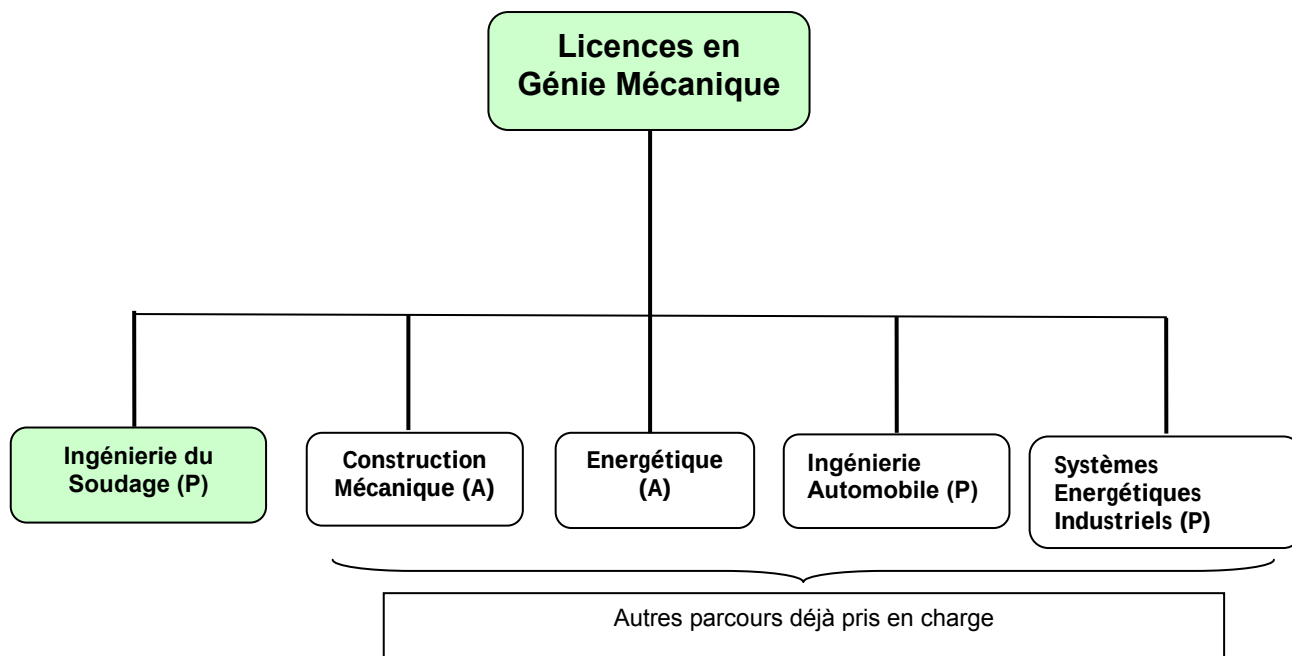
3 – Contexte et objectifs de la formation

A – Organisation générale de la formation : position du projet

Si plusieurs Masters sont proposées ou déjà prises en charge au niveau de l'établissement (même équipe de formation ou d'autres équipes de formation), indiquer dans le schéma suivant, la position de ce projet par rapport aux autres parcours.

*Le Master en **Ingénierie du Soudage**, est domicilié au Département de Génie Mécanique, Faculté des Sciences de la Technologie. Le Département de Génie Mécanique a déjà à son actif d'une part 3 licences académiques et 2 professionnelles et d'autre part 3 Masters Académiques et 2 professionnels.*

*Eu égard à la politique de développement de l'enseignement, la formation **Master en Ingénierie du Soudage**, qui est supportée par le Projet ERASMUS+ SMWeld, a une portée nationale et répond à un besoin crucial et urgent en matière de compétences dans le domaine du soudage. Par rapport aux autres parcours en cours au niveau du Département de Génie Mécanique, ce Master se positionne pour compléter les différentes formations offertes selon le schéma ci-dessous :*



B – Conditions d'accès (indiquer les parcours types de licence qui peuvent donner accès à la formation Master proposée)

Eu égard à sa dimension internationale, supporté par le Projet ERASMUS+ SMWeld, les parcours types qui peuvent donner accès à la formation de Master "Ingénierie du Soudage" doivent être des domaines en relations avec la conception, la construction, la fabrication mécanique et la productique, la maintenance industrielle, la métallurgie et le génie des matériaux.

Conditions d'accès

(Indiquer les spécialités de licence qui peuvent donner accès au Master)

Filière	Master	Licences ouvrant accès au master	Classement selon la compatibilité de la licence	Coefficient affecté à la licence
		Construction mécanique	1	1.00
		Fabrication mécanique et productique	1	1.00
		Métallurgie	2	0.80
		Maintenance Industrielle	2	0.80
		Génie des Matériaux	3	0.70
		Electromécanique	4	0.65
		Autres licences du domaine ST	5	0.60

B - Objectifs de la formation:

La majorité des constructions fait appel aux techniques d'assemblage. Parmi ces techniques, le soudage et ses techniques occupent une place prioritaire dans les domaines porteurs comme la charpente métallique, la tuyauterie, la chaudronnerie, les domaines de l'énergie, l'aéronautique, la construction navale, l'industrie automobile...

Les pays industrialisés l'ont bien compris puisqu'ils ont créé un standard de qualité pour la post formation et défini le titre d'International Welding Engineer (IWE). Ce titre est reconnu internationalement, sans limitation dans le temps.

L'objectif de ce Diplôme d'Université est de former et préparer les stagiaires à l'obtention de la certification IWE.

Cette formation s'adresse **aux Masters ou ingénieurs ou titulaires de L3 dans des domaines du Génie Mécanique et de la transformation des matériaux métalliques** qui, dans leur activité professionnelle, sont régulièrement confrontés à des problèmes liés au soudage.

Elle s'adresse aussi aux entreprises auxquelles les nouvelles législations nationales et/ou européennes, par exemple l'EN 1090 pour les structures métalliques ou l'EN 15085 pour la construction ferroviaire, imposent la supervision des opérations de soudure par un coordinateur en soudage. En effet, selon les normes ISO 3834, un ingénieur possédant la certification IWE est de facto coordinateur en soudage pour les niveaux d'exigences les plus élevés.

C – Profils et compétences visées:

Spécialiste en soudage Niveau 3 : Ingénieur Soudeur

D – Potentialités régionales et nationales d'employabilité:

Industries du pétrole et du gaz à l'échelle régionale,
L'industrie de construction mécanique
Sonatrach et Sonalegaz

E – Indicateurs de performance attendus de la formation:

1. Evaluation du déroulement de la formation :

En amont de la formation :

Le nombre de demande d'inscription dans la spécialité

Pendant la formation :

Evaluation par les étudiants

En aval de la formation :

Employabilité : nombre de diplômés et certifiés recrutés

Fiche de l'offre de formation de Master

Master L2 Intitulé: Ingénierie du Soudage Université : USTHB

Présentation

Il y a actuellement une forte demande d'ingénieurs soudeurs en Algérie, principalement du fait qu'un certain nombre de codes et de normes demande la présence au sein des entreprises de coordinateurs en soudage. Les personnels certifiés IWE (International Welding Engineer) sont de facto coordinateurs en soudage, ce qui en fait des collaborateurs très recherchés.

Cette offre de formation Master vise à préparer les étudiants à la certification en « Soudage » du fait que l'USTHB étant membre du consortium du Projet Erasmus+ SM Welda obtenue l'accréditation de l'Association Algérienne de Soudage de Contrôle en tant que « ATB : Authorized Trainer Body » centre de formation et d'examen.

Fonctions

Le **métier de l'Ingénieur soudage** consiste en la mise en œuvre du plan d'exécution des opérations et de la logistique des travaux afin d'atteindre les objectifs de l'entreprise. L'**Ingénieur soudage** assure la supervision et la coordination des ressources et activités sur le terrain où il veille au respect des règles de sécurité et des budgets établis. En établissant la faisabilité technique à partir du cahier de charge, l'**Ingénieur soudage** gère le suivi client du point de vue technique de soudage (organisation des inspections, analyse des exigences).

L'**Ingénieur soudage** rédige les procédures de soudage et les procédés de fabrication en respectant les normes réglementaires et contractuelles.

Selon l'exigence de la situation, l'**Ingénieur soudage** peut être en charge de la formation des équipes de soudeurs (sur chantier et en atelier).

Assurant un contrôle très méticuleux des soudures, l'**Ingénieur soudage** dépiste les dysfonctionnements et engage les actions correctives requises vitales pour la pérennité et la sécurité des structures métalliques réalisées.

L'**Ingénieur soudage** intervient sur divers chantiers sur des structures soudées, des appareils à pression, des grues, des infrastructures, des pipelines, des constructions neuves où seule son exigence prime.

Qualités

L'**Ingénieur soudage** a plusieurs casquettes en véritable **expert** esthète dans la diversité des matériaux à souder: c'est toute la difficulté de son métier.

Exigeant, l'Ingénieur soudage soude dans diverses situations en hauteur, sous l'eau, sous terre, où les soudures doivent donc être impeccables pour répondre aux nécessités du cahier des charges et de sécurité. L'**Ingénieur soudage** est à la recherche de nouveaux procédés de soudage pour améliorer les matériaux choisis. **Responsable du poste soudage**, l'Ingénieur soudage réalise un travail d'écriture de procédures de soudure et de contrôle très stricts. L'Ingénieur soudage veille d'ailleurs à l'aspect contrôle des opérations de soudage, qu'il soit réalisé en interne ou en externe: l'amélioration du processus de production est aussi au cœur du métier de l'Ingénieur soudage.

Licences (Nouvelles) donnant accès à ce master: Licence en Construction Mécanique ou équivalent (Sur étude de dossier).

Employabilité: Secteurs potentiellement recruteurs: Ce Master ouvre les portes sur différents domaines industriels :

Fabrication Mécanique, Plasturgie, Industrie automobile, Hydrocarbures, etc...

Débouchées :

1. Production

- 1.1. Responsable secteur de production
- 1.2. Responsable fabrication et/ou conditionnement
- 1.3. Directeur de production
- 1.4. Responsable des achats industriels
- 1.5. Responsable planning/ordonnancement
- 1.6. Responsable méthodes
- 1.7. Directeur industriel/directeur des opérations

2. Qualité

- 2.1. Responsable assurance-qualité
- 2.2. Auditeur qualité
- 2.3. Responsable validation-qualification
- 2.4. Directeur qualité
- 2.5. Responsable achats
- 2.6. Acheteur industriel

3. Commercialisation-diffusion

- 3.1. Métiers de l'administration des ventes
- 3.2. Directeur des opérations
- 3.3. Directeur du marketing
- 3.4. Chef de produit

4. Développement

- 4.2. Responsable développement industriel

5. Recherche

- 5.1. Responsable projet recherche développement

E – Indicateurs de performance attendus de la formation:

1. Evaluation du déroulement de la formation :

En amont de la formation :

Nombre de demande à intégrer cette formation

Pendant la formation :

Taux de Satisfait par la formation

Taux de réussite

En aval de la formation :

Employabilité : Taux de diplômés et d'homologués ou certifiés ayant trouvé un emploi

2. Evaluation du déroulement des programmes et des cours :

Par les étudiants poursuivant le cursus

3. Insertion des diplômés :

Insertion professionnelle des diplômés :

Créneau porteur : Forte demande Nationale et internationale en soudeur tous niveaux confondus (du soudeur à l'Ingénieur en soudage Certifié)

Intérêt porté par le professionnel à la spécialité :

Leurs participations à la mise en œuvre de cette offre de formation en tant que partenaire dans le projet Erasmus+ (Tel que : SNVI, German, YIT, CTMC, Anabib)

D : Synthèse globale des ressources humaines mobilisées pour la spécialité:

Grade	Effectif Interne	Effectif Externe	Total
Professeurs	8	3	11
Maîtres de Conférences (A)	5	6	11
Maîtres de Conférences (B)	3	-	3
Maître Assistant (A)	2	-	2
Maître Assistant (B)	-	-	-
Autre (*)	-	4	4
Total	18	13	31

(*) Personnel technique et de soutien

5 - Moyens matériels spécifiques à la spécialité

A- Laboratoires Pédagogiques et Equipements : Fiche des équipements pédagogiques existants pour les TP de la formation envisagée (1 fiche par laboratoire)

Intitulé du laboratoire : Laboratoires pédagogiques du département

Capacité en étudiants : 15

N°	Intitulé de l'équipement	Nombre	Observations
01	Tours universels	05	
02	Tours à commande numérique	02	
03	Fraiseuses universelles	03	
04	Fraiseuses à commande numérique	02	
05	Perceuse	03	
06	Scie mécanique	01	
07	Atelier de soudage	06 postes	Local : équipé de cabines individuelles pour le soudage à électrodes enrobées, TIG et MIG-MAG. 6 tables pour le soudage au chalumeau, 1 cabines de meulage, Matériels de soudage : Un parc interne d'équipements de soudage comprenant: 2 postes en soudage oxyacétylénique, 6 postes de soudage à l'ARC à électrodes enrobées, 7 postes de soudage à l'ARC, procédé TIG, à courant continu ou alternatif, Autres matériels selon besoins et demandes. Sécurité : Aspiration intégrée sur les cabines de soudage, de meulage, d'oxycoupage, Un ensemble d'EPI (casques, gants...) est mis à disposition des étudiants.
08	Machine de soudage par friction rotative	01	Diamètre maximal des éprouvettes 12 mm
09	Machine de traction universelle	01	
10	Machine de fatigue servohydraul	01	
11	Banc d'équilibrage statique et dynamique	01	

Intitulé du laboratoire : Laboratoire de Mécanique Avancée
Capacité en étudiants : 20

N°	Intitulé de l'équipement	Nombre	Observations
01	Salle de CAO/FAO	20 postes	
02	Imprimante 3D	01	
03	Laboratoire de préparations des échantillons	01	
04	Microscope optique équipé d'1 Caméra	01	

B- Terrains de stage et formations en entreprise:(voir rubrique accords/conventions)

Lieu du stage	Nombre d'étudiants	Durée du stage
SNVI	04	2 X 15 jours en moyenne
GERMAN	02	
ENGTP	04	
ENTP	03	
CRTI	03	
PME de la région centre	04	
CDTA	02	
CTMC	04	
YIT	02	

C- Documentation disponible au niveau de l'établissement spécifique à la formation proposée (Champ obligatoire) :

- Ouvrages en rapport avec la formation proposée et se trouvant au niveau des deux bibliothèques : bibliothèque centrale de l'USTHB et bibliothèque du département de Construction Mécanique et productive

bibliothèque centrale offre :

- un fonds documentaire très riche et mis à jour
 - Des bases de données électroniques à consulter au niveau de l'université : Proquest, Science Direct, Springer, Elsevier et Techniques de l'Ingénieur.
 - HandBooks disponible sous format électronique
 - Internet
 - Plateforme du projet Erasmus+ SM Weld
- Plateforme Canevas de l'institut Royal de Technologie, Stockholm-Suède
- Documents personnels des enseignants engagés dans la formation.

