Soumis pour avis au Conseil Administration de Chimie-ParisTech de juin 2026 ;
Soumis pour avis au Conseil Académique de PSL de juin 2026 ;

REGLEMENT DE LA SCOLARITE ET DES ETUDES

Année universitaire 2026-27

Dispositions générales communes

GLOSSAIRE :

« PSL » : Paris Sciences et Lettres

« UE » : Unité d'Enseignement

« EC » : Elément Constitutif

« CPES » : Cycle Pluridisciplinaire d'Études Supérieures

« ITI » : Institut de Technologie et d'Innovation

TITRE I – DISPOSITIONS COMMUNES A L'ENSEMBLE DES FORMATIONS

Article 1 – Obligations de scolarité

Chaque étudiant des formations organisées par PSL doit se conformer au règlement de la scolarité qui est porté à sa connaissance lors de son inscription administrative et qui est disponible sur le site internet. Le responsable de la formation est chargé de l'exécution du présent règlement.

Un manquement à l'une des obligations de scolarité peut entrainer le redoublement ou la non-obtention du diplôme. L'inscription administrative, la conformité aux modalités d'évaluation et à l'organisation de la formation, l'honnêteté intellectuelle ainsi que l'assiduité et la ponctualité sont des obligations de scolarité.

Les étudiants ayant contrevenu aux règles de fonctionnement de l'établissement peuvent faire l'objet de sanctions disciplinaires dans le cadre de la saisie de la section disciplinaire.

Article 2 - Inscription administrative

L'inscription administrative est annuelle. Elle est valable de septembre de l'année n à octobre de l'année n+1. Pour valider l'inscription, les étudiants doivent s'acquitter au préalable de la Contribution Vie Etudiante et de Campus (CVEC) pour l'année universitaire en cours (voir article 3). Ces droits sont obligatoires. Plusieurs cas d'exonération existent et sont à consulter sur le site dédié : *cvec.etudiant.gouv.fr.*

Article 3 - Sécurité sociale, mutuelle et CVEC

- L'affiliation à la sécurité sociale est obligatoire pour tous les étudiants et permet de bénéficier d'un remboursement partiel ou total des frais médicaux.
  - les étudiants s'inscrivant pour la première fois dans un établissement d'enseignement supérieur, n'ont aucune démarche à effectuer pour l'affiliation à la sécurité sociale car ils restent affiliés à leur régime actuel de protection sociale, généralement celui de leurs parents ou tuteurs légaux.
  - les étudiants déjà inscrits en 2025/26 restent affiliés pour une année supplémentaire à leur régime de sécurité sociale, et basculeront automatiquement sur le régime général.

  Les étudiants étrangers sont invités à se renseigner auprès de l'assurance maladie (*www.ameli.fr*) pour réaliser les démarches nécessaires et demander leur affiliation à la sécurité sociale.

- Les étudiants doivent obligatoirement obtenir une attestation d'acquittement de la contribution vie étudiante et de campus (CVEC), par paiement ou exonération, et ce avant d'engager leurs démarches d'inscription à l'Université PSL. D'un montant de 105€ au titre de 2026/27, la CVEC permet de développer des services utiles aux étudiants sur le campus : accès aux soins, accompagnement social, soutien aux projets, pratiques sportives etc.

  L'obtention de cette attestation se fait en ligne sur le site *cvec.etudiant.gouv.fr*. Plusieurs cas d'exonération existent (boursiers sur critères sociaux du CROUS etc.) et sont détaillés sur le site.
  A la fin de la procédure, une attestation avec un numéro unique est fournie. Ce numéro CVEC sera à transmettre lors de l'inscription ou réinscription à PSL. Les étudiants exonérés de la CVEC doivent également obligatoirement faire la démarche pour obtenir ce numéro et cette attestation, indispensables pour leur inscription en ligne.

Article 4 - Messagerie étudiante

Tout au long de leurs études à PSL, les étudiants disposent d'une adresse électronique PSL, qui leur est communiquée au moment de leur inscription administrative. C'est à cette adresse, et uniquement à celle-ci, que sont envoyées par l'administration toutes les informations d'ordres pédagogique et administratif, ainsi que les informations relatives aux activités scientifiques, culturelles ou sportives de PSL.

Sauf à la demande de l'autorité judiciaire ou d'une autorité administrative légalement habilitée, PSL n'exerce aucune surveillance ni aucun contrôle éditorial sur les messages envoyés dans le cadre de la messagerie électronique individuelle. PSL ne pourra être tenue pour responsable des propos qui y seront tenus. Néanmoins, PSL se réserve le droit de désactiver temporairement ou définitivement l'adresse électronique individuelle pour le cas où elle aurait été utilisée pour propager des propos constitutifs d'une infraction pénale ou qui incitent à la commission d'une infraction pénale, dans un délai de 5 jours après avoir demandé au titulaire de la messagerie concernée de fournir toutes explications.

Article 5 - Assiduité et ponctualité

Sauf exceptions prévues au sein des programmes de la formation suivie, les cours et les examens ont un caractère obligatoire. Ils peuvent se dérouler du lundi au samedi inclus.