D- Espaces de travaux personnels et TIC disponibles au niveau du département et de la faculté :

- Bibliothèque centrale du département de Construction Mécanique et productive
- Espace Internet
- Salle des Masters

II – Fiches d’organisation semestrielles des enseignements de la spécialité

a. Descriptif de la formation

Nous tenons à souligner que la fiche d'organisation semestrielle des enseignements du **troisième Semestre** a été conçue à partir des résultats de réflexions sur le Projet ERASMUS+ project ref. no: 561786-EPP-1-2015-1-SE-EPPKA2-CBHE-JP, South Mediterranean Welding Centre for Education, Training and Quality Control, SM Weld. Les fiches d'organisations semestrielles des enseignements du **premier et deuxième Semestres** résultats du Projet Tempus Mastech ref. no: **511277-TEMPUS-1-2010-1-DE-TEMPUS-JPCR**, sont celles du master intitulé : **Technologie de Fabrication Mécanique** déjà Habilité et en cours d'enseignement

Description du Projet Erasmus+ SM Weld :



Logo du Master

Le Projet a pour objectif la mise en place au sein de l'Université des Sciences et de la Technologie Houari Boumediene - USTHB, d'une Offre de Formation Master de Haut Niveau en Technologie de Soudage pouvant répondre au besoin du secteur industriel Algérien et Maghrébin. La mise en place de cette offre de formation sera financée par la Commission Européenne dans le cadre des Projets «Erasmus+» et l'Université des Sciences et de la Technologie Houari Boumediene respectivement à hauteur de 90% et 10%. Elle sera pilotée conjointement par l'Université KTH « Kungliga Tekniska Högskolan – Institut Royal de Technologie » de Stockholm – Suède et la Commission Suédoise de Soudage (organisme auquel adhère environ 400 entreprises Suédoises des différents secteurs industriels (mécanique, sidérurgique, fabricants de produits consommables pour le soudage,...)).

Au-delà de cette formation Master, ce projet aura aussi pour but d'aider à la mise en place en Algérie d'un Centre de Soudage d'envergure Régionale (Sud-Méditerranéen, Nord-Africain, voir même Africain) en relation avec le IIW et la EWF permettant d'apporter des progrès dans le domaine de la technologie de soudage par :

- ✓ -La collaboration entre les universités Algériennes et Européennes
- ✓ -La collaboration entre les universités Algériennes et les industries de soudage
- ✓ -La mise en œuvre du système qualité de soudage ISO 3834 dans l'industrie
- ✓ -L'amélioration de la qualité dans la formation, l'homologation et la certification des soudeurs
- ✓ -L'information des industries du soudage à travailler selon le standard ISO 3834
- ✓ -L'amélioration de la compétitivité dans l'industrie manufacturière nationale

Il a été proposé des modules de bases correspondants aux unités de bases et des modules de spécialités correspondant aux unités de spécialités.

Chacune des unités ou des modules est composé de 2 à 4 matières. Le volume horaire et le nombre de crédits attribués par module sont les mêmes par module ou par unité afin d'éviter toute ambiguïté dans la validation des semestres afin de faciliter la mobilité des étudiants d'une université à une autre.

La structure du programme est composée de 13 unités d'enseignements réparties et équilibrées sur 3 semestres, clôturé par la préparation d'un mémoire de Master au 4ème Semestre :

Cette structure est organisée dans ce qui suit selon le canevas des offres Master proposé par le Ministère de l'enseignement supérieur et de la recherche scientifique.

Par ailleurs, à cause de son caractère international nous avons gardé les dominations en Langue Anglaise

Référentiel de l'International Institute of Welding- IIW

**IIW Guideline for
International Welding Engineers, Technologists,
Specialists and Practitioners**

PERSONNEL WITH QUALIFICATION FOR WELDING COORDINATION



Minimum Requirements for the Education, Examination and Qualification



Mod	Mod	Subject Title	(Hour s)	3 (Hour s)	KT H	CU C	UL E	U C	PO EWF	U M	OU S	USTH B	UF M
M1	1.1	1.1 General introduction to welding technology	3	0					1			1	
M1	1.2	1.2 Oxy-gas Welding and related processes	2	0			1			1			
M1	1.3	1.3 Electrotechnics, a review	1	0			1					1	
M1	1.4	1.4 The arc	3	0			1			1			
M1	1.5	1.5 Power sources for arc welding	4	0			1			1			
M1	1.6	1.6 Introduction to gas shielded arc welding	2	0			1			1			
M1	1.7	1.7 TIG Welding	4	1				1					1
M1	1.8.1	1.8.1 MIG/MAG	4	2				1				1	
M1	1.8.2	1.8.2 Flux Cored Arc Welding	2	0				1			1		
M1	1.9	1.9 MMA Welding	4	2				1			1		
M1	1.10	1.10 Submerged-Arc Welding	4	1				1			1		
M1	1.11	1.11 Resistance Welding	0	6	1								1
M1	1.12.1	1.12.1 Other Welding Processes - Laser; Electron Beam; Plasma	0	8					1			1	
M1	1.12.2	1.12.2 Other Welding Processes, other than 1.12.1	0	6					1	1			
M1	1.13	1.13 Cutting, Drilling and other edge preparation processes	2	2				1					1
M1	1.14	1.14 Surfacing and Spraying	0	2					1			1	
M1	1.15	1.15 Fully mechanised processes and robotics	0	8					1	1			
M1	1.16	1.16 Brazing and soldering	0	4		1							1
M1	1.17	1.17 Joining processes for plastics	0	2					1			1	
M1	1.18	1.18 Joining processes for ceramics and composites	0	1		1				1			
M1	1.19	1.19 Welding laboratory	0	10	1							1	
M2	2.1	2.1 Structure and properties of metals	4	0		1							1
M2	2.2	2.2 Phase Diagrams and Alloys	4	0		1							1
M2	2.3	2.3 Iron - carbon alloys	5	0		1							1
M2	2.4	2.4 Manufacture and classification of steels	2	2		1							1
M2	2.5	2.5 Behaviour of structural steels in fusion welding	4	0		1					1		
M2	2.6	2.6 Cracking phenomena in welded joints	2	6		1							1
M2	2.7	2.7 Fractures and different kinds of fractures	4	0		1							1
M2	2.8	2.8 Heat treatment of base materials and welded joints	4	0			1					1	
M2	2.9	2.9 Structural (unalloyed) steels	2	2			1				1		
M2	2.10	2.10 High strength steels	4	6			1						1
M2	2.11	2.11 Application of structural and high strength steels	0	2			1				1		
M2	2.12	2.12 Creep and creep resistant steels	0	4		1				1			
M2	2.13	2.13 Steels for cryogenic applications	0	4	1						1		
M2	2.14	2.14 Introduction to corrosion	0	4	1								1
M2	2.15	2.15 Stainless and heat resistant steels	0	12		1							1
M2	2.16	2.16 Introduction to wear and protective layers	0	5	1						1		
M2	2.17	2.17 Cast irons and steels	0	2		1						1	
M2	2.18	2.18 Copper and copper alloys	0	2		1							1
M2	2.19	2.19 Nickel and nickel alloys	0	2		1							1
M2	2.20	2.20 Aluminium and aluminium alloys	0	6		1							1
M2	2.21	2.21 Titanium and other metals and alloys	0	3	1								1
M2	2.22	2.22 Joining dissimilar materials	0	4				1				1	
M2	2.23	2.23 Destructive testing of materials and welded joints	4	10		1						1	
M3	3.1	3.1 Basic theory of structural systems	4	0			1				1		
M3	3.2	3.2 Fundamentals of the strength of materials	6	0			1				1		
M3	3.3	3.3 Joint design for Welding and Brazing	4	0			1				1		
M3	3.4	3.4 Basics of weld design	0	6	1						1		
M3	3.5	3.5 Behaviour of welded structures under different types of loading	0	4		1						1	
M3	3.6	3.6 Design of welded structures with predominantly static loading	0	8	1						1		
M3	3.7	3.7 Behaviour of welded structures under cyclic loading	0	8	1						1		
M3	3.8	3.8 Design of cyclic loaded welded structures	0	8	1						1		
M3	3.9	3.9 Design of welded pressure equipment	0	6				1			1		
M3	3.10	3.10 Design of aluminium alloys structures	0	4		1					1		
M3	3.11	3.11 Introduction to fracture mechanics	0	4	1						1		
M4	4.1	4.1 Introduction to quality assurance in welded fabrication		6					1		1		
M4	4.2	4.2 Quality control during manufacture		16					1	1			
M4	4.3	4.3 Residual Stresses and Distortion		6	1					1			
M4	4.4	4.4 Plant facilities, welding jigs and fixtures		4	1					1			
M4	4.5	4.5 Health and Safety		4	1							1	
M4	4.6	4.6 Measurement, Control and Recording in Welding		4				1		1			
M4	4.7	4.7 Imperfections and Acceptance Criteria		4	1						1		
M4	4.8	4.8 Non Destructive Testing		18			1					1	
M4	4.9	4.9 Economics and Productivity		8	1					1			
M4	4.10	4.10 Repair Welding		2				1				1	
M4	4.11	4.11 Reinforcing-steel welded joints		2				1		1			
M4	4.12	4.12 Case Studies		40				1					

Les enseignements sont regroupés en 17 Unités d'Enseignement (UE), en fonction des semestres, composées de plusieurs modules.

Le semestre 4 sera consacré à la réalisation d'un stage en entreprise ou en laboratoire, ponctué par un rapport de stage, qui sera soutenu devant un jury

Un module se caractérise par un intitulé, un horaire, ventilé en Cours Magistraux (CM)/Travaux Dirigés (TD)/Travaux Pratiques (TP), un objectif des compétences visées et un contenu qui précise les thèmes abordés.

5- Récapitulatif global de la formation :(indiquer le VH global séparé en cours, TD, pour les 04 semestres d'enseignement, pour les différents types d'UE)

VH \ UE	UEF	UEM	UET	Total
Cours	337,5	0	90	427.5
TD	232.5	0	0	232.5
TP	112.5	195	0	307.5
Travail personnel	517.5	232.5	90	840
Autre (préciser)				
Total	1200	427,5	180	1807.5
Crédits	59	23	8	90 *
% en crédits pour chaque UE	65,56%	25.56%	8.88%	100%

* Le total crédit est calculé sur la base 30 crédits par semestre. Les % en crédits sont déterminés pour les 3 premiers semestres. Le 4^{ème} semestre étant un semestre de Fin d'études comportant un stage en entreprise et un travail personnel. Au total le nombre de crédits avec le semestre 4 est égal à 90+30 c'est-à-dire **120**crédits.

Evaluation du Projet de Fin de Cycle de Master

- Valeur scientifique (Appréciation du jury) /6
- Rédaction du Mémoire (Appréciation du jury) /4
- Présentation et réponse aux questions (Appréciation du jury) /4
- Appréciation de l'encadreur /3
- Présentation du rapport de stage (Appréciation du jury) /3

III - Fiche d'organisation des unités d'enseignement

Tableau synthétique des modules et des UE par semestre

Semestre 3 Master Intitulé : INGENIERIE DU SOUDAGE

Université: USTHB

Unité d'enseignement	Matières	Crédits	Coefficient	Volume horaire hebdomadaire			Volume Horaire Semestriel (15 semaines)	Mode d'Evaluation	
	Intitulé			Cours	TD	TP		Contrôle continu	Examen
UE Fondamentale Code : UEF 1.1 Crédits : 12 Coefficients : 10	Materials Engineering and Technology : BM1	6	6	3h00	0,64	0,86	63h00	33%	67%
	Manufacturing Technology : BM2	6	4	2,57	1,28	0,64	63h00	33%	67%
UE Méthodologique Code : UEM 1.1 Crédits : 6 Coefficients : 3	Product and Process Development : BM5	6	3	2,57	1,28	0,64	63h00	33%	67%
UE Découverte Code : UED 1.1 Crédits : 6 Coefficients : 1	Project and Laboratory Works I : PLW1	6	1			4h30	63h00	100%	
UE Transversale Code : UET 1.1 Crédits : 6 Coefficients : 1	Technical English and Communication : BM7	6	1	3h00	1h30		63h00	33%	67%
Total semestre 1		30	15				315		

Semestre 2 Master Intitulé : INGENIERIE DU SOUDAGE

Université: USTHB

Unité d'enseignement	Matières	Crédits	Coefficient	Volume horaire hebdomadaire			Volume Horaire Semestriel (15 semaines)	Mode d'Evaluation	
	Intitulé			Cours	TD	TP		Contrôle continu	Examen
UE Fondamentale Code : UEF 1.1 Crédits : 18 Coefficients : 13									
	Forming Technology PART I : SM1	6	4	3h00	1h30		63h00	33%	67%
	Machining and Joining Technology-PART I : SM2	6	4	2,57	1,28	0,64	63h00	33%	67%
	Casting and Polymer Processing-PART I : SM31	6	5	3h00	1h30		63h00	33%	67%
UE Méthodologique Code : UEM 1.1 Crédits : 9 Coefficients : 5									
	Production Management and Maintenance : SM4	6	3	2,57	1,93	0,64	63h00	33%	67%
UE Découverte Code : UED 1.1 Crédits : 2 Coefficients : 2	Project and Laboratory Works II : PLW2	6	5			4h30	63h00	100%	
Total semestre 2		30	21				315		

Semestre 3 Master Intitulé : INGENIERIE DU SOUDAGE

Université: USTHB

Unité d'enseignement	Matières	Crédits		Coefficient	Volume horaire hebdomadaire			Volume Horaire Semestriel (15 semaines)	Mode d'Evaluation		
	Intitulé				Cours	TD	TP		Contrôle continu	Examen	
UE Fondamentale 1 Code : SM5 Crédits : 6 Coefficients :3	Welding processes and equipment : SM5				3h00	1h30		67h30	33%	67%	
	M1.1 Arc welding	3	6	2	3	1h30	1h30				
	M1.2 Other welding processes Part II	3		1		1h30					
UE Fondamentale 2 Code : SM6 Crédits : 6 Coefficients : 3	Materials and their behaviour during welding : SM6				3h00	1h30		67h30	33%	67%	
	M2.1 Weldable metals and their properties	3	6	2	3	1h30	1h30				
	M2.2 Behaviour of welded structures	3		1		1h30					
UE Fondamentale 3 Code : SM7 Crédits : 6 Coefficients : 3	Construction and design of welded structures : SM7				3h00	1h30		67h30	33%	67%	
	M3.1 Design of welded structures	3	6	2	3	1h30	1h30				
	M3.2 Calculation of welded structures	3		1		1h30					
UE Méthodologique 1 Code : SM8 Crédits : 6 Coefficients :3	Fabrication, applications engineering : SM8				3h00		1h30	67h30	33%	67%	
	M4.1 Production means and quality assurance	3	6	1	3	1h30		1h30			
	M4.2 Non Destructive Testing NDT	3		2		1h30					
UE Méthodologique 2 Code : PLW3 Crédits : 3 Coefficients : 2	Project and Welding Laboratory Works: PLW3						2h30	37h30	100%		
	PLW SM5 / PLW SM6 / PLW SM7		3		2			2h30			
UE Découverte Code : BM6 Crédits :2 Coefficients : 2	Entrepreneurship and Innovation Management : BM6				3h00			45h00	33%	67%	
	BM6.1 The enterprise, Environment and Management	1	2	1	2	1h30					
	BM6.2 Methodology of Research &Project Management	1		1		1h30					
UE Transversale Code : UET 1.2 Crédits : 1 Coefficients : 1	Managing innovation and creation innovative enterprise : BM6.3				1h30			22h30	33%	67%	
	BM6.3 Managing innovation and creation of a virtual innovative enterprise	1	1	1		1h30					
Total semestre 3			30		17	16h30	4h30	4h00	375h00		

Semestre 4 Master Intitulé : INGENIERIE DU SOUDAGE

Université: USTHB

Unité d'enseignement	Matières		Crédits	Coefficient	Volume horaire hebdomadaire			Volume horaire Par UE	Volume Horaire Semestriel (15 semaines)
	Intitulé								
UE Fondamentale Code : UEF 4.1 Crédits : 30 Coefficients : 10	Projet de Fin d'Etudes	Travail en Laboratoire	10	2					375H
		Travail Personnel	20	3					
Total semestre 4			30	5				25h	375H

III – Fiches d'organisation des unités d'enseignement (Etablir une fiche par UE)

Semestre: 1

Unité d'enseignement: UEM 1.1

Matière 1 : Materials Engineering and Technology BM1

VHS: 63h00 (C: 03h00 TD : 0,64 TP: 0,86)

Crédits: 6

Coefficient: 6

Objectifs de l'enseignement:

- Comprehend materials and their various manufacturing processes;
- Be acquainted with engineering materials classification;
- Understand different properties with emphasis on mechanical characteristics;
- Be able to check and to select a material for a given (new) application;
- Consider cost factor for materials manufacturing;
- Use a computer aided tool to achieve an acceptable right choice;
- Acquire and employ basics of fracture mechanics as a selection and design criterion.