L'assiduité et la ponctualité sont des obligations de scolarité qui s'étendent à l'ensemble des éléments de la formation. Toute absence doit être justifiée auprès de l'administration de la formation et de l'enseignant(e) concerné(e).Des retards répétés peuvent être comptabilisés comme une absence.

Lorsqu'un cours est annulé et une séance de remplacement programmée, l'assiduité est obligatoire sauf dans le cas d'un conflit horaire entre plusieurs cours ou d'une obligation personnelle ne pouvant être déplacée dûment justifiée auprès du responsable de la formation. Dans ce dernier cas, l'appréciation de la situation est laissée à l'administration de la formation.

Article 6 - Fraude et plagiat

En cas de flagrant délit de fraude ou de tentative de fraude aux examens, le responsable de la surveillance de la salle prend toutes mesures pour faire cesser la fraude (sans interrompre pour autant la participation à l'épreuve entamée) et transmet les éléments à la Direction de sa formation afin d'engager la procédure disciplinaire.

Le plagiat est constitué lorsque l'étudiant a rendu un travail qui ne permet pas de distinguer sa pensée propre d'éléments d'autres auteurs : il peut se caractériser par l'absence de citation d'un groupe de mots consécutifs, par la reformulation ou la traduction, par la copie. En cas de soupçon de plagiat, l'enseignant doit informer l'équipe de direction de la formation et lui communiquer les éléments dont il dispose. Lorsqu'un plagiat est avéré, la note de 0 est attribuée à l'évaluation. Une procédure disciplinaire peut être déclenchée. La sanction peut aller jusqu'à l'exclusion.

Article 7 - Bizutage

L'article 225-16-1 du code pénal dispose que : « Hors les cas de violences, de menaces ou d'atteintes sexuelles, le fait pour une personne d'amener autrui, contre son gré ou non, à subir ou à commettre des actes humiliants ou dégradants lors de manifestations ou de réunions liées aux milieux scolaires et socio-éducatif est puni de six mois d'emprisonnement et de 7 500€ d'amende ».

Hors les sanctions pénales prévues par cet article, des sanctions disciplinaires pouvant aller jusqu'à l'exclusion définitive seront prises à l'égard des étudiants responsables d'actes de bizutage.

Article 8 - Règlements intérieurs des établissements partenaires d'enseignement ou de logement

Lorsque des formations ont lieu au sein de locaux d'établissements de PSL et de partenaires, les étudiants sont tenus de prendre connaissance et de respecter les règlements intérieurs des différents établissements. Tout manquement à l'un de ces règlements peut faire l'objet de sanctions disciplinaires.

Lorsque les étudiants bénéficient d'un logement grâce à un partenariat (internat du Lycée Henri-IV pour les étudiants mineurs du CPES, résidence Honnorat ou fondation Deutsche de la Meurthe de la CIUP pour les étudiants boursiers du CPES, ou tout autre établissement qui passerait une convention avec PSL), ils sont tenus de respecter les locaux, de prendre connaissance et de respecter les règlements internes à ces établissements. Tout manquement peut faire l'objet de sanctions disciplinaires et d'une exclusion de ces infrastructures ou de la formation.

Article 9 - Respect d'autrui et du principe de laïcité

Sont strictement interdits les actes de prosélytisme, les manifestations de discrimination, les incitations à la haine et toute forme de pression physique et psychologique visant à imposer un courant de pensée religieux, philosophique ou politique qui s'opposerait au principe de laïcité et plus généralement de violences physiques ou verbales punies par les textes législatifs ou réglementaires.

Aucune raison d'ordre religieux, philosophique, politique, ainsi qu'aucune considération de sexe ne peut être invoquée pour refuser de participer à certains enseignements, empêcher d'étudier certains ouvrages ou auteurs, refuser de participer à des examens, contester les sujets, les choix pédagogiques ou des examinateurs. Le port de tenues ne permettant pas l'identification des étudiants est prohibé.

Article 10 - Sanctions disciplinaires

Tout manquement au présent règlement peut faire l'objet d'une sanction disciplinaire, allant de l'avertissement à l'exclusion définitive.

Conformément au code de l'éducation, les membres de la section disciplinaire sont élus respectivement par les représentants des enseignants, des élèves et des salariés membres du Conseil de Direction.

Le président de la section disciplinaire est un Professeur des universités. Il est élu par l'ensemble des enseignants de la section.

La section disciplinaire est saisie par le président de PSL.
Les sanctions sont fixées par un décret en Conseil d'Etat. Elles peuvent aller de l'avertissement à l'exclusion définitive de tout établissement public d'enseignement supérieur.

Article 11 - Les jurys de délibération

Les jurys de fin de semestre et de fin d'année prennent les décisions qui leur incombent en toute souveraineté et en toute indépendance à partir de l'ensemble des résultats obtenus par chaque étudiant.

Toute contestation doit être formulée par écrit et adressée aux responsables de la formation concernée dans un délai d'un mois à compter de la publication des résultats. II est rappelé que les étudiants ne peuvent pas remettre en cause le pouvoir souverain d'appréciation du jury.

Article 12 - Les aménagements de scolarité

Les étudiants peuvent obtenir des aménagements de scolarité dans certaines situations. Ces aménagements sont accordés par la direction de la formation concernée.

Peuvent bénéficier d'un régime spécial d'études, en application des dispositions de l'arrêté du 23 avril 2002, les étudiants appartenant aux catégories suivantes :
- les étudiants chargés de famille ;
- les étudiants engagés dans plusieurs cursus universitaires ;
- les étudiants handicapés ;
- les sportifs de haut niveau.

Au titre de ce régime spécial, les étudiants concernés et qui en font expressément la demande auprès du responsable de la formation bénéficient d'une suspension de contrôle continu pour l'ensemble des éléments constitutifs du cursus.

Par ailleurs, les étudiants indisponibles pour raison de santé sur une période d'au moins 30 jours consécutifs pourront demander à bénéficier du régime spécial. Le responsable de la formation précisera l'application de cette disposition, soit pour la période d'indisponibilité, soit pour l'ensemble du semestre, au vu de la demande de l'étudiant et des justificatifs médicaux présentés.

Les étudiants justifiant d'une activité salariée peuvent, sur leur demande dûment motivée, bénéficier de ce régime spécial. Le responsable de la formation apprécie la demande des étudiants concernés en tenant compte des justificatifs fournis et des exigences spécifiques du cursus.

Dans tous les cas, sauf motif grave et imprévisible survenant en cours de scolarité, les candidats intéressés par le régime spécial devront en faire la demande dans le mois qui suit le début des enseignements auprès du responsable de la formation.

Article 13 - L'année d'interruption d'études

L'étudiant qui est empêché de poursuivre ses études ou qui choisit de les interrompre pour des motifs personnels, peut demander à bénéficier d'une interruption d'études pendant un an. La demande d'interruption est transmise à la direction du programme qui prend une décision au vu du dossier de l'étudiant.

Durant l'année d'interruption, l'étudiant n'est plus inscrit : il n'a donc plus à ce titre d'assurance sociale étudiante et ne peut demander le bénéfice d'une convention de stage impliquant PSL.

II a cependant le droit de réintégrer son cursus à l'issue de cette année.

Article 14 - L'année de césure

L'étudiant peut demander à bénéficier d'une année de césure par une demande motivée auprès de son responsable de formation. Elle est accordée par la direction de la formation concernée, en indiquant la nature, les modalités de mise en œuvre et les objectifs de son projet.

Conformément à l'art. D611-14 du code de l'éducation, la période de césure ne peut se substituer aux modalités d'acquisition des compétences prévues dans le cadre de la formation, telles que le projet de fin d'études, les stages en milieu professionnel ou l'enseignement en langue étrangère. Sa durée ne peut être inférieure à celle d'un semestre universitaire, ni supérieure à deux semestres consécutifs.

Selon l'article D611-20 du code de l'éducation, L'établissement assure un encadrement pédagogique lors de la période de césure et accompagne l'étudiant dans la préparation de cette période et pour l'établissement de son bilan.

Durant l'année de césure, l'étudiant est inscrit administrativement et il conserve son statut d'étudiant. L'établissement où il est inscrit lui délivre une carte d'étudiant. II réintègre son cursus à l'issue de cette année.

La césure peut être effectuée dès l'admission en Master 1. Elle peut avoir lieu avant le premier semestre, entre le premier et le deuxième semestre de première année de master, entre la première et la deuxième année de master, et entre les deux semestres de la deuxième année de master. Une césure ne peut être acceptée après obtention du Master 2.

Par ailleurs, une césure peut être réalisée sous la forme d'un stage dès lors qu'elle est d'une durée égale à un semestre universitaire et qu'elle s'intègre dans un cursus respectant le minimum de deux cents heures de formation au sens de la loi n° 2014-788 du 10 juillet 2014. En revanche, un stage réalisé dans le cadre de la césure ne peut excéder six mois.

Article 15 - Propriété intellectuelle, publications et diffusion des supports

L'utilisation du nom et du logo de l'Etablissement membre de PSL et de PSL est prohibée, sauf dans le cadre de travaux effectués au sein de la formation et avec l'accord de la direction de la communication, à qui la demande est adressée.

L'Etablissement met à la disposition des personnes suivant une formation des publications et ressources pédagogiques protégées par la législation sur le droit d'auteur. L'utilisation de ces ressources obéit aux règles suivantes : la reproduction intégrale d'un ouvrage est interdite sans l'accord de l'auteur et/ou de l'éditeur. La copie réalisée par une personne suivant une formation doit être destinée à un usage exclusivement privé, ce qui exclut notamment toute reprographie à des fins collectives ou toute mise en ligne sur internet.

Quel que soit le mode de diffusion, y compris de façon dématérialisée, sauf dispositions contractuelles contraires, les travaux réalisés dans le cadre de la formation par une ou plusieurs personnes suivant une formation, leur appartiennent.

Les personnes suivant une formation peuvent, sous leur responsabilité, rédiger et diffuser des publications dans l'enceinte de l'établissement conformément aux conditions exposées ci-dessous. Toute publication ne peut être diffusée dans l'enceinte de l'établissement qu'après accord préalable de la Doyenne de la formation ou son représentant.