Connaissances préalables recommandées:

RDM, MMC

Contenu de la matière:

- Applied Mathematics I (Calculus)
- Introduction to Scientific Computing
- Chemistry I
- Physics I
- Strength of Materials

Contenu de la matière :

I- Introduction to Materials Engineering

1. Reviewing, Classification, Properties of Materials

- History of materials,
- Atomic structure of solids
- Engineering applications
- Classification
- Properties
- Factor of safety

2. Materials in Design (process, tools, functions, data....)

- Design process (system optimization)
- Ranking and documentation
- Materials production techniques
- Functions (Mechanical, Chemical, Physical, Thermal, Electrical...)
- Materials degradation (oxidation, wear, creep, erosion, segmentation, cavitations...)
- Case Study: Materials for pressure vessels

3. Materials Testing Techniques

- Introduction to standards
- Traditional strength tests and associated materials
 - Tension, - Compression, - Flexion, - Torsion, - Shear: Stress strain relationships
 - Environmental effects (ESC, Heat ...)

4. Heat Treatment

- Relationship between structure and properties
- Brittleness, ductility, toughness, tenacity
- Annealing, - Quenching, - Tempering, - Thermo mechanical treatments
- Relationship between heat treatments and manufacturing processes
- Encountered problems in heat treatments

II Materials Selection for Engineering Applications

1. Introduction to Materials Selection (Ashby Methods)

- General Features
- Materials in design: advantages and difficulties
- Industrial needs
- Data availability and analysis (the way to Ashby Charts)

2. Ashby Charts: Materials Selection 18 Charts and CES Software

- Histogramm of thermal conductivity and thermal isolation
- Basics of material properties chart (Data Gathering and Construction)
- Detailed Case 1: Modulus-density
- Detailed Case 2: Resistance-density
- Detailed Case 3: Toughness-density
- Give the remaining charts

3. Process characterization and Process Cost

- Introduction to cost as final decision factor
- Effect of processes on design;
- Process characterization,
- Systematic selection of a process;
- Use of diagrams of material selection;
- Classification and process cost;

4. Cases Studies on material process manufacturing

- Case 1: Steel Alloying
- Case 2: Co-polymers
- Case 3: Mixed Ceramics

III Fracture Mechanics of Engineering Materials

1. Linear elastic fracture Mechanics

- Atomic approach of brittle failure
- Defect and stress concentration
- Griffith energy criteria

2. Stress Intensity factors: calculation and combined modes

- Stress field around a defect
- Relationship between KI and G
- SIF and material behavior
- Fracture and fracture toughness
- Mixed modes
- Material property for charts for toughness (Recall)

3. Fatigue Crack propagation

- Fatigue phenomenon

- SIF range
- Empirical FCP laws
- Factors affecting FCP

4. Damage Analysis

- Crack detection techniques
- Flaw sizes
- Fail-safe and safe-life design concepts
- Damage growth

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques :

1. The mechanics of fracture and fatigue A. P. Parker, E & F. N Spon limited, London, 1979.
2. Materials : Engineering, science, processing and design, M. Ashby, H. Shercliff, D. Cebon, Univ Cambridge, UK, Elsevier, 2008
3. Strength and fracture of engineering solids, D.K. Felbeck and A. G. Atkins, Prentice Hall Inc., NJ, USA 1984
4. HDB of Experimental Mechanics, SEM Inc (Society of Experimental Mechanics), Prentice Hall Inc., NJ, USA 1987

Semestre :1

Unité d'enseignement : UEF 1.1

Matière 2 : Manufacturing Technology BM2

VHS: 63 h00 (Cours: 2h30, TD: 1,28 TP 0,64)

Crédits : 6

Coefficient : 4

Objectifs de l'enseignement:

- General knowledge of the material processing and manufacturing process in order to get good product and answer to the industrial requirements and new challenges in industry.
- Knowledge about the main physical laws, models and methods used in manufacturing technologies.
- Knowledge about the capability of each manufacturing technology and driven parameters.
- Fundamental knowledge about integrated design and manufacturing, virtual manufacturing and product data management for manufacturing process.
- Design of process plan by taking into account of technical, economical and logistical constraints.

Connaissances préalables recommandées:

- product geometry representation,
- kinematics and solid mechanics
- base material science
- base of computer science
- mathematics: statistics, matrixes, algebra, geometry

Contenu de la matière:

I- Advanced manufacturing processes

1. Material processing, manufacturing processes, and technology overview: machining, forging casting, assembly, others processes, manufacturing process capabilities
2. Taxinomy of manufacturing process
3. Mechanical processing without volume loosing,
4. Mechanical processing with volume loosing: machining
5. Moulding
6. Assembly
7. Others processing: laser , water jet , electrical, chemical

II Models, methods and tools for manufacturing technology

1. Product model,
2. Tolerance analysis,
3. Geometrical defects,
4. Accessibility – visibility,
5. Manufacturing features,
6. CAM,
7. Virtual manufacturing

III Process planning

1. Process plan planning activities: constraints, choice criteria,
2. Manufacturing process and technology choice
3. Process plan strategies
4. Cost estimation

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

Black SD.C., Chiles V., Lisseman A.J., Martin S. L., Principles of Engineering Manufacture, Arnold, 1996
G. Boothroyd, "Product design for manufacture and assembly", edition Marcel Dekker, 1994
S. Kalpakjian, " manufacturing process for engineering materials ", edition Menlo Park, 1997
Martin P, "Some aspects of integrated product and manufacturing process", Advances in Integrated Design and Manufacturing in Mechanical Engineering, Editors: Bramley A., Brissaud D., Coutellier D., McMahon C, Springer, 2005, ISBN 1-4020-3481-4, pp. 215-226
Martin P., Dantan J.Y., D'Acunto A., 2011,"Virtual manufacturing : Prediction of work piece geometric quality by considering machine and set-up accuracy", International Journal of Computer Integrated Manufacturing, Vol.24, Issue 7, pp.610-626.

Semestre :1

Unité d'enseignement :UEM 1.1

Matière 1 : Product and Process Development BM5

VHS: 63 h00 (Cours: 2h30, TD: 1 ,28 TP 0,64)

Crédits : 6

Coefficient : 3

Objectifs de l'enseignement:

To know the different approaches to:

- Part design
- Assembly design
- Mechanical analysis: kinematics, dynamics and Finite element analysis of structures
- Process analysis: planning, machining process, sequencing

Connaissances préalables recommandées:

1. Mathematics I
2. Basics in probability and statics: random variables, random vectors, probability distribution, independence, sampling, test, sampling.....

Contenu de la matière:

I- Product Development Part and assembly design

- 1- CAD softwares
- 2- Part design, different techniques ...
- 3- Assembly design
- 4- Kinematics and dynamics analysis of mechanical systems
- 5- Mobility and overconstraints of mechanisms
- 6- Geometric, velocity and force analysis of planar mechanisms
- 7- Structure analysis, FEM
- 8- The formulation of finite element methods for linear static analysis of solids and structures: Two- and three-dimensional solids, Beam, plate and shell structures, finite element methods for beams, plates and shells.
- 9- Life cycle of a product

II Process Development

- 1 Problem Formulation
 - Introduction
 - Basics on problems and formulation
- 2 Concept of process planning
- 3 Logical design of the process plan
 - election of process plan
 - Tool-workpiece holders

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

- CAD/CAM: Principles, Practice and Manufacturing Management (2nd Edition) (Hardcover), Author: Cris McMohan, Jimmie Browne
- Principles of CAD/CAM/CAE (Paperback), Author: Kunwoo Lee

- Mastering CAD/CAM (Engineering Series) (Hardcover), Author: Ibrahi Zeid
- Cad/Cam: Computer-Aided Design and Manufacturing, Author: Mikell P. Groover and Emory W., Jr. Zimmers
- Lean Product And Process Development, by Allen C. Ward, ISBN : 1934109134 (ISBN13: 9781934109137)

Semestre :1

Unité d'enseignement : UED 1.1

Matière 1 :Project and Laboratory Works I

VHS: 63 h00 (TP: 4h30)

Crédits :6

Coefficient :1

Objectifs de l'enseignement:

To know the different approaches to:

- Part design
- Assembly design
- Mechanical analysis: kinematics, dynamics and Finite element analysis of structures
- Process analysis: planning, machining process, sequencing

Connaissances préalables

- product geometry representation,
- kinematics and solid mechanics

Contenu de la matière :

I Projet 1 : Conception de systèmes mécaniques (CAD)

II Atelier 1. : Les travaux de Tournage et Fraisage

II Atelier 2 : TTH et Analyse Métallographique e

Mode d'évaluation : **Projet 1 :Contrôle continu,**
 Atelier1 :Contrôle continu
 Atelier2 :Contrôle continu

Références bibliographiques:

- CAD/CAM: Principles, (Hardcover), Author: Cris McMohan, Jimmie Browne
- Principles of CAD/CAM/CAE (Paperback), Author: Kunwoo Lee
- Turn and milling fascicules

Semestre :1

Unité d'enseignement : UET 1.1

Matière 1 :Technical English and Communication

VHS: 63 h00 (Cours: 3h00, TD: 1h30)

Crédits :6

Coefficient :1

Objectifs de l'enseignement:

- Following the conventions of standard written English.
- Performing analytical experiments.
- Building communication skills.
- Writing: ideas, organization, word choice, sentence fluency...

Connaissances préalables recommandées:

- Mastery of the basic language forms.
- Elementary writing skills.
- Basic computer mastery.

Contenu de la matière:

- 1- The World of Science : Science and Technology
- 2- Industry, Technology, and Human Activity:

Références (*Livres et photocopiés, sites internet, etc*).

- White, Lindsay. Engineering. Oxford University Press, 2011
- Zhang Peng. Industrial Control Technology: A Handbook for Engineers and Researchers. William Andrew Inc, 2008
- Ibbotson Mark. Cambridge English for Engineering. Cambridge University Press, 2008
- Ashby Michael, Shercliff Hugh and Cebon David. Materials Engineering, Science, Processing and Design. Cambridge University Press, 2007.
- Kirkman John. Good Style: Writing for science and technology. London and New York, 2005.
- The Cambridge Guide to English. Cambridge University Press, 2004
- Modern World for Science and Technology. IPN
- <http://connect.luc.edu/engl290>

Mode d'évaluation:

Contrôle continu : 40% ; examen : 60%.

Références bibliographiques:

Semestre :2

Unité d'enseignement : UEF 2.1

Matière 1 :Forming Technology part I

VHS: 63h00 (Cours: 3h00, TD: 1h30)

Crédits : 6

Coefficient : 4

Objectifs de l'enseignement:

- Students gain a basic knowledge of plasticity and lubrication as well as a broad understanding of the processes of metal forming and related machinery and tools
- Students are able to identify special problems of bulk and sheet metal forming technology, treat them and offer solutions using various methods
- The lecture, the accompanying exercises, laboratory and project work extend students' analytical thinking, communication and team-work skills

Connaissances préalables recommandées:

- Characterization and properties of metals
- Basics of the theory of continuum mechanics

Contenu de la matière:

I- Plasticity and Tribology for Metal Forming

1. Plasticity for metal forming
 - Strain and Stress tensors
 - Plastic behavior laws : formulation and identification
2. Tribology for metal forming
 - Friction models for metal forming
 - Friction and lubrication : technological solutions and measurement

II- Bulk forming

- Hot and cold rolling,
- Hot bar and tube extrusion,
- Bar and tube drawing,
- Hot and cold Forging,
- Die forging,
- Powder compaction and sintering,
- Product and die design,
- Kinematics of machines

III Sheet metal forming

- Basics of Sheet Metal Forming
- Deep Drawing and Stretch Forming
- Sheet Metal Bending
- Roll Forming
- Profile Bending
- Sheet Metal Spinning
- Incremental Sheet Metal Forming
- Forming of Tubes with Working Media
- Forming of Sheets with Working Media
- Impulse Forming
- Hot Sheet Metal Forming

- Cutting by Forming

▪ **Mode d'évaluation:**

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

- Schuler GmbH, Metal Forming Handbook, Springer, Berlin, 1998
- Heinz Tschaetsch, Metal Forming Practicse: Processes- machines and tools, Springer, 2006
- Serope Kapakjian, Steven schmid, Manufacturing Engineering and Technology, prentice-Hall, 2006
- Herbert friz, Günter Schulze, Fertigungstechnik, Springer, 2010
- Fundamentals of Modern Manufacturing : Materials, Processes, and Systems Mikell P. Groover Ed. Wiley
- Volume 14A, Metalworking: Bulk Forming, was published in 2005. ASM International Handbook
- ME 6222: Manufacturing Processes and Systems Prof. J.S. Colton © GIT 2011
- CHASTEL (Y.). – Approches scientifiques des procédés de mise en forme des métaux. École des Mines de Paris, CEMEF – Sophia Antipolis ; Cycle de cours, Tome 1 : Rhéologie des métaux et essais rhéologiques, nov.1999.
- Techniques de l'Ingénieur M3000 - Procédés de mise en forme - Introduction
- Techniques de l'Ingénieur M3085- Forgeage à froid de l'acier
- Dieter, G.E., Mechanical metallurgy, 1988, SI metric edition, McGraw-Hill, ISBN 0-07-100406-8.
- Edwards, L. and Endean, M., Manufacturing with materials, 1990, Butterworth Heinemann, ISBN 0-7506-2754-9.
- Z. Marciniak, J.L. Duncan, S.J. Hu, Mechanics of Sheet Metal Forming, Butterworth-Heinemann 2002
- Schuler GmbH, Metal Forming Handbook, Springer, Berlin, 1998
- Heinz Tschaetsch, Metal Forming Practics: Processes- machines and tools, Springer, 2006

Semestre : 2

Unité d'enseignement : UEF 2.1

Matière 2: Machining and Joining Technology-PART I

VHS: 63 h00 (Cours: 2h30, TD: 1,28 TP 0,64)

Crédits : 6

Coefficient : 4

Objectifs de l'enseignement:

The course aims to get familiar and understand

- nomenclature of standard cutting tools
- basics of metal cutting process
- Measurement of cutting forces and Thermal aspects in machining)
- basics concepts of processes and machine tools
- Aspects of Physics and metallurgy of welded joints.