Les publications, quel que soit le support de diffusion (papier ou numérique), doivent respecter les lois en vigueur, notamment la loi du 29 juillet 1881, et ne doivent pas porter atteinte à l'ordre public ni aux droits des tiers. En particulier :

- Sont interdits les écrits injurieux, diffamatoires ou portant atteinte au respect de la vie privée ;
- Le droit de réponse doit être assuré ;
- Avant leur diffusion, le décanat de la formation doit recevoir une copie des publications diffusées ou distribuées dans l'enceinte de l'établissement. Cette copie doit comporter notamment l'indication du nom du ou des auteurs des articles, ainsi que l'indication du responsable de la publication, le moment et le lieu de diffusion.

Les tracts peuvent être diffusés au sein de l'établissement sous réserve que, outre le respect des conditions susvisées, ils portent sur un sujet entretenant un rapport avec la scolarité des personnes suivant une formation ou la vie de l'établissement et que la direction de la formation ait été préalablement prévenue de cette diffusion. La responsabilité personnelle des auteurs est engagée par tous leurs écrits. En cas de manquement aux dispositions ci-dessus, le directeur de l'établissement (ou son représentant) peut suspendre ou interdire la diffusion de la publication à l'intérieur de l'établissement.

Les photographies et films réalisés par les personnes suivant une formation dans l'enceinte de l'établissement sont soumis à l'autorisation préalable de la Doyenne de la formation ainsi que des personnes figurant sur les photographies et films.

Article 16 : Droit à l'image et protection des données

Les étudiants inscrits aux formations de PSL acceptent l'utilisation de leur image et de leurs données à caractère personnel dans le cadre de l'organisation de leur formation et de la vie étudiante (utilisation de photo, de vidéo ou de témoignage sur tous supports). Pour la promotion de celles-ci, ils sont libres de le refuser. Ils signent une autorisation dans le respect de la législation en vigueur.

REGLEMENT DE LA SCOLARITE ET DES ETUDES DU MASTER SGM DE PSL

TITRE II – LES DISPOSITIONS SPECIFIQUES AUX ELEVES DU MASTER SGM DE PSL

Article 17 - Modalités de recrutement

Les modalités de candidature, de même que les pièces à fournir et la procédure de recrutement (dossier, dossier et entretien, concours) sont précisées sur le site internet de PSL. Pour la procédure totalement dématérialisée, le portail de candidature dédié est accessible via le site web de PSL.

Le jury de recrutement du Master est constitué du(des) directeur(rice) de la mention ainsi que des responsables de parcours. Les responsables d'"electives" (colorations internes aux parcours) sont également conviés.

Les membres du jury de recrutement examinent les dossiers de candidatures de M1 et de M2. La liste des candidats retenus est dressée sous forme de procès-verbal adressé à l'ensemble des membres du jury de recrutement par le président du jury ou son représentant. Si besoin, une liste complémentaire peut être dressée.

Article 18 - Inscription pédagogique

L'inscription pédagogique est obligatoire. Elle consiste à formuler par mail le choix du parcours et des unités d'enseignement (UE) ainsi que des cours optionnels. Les responsables de parcours collectent ces choix en amont de la rentrée, et procèdent à l'inscription pédagogique des étudiants. Les semestres sont composés d'UE dont l'accès, les conditions d'examen, nombre d'ECTS et compensations sont détaillées dans les modalités de contrôle des connaissances. Cependant, en cas de situation exceptionnelle, l'équipe pédagogique (responsables de la mention et de parcours) peut proposer un contrat pédagogique spécifique pour un(e) étudiant(e). Les étudiants sont tenus de choisir des enseignements compatibles avec le planning fixé par la scolarité. Sauf difficulté particulière, aucun changement d'enseignement ou d'horaire ne peut avoir lieu une fois que le contrat d'étude est validé.

En cas de difficulté, avant la validation des inscriptions pédagogiques, il appartient à chaque étudiant(e) de fournir auprès du responsable de la scolarité, le justificatif des contraintes particulières qu'il (elle) peut rencontrer. Les étudiants sont tenus de suivre de façon assidue des enseignements choisis, y compris les options.

Article 19 - Types d'enseignements

Les enseignements au sein des Masters peuvent prendre les formes les plus diverses : cours magistraux, travaux dirigés, séminaires, conférences, travaux pratiques, projets tutorés, dossiers et mémoires de recherche, etc.

Article 20 - Principes généraux

Les enseignements de la première année (M1) à la deuxième année (M2) du Masters sont organisés en semestres 1 à 4. La validation des semestres 1 à 4 repose sur le principe du contrôle continu et/ou de l'examen terminal. Les modes de validation sont précisés au sein d'une annexe propre au Master concerné.
Chaque semestre est constitué de plusieurs blocs eux-mêmes constitués de plusieurs unités d'enseignement ou UE (cf. art. 21), obligatoires et/ou optionnelles.

Article 21 - Validation d'une UE

La note finale d'un bloc est la moyenne pondérée des notes finales obtenues dans le cadre de chaque UE qui le compose. Une note finale peut correspondre à un examen terminal, à une moyenne des différents travaux effectués durant le semestre, ou à une moyenne possiblement pondérée des différents travaux et de l'examen terminal d'une matière.
Une UE dont la note finale est supérieure ou égale à 10/20 est validée. La validation de l'UE emporte l'acquisition des crédits européens correspondants. Une UE est dite non compensable si les crédits ECTS ne sont acquis que si l'élève obtient à l'UE une note supérieure ou égale à 10/20.