Connaissances préalables recommandées:

- Technical drawing.
- Physics and rational mechanics

Contenu de la matière:

I Metal Machining 1

1-1 Tool Nomenclature

- Single point tool-significance of the various angles provided and nose radius, tool nomenclature, classification, Nomenclature of drills, turning tools, milling cutters, and broaches-Need for chip breakers.....

1-2 Mechanics of Metal Cutting

- Theory of metal cutting....
- Material removal Process, Machining, Chip Formation, Machining opérations, cutting tools, Machine tools, Cutting conditions in machining, Types of chip, Forces acting on chip, Merchant equation , Power, energy and cutting temperature.)

1-3 Measurement of Cutting Forces

- Basics on cutting forces- Facteurs influençant a cutting force - Impact of cutting forces on the components of the machining system – Measurement techniques of the cutting force.

1-4 Thermal Aspects in Machining

- Sources of heat generation in machining-temperature measurement techniques in machining, Functions of cutting fluid-characteristics of cutting fluid types for machining steel,

II General Concepts of Processes and Machines

- Turning
- Milling
- Drilling
- Grinding
- Gearing
- Welding

III Physics and Metallurgy of Welded Joints

1. Introduction

- Welding technology, fields and domains applications, career opportunities.

2. Welding metallurgy

- Basic metallurgy of : crystalline structures, grains, micro-structures, phase transformation, iron-carbon diagram, martensite formation.
- Welding metallurgy of the heat affected zone.
- Metallurgical problems : burning, segregation, gas pockets.
- Chemical reactions and metal flow welding.

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

1. Advanced Methods of Machining , J. A. McGeough
2. Advanced Machining Processes Of Metallic Materials: Theory, Modelling and Applications , Wit Grzesik
3. CNC Machining , Alan Overby
4. Machining Data Handbook. Réf. TJ1185M32.1992
5. Tool and Manufacturing Engineers Handbook, Machining. Réf. TS176T66.1988
6. Technical engineer books (Tool and Manufacturing).
7. Welder's handbook, Richard Finch 2007 USA ISBN: 1-4362-6186-4
8. Pipe Welding procedures, Houbasar Rampaul, ISBN: 0-8311-3141-1 USA 2003.
9. "Metal Handbook", Vol 6, 73; ASME
10. "Welding Handbook", Vol. 1 and 2, seventh edition; American welding society.
11. Richard L. Little, "Welding and Welding Technology", McGraw Hill
12. L.M. Gourd, "Principles of Welding Technology", ELBS/ Edward Arnold
13. The Physics of welding", Lancaster; Pergaman Press.
14. Raj, Shankar, Bhandari, "Welding Technology for Engineers", Narosa Publication House Pvt. Limited.
15. S.V. Nandkarni, "Modern Arc Welding Technology", Oxford and IDH publishing Co.
16. R.S.Parmar, "Welding processes and technology", Khanna Publishers.
17. American Welding Society, www.aws.org
18. European Federation for Welding, joining and cutting

Semestre : 2

Unité d'enseignement : UEF 2.1

Matière 3: Casting and Polymer Processing-PART I

VHS:63 h00 (Cours: 2,57, TD: 1 ,28 TP 0,64)

Crédits : 6

Coefficient : 5

Objectifs de l'enseignement:

Le module a pour objectif de donner aux étudiants des compétences pouvant répondre aux différents besoins des industries de plasturgie et de fonderie.

Ce module de formation permettra aux étudiants de :

- Comprendre les différents phénomènes relatifs aux matériaux plastiques et métalliques, leurs comportements lors des processus de fusion et de solidification,
- Etudier les causes d'apparition des défauts de moulage et les remèdes à apporter,
- développer les connaissances et les habiletés concernant le fonctionnement des principales unités de production de pièces coulées ;
- Participer à la mise au point de méthodes, conception et réalisation;
- S'insérer rapidement dans une unité de production, un laboratoire de contrôle ;
- Maîtriser le déroulement d'un procédé ;
- Effectuer une évaluation critique sur la bonne marche des travaux et rédiger des rapports clairs et concis ;
- Simuler des situations critiques et d'en tirer les conclusions nécessaires ;
- Mettre en œuvre les analyses de contrôle des produits, d'interpréter les résultats et de contrôler leur fiabilité ;
- Prendre en charge une chaîne de production en plasturgie et en fonderie
- Acquérir des connaissances relatives aux comportements mécaniques de différents matériaux (métalliques et polymères) soumis à des contraintes

Connaissances préalables recommandées:

- Dessin technique.
- Matériaux plastique.
- Matériaux métalliques.
- Méthodes D'analyse.
- Fabrication mécanique.
- Thermodynamique.

Contenu de la matière:

I- Foundry technology and Casting Design

- Various casting techniques
- metal processing and solidification
- molding and casting process foundry equipment and processing
- Ferrous casting alloys, nonferrous casting alloys. The selection, properties, and applications
- Product design
- Design for die casting
- Surface finishing

II- Rheology and Viscoelasticity of materials

- Generalities
- Rheometry
- Mechanical properties

III- Industry of Plastics

- Mechanical properties
- Organic Chemistry ; Basic elements for polymers and plastics
- Process of industrial synthesis of plastics and applications
- Advanced plastic materials
- Manufacturing processes and implementation of polymers Technology

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

-
- Michel GEIER , Metallurgie de fonderie :Tome I ; Initiation avec exercices. 1976
- Michel GEIER , Metallurgie de fonderie :Tome II ; Initiation avec exercices. 1976
- Jean LARGETEAU , LA FONDERIE 2 : Fusion des métaux ; 1976
- Edition CTIF , Le moulage sous pression des alliages d'Aluminium 1; 1993
- Edition CTIF , Le moulage sous pression des alliages de Zinc (Zamak) ; 1993
- Manuel technique Deutz, «Principe et technique de fonderie », Service des Méthodes fonderie, Complexe Moteurs et Tracteurs oued hamimime 2000, Constantine, Algérie.
- I. Amara, « Support de Cours : fabrication mécanique et métrologie », Département de Génie Mécanique, Université Mentouri Constantine, 2000-2001.
- Gilles DOOR, « Fonderie alliages, procédés, propriétés d'usage, défauts », Editeur Dunod 2004, France.
- C. Marty, J.M Linares, « Procédés de mise en forme T 3» Hermès Science, Paris 1999, France.
- Y . HEMON edition CTIF , Conception et calcul des systèmes d'alimentation en Fonderie sous pression. 1996
- D. Gelin, M. Vincent, « Eléments de fabrication », Les Editions Foucher, 1995.
- Fonderie et moulage des alliages d'aluminium Techniques de l'Ingénieur, Article M813 1991.
- Aluminium Laufen S.A., «Documentation technique : moulage en coquille », 2007, site : site
- <http://www.alu-laufen.ch/>. – 75
- Edition CTIF , Masselottage en moulage sable. 1994
- ASM- Metals Handbook, Vol 15, Casting. ASM international 1998
- S. Kalpakjian, S. R. Schmidt, Manufacturing Engineering and Technology. Pearson, 2006.

Semestre : 2

Unité d'enseignement : UEM 2.1

Matière 1 : Production Management and Maintenance

VHS: 63 h00(Cours: 2h30, TD: 1 ,28 TP 0,64)

Crédits : 6

Coefficient :3

Objectifs de l'enseignement:

The primary goal of this course is to impart to the student an understanding Operations Management, Maintenance Management Systems and Quality Management.

Connaissances préalables recommandées:

- product geometry representation,
- kinematics and solid mechanics

Contenu de la matière :

I. Operations Management

- 1 Generalities : Production management
- 2 Material requirement planning and Manufacturing Resource Planning
- 3 Project management,
- 4 Scheduling,
- 5 Inventory management

II. Maintenance Management Systems

- 1 Maintenance Functions and Philosophies
- 2 Maintenance Management Skills and Techniques
- 3 Maintenance Planning and Scheduling
- 4 Root Cause Analysis and Failure
- 5 Reliability of Systems, Equipment and Components
- 6 Risk and Reliability Management
- 7 Computerized Maintenance Management Systems
- 8 TPM

III. Quality Management

- 1 Principles of Quality Management. Study of the major principles of quality management: customer focus, continuous improvement, employee involvement, and process improvement. Use of case studies and a project to gain knowledge in implementing quality management principles
- 2 Continuous Quality Improvement
- 3 Quality Management in Product Development
- 4 Quality Management in Production Processes

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

- 1 Cannell, M., Management Development. London, November 2004, CIPD

- 2 Roberta, S. R. and Bernard W. T., Operations Management, 4th edition 2003, Prentice Hall
- 3 Richard, B. and Chase, M. G. H., Operations and Supply Management, 2008
- 4 Chase, J. and Aquilano., Operations Management for Competitive Advantage, 10^e edition 2004, McGraw-Hill
- 5 Jay H. H. and Barry, R. P. H., Principles of operations management, 2001
- 6 Richard, B. C., Nicholas J. A. and Robert, J., Production and operations management: manufacturing and services, 1981, Irwin/McGraw-Hill
- 7 William J. S., Production/operations management, 1996, Irwin
- 8 Cours de Michel VILLAIN - l'IUT de Saint-Malo (2004)
- 9 'Maintenance : méthodes et organisation' – F. MONCHY – DUNOD – (2000)
- 10 'Management de la maintenance' – Renaud CUIGNET – DUNOD – (2002)
- 11 'Ingénierie de la Maintenance' – Jean-Claude FRANCASTEL – DUNOD – (2003)
- 12 'Approche fonctionnelle de la maintenance'- Antoine DESPUJOLS- technique de l'ingénieur MT 9 020 (2004)
- 13 'Méthodes d'optimisation des stratégies de maintenance'-Antoine DESPUJOLS- technique de l'ingénieur MT 9 050 (2004)
- 14 'Total Productive Management' - Tito GATTI- technique de l'ingénieur AG 4 840 (2003)
- 15 'AMDEC-Moyen' - Michel RIDOUX- technique de l'ingénieur AG 4 220
- 16 'Fiabilité. Maintenabilité' - Pierre CHAPOUILLE- technique de l'ingénieur T 4 300 (1999)
- 17 'Maintenabilité. Maintenance'- Pierre CHAPOUILLE- technique de l'ingénieur T 4 305 (1999)
- 18 'GMAO Identifier les objectifs et les enjeux' - Yves LE CAZ- technique de l'ingénieur - MT 9 460 (2005)
- 19 Benhabib, B., Charette, C., Smith, K. C., Yip, A. M. (1990). Automatic visual inspection of printed-circuit-boards—an experimental system. IASTED, Int. J. of Robotics and Automation 5(2):49–58.
- 20 Bennett, J. M. (May-June 1985). Comparison of techniques for measuring the roughness of optical surface. Optical Engineering 24(3):380–387.
- 21 Bernstein, Peter L. (1996). Against the Gods: The Remarkable Story of Risk. New York: John Wiley.
- 22 Besterfield, Dale H. (2001). Quality Control. Upper Saddle River, NJ: Prentice Hall.
- 23 Brodmann, R., Thurn, G. (1984). An optical instrument for measuring the surface roughness in production control. CIRP Annals 33:403–412.
- 24 Brodmann, R., Gerstorfer, O., Thurn, G. (May-June 1985). Optical roughness measuring instrument for fine-machined surfaces. Optical Engineering 24(3):408–413.
- 25 Cielo, Paolo G. (1988). Optical Techniques for Industrial Inspection. Boston: Academic Press.
- 26 Cleaver, Thomas G., Michels, James C., Jr., Dennis, Lloyd A. (1991). Appearance Inspection of Finished Surfaces. Milwaukee, WI: ASQC Quality Press.
- 27 Crosby, Philip B. (1996). Quality is Still Free: Making Quality Certain in Uncertain Times. New York: McGraw-Hill.
- 28 Demant, Christian, Streicher-Abel, Bernd, Waszkewitz, Peter (1999). Industrial Image Processing: Visual Quality Control in Manufacturing. New York: Springer-Verlag.
- 29 Deming, W. Edwards (1952). Elementary Principles of the Statistical Control of Quality: A Series of Lectures. Tokyo, Japan: Nippon Kagaku Gijutsu Remmei.
- 30 Deming, W. Edwards (2000). Out of The Crisis. Cambridge, MA: MIT Press.
- 31 DeVor, Richard E., Chang, Tsong-How, Sutherland, John W. (1992). Statistical
- 32 Quality Design and Control: Contemporary Concepts and Methods. New York: Maxwell Macmillan International.

Semestre : 2

Unité d'enseignement : UED 2.1

Matière 1 :Project and Laboratory Works II

VHS: 63 h00 (TP: 4h30)

Crédits :6

Coefficient :5

Objectifs de l'enseignement:

- Acquérir les méthodes d'analyse de systèmes mécanique assisté par ordinateur.
- Apprendre à programmer et à usiner sur machines à commande numérique

Connaissances préalables recommandées:

- Mastery of the basic language forms.
- Elementary writing skills.
- Basic computer mastery.

Contenu de la matière:

- 1- projet II : Analyse de systèmes mécaniques assistée par ordinateur
- 2- Atelier 3 : Programmation en commande numérique et Usinage sur machines à commande numérique

Mode d'évaluation:

Contrôle continu : 100%.

Références bibliographiques:

- Documentation CAE
- Document EMCO Turn et Milling
- Site web www.emco-word.com

Semestre : 3

Unité d'enseignement : UEF 3.1

Matière 1 :Arc welding

VHS: 45 h00 (C 1h30 TD: 1h30)

Crédits : 3

Coefficient :2

Objectifs de l'enseignement:

This course aims to provide the student with a deep understanding of arc welding in all its aspects:

Connaissances préalables recommandées:

Science des matériaux

Contenu de la matière:

1.1 General introduction to welding technology

Objective: Understand in detail the developments in welding processes including accepted terminology, standards and abbreviations :

- History
- General applications for welding
- Schematic presentation of welding processes
- Brief description with characteristics
- Applicability of the most common welding processes
- Abbreviations used for welding processes
- Hints in use for welding processes
- Welding positions and Terminology (ISO 6947, ISO 17659)
- Symbolic representation of joints (overview)
- Classification of welding processes (ISO, CEN and national standards)

1.2 Oxy-gas Welding and related processes

Objective: Understand in detail the fundamentals of oxy-gas combustion, characteristics of the different fuel gases, equipment, safety and typical applications :

- Process principles
- Range of Application
- Types of Flames
- Characteristics of fuel gases, (acetylene, propane, etc.)
- Combustion reactions
- Temperature distribution effects
- Equipment
- Methods of welding techniques, rightward, leftward
- Standards for filler materials (at least for non-alloy steels)
- Welding applications, typical problems and imperfections
- Health and safety issues specific to the process

1.3 Electrotechnics, a review

Objective: Understand in detail the basics of electricity in relation to the requirements of welding technology and appreciate the key electronic components used in welding power sources :

- Direct current (DC), polarity, alternating current (AC)
- Magnetism in welding
- Capacity, condenser, Inductance, inductors
- Transformer, and rectifying bridge (half wave and full wave rectification)
- Transistor, thyristor,
- Hazard
- Health and safety

1.4 Other Welding Processes : Part I

Objective: Understand in detail the principles and the fields of application of plasma; electron beam; Laser welding and the fundamentals of each process, including equipment, applications, main variables, safety and common problems :

- Basic principle of plasma and plasma-MIG welding process and equipment
- Basic principle of electron beam welding process and equipment)
- Basic principle of laser welding process and equipment
- Basic principle of laser- hybrid welding process and equipment
- Heat generation for each type of process
- Typical process applications and problems
- Consumables
- Welding parameters for each process
- Joint preparation: typical joint design for welding, fit-up, cleaning
- Relationship between welding parameters and joint configuration
- Comparison between high energy processes
- Health and safety specific to the processes
- Appropriate standards (ISO, CEN and National) for each process

1.1.1 The arc

Objective: Understand in detail the fundamentals of an electric arc, its characteristics, limitations and application in welding, including arc stability problems :

- Arc physics (producing an electric arc, the main arc areas, stability of the arc, gas ionization, ionization potentials, arc forces)
- Voltage distribution across the arc
- Heat generation at the cathode and anode
- Polarity and arc characteristics in AC and DC and its control for the key welding processes
- Influence on the welding process
- Temperature distribution in the arc and effects.

Influence of the magnetic fields on the arc (why, how to solve)

- Limits of application

1.1.2 Power sources for arc welding

Objective: Understand in detail the characteristics and main components of arc welding power sources :

- Power source classification, types and characteristics (static and generators, and each sub-group)
- Power source electrical characteristics (static and dynamic)
- Relationship between static characteristic and welding process
- Control of the electrical static characteristic (flat and drooping)
- Arc stability for the main processes (MMA, TIG, MIG/MAG, SAW, PAW)
- The operation working point
- Inverter technology (overview, in terms of the most important blocks)
- Power sources controlled by a CPU
- Stability of processes in AC and DC
- AC (sine wave and square wave) and DC power sources
- Open circuit voltage, short circuit current, power factor of transformers
- Duty cycle of a power source and typical values for the most common arc welding processes
- Voltage losses, relationship between welding current value and cable section
- Current and voltage setting (electromagnetic and electronic devices)
- Standards related with welding power sources and their requirements

1.1.3 Introduction to gas shielded arc welding

Objective: Understand in detail the principles and physical phenomena of gas shielded welding processes :

- Physical phenomena
- Shielding gases (inert, active) and their effect on arc characteristics

- Handling and storage of gases (overview)
- Influence of the welding parameters on the weld bead morphology.
- Standards (ISO, CEN and National) for shielding gases

1.1.4 TIG Welding

Objective: Understand in detail TIG welding fundamentals, including equipment, applications, main variables, safety and specific problems :

- Power source characteristics
- Methods for arc ignition and necessary equipment
- Equipment and accessories: torches, gas lens, control panel, up and down slope, pulse techniques
- Effect of current type and polarity: DC(+), DC(-) and AC
- Specific requirements for different materials, e.g. Al
- Consumables: shielding gases, filler materials, electrodes
- Welding parameters: current, voltage, travel speed, gas flow rate
- Joint preparation: typical joint design for welding, fit-up, cleaning
- Special techniques: spot-welding, key-hole, hot-wire, orbital welding, tube to tube and tube to sheet, narrow gap and others
- Standards for filler materials, and electrodes (at least for non-alloy steels).
- Welding applications, typical problems and how to solve them
- Health and safety issues specific to the process

1.1.5.1 MIG/MAG

Objective: Understand in detail MIG/MAG welding fundamentals, including equipment, applications, main variables, and common problems :

- Power source characteristics for conventional process and CPU controlled power sources
- Effect of current type and polarity
- Equipment and accessories: torches, wire feeders, hose assembly, control panel
- Metal transfer modes (dip, globular, spray, pulsed and rotating), and their application
- Welding parameters and settings: current, voltage, travel speed, gas flow rate, etc.
- Consumables: shielding gases, filler materials (solid wires), and their combinations
- Joint preparation: fit-up, cleaning
- Special techniques: electro-gas welding, high efficiency processes, spot welding, double wire, flat wire, electronic stability control (arc and wire feed), etc.
- Standards for filler materials (at least for non-alloy steels)
- Welding applications, typical problems and how to solve them.
- Health and safety specific to the process

1.1.5.2 Flux Cored Arc Welding

Objective: Understand in detail FCAW fundamentals, including equipment, applications, main variables and common problems :

- Power source characteristics for conventional process and CPU controlled power sources (only the specific aspects for FCAW)
- Effect of current type and polarity
- Equipment and accessories: torches, wire feeders
- Relation between the consumables and the type of Metal transfer mode, and their applications
- Welding parameters and settings: current, voltage, travel speed, gas flow rate, etc
- Consumables: shielding gases, filler materials (flux cored wires), and their combinations
- Joint preparation: fit-up, cleaning
- Standards for filler materials (at least for non-alloy steels)
- Welding applications, typical problems and how to solve them
- Health and safety specific to the process

1.1.6 MMA Welding

Objective: Understand in detail MMA welding fundamentals, including equipment, applications, main variables, safety and common problems :

- Process principles and arc characteristics
- Effect of current type and polarity

- Power source characteristics applicable to MMA (open circuit voltage, static and dynamic characteristics, types of current, arc striking methods).
- Equipment and accessories
- Process application range, typical problems and how to solve them.
- Covered electrodes (functions of the coating and rod, types of electrodes, slag-metal and gas-metal covered reactions) .
- Production of electrodes (how, typical defects)
- Handling and storage of electrodes (storage environment, redrying)
- Standards for filler materials (at least for non-alloy steels)
- Selection of covered electrodes for their applications
- Welding parameters: current, voltage, run out length, etc
- Joint preparation: fit-up, cleaning, welding position
- Relationship between electrode diameter and current range, rod material, electrode length and welding position
- Special techniques (gravity welding, etc.)
- Health and safety specific to the MMA process

1.1.7 Submerged-Arc Welding

Objective: Understand in detail the SAW fundamentals, including equipment, applications, main variables, safety and common problems :

- SAW process principles and arc characteristics Effect of current type and polarity
- Power source characteristics applicable to SAW (open circuit voltage, static and dynamic characteristics, types of current, arc striking methods) Equipment and accessories
- Process application range, typical problems and how to solve them
- Consumables (functions of the flux and wire -solid or flux cored-, types of flux and wire, wire-flux combination, slag-metal and gas-metal reactions).. Production of consumables (how, typical defects)
- Handling and storage of consumables (storage environment, re-drying).... Standards for filler materials wires and fluxes (at least for non-alloy steels)
- Welding parameters: current, voltage, travel speed, type of flux and particle size, stick-out, etc
- Joint preparation: fit-up, cleaning
- Relationship between the wire-flux combination and the characteristics of deposited material
- One side welding including backing methods
- Single-wire and multi -wire techniques
- Special techniques (strip-cladding, iron-powder addition, cold and hot wire addition)
- Health and safety specific to SAW process

1.1.8 Resistance Welding

Objective: Understand in detail resistance welding fundamentals, including equipments, applications, main variables, safety, common problems and their solution :

- Process principles and overview on types of processes (spot, projection, butt, seam, and flash)
- Joule effect and temperature distribution
- Equipment and accessories
- Process application range and typical problems (welding thin to thick material, welding of coated/ painted materials, welding dissimilar materials, mass effect, shunt effect, Peltier effect, resistance brazing).
- Electrodes (functions, types, shapes, material)
- Electrode classification (ISO, CEN and National standards).
- Welding parameters: current, pressure, time, type of current, pulse, etc ... Joint preparation: typical joint design for welding, fit-up, cleaning
- Relationship between welding parameters and the characteristics of the weld nugget
- Monitoring systems, process control, measuring
- Specific testing
- Health and safety specific to the resistance welding process

Mode d'évaluation:

Contrôle continu : 40% ; examen : 60%.

Références bibliographiques:

- Metals Handbook-Welding, Brazing and Soldering, American Society for
- Metals, 1993, 10th edition, Volume 6, USA. R S Parmar, Welding process and technology, Khanna Publisher, New Delhi
- R S Parmar, Welding engineering
- & technology, Khanna Publisher, 2002, 2nd edition, New Delhi. Richard Little, Welding and Welding Technology, McGraw Hill, 2001, 1st
- edition. Technical document, MMAW, Aachen, ISF, Germany, (2005)
- H Cary, Welding Technology, Prentice Hall, 1988, 2nd edition. • S V Nadkarni, Modern Arc Welding Technology, Ador Welding Limited, 2010
- New Delhi. Welding handbook, American Welding Society, 1987, 8th edition, volume 1 & 2, USA.
- http://www.esabna.com/EUWeb/AWTC/Lesson1_1.htm
- http://teacher.buet.ac.bd/shabnam/14250_ch3.pdf
- <http://ebookbrowse.com/chapter2-manual-metal-arc-welding-pdf-d79324541>
- <http://www.esab.ch/de/de/support/upload/XA00136020-Submerged-Arc-welding-handbook.pdf>

Semestre : 3

Unité d'enseignement : UEF 3.1

Matière 2:Other welding processes Part II

VHS: 22 h30 (C: 1h30)

Crédits : 3

Coefficient :1

Objectifs de l'enseignement:

Understand in detail the fundamentals and the field of application of electro-slag, friction; friction stir, magnetically impelled arc butt (MIAB); magnetic pulse welding, ultrasonic; explosive; diffusion; aluminothermic; high-frequency; stud, cold-pressure welding, etc. including equipment, main variables and common problems :

- Basic principles for the processes given in the relevant objective
- Heat generation for each type of process
- Equipment and accessories for each type of process
- Typical process applications and problems
- Consumables
- Welding parameters for each process
- Joint preparation: typical joint design for welding, fit-up, cleaning
- Relationship between welding parameters and joint configuration
- Health and safety specific to the processes
- Appropriate standards (ISO, CEN and National) for each process

Connaissances préalables recommandées:

Science des matériaux

Contenu de la matière:

1.2.1. Cutting, Drilling and other edge preparation processes

Objective: Understand in detail the basic principles and the fields of application of the most common cutting and edge preparation processes used in weld construction, including equipment, main variables, safety and common problems :

- Survey of edge preparation processes
- Mechanical cutting
- Principles of flame and flame powder cutting, equipment, applications and auxiliaries
- Flame cutting parameters, edge quality, oxygen purity grades
- Materials suitable for flame cutting
- Basic principles of the various arc cutting processes (air arc, carbon and metal-arc, oxy-arc cutting, gauging with carbon electrode) equipment and auxiliaries
- Materials suitable for arc-cutting, applications, cutting parameters for each process
- Fundamentals of plasma cutting, equipment and auxiliaries
- Materials suitable for plasma cutting, applications, cutting parameters, cutting gases
- Plasma cutting special applications (under water cutting, cutting with water vortex)
- Plasma gouging
- Fundamentals of electron beam and laser drilling and cutting, equipment, parameters, applications
- Fundamentals of water jet cutting, equipment, parameters, applications
- Fundamentals of arc gouging and flame gouging, parameters and applications
- Appropriate standards (ISO, CEN and National) for each process
- Health and safety

1.2.2. Surfacing and Spraying

Objective: Understand in detail the principles and fields of application of the most common surfacing techniques and their working principles, including equipment, main variables, safety and common problems. :

- Working principles and applications for cladding techniques (rolling, explosive, strip, plasma-MIG, electroslog, laser, etc)
- Basic phenomena (metallurgical and stress) in interface region
- Consumables for surfacing (cladding)
- Working principles and applications of the spraying techniques (flame spraying with powder, flame spraying with wire, arc spraying with powder, arc spraying with wire, plasma spraying with powder, HVOF spraying, cold gas)
- Equipment and parameters for each technique
- Surface preparation of the base material
- Spraying materials
- Sprayed layer structure, and substrate structure
- "Cold " and "fusion" spraying techniques
- Applications and special problems
- Standards for surface treatment and processes for spraying of materials
- Health and safety

1.2.3. Fully mechanised processes and robotics

Objective: Understand in detail the principles and industrial applications of welding mechanisation and the use of robotics in welding, including applications and systems.

- Survey of welding mechanisation for higher productivity
- Robotics, mechanisation, and automation: differences, advantages disadvantages and applications.
- Robotics (on-line and off-line programming, simulation, flexible manufacturing systems) .
- CAD/CAM systems
- Virtual factory (factory simulation)
- Seam tracking, types and typical applications
- Gas nozzle sensor, arc sensing, magnetic induction, vision system
- Narrow gap welding (SAW, MIG/MAG, TIG)
- Orbital welding (MIG/MAG, TIG)
- Typical robot type depending upon application field
- Application, typical problems and how to solve them
- Health and safety

1.2.4. Brazing and soldering

Objective: Understand in detail the fundamentals and the field of application of brazing and soldering, main variables, safety, equipment, applications, and common problems :

- Fundamentals of brazing and soldering (bonding mechanisms, surface tension, wetting, capillary action)
- Survey of brazing and soldering techniques, equipment, range of applications
- Consumables and fluxes for brazing and soldering, types, applications, and main functions of the fluxes
- Materials suitable for brazing, brazing requisites
- High vacuum brazing, brazing under controlled atmosphere
- Braze welding (Arc and laser brazing)
- Survey of soldering techniques (dip, wave flow, vapour phase)
- Brazing and soldering advantages and disadvantages
- Applications and special problems
- Overview on standards
- Health and safety

1.2.5. Joining processes for plastics

Objective: Understand in detail the principles involved in joining plastics, including the common techniques, equipment, applications, main variables, safety and common problems :

- General information on materials and joining processes
- Study the operating principle for each type of process
- Hot plate welding, butt fusion, hot gas welding, extrusion welding, induction welding, resistance welding, implant welding, high frequency, friction, electro-fusion welding, ultrasonic welding, vibration welding, adhesive bonding
- Control of welding parameters, types of equipment, joint design
- Advantages and disadvantages
- Applications and typical problems and how to solve them
- Health and safety

1.2.6. Joining processes for ceramics and composites

Objective: Outline the general principles of joining ceramics and composites, including the common techniques (diffusion bonding, brazing and soldering, ultrasonic, adhesive bonding, etc.), applications, and common problems :

- General information on ceramics and composites and typical joining processes
- General study of the operating principles for each process.
- Advantages and disadvantages
- Applications and special problems

Mode d'évaluation:

Contrôle continu : 40% ; examen : 60%.