Une UE est dite compensable si les crédits ECTS sont délivrés même lorsque la note à l'UE est inférieure à la moyenne. La délivrance des crédits reste néanmoins subordonnée aux deux conditions suivantes :

- la note à l'UE est supérieure ou égale au seuil de compensation fixé à 08/20 ;
- la note finale du bloc auquel appartient l'UE est supérieure ou égale à 10/20.

Une note comprise entre 08/20 et 10/20 à une UE peut être compensée au sein d'un même bloc d'UE par une note supérieure à 10/20, à condition que la moyenne des deux notes soit égale ou supérieure à 10/20. La note compensante ne peut être utilisée que pour une seule compensation au sein du bloc.

Une UE est dite non compensante si elle ne peut compenser aucune autre UE.

Un étudiant sera déclaré défaillant à une UE et donc au semestre s'il a été absent (non justifié) à l'ensemble des épreuves évaluatives, s'il a été absent à l'épreuve terminale lorsque cette épreuve est la seule modalité d'évaluation, ou s'il n'a pas rendu les travaux concernant l'UE. De même, une copie non rendue par un étudiant présent à un examen se voit attribuer la note de zéro. Dans tous ces cas, l'étudiant se voit attribuer un zéro à ces épreuves évaluatives et/ou travaux non rendus.

Dans le cas d'absence justifiée à l'épreuve terminale, l'étudiant est ajourné. Le caractère « justifié » d'une absence est apprécié par l'enseignant responsable de l'UE et le responsable de master sur présentation d'un justificatif réglementaire. L'étudiant est tenu, dans ce cas, de contacter au plus vite l'enseignant(e) concerné(e) ainsi que les responsables du master, pour fournir le justificatif réglementaire. En cas d'absence dûment justifiée, dans des circonstances exceptionnelles, l'équipe pédagogique a capacité à proposer, pour la même session, une solution de remplacement visant à vérifier l'acquisition des compétences visées, dans des conditions équitables vis-à-vis des autres étudiants de l'UE.

La défaillance à une épreuve fait obstacle à la validation de la matière. Le redoublement voire la non-reconduction pour défaillance ou non-assiduité peuvent être décidés par le jury de Master de fin d'année.

Article 22 - Validation d'un semestre en Master

Chaque semestre est constitué de 30 crédits minimum. Un semestre est considéré comme validé si la note finale de chaque bloc est supérieure ou égale à 10/20. Il est à noter qu'il n'y a pas de compensation entre semestres.

Article 23 - Validation d'une année

La note finale de l'année correspond à la moyenne des notes finales des deux semestres qui constituent l'année. Une année est définitivement validée si elle totalise 60 crédits européens (crédits ECTS) et si la note finale de l'année est supérieure ou égale à 10/20, sous réserve que les conditions de validation des UE soient respectées. La validation d'une année entraine la validation de chacun des deux semestres et de toutes les UE les composant.

La validation de l'année emporte l'acquisition des crédits européens afférents (crédits ECTS) et vaut autorisation de passage en année supérieure. Si la totalité des crédits de première année de Master est supérieure à 60 ECTS, l'étudiant conserve les crédits supplémentaires pour son M2. L'autorisation de passage en deuxième année de Master ne permet pas automatiquement l'accès au parcours choisi par l'étudiant. Il appartient au jury de valider l'accès à ce parcours ou de proposer à l'étudiant un autre parcours adapté à ses résultats.

Article 24 - Organisation d'une session de rattrapage

Le jury de Master autorise l'organisation une session de rattrapage pour les étudiants n'ayant pas validé certaines matières ou UE. L'enseignant de l'UE/de la matière concernée contacte les étudiants par mail pour leur proposer une date de rattrapage. Aucune convocation papier n'est envoyée. L'étudiant doit valider par mail le créneau proposé pour la seconde session sous une semaine à réception du mail de l'enseignant. En cas d'absence de réponse sous une semaine et sans justification, l'étudiant peut être considéré comme défaillant.
Un étudiant n'ayant pas obtenu la moyenne à une UE doit présenter l'UE en seconde session, lorsqu'elle est proposée :

I. parce que l'UE est non compensable ;
II. parce que l'UE est compensable mais qu'il n'obtient pas la moyenne au bloc de rattachement;
III. parce que l'UE peut être compensée mais qu'il refuse la compensation ; dans ce cas, l'étudiant doit exprimer, de manière volontaire et écrite, un refus de compensation et le transmettre au plus tard une semaine après la délibération du jury, au responsable de la formation.
IV. parce qu'il n'a pas pu se présenter à l'examen de première session.