Références bibliographiques

1. Whitaker S., « Fundamental principles of heat transfer », Robert E. Krieger Publishing Company Inc., 1983.
2. Rao S.S., "The Finite Element Method in Engineering", Pergamon Press, 1989
3. Logan D.L., "A First course in the Finite Element Method", Third Edition, Thomson Learning, 2002.
4. Robert D. Cook., David S., Malkus Michael E Plesha, "Concepts and Applications of Finite Element Analysis" 4 Ed. Wiley, 2003.
5. Reddy J.N., "An Introduction to Finite Element Method", McGraw-Hill International Student Edition, 1985
6. O.C. Zienkiewicz and R.L. Taylor, "The Finite Element Methods, Vol.1", "The basic formulation and linear problems, Vol.1", Butterworth Heineman, 5th Edition, 2000.
7. Moaveni, S., Finite Element Analysis – Theory and Application with ANSYS, 2nd Ed., Pearson Education, 2003.
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10. M.C. Flemings, Solidification Processing, McGraw-Hill, 1974
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12. B. Cantor and K. O'Reilly, Solidification and Casting, IOP, 2003
13. R. Abbaschian and R.E. Reed-Hill, Physical Metallurgy Principles, CL-Engineering (2008)
14. D.R. Askeland, P.P. Fulay, W.J. Wright, The Science and Engineering of Materials, CL-Engineering, (2011)
15. Holman J.P., « Heat transfer », seventh edition, Mac Graw Hill, 1990.
16. [http://fabkono.free.fr/ Auto-Formation SolidWorks](http://fabkono.free.fr/Auto-Formation SolidWorks)

Semestre : 3

Unité d'enseignement : UEF 3.2

Matière 1:Weldable metals and their properties

VHS: 45 h00 (C: 1h30 TD : 1h30)

Crédits : 3

Coefficient : 2

Objectifs de l'enseignement:

This Module is intended to cover recent advances in foundry engineering. Topics are chosen from special interests of theory of foundry and applications. Three subjects are considered. The course is addressed to advanced students and scientists from engineering and applied sciences, as well as to physicists and mathematicians interested in the fundamentals of the field. There are three groups of lectures, phase transformation of metal, mathematical description of the solidification problems and numerical implementations. For better understanding the first and second parts some basic courses of thermodynamics, Fluid mechanics and course of numerical methods and simulation are necessary.

Connaissances préalables recommandées:

- Base material science
- Base of computer science
- Mathematics: statistics, matrixes, algebra, geometry and analysis.
- CAO, DAO

Contenu de la matière:

1.1 Phase Diagrams and Alloys

Objective: Understand in detail the principles of alloying, the structures of alloys, phase diagrams, compounds in diagrams.:

- Pure metals and alloys
- Alloying elements
- Binary diagrams (basic types, non-, fully- and partly soluble components)
- Ternary diagrams
- Solidification, segregation and coring
- Structure of alloys
- Structure of castings
- Solutions (solid, interstitial,)
- Intermetallic compounds
- Solid state transformations
- Equilibrium and non equilibrium transformations
- Strengthening mechanisms (solid solution, precipitation, grain size)
- Ageing
- Mechanical properties versus microstructure

1.2 Iron – carbon alloy

Objective: Understand in detail the metallurgical processes occurring in welding of iron carbon alloys.:

- Iron solidification and changes in solid
- Fe-C equilibrium diagram
- Microstructure of Fe-C alloys (pearlite, ledeburite, etc.)
- Influence of alloying elements on the Fe-C equilibrium diagram
- Carbide forming elements
- Iron-alloys with closed gamma-loop, with broadened gamma-area
- Influence of cooling rate, hardenability

- TTT and CCT diagrams
- Influence of alloying elements on TTT diagrams
- Grain growth effect
- Classification of heat treatment

1.3 Manufacture and classification of steels

Objective: Understand in detail the fundamentals of steels, production, their properties and composition, classification and standardization, steel semi-products. :

- Introduction to metallurgy of steels
- Steel making processes (furnaces, convertors, deoxidation, etc.)
- Processing of steel products (hot, cold rolling, casting, etc.)
- Chemical composition and impurities
- Properties of steels
- Discontinuities and defects in steel
- Classification of steel (purpose of use, ISO/TR 15608)
- Designation of steels (National, EN Standards, Wr. No.)
- Steel products (plates, tubes, profiles)
- Inspection Certificate (i.e. EN 10204)

M2.2 Behaviour of welded structures

2.2.1 Behaviour of structural steels in fusion welding

Objective: Understand in detail the metallurgical fundamentals of welding of all types of structural steels :

- Thermal field
- Heat input and efficiency of heat input
- Peak temperature
- Cooling rate and thermal cycle, Δt 8/5
- Heat flow
- Heat-affected zone (grain growth and grain refinement, CCT diagrams)
- Properties of HAZ
- Carbon equivalent
- Weld pool, weld shape
- Dilution
- Structure of weld metal
- Effect of multipass welding
- Equations for the heat distribution
- Weld metal structure (weld protection, consumables, etc.)
- Solidification of weld pool
- Relationship grain size – toughness
- Transition temperature

2.1.1.1 Cracking phenomena in welded joints

Objective: Understand in detail the fundamentals of various cracking mechanisms in welded joints, the way in which welding variables affect the incidence of cracking, and methods of avoidance :

For unalloyed, heat resistant and stainless steels as appropriate :

Cold cracking :

- Cracking mechanisms in weld metal and HAZ, causes and avoidance
- Effect of hydrogen
- Source and diffusion of hydrogen
- Control of hydrogen
- Effect of microstructure
- Susceptible microstructure and its control
- Influence of alloying elements on susceptibility
- Effect of stresses
- Influence of restraint
- Influence of preheat
- Influence of austenitic weld metal
- Testing of cold cracking susceptibility
- Determination of preheat and interpass temperature (diagrams) ISO/TR 17671-2 and ISO 13916

Hot cracking :

- Cracking mechanisms in particular in weld metal and in HAZ (solidification cracking, liquation cracking, etc.); causes and avoidance
- Effect of alloy elements, heat input, bead shape, nugget shape
- Liquation phases
- Avoidance of hot cracking, ISO/TR 17671-2
- Testing for hot cracking susceptibility

Reheat cracking :

- Cracking mechanisms in weld metal and HAZ; causes and avoidance
- Type of steels sensitive to reheat cracking
- Effect of alloy elements, thermal cycles, stress
- Cracking during heat treatment and multi-pass welding
- Avoidance of reheat cracking
- Testing for reheat cracking susceptibility

Lamellar tearing :

- Cracking mechanism; causes and avoidance
- Effects of inclusions, joint configuration, stress
- Control of lamellar tearing by material choice and joint configuration ISO/TR 17671-2
- Testing for susceptibility (through-thickness properties)
- Steels with increased resistance to lamellar tearing

2.1.1.2 Fractures and different kinds of fractures

Objective: Understand in detail the metallurgical mechanisms of different kinds of fractures in base materials and weldments :

- Fractures because of mechanical overload (mechanism and avoidance)
- Fatigue fractures (mechanism and avoidance)
- Creep fractures (mechanism and avoidance)
- Brittle fractures, ductile fractures
- Samples for cases of damage

2.1.1.3 Heat treatment of base materials and welded joints

Objective: Understand in detail the metallurgical transformations of materials during different heat treatment. :

Heat treatment of base materials

- Normalising
- Hardening
- Quenching and Tempering
- Solution annealing
- Homogenisation
- Recrystallisation annealing
- Precipitation hardening

Heat treatment of welded joints and work pieces

- Post Weld Heat Treatment (Stress relieving, normalizing, hardening)

Technical guidelines for heat treatment

- Heat treatment procedures
- Introduction to heat treatment equipment
- Regulations/guidelines (codes and technical reports) ISO/TR 17663
- Introduction to temperature measurement and recording ISO 13916

2.1.1.4 Structural (unalloyed) steels

Objective: Understand in detail the structural unalloyed steels and the effects of welding processes on the weld joint. :

- Steels group 1 according to ISO/TR 15608

- Chemical composition
- Grades of unalloyed steels
- Carbon equivalent CE
- Relationship CE – hardenability
- Welding processes.
- Filler materials, choice, standards
- HAZ microstructure and properties (hardness, toughness)
- Effects of weld heat treatment.
- Applications
- Standards, (ISO, CEN and National)

2.1.1.5 High strength steels

Objective: Understand in detail the effects of micro-alloying elements on structure, mechanical properties and weldability with reference to fine-grained and high strength steels. :

- Steels group 2 and 3 according to ISO/TR 15608
- Concept of grain refinement (micro-alloying elements, formation and dilution of particles)
- Principles of treatment (controlled rolling, accelerated cooling, direct quench, thermomechanical treatment etc.)
- Normalised grades (Chemical composition, properties)
- Quenched and tempered grades (Chemical composition, properties)
- High strength steels (Chemical composition, Mechanical properties)
- Weldability, $t_{8/5}$ concept, preheat and interpass temperature, CE
- Influence of welding process on HAZ (microstructure, properties)
- Steels for automotive industries (TRIP, TWIP, dual phase, etc.)
- Applications
- Standards global (ISO), regional (CEN) and National
- Choice of filler metal (mismatching, etc.)

2.1.1.6 Application of structural and high strength steels

Objective: Understand in detail welding problems dealing with the fundamental aspects of the application of structural and high strength steels with particular reference to physical, chemical and mechanical characteristics. :

- Cranes
- Buildings
- Ships
- Pipelines
- Pressure vessels
- Automotive equipment
- Standards global (ISO), regional (CEN) and National

2.1.1.7 Creep and creep resistant steels

Objective: Understand in detail creep phenomena, general creep resistant steel types, their structure and alloying elements. :

- Creep mechanism
- Creep sensitivity testing
- Temper embrittlement, e.g. step cooling test
- Types of creep/heat resistant steels ISO/TR 15608, groups 4, 5, and 6.
- Applicable welding processes
- Filler materials – special chemical requirements for creep resistance
- Welding problems and precautions
- Effects of weld heat treatment
- Quality control of the welded joint

- Standards (ISO, CEN and National)

2.1.1.8 Steels for cryogenic applications

Objective: Understand in detail creep phenomena, general creep resistant steel types, their structure and alloying elements. :

- Steels group 9 according to ISO/TR 15608
- Requirements for low temperature applications
- Survey/list of cryogenic steels (including 9% Ni)
- Effects of nickel on low temperature properties of low alloy steels
- Applicable welding processes
- Filler materials
- Welding problems and precautions
- Properties and application of various types of cryogenic steels
- Quality control of the welded joint
- Standards (ISO, CEN and National)

2.1.1.9 Introduction to corrosion

Objective: Understand in detail the fundamentals of the various types of corrosion. :

- Fundamentals of electrochemistry
- Redox potential
- Passivation
- Overall corrosion
- Differential aeration
- Cathodic, anodic protection
- Types of corrosion (intercrystalline, transcrystalline, knife-line attack. Pitting, crevice, and stress-corrosion)
- Pickling and passivating
- Corrosion testing
- Demonstrations

2.1.1.10 Stainless and heat resistant steels

Objective: Understand in detail the fundamentals of the various types of stainless and heat resistance steels and their weldability including the filler material choice. :

- Effect of alloying elements on binary diagrams and phase composition
- Systems Fe-Cr, Fe-Ni, Fe-Cr-Ni
- Austenite and ferrite formers
- Influence of nitrogen
- Cr- and Ni-equivalent
- Schaeffler diagram, DeLong and other constitution diagrams
- Measuring of ferrite content (ISO 8249, ISO 17655)
- t 12/8 weldability concept
- Survey on stainless steels (fully austenitic, ferrite-containing steels, ferritic, martensitic, precipitation hardened, duplex stainless steels, chemically resistant, creep resistant, heat resistant steels, superferritic, supermartensitic and superaustenitic stainless steel e.g. duplex and lean duplex stainless steel) ISO/TR 15608, groups 7, 8, 9 and 10
- Welding of stainless steels
- Applicable welding processes
- Weldability and selection of consumables
- Choice of filler materials
- Shielding and backing gases

- Details of joint design
- Heat treatment
- Post-weld heat treatment (PWHT)
- Passivation
- Knife-line attack
- 475 °C-embrittlement
- Weld decay (intergranular corrosion)
- Pitting Index
- Mechanism of heat resistance
- Oxidation resistance
- Standards (ISO, CEN and National)

2.1.1.11 Introduction to wear and protective layers

Objective: Understand in detail the fundamentals wear and protective layers and the methods and materials used. :

Wear :

- Different types of wear (hydrodynamic friction, reaction, layer wear, adhesive wear, abrasive wear, fatigue wear, fretting, erosion, cavitation, impact, thermal, dynamic)
- Buttering
- Wear tests

Cladding :

- Cladding layers and cladding processes (dilution)
- Joining clad steels
- Joint design and welding procedures in respect to the access to the joint
- Applications
- Standards

Linings :

- Welding of linings
- Joint design and welding procedures

Surfacing :

- Corrosion-resistant layers
- Wear-resistant layers

Coatings :

- Coated steels
- Galvanised steels (Si-content)
- Painting
- Problems of joining

2.1.1.12. Cast irons and steels

Objective: : Understand in detail the metallurgy of the different types of cast irons and steels, their application fields and weldability. :

- Cast iron and cast steels – definition and classification ISO/TR 15608
- Survey of cast steels
- Survey of cast irons
- Weldability of cast iron and cast steels
- Applicable welding processes and procedures
- Filler materials
- Application and special welding problems
- Standards (ISO, CEN and National).

2.1.1.13. Copper and copper alloys

Objective: : Understand in detail the metallurgy and the range of application and weldability of copper and copper alloys :

- Classification of copper and copper alloys ISO/TR 15608
- Physical and mechanical properties
- Deoxidation and weldability
- Applicable joining processes (welding, brazing, soldering, diffusion bonding)
- Filler materials
- Shielding and backing gases
- Application and special problems
- Standards (ISO, CEN and National)
- Quality control of the welded joint

2.1.1.14. Nickel and nickel alloys

Objective: : Understand in detail the metallurgy, the range of application and the weldability of nickel and nickel alloys. :

- Classification of nickel and nickel alloys ISO/TR 15608.
- Weldability of nickel and nickel alloys
- Applicable welding processes and filler materials
- Shielding and backing gases
- Welding problems (hot cracking) and prevention
- Quality control of the welded joint
- Application and special problems
- Standards (ISO, CEN and National)

2.1.1.15. Aluminium and aluminium alloys

Objective: : Understand in detail the metallurgy, the range of application and the weldability of nickel and nickel alloys. :

- Classification of Al and Al-alloys (pure, cold work alloys, heat treatable) ISO/TR 15608
- Weldability of Al and Al-alloys (HAZ softening, porosity and hot cracking, cracking diagrams, distortion)
- Oxide layer cleaning (cathodic cleaning, trailing and trailing shield)
- Applicable welding processes
- Filler materials (choice, storage and handling)
- Shielding and backing gases
- Design details
- Joint preparation
- Application and special problems (lightweight structures, cryogenic use)...