Quand l'étudiant passe une UE en seconde session, quelle qu'en soit la raison, la note de la seconde session est retenue *in fine*. Les relevés de notes préciseront au titre de quelle session la note a été attribuée. Les examens de rattrapage peuvent prendre différentes formes (examens écrits ou oraux, mémoire…). Le niveau d'exigence est le même pour la première et la seconde session mais le format des épreuves peut différer. Les conditions de validation de la seconde session sont les mêmes que la première session. En cas d'absence non justifiée, l'étudiant est défaillant et se voit attribuer la note de zéro, empêchant de fait la validation de l'UE.
Les modalités sont précisées par chaque jury de Master.

Article 25 – Conditions d'obtention du diplôme et mentions

L'obtention du diplôme est conditionnée à l'obtention de chacune des années d'étude du Master, dans les conditions mentionnées à l'article 23.

Une moyenne finale est attribuée à l'étudiant pour l'obtention de son diplôme, elle correspond à la moyenne des notes des deux semestres de deuxième année.

En fonction de cette moyenne finale N du diplôme, le jury de fin d'année attribue à tout étudiant déclaré « reçu », l'une des mentions suivantes :

- $10 \leq N < 12$ mention passable (P)
- $12 \leq N < 14$ mention assez bien (AB)

- $14 \leq N < 16$ mention bien (B)
- $16 \leq N$ mention très bien (TB)

Conformément à l'article 11 du présent règlement, le jury de fin d'année peut attribuer une mention à un étudiant dont la note ne correspond pas à ces exigences. Les options facultatives sont prises en compte au moment du jury pour l'octroi d'une mention.

Article 26 - Assiduité

Le Master de PSL est une formation exigeante. Les cours et les examens peuvent se dérouler du lundi au samedi inclus. Lors de chaque cours, les enseignants peuvent procéder à l'appel des présents et établir un relevé des absences qui est transmis à la scolarité.

Des retards répétés peuvent être comptabilisés comme une absence. Dès lors que l'étudiant est signalé absent trois fois dans un enseignement au cours d'un même semestre, il obtient la note de zéro à cet enseignement. Il/elle est défaillant à l'UE concernée, et doit se présenter directement en seconde session. Les retards sont également relevés par les enseignants.

Les étudiants ont à justifier de leurs absences éventuelles auprès du responsable de la formation, tout en informant leurs enseignants. II reviendra au jury de fin de semestre, lors de l'attribution définitive des notes, d'examiner les situations particulières de défaillance (notamment pour motif médical), chaque étudiant ayant la responsabilité de transmettre au service de la scolarité tous les éléments pertinents permettant de juger de sa situation. Seul le jury de fin de semestre est souverain pour lever une défaillance. La défaillance est mentionnée sur le bulletin de notes. Un nombre élevé d'absences peut conduire le jury à considérer l'étudiant comme démissionnaire.

Article 27 - Changements de parcours

Les étudiants souhaitant changer de parcours au sein de leur Mention peuvent en faire la demande auprès de la direction du Master, soit au cours du mois de la rentrée, soit à l'issue du premier semestre, soit au jury de délibération en fin d'année pour la rentrée suivante. La direction du Master rend sa décision après consultation du responsable du parcours concerné.

Article 28 - Réinscriptions en première année ou en deuxième année de Master

Le redoublement est une exception. Le jury de fin d'année peut le proposer pour des motifs médicaux ou tenant à la situation personnelle de l'étudiant. Il est accordé par la direction du Master.

Article 29 - Jury du Master

Le jury du Master est constitué du(des) directeur(rice) de la mention ainsi que des responsables de parcours. Les enseignants intervenant dans le master peuvent également être conviés aux jurys de semestre.

Le jury établit un procès-verbal indiquant la liste des étudiants déclarés « reçus » ou « ajournés » et attribue les mentions. Le jury peut attribuer une mention à un étudiant dont la note ne correspond pas aux exigences précisées à l'article 27.

Le jury peut accorder à un étudiant la validation d'un semestre dont la note finale est inférieure à 10/20.
Le jury peut accorder à un étudiant la validation d'une UE dont la note finale est inférieure à 10/20.

Article 30 – UE et stages non obligatoires (hors contrat d'étude)

L'étudiant doit solliciter les responsables de parcours et du master lors de l'inscription pédagogique (avant la rentrée) s'il souhaite suivre une UE en plus de son cursus obligatoire, de manière non-évaluée. La même procédure doit être suivie en cas de demande d'un stage court non évalué, compatible avec les enseignements et les plages libres pour le travail personnel. Le sujet du stage doit être en lien avec le contenu du master. Les responsables de l'UE concernée, du parcours d'inscription et du master décident de manière collégiale et sont souverains pour autoriser ou non l'inscription à l'UE demandée, ou au stage. Dans un cas favorable, le tuteur pédagogique du stage est le responsable d'année ou de parcours.