2.1.1.16. Titanium and other metals and alloys

Objective: Understand in detail the metallurgy, application fields and weldability of the specified metals:

- Titanium, Classification according to ISO/TR 15608
 - Magnesium. Classification according to ISO/TR 15608
 - Tantalum
 - Zirconium
- Applicable welding processes and filler materials
- Special problems

2.1.1.17. Joining dissimilar materials

Objective: Understand in detail the principles of joining dissimilar materials and the problems involved :

- Fundamentals of joining dissimilar materials
- Use of the Schaeffler / De Long / WRC diagram for welding dissimilar metals
- Choice of processes
- Effect of dilution, buttering
- Consumables
- Welding problems and measures, (formation of intermetallic compounds, carbon migration)
- In service failures (thermal fatigue, disbanding)

2.1.1.18. Destructive testing of materials and welded joints

Objective: Understand in detail the fundamental aspects of testing materials with particular reference to welded test pieces.. :

Destructive testing :

Tensile tests, Bend tests, Impact tests, Hardness tests, Fatigue tests, Fracture mechanics tests, CTOD, etc.), Creep tests, Corrosion tests, Chemical analysis, Determination of hydrogen content

1.1 Phase Diagrams and Alloys

Objective: Understand in detail the principles of alloying, the structures of alloys, phase diagrams, compounds in diagrams

1.2 Iron – carbon alloy

Objective: Understand in detail the metallurgical processes occurring in welding of iron carbon alloys

1.3 Manufacture and classification of steels

Objective: Understand in detail the fundamentals of steels, production, their properties and composition, classification and standardization, steel semi-products

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

1. Whitaker S., « Fundamental principles of heat transfer », Robert E. Krieger Publishing Company Inc., 1983.
2. Rao S.S., "The Finite Element Method in Engineering", Pergammon Press, 1989
3. Logan D.L., "A First course in the Finite Element Method", Third Edition, Thomson Learning, 2002.
4. Robert D.Cook., David.S, Malkucs Michael E Plesha, "Concepts and Applications of Finite Element Analysis" 4 Ed. Wiley, 2003.
5. Reddy J.N., "An Introduction to Finite Element Method", McGraw-Hill International Student Edition, 1985
6. O.C.Zienkiewicz and R.L.Taylor, "The Finite Element Methods, Vol.1", "The basic formulation and linear problems, Vol.1", Butterworth Heineman, 5th Edition, 2000.
7. Moaveni, S., Finite Element Analysis – Theory and Application with ANSYS, 2nd Ed., Pearson Education, 2003.
8. Pepper, D.W. and Heinrich, J.C., The Finite Element Method: Basic Concepts and applications, Hemisphere, 1992.
9. Fung, Y.C. and Tong, P., Classical and Computational Solid Mechanics, World Scientific, 2001.
10. M.C. Flemings, Solidification Processing, McGraw-Hill, 1974
11. Fundamentals of Solidification, Trans. Tech. Publications, Switzerland, 1992
12. B. Cantor and K. O'Reilly, Solidification and Casting, IOP, 2003
13. R. Abbaschian and R.E. Reed-Hill, Physical Metallurgy Principles, CL-Engineering (2008)

14. D.R. Askeland, P.P. Fulay, W.J. Wright, The Science and Engineering of Materials, CLEngineering, (2011)
15. Holman J.P., « Heat transfer », seventh edition, Mac Graw Hill, 1990.
16. <http://fabkono.free.fr/> Auto-Formation SolidWorks

Semestre : 3

Unité d'enseignement : UEF 3.2

Matière 1:Behaviour of welded structures

VHS: 45 h00 (C: 1h30 TD : 1h30)

Crédits : 3

Coefficient : 1

Objectifs de l'enseignement:

This Module is intended to cover recent advances in foundry engineering. Topics are chosen from special interests of theory of foundry and applications. Three subjects are considered. The course is addressed to advanced students and scientists from engineering and applied sciences, as well as to physicists and mathematicians interested in the fundamentals of the field. There are three groups of lectures, phase transformation of metal, mathematical description of the solidification problems and numerical implementations. For better understanding the first and second parts some basic courses of thermodynamics, Fluid mechanics and course of numerical methods and simulation are necessary.

Connaissances préalables recommandées:

- Base material science
- Base of computer science
- Mathematics: statistics, matrixes, algebra, geometry and analysis.
- CAO, DAO

Contenu de la matière:

3.1.1 Basic theory of structural systems

Objective: Understand in detail the effect of external loads on structures, the types of structural systems and the relationship between external loads and internal forces :

- Power source characteristics
- Structural elements (cables, bars, beams, plates, slabs, shells)
- Theory of forces
- Combination and resolution of forces
- Equilibrium of forces and torques
- Bearings, constraints and basic types of connections
- Equilibrium of structural systems
- Statically determinate and indeterminate systems
- Stress in structural systems resulting from external actions
- Relationship between external loads and internal forces
- Calculation and determination of the internal forces and moments of simple statically determinate systems

3.1.2 Fundamentals of the strength of materials

Objective: Understand in detail the principles governing the behaviour of metallic structures under loading :

- Types of stresses (normal stress, shear stress)
- Types of deformation (axial strain, shear strain)
- Stress-strain relationship, yielding theories
- Elastic and plastic deformation

- Young's modulus, shear modulus, transverse contraction coefficient
- Characteristic material properties
- Different stresses resulting from internal forces and moments.
- Different types of section properties
- Cross section variables
- Calculation of stresses
- Limit states of failures: ductile, brittle, fatigue, creep.

3.1.3 Joint design for Welding and Brazing

Objective: Be able to design and draw weld details related to a given material, wall thickness, accessibility, loading, welding process, welding position, welding symbols, available equipment, tolerances :

- Introduction (importance of welding joint design and groove shapes, influence on welding stresses and distortion)
- Types of welded/brazed joints (ISO 9692, CEN, national)
- Importance of weld joint design and groove shapes, types of welded joints, design of welded joints
- Classification of groove shapes (by material type, thickness, welding process, accessibility)
- Tolerance requirements (ISO 13920)
- Welding symbols on drawings, symbols for groove shapes
- Symbolic representation of welded, brazed and soldered joints according to ISO 2553
- National Standards

3.1.4 Basics of weld design

Objective: Be able to design and draw weld details related to a given material, wall thickness, accessibility, loading, welding process, welding position, welding symbols, available equipment, tolerances :

- Types of stresses in welded joints (nominal stress, hot spot stress, notch stress)
- Stresses in butt welds, stresses in fillet welds
- Calculation of cross section variables of welded joints
- Determination of nominal stresses in single welded joints
- Determination of reference values of stresses due to multi-axial stressing.
- Determination of design resistance of arc-welded and resistance-welded joints
- Worked examples of calculation of nominal stresses in welded joints
- Principal stresses, nominal/normal stress, shear stress, Mohr circle
- Stress concentration, factor-k, SCF elastic, strain concentration factor.
- Constraint factor. Stress calculation by finite elements method. Experimental elasticity: strain gauges, photoelasticity, method Moiré, holography

3.1.5 Behaviour of welded structures under different types of loading

Objective: Understand in detail the different types of loading and the influence of ambient conditions on structures

- Static strength
- Elevated temperature strength
- Low-temperature strength
- Creep resistance
- Impact behaviour
- Influence of notches and weld defects
- Types of fracture (ductile fracture, fatigue fracture, brittle fracture, lamellar tearing)
- Selection of steel quality groups, Z-quality
- Typical data for common steels
- Use of standards and specifications
- Collecting and processing experimental stress/strain data

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

- American Society of Mechanical Engineers Boiler and Pressure Vessel Committee. 1998. 1998 Boiler and pressure vessel code. New York: American Society of Mechanical Engineers (ASME).
- American Society of Mechanical Engineers ASME Code for Pressure Piping, B31; Revision of ASME B31.3-2002. New York: American Society of Mechanical Engineers.
- American Welding Society (AWS) Committee on Structural Welding. 2000. Structural welding code—Steel. AWS D1.1:2000. Miami: American Welding Society.
- American Society for Civil Engineers (ASCE). 1998. Minimum design loads for buildings and other structures. ASCE 7-98. Reston, Virginia: ASCE Publications.
- American Society for Testing and Materials. (ASTM). 1997. Standard test methods and definitions for mechanical testing of steel products. A370-97a. West Conshohocken, Pennsylvania: American Society for Testing and Materials.
- LANL Engineering Standards Manual ISD 341-2 Chapter 13, Welding & Joining Section WFP 2-01 – Welding Fabrication Procedure Rev. 1, 10/27/06
- <http://nptel.ac.in/courses/112107090/25>
- Course: Quality Assurance Module 2 Welders/Welding personnel; EC Education and culture DG, lifelong learning program 2010-11-02
- Welding Fabrication Standards, Istituto Italiano della saldatura, Ente Morale, Leonardo continued education program for International welding engineers and International welding Inspectors - Comprehensive

Semestre : 3

Unité d'enseignement : UEF 3.3

Matière 2:Design of welded structures

VHS: 22 h30 (C: 1h30 TD : 0h00)

Crédits : 3

Coefficient : 1

Objectifs de l'enseignement:

An understanding of effect of the external loads on welded structures and the reactions that take place within.

Connaissances préalables recommandées:

- Base material science
- Base of computer science
- Mathematics: statistics, matrixes, algebra, geometry and analysis.
- CAO, DAO

Contenu de la matière:

3.2.1 Design of welded structures with predominantly static loading

Objective: Be able to design and calculate joints and relevant details of welded metallic structures :

- Steel constructions including lightweight structures
- Structural details e.g. (stiffeners, knots, columns, base- and cap-plates, reinforced structures, supports, frame-corners, frame structures, trusses, nodal joints, weld connections, braces / bracing, lattice work structures, etc.)
- Use of different types of welds related to joint types
- Use of standards and specifications
- Worked examples

3.2.2 Behaviour of welded structures under cyclic loading

Objective: Understand in detail the development of fatigue, calculation of load cycles, the influence of notches and their avoidance :

- Types and variables of cyclic loading
- Statistical stress analysis on real structures
- S-N diagram
- Stress collective
- Fatigue strength (low cycle, and others)
- Effect of mean stress including residual stresses
- Effect of stress range
- Stress distribution
- Influence of notches
- Influence of weld imperfections
- Fatigue improvement technique (needle peening, TIG dressing, burr grinding, - hammering, stress relieving, etc.)
- Standards ISO, CEN and National
- Palmgren-Miner rule
- Classification of weld joints

3.2.3 Design of cyclic loaded welded structures

Objective: Understand in detail the different design methods in the range of application :

- Range of application: bridges, cranes, machines, ships and offshore constructions, chimneys, towers and masts, vehicles (cars, trucks, railway vehicles), etc
- Acceptance criteria
- Dimensioning according to different standards and specifications
- Worked examples
- Calculation methods

3.2.4 Design of welded pressure equipment

Objective: Understand in detail the special requirements of design and construction of structural elements in this field of application with regard to the welds:

- Construction of boilers, pressure vessels, pipelines, etc...
- Calculation (formulae) of the welds
- High and low temperatures applications
- Details of design (flanges, nozzles, shells, compensating plates etc.)
- Use of laws and design rules, standards and specifications
- Worked examples of construction and design
- Standards (ISO, CEN and National)

3.2.5 Design of aluminium alloys structures

Objective: Understand in detail the behaviour of welded aluminium structures with respect to strength, stresses and design :

- Comparison of design between steel and aluminium structures
- Lightweight structures
- Standard alloys for practical use and relevant stresses and strains
- Effects of heat affected zone (HAZ) (softening)
- Special design principles regarding profiles
- Significance of defects
- Range of application (vehicles, rolling stocks, ships, aircraft, vessels and space)
- Dimensioning according to different standards and specifications
- Worked examples

3.2.6 Introduction to fracture mechanics

Objective : Understand in detail the use of fracture mechanics for welded structures :

- Viewpoint of fracture mechanics
- Application of fracture mechanics
- Linear elastic fracture mechanics
- Fundamentals of elastic-plastic fracture mechanics
- Critical flaw size, K_{Ic}-value
- Fracture mechanics testing (CTOD, etc.)
- Different assessment method
- Sub-critical crack growth
- Fatigue testing
- Standards global (ISO), regional (CEN) and National

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

- American Society of Mechanical Engineers Boiler and Pressure Vessel Committee. 1998. 1998 Boiler and pressure vessel code. New York: American Society of Mechanical Engineers (ASME).
- American Society of Mechanical Engineers ASME Code for Pressure Piping, B31; Revision of ASME B31.3-2002. New York: American Society of Mechanical Engineers.
- American Welding Society (AWS) Committee on Structural Welding. 2000. Structural welding code—Steel. AWS D1.1:2000. Miami: American Welding Society.
- American Society for Civil Engineers (ASCE). 1998. Minimum design loads for buildings and other structures. ASCE 7-98. Reston, Virginia: ASCE Publications.
- American Society for Testing and Materials. (ASTM). 1997. Standard test methods and definitions for mechanical testing of steel products. A370-97a. West Conshohocken, Pennsylvania: American Society for Testing and Materials.
- LANL Engineering Standards Manual ISD 341-2 Chapter 13, Welding & Joining Section WFP 2-01 – Welding Fabrication Procedure Rev. 1, 10/27/06
- <http://nptel.ac.in/courses/112107090/25>
- Course: Quality Assurance Module 2 Welders/Welding personnel; EC Education and culture DG, lifelong learning program 2010-11-02
- Welding Fabrication Standards, Istituto Italiano della saldatura, Ente Morale, Leonardo continued education program for International welding engineers and International welding Inspectors - Comprehensive

Semestre : 3

Unité d'enseignement : UEM 3.1

Matière 2: Production means and quality assurance

VHS: 22 h30 (C: 1h30 TD : 0h00)

Crédits : 3

Coefficient : 1

Objectifs de l'enseignement:

To enable the candidate to understand the precautions and norms to respect in order to insure quality and reliability.

Connaissances préalables recommandées:

Contenu de la matière:

4.1.1 Introduction to quality assurance in welded fabrication

Objective : Understand in detail the principles of quality assurance and quality control, the related standards and their application to welded fabrication as a special process :

- Concept of quality assurance and quality control (including analysis, continuous improvement)
- Weldability ISO/TR 581
- Testing and Inspection Plan (the goal, content and sources to develop it).. Audit of plant
- Personnel and Equipment
- Maintenance
- Inspection
- Activities of the welding engineer/technologist/specialist/practitioner in the different functions - in industry (ISO 14731)
- Standards (ISO 9000, ISO 3834, national and international standards)

4.1.2 Quality control during manufacture

Objective : Understand in detail the principles of quality assurance and quality control, the related standards and their application to welded fabrication as a special process :

- Advantages to the quality of brazed and welded constructions
- Brazing and Welding sequence
- Welding coordination and inspection personnel; qualification tasks and responsibilities (ISO 14731, ISO 9712, CEN and National standards)
- Brazer and Welder Approval /Qualification and Brazing and Welding Procedure - - Qualification - Introduction/Overview
- Brazer and Welder Approval/Qualification (ISO 9606, CEN and National Standards)
- Brazing and Welding Procedure Specification – The goal, how to create and develop (ISO 15607 and 15609, CEN and National Standards)
- Brazing and Welding Procedure Qualification (ISO 15610, 156111, 15612, 15613 and 15614), CEN and National standards)
- Brazing and Welding Operator Qualification (ISO 14732, CEN and National Standards)
- Traceability (materials identification, welder/operator, procedures, certificates)

Practical exercises:

- IWE - Welding procedure qualification
- IWE - Welder and welder operator qualification

4.1.3 Residual Stresses and Distortion

Objective : Understand in detail the main factors affecting welding stress and distortion in welded fabrications and how these effects can be measured and minimised :

- Influencing factors
- Thermal data of the materials
- Origin of the residual stresses and deformation
- Relationship between the material at a certain temperature and its mechanical characteristics
- Magnitude of longitudinal and transverse shrinkage stresses
- Distribution of the residual stresses at weld (parallel to the weld axis, perpendicular, and through thickness, influence of the material thickness)
- Relationship between heat input, shrinkage stresses and distortion
- Methods of residual stress measurement
- Welding sequence techniques
- Effects of residual stresses on the behaviour of the structure in service..... Methods of reducing residual stresses or distortion
- Examples to prevent and control of distortion
- Weld straightening, correction and removal of welding deformation (pressing, rolling, local heating, etc.)