Maquette / Modalités de contrôle des connaissances

Année universaire 2026/2027

Composante

Niveau d'étude *Master 1*

Mention *Sciences et Génie des Matériaux*

Dispositions particulières

Semestre 1

Code UE	Compensable : C / non compensable : NC	Obligatoire (TC) / Optionnel (Opt)	Intitulé de l'UE	Volume horaire CM	TD	TP	Total	ECTS	Coeff.	Session 1 – Contrôle continu %	TP	CC	Session 1 – Examen terminal % ET	%	Ecrit Rapport (R) Examen (Ex)	Ecrit Durée	Oral %	Oral Durée	Session 2 – Examen de rattrapage Oui (O) Non (N)	% ER	Ecrit %	Ecrit Durée	Oral %	Oral Durée	Responsable
Bloc "Bases en matériaux"																									
MHM1SGMC	C	TC	Crystalline Materials	14	14	8	36	4	1				100%	100%	Ex	2	0%	0	O	100%	100%	2			Vanessa Pimenta / Sandrine Ithurria
MHM1SGMM	C	TC	Metallic Materials	24	4,5	6	34,5	4	1				100%	100%	Ex	1,5	0%	0	O	100%	100%	1			Frédéric Prima
MHM1SGPOL	C	TC	Physical Chemistry of Polymers	24		3	27	3	1	40%	10%	30%	60%	100%	Ex	1,5	0%	0	O	100%	100%	1,5			Josh McGraw / Kawthar Bouchemal
MHM1SGMEC	C	TC	Introduction to mechanics	15	9	3	27	3	1	20%	100%	0%	80%	100%	Ex	1,5	0%	0	O	100%			100%	0,5	Cristian Ovalle
MHM1SGEC	C	TC	Corrosion and electrochemistry	20	16	3	39	3	1	30%	60%	40%	70%	100%	Ex	1,5	0%	0	O	100%	100%	1,5	s première sess		Cécilie Duhamel / Virginie Lair
Bloc "Outils et communication scientifiques"																									
MHM1SGML	C	TC	Machine Learning	9		9	18	2	1				100%	100%	R				O	100%	100%	0,5			Assaad Zoughaib / Michael KAIRALLAH
MHM1SGTEX	C	TC	Experimental Methods	21	3,5	6	30,5	3	1				100%	100%	Ex	1,5			O	100%	100%	1,5			Anouk Galtayries Franck N'Guyen / Mathias Lamari
MHM1SGBIB	C	TC	Bibliographic Project	3		12 (p)	15	3	1				100%	50%	R		50%	30 mn	O	50%	R		50%	30 mn	Responsables du master
MH23TC.PIG	C	TC	Innovation Project in Group (PIG)				27	3	1				100%	50%	R		50%		N						Fréderic de Montigny
MHM1SGANG	C	TC	Language	20			20	2	1				100%	100%	Ex				O	100%	100%				Linda Koiran / claire bazin (ANG); Javier CASAS (FLE-centre de langues PSL)
			TOTAL					30																	

Semestre 2

Code UE	Compensable : C / non compensable : NC	Obligatoire (TC) / Optionnel (Opt)	Intitulé de l'UE	Volume horaire CM	TD	TP	Total	ECTS	Coeff.	Session 1 – Contrôle continu %	TP	CC	Session 1 – Examen terminal % ET	%	Ecrit Rapport (R) Examen (Ex)	Ecrit Durée	Oral %	Oral Durée	Session 2 – Examen de rattrapage Oui (O) Non (N)	% ER	Ecrit %	Ecrit Durée	Oral %	Oral Durée	Responsable
Bloc "cours de spécialisation" - 3 UE au choix parmi les UE optionnelles																									
MH24OP.NOR	C	TC	Inorganic Assemblies: from molecules to materials	22	2		24	3	1			O	100%	100%	Ex	1,5	0%	0	O	100%	100%	0,5			Domitille Giaume
MH24OP.ELA	C	Opt	Inorganic Materials Elaboration	10,5	7,5		18	3	1				100%	100%	Ex	0,5	0%	0	O	100%	100%	0,5			Domitille Giaume
MH24OP.PES	C	Opt	Electronic Properties of Solids	18	4,5		22,5	3	1				100%	100%	Ex	1,5	0%	0	O	100%	100%	1,5			Laurent Binet
MHM1SGAFM	C	Opt	Advanced Fluids Mechanics	30			30	3	1				100%	100%	Ex	3	0%	0	O	100%	0%	0	100%	30 min	Nicolas Bremond / Philippe Bourrianne / Laurent Duchemin
MH24OP.MM	C	Opt	Surface Properties and Endurance of Materials	18	4,5		22,5	3	1				100%	100%	Ex	1,5			O	100%	100%	1,5			Frédéric Wiame
MHM1SGESS	C	Opt	From Mechanical Testing to Materials Behavior	4	10	10	24	3	1	30%	100%		70%	100%	Ex	1,5			O	100%	100%	1,5			Pierre Arnaud
Bloc "Outils et communication scientifiques"																									
MH24OP.MOD	C	TC	Modelling	3		12	15	2	1				100%	100%	R				O	100%			100%	0,5	Frédéric Labat
MHM1SGANG2	C	TC	Language				20	2	1				100%	100%	Ex				O						Linda Koiran/Javier Casas
MHM1SGPSL2	C	TC	Spring PSL Week				35	3	1																dépend de la semaine choisie
MH24TC.PIG	C	TC	Innovation Project in Group (PIG)				18	3	1				100%	50%	R		50%	30 mn	N						Kawthar Bouchemal
Bloc "Expérience porfessionnelle"																									
MHM1SGSTG	C	TC	Internship					8	1	33			67%	33%	R		34%	15							Responsables du master
			TOTAL					30																	