4.1.4 Plant facilities, welding jigs and fixtures

Objective : Understand in detail the need for, and function of, auxiliary equipment, jigs and fixtures from the viewpoint of quality, economics and the environment :

- Layout of production line
- Jigs, fixtures and positioners (types, applications, advantages, special precautions)
- Roller beads, manipulators
- Cables, electrical connections, and special precaution
- Operational environment
- Auxiliary equipment (for fit up, movement, backing gas devices, flow meters, etc)
- Joint fit up
- Tack welding (specific cares, distribution, length and their removal)
- Equipment for preheat, postheat, and other heat treatments, also temperature control including furnace and local heat treatment

4.1.5 Health and Safety

Objective : Understand in detail the health and safety hazards associated with welding and fabrication processes, including techniques to minimise them:

- Introduction to health and safety requirements
- Survey of safety and environmental aspects, risk assessment
- Hazards of electric power
- Electro-magnetic fields
- Connecting of equipment
- Problems with shielding gases
- Radiation and eye protection
- Welding fume emission
- Exposure limits (Maximum Allowable Concentration) MAC and UEL (Upper Exposure - Limit) values
- Ventilation filters (ISO 15012) and fume extraction (type of equipment and airflow)
- Ergonomics
- Determination of acceptable emissions
- Tests for measuring emissions
- Noise levels and ear protection

- Special risks for automated processes
- Standards and National regulations
- Protective clothing
- Health effects of grinding (vibration and dust)
- Hazards regarding the heat (spatter, flame, combustion, fire)
- Oxygen environment enrichment

4.1.6 Measurement, Control and Recording in Welding

Objective : Understand in detail the requirements for measurement, control and recording during welding and allied operations :

- Methods of measurement (electrical parameters, gas flow rate, temperature, velocity)
- Instruments (types, measuring applications)
- Temperatures (ISO 13916), humidity, wind
- Cooling time e.g. $\square t$ 8/5
- Welding parameters (voltage, current, speed, gas flow rate, etc.)
- Control in heat treatment (heating and cooling rate, ISO/TR 17663)
- Calibration and validation of equipment (ISO 17662)
- Laboratory exercises

4.1.7 Imperfections and Acceptance Criteria

Objective : Understand in detail the principles of imperfections and acceptance criteria and fitness for purpose:

- Types of weld imperfections according to ISO 6520 standards
- Acceptance criteria (e.g. ISO 5817, ISO 10042, ISO 13919, ISO 9013, ISO 17635)
- Significance of imperfections
- Introduction to ISO/TR 15235
- Engineering critical assessment techniques

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

[1] ANTULOV, D.; LUKAČEVIĆ, Z.; SAMARDŽIĆ, I.; KOLAKOVSKI, D.: “On – line” mjerenje parametara zavarivanja, 2. međunarodno savjetovanje proizvodnog strojarstva, Zagreb, 1993., C27-C35.

[2] SAMARDŽIĆ, I.; GRUBIĆ, K.: Computer aided welding parameter monitoring, Časopis Zavarivanje 39(1996)1/2, 23-28.

[3] SAMARDŽIĆ, I.; KÖVEŠ, A.: Osiguranje kvalitete zavarivačkih radova podržano sustavom za mjerenje i registraciju parametara zavarivanja, Međunarodno savjetovanje “Zavarivanje u pomorstvu”, Haludovo (Krk), listopad, 1998. Haludovo (Krk, Croatia), 1998., 437-448.

[4] Samardžić, I.; Kolumbić, Z.; Klarić, Š.: The influence of shielding gas composition and insufficiency on MAG welding process stability and weld quality, Tehnički vjesnik 12 (2005) 1-2; 9-21.

- [5] Siewert, T.; Samardžić, I.; Kolumbić, Z.; Klarić, Š.: On-line monitoring system - an application for monitoring key welding parameters of different welding processes, Tehnički Vjesnik, 15 (2008) 9-18.
- [6] SIEWERT, T.; SAMARDŽIĆ, I.; KOLUMBIĆ, Z.: Estimation of process stability in the MAG welding process by monitoring the welding parameters, International scientific-professional conference "Economical and qualitative aspects of high effective welding processes", Đuro Đaković, Slavonski Brod, 2001.,1-13.
- [7] SAMARDŽIĆ, I.; KOLUMBIĆ, Z.; BAOTIĆ, M.: Doprinos primjeni praškom punjenih žica za zavarivanje MAG postupkom, Znanstveno-stručni časopis Tehnički vjesnik, (2001)(3,4)23-37.
- [8] LUKAČEVIĆ, Z.; SAMARDŽIĆ, I.; SIEWERT, T.: Characterization of a Welding Procedure Based on Monitoring of Welding Variables, International Institute of Welding (IIW) Conference Doc. XII- 1627-00, Firenca, 2000.
- [9] SAMARDŽIĆ, I.; ŽAGAR, D.; KLARIĆ, Š: Application and Upgrading of On-line Monitoring System for Measurement and Processing of Electric Signaly at Arc Stud Welding Processes, Strojarsvo, 4(2009) 355-363.
- [10] NATIONAL INSTRUMENTS (HARDWARE & SOFTWARE): <http://www.ni.com>
- [11] HALL PROBES <http://www.cy-sensors.com/>

Semestre : 3

Unité d'enseignement : UEM 3.1

Matière 2:Non Destructive Testing NDT

VHS: 22 h30 (C: 1h30 TP : 1h30)

Crédits : 3

Coefficient : 1

Objectifs de l'enseignement:

Understand in detail the use of Non Destructive Testing as applied to welding fabrications

Connaissances préalables recommandées:

Contenu de la matière:

- Fundamentals of NDT methods (visual, dye penetrant, magnetic particle, eddy current, acoustic emission, radiography, digital RT, ultrasonic, etc.).. Field of application and limitations
- Design in respect of NDT
- Calibration
- Interpretation (IIW Radiographic reference)
- Recording of data
- Correct selection of the NDT methods versus application (e.g. CEN/TR 15135)
- Qualification and certification of NDT personnel (EN ISO 9712)
- NDT procedures
- Automation of NDT (computer aided evaluation, etc.)
- Use of standards and specifications
- Health and safety aspects
- Review of documents and protocols from NDT test sites
- Laboratory exercises

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

1. Nondestructive Testing, Louis Cartz, ASM International
2. Nondestructive Evaluation and Quality Control, ASM Handbook, Vol. 17.
3. <https://www.nde-ed.org>

Semestre : 3

Unité d'enseignement : UEM 3.2

Matière 1:Project and Welding Laboratory Works: PLW3

VHS: 22 h30 (TP : 0h00)

Crédits : 3

Coefficient : 1

Objectifs de l'enseignement:

Connaissances préalables recommandées:

Contenu de la matière:

PLW SM5 Project and Welding Laboratory Works SM5

Objective: Understand in detail the effect of parameters on weld bead shape and cut surface quality.

- Practical exercises showing the effect of each main welding parameter on the weld bead shape
- Discussion of results to help future evaluation and diagnosis
- Exercises should cover: MMA, TIG, MIG/MAG, Flux Cored wires, SAW, Oxy-gas
- Practical exercises showing the effect of each main cutting parameter on the cut surface

Exercises should cover: Oxy-cutting, Arc-Air, Plasma, Arc-Cutting

PLW SM6 Project and Welding Laboratory Works SM6

Joining dissimilar materials ; Typical applications :

Joining high alloyed steel and mild steel, Joining stainless steel and mild steel

Joining dissimilar materials ;

Joining Austenitic stainless steel and martensitic stainless steel, Joining Austenitic stainless steel and ferritic stainless steel, Joining Austenitic stainless steel and duplex stainless steel, Joining Cu-Ni-alloys with mild steel/stainless steel, Joining Ni-alloys with mild steel, Joining stainless steel and copper alloys, Joining steel and Al / Al alloys, Joining Cu and Al / Al alloys, Joining Ni and Cu.

Destructive testing of materials and welded joints ; Metallographic examination of materials and their welded joint :

- Preparation of specimens (grinding, polishing, etching)
- Equipment for preparation (manual, mechanical, automatic)
- Microscopes for examination (optical, electron)
- Microscopic and macroscopic examination of welds
- Standards for testing

PLW SM7 Project and Welding Laboratory Works SM7

Welding Technology laboratory

- Assembly / disassembly of various welding devices;

Practical exercises

- Welding with coated electrodes (rutile, basic, cellulose) in positions 1F, 2F, 3F, on unalloyed structural steel.

- MIG/MAG welding, plain and pulsed with solid wire and cored wire, of unalloyed structural steel, stainless steel and aluminum.
- Submerged arc welding, plasma cutting, oxy-acetylene cutting.

Mode d'évaluation:

Contrôle continu : 100%.

PLW SM8 Project and Welding Laboratory Works SM8

Welding Technology laboratory

- Assembly / disassembly of various welding devices;
- Measuring of electrical characteristics of different processes;
- Determining deposition characteristics and tests on robotic welding;

Practical exercises

- Welding with coated electrodes (rutile, basic, cellulose) in positions, 1G, 2G on unalloyed structural steel.
- Resistance welding, AC 50Hz, 1000Hz MFDC, CD, adaptive, Delta Spot, After-Hem welding.
- Coating and Surface alloying of resistance welding electrodes through ESD, PVD, Laser...

Mode d'évaluation:

Contrôle continu : 100%.

Semestre : 3

Unité d'enseignement : UED 3.1

Matière 1: The enterprise, Environment and Management

VHS: 22 h30 (C: 1h30)

Crédits : 1

Coefficient : 1

Objectifs de l'enseignement:

The purpose of this subject is to bring together business ideas, concepts and techniques that will develop skills and allow a decision knowingly about the future direction of an organization. This kind of thinking encouraged by adopted approach will provide a bridge between the program of technical training "MASTECH" and concepts of project management resulting in the creation of a new business based on developing of an innovative new product. This topic is intended to provide a framework and an overview for students to think in an integrated manner on the future strategy of a company.

In term of this modules, students will be able to deal with group decisions and conflict, learn how to communicate better both orally and in writing and how to critique and improve the work of others.

Connaissances préalables recommandées:

Contenu de la matière:

- 1. The enterprise, Environment and Management**
 - Structure and organization of the company
 - Business strategies and strategic management
 - Company Management
 - Supply Chain Management
- 2. Project Management**
 - Principles phases of project management and associated deliverables
 - Tools in project management.
 - Decision making tools.
- 3. Managing innovation and creation of an innovative enterprise**
 - Managing innovation
 - Elaboration of business plan of an innovative project.

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

1. « Le management – voyage au centre des organisations » - Henry Mintzberg – Editions d'Organisation – 1989.
2. « Management – stratégie et organisation » - J.P. Helfer, M. Kalika, J. Orsoni, Vuibert Gestion – 2000.
3. « Stratégor » – Dunod – 2005.

4. Le pilotage de portefeuilles de projets Jean-Yves Moine. Publié le 03/06/2010 aux éditions AFNOR.
5. Le management de projet ; Auteur : Gile Garell ; La Découverte : 2e édition 13 oct. 2011.
6. AFITEP : <http://www.afitep.fr> ; IPMA : <http://www.ipma.ch>
7. 1- Dupont E. (2009), Développer et lancer un nouveau produit, De Boeck.
8. 2- Gotteland D. et Haon Ch. (2005), Développer un nouveau produit : Méthodes et outils, Pearson.
9. 3- Paul Millier (2005), Stratégie et marketing de l'innovation technologique : Lancer avec succès des produits qui n'existent pas encore, Dunod.
10. 4- Jacqueline Delahaye et Florence Delahaye, Finance d'entreprise, Dunod.
11. 5- www.apce.com : « étapes de la création » ; « boîte à outils » : modèle de dossier de création d'entreprise
12. 6- www.oseo.fr: Innovation – « manager son projet en ligne ».

Semestre : 3

Unité d'enseignement : UED 3.1

Matière 2:Managing innovation and creation of a virtual innovative enterprise

VHS: 22 h30 (C: 1h30)

Crédits : 1

Coefficient : 1

Objectifs de l'enseignement:

Connaissances préalables recommandées:

Contenu de la matière:

Managing innovation and creation of an innovative enterprise

- Managing innovation
- Elaboration of business plan of an innovative project.

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

13. « Le management – voyage au centre des organisations » - Henry Mintzberg – Editions d'Organisation – 1989.
14. « Management – stratégie et organisation » - J.P. Helfer, M. Kalika, J. Orsoni, Vuibert Gestion – 2000.
15. « Stratégor » – Dunod – 2005.
16. Le pilotage de portefeuilles de projets Jean-Yves Moine. Publié le 03/06/2010 aux éditions AFNOR.
17. Le management de projet ; Auteur : Gile Garell ; La Découverte : 2e édition 13 oct. 2011.
18. AFITEP : <http://www.afitep.fr> ; IPMA : <http://www.ipma.ch>
19. 1- Dupont E. (2009), Développer et lancer un nouveau produit, De Boeck.
20. 2- Gotteland D. et Haon Ch. (2005), Développer un nouveau produit : Méthodes et outils, Pearson.
21. 3- Paul Millier (2005), Stratégie et marketing de l'innovation technologique : Lancer avec succès des produits qui n'existent pas encore, Dunod.
22. 4- Jacqueline Delahaye et Florence Delahaye, Finance d'entreprise, Dunod.
23. 5- www.apce.com : « étapes de la création » ; « boîte à outils » : modèle de dossier de création d'entreprise
24. 6- www.oseo.fr: Innovation – « manager son projet en ligne ».

Semestre : 3

Unité d'enseignement : UET 3.1

Matière 2:Methodology of Research & Project Management

VHS: 22 h30 (C: 1h30)

Crédits : 1

Coefficient : 1

Objectifs de l'enseignement:

Connaissances préalables recommandées:

Contenu de la matière:

Project Management

- Principles phases of project management and associated deliverables
- Tools in project management.
- Decision making tools.

Mode d'évaluation:

Contrôle continu : 33% ; examen : 67%.

Références bibliographiques:

1. « Le management – voyage au centre des organisations » - Henry Mintzberg – Editions d'Organisation – 1989.
2. « Management – stratégie et organisation » - J.P. Helfer, M. Kalika, J. Orsoni, Vuibert Gestion – 2000.
3. « Stratégor » – Dunod – 2005.
4. Le pilotage de portefeuilles de projets Jean-Yves Moine. Publié le 03/06/2010 aux éditions AFNOR.
5. Le management de projet ; Auteur : Gile Garell ; La Découverte : 2e édition 13 oct. 2011.
6. AFITEP : <http://www.afitep.fr> ; IPMA : <http://www.ipma.ch>
7. 1- Dupont E. (2009), Développer et lancer un nouveau produit, De Boeck.
8. 2- Gotteland D. et Haon Ch. (2005), Développer un nouveau produit : Méthodes et outils, Pearson.
9. 3- Paul Millier (2005), Stratégie et marketing de l'innovation technologique : Lancer avec succès des produits qui n'existent pas encore, Dunod.
10. 4- Jacqueline Delahaye et Florence Delahaye, Finance d'entreprise, Dunod.
11. 5- www.apce.com : « étapes de la création » ; « boîte à outils » : modèle de dossier de création d'entreprise
12. 6- www.oseo.fr: Innovation – « manager son projet en ligne ».