Maquette / Modalités de contrôle des connaissances

Année universaire 2026/2027

Composante

Niveau d'étude *Master 2*

Mention *Sciences et Génie des Matériaux*

Dispositions particulières

Semestre 1

Code UE	Compensable : C / Non compensable : NC	Obligatoire (TC) / Optionnel (Opt)	Intitulé de l'UE	Commentaire	Volume horaire CM	TD	TP	Projet	Total	ECTS	Coeff.	Session 1 – Contrôle continu %	TP	CC	Session 1 – Examen terminal % ET	%	Ecrit Rapport (R) Examen (Ex)	Durée	Oral %	Durée	Session 2 – Examen de rattrapage Oui (O) / Non (N)	% ER	Ecrit %	Durée	Oral %	Durée	Responsable
Bloc "Material Science Specialization" (Electives)																										
MH35MAT3	C	TC	Selection and design of materials for a sustainable city	Mandatory in all electives	39	0			39	4	1				100%	100%	Ex	1,5			O				100%	1	Frederic Prima
MHMADENE	C	TC	Sustainable Energy and Materials	Mandatory in elective 1	72	9	9		90	8	1				100%	100%	Ex	3h			O	100%			100%	1	Armelle Ringuedé
à créer pegasus	C	TC	Life cycle assessment	Mandatory in electives 1 and 2	9	30			39	4	1				100%	50%	Ex		50%		O	100%					Daye Lee
à créer pegasus	C	TC	Overview of recycling processes	Mandatory in electives 1 and 3	39	12			51	4	1				100%	0%	Ex		100%		O	100%					Frédéric Rousseau
MHMADQUOT	C	TC	Materials for everyday life : scientific challenges	Mandatory in elective 2	36				36	4	1				100%	100%	R				O	100%		R			Corinne Soulié-Ziakovic
MHMADAGE	C	TC	Endurance and durability of metal materials	Mandatory in elective 3	18	18			36	4	1	25%		QCM	75%	100%	Ex	3h			Oui (O)	75%	75%	écrit ou oral (selon les cas); durée: selon les cas; la note de CC (25%) de la première session est conservée			Cécilie Duhamel, Anne-Françoise Gourgues-Lorenzon
MHMADPHYS	C	TC	Physical Metallurgy	Mandatory in elective 3	18	18			36	4	1	25%		QCM	75%	100%	Ex	3h			Oui (O)	75%	écrit ou oral (selon les cas); durée: selon les cas; la note de CC (25%) de la première session est conservée				Mathias LAMARI, Abdelali OUDRISS
MHMADCOAT	C	TC	Processes and coatings	Mandatory in electives 2 and 3	33		3	3	39	4	1				100%	50%	poster		50%	1h30	O	100%			100%		Frédéric Rousseau
MH35MAT2	C	TC	Materials of the cultural heritage and durability	Mandatory in elective 2	27	3		3	33	4	1				100%	50%	Ex	1,5	50%		O	100%			100%	1	Odile Majerus
Bloc "innovation application classes" (Group 1 or Group 2)																										
Group 1 - mandatory for students in "contrat de professionnalisation"																										
MHMADINNO	C	Optionnel (Opt)	Managing the unknown		15	0	15		30	3	1				100%		Ex				O	100%	100%	R			Pascal Le Masson
MHMADIND	C	Optionnel (Opt)	Tutored project					27	27	3	1				100%				100%	1h	O	100%	50%	R	50%	20min	Responsables du master
Group 2																										
MHMADTHK	C	Optionnel (Opt)	Design thinking		10,5	10,5		7	28	3	1				100%	50%	R		50%	30 mn	O	100%	100%	R ou Oral			Faustine Vanhulle
MHMADDES	C	Optionnel (Opt)	Design Project		3,5	16		7	26,5	3	1				100%	50%	R		50%	30min	N						Faustine Vanhulle
Bloc "Outils et communication scientifique"																										
MHMADPSL	NC	Optionnel (Opt)	PSL WEEK	Pour les étudiants du groupe 2 seulement					35	2	1				fonction de la semaine PSL choisie						O	100%	100%				fonction de la semaine PSL choisie
MHMADHIS	NC	Optionnel (Opt)	History of science and technology in society	Pour les étudiants du groupe 1 seulement	18			2	20	2	1				100%	100%	Ex	1h30			O	100%			100%	15min	Emanuel Bertrand
MHMADCPR	NC	Optionnel (Opt)	Report on the first period in the company	Pour les étudiants en contrat de professionnalisation						2	1				100%	100%	R				O	100%	100%				
MHMADANG	NC	TC	LANGUAGE		20				20	2	1				100%	100%	Ex				O	100%	100%				Linda Koiran
			TOTAL							30																	

Semestre 2

Code UE	Compensable : C / Non compensable : NC	Obligatoire (TC) / Optionnel (Opt)	Intitulé de l'UE	Volume horaire CM	TD	TP		Total	ECTS	Coeff.	Session 1 – Contrôle continu %	TP	CC	Session 1 – Examen terminal % ET	%	Ecrit Rapport (R) Examen (Ex)	Durée	Oral %	Durée	Session 2 – Examen de rattrapage Oui (O) / Non (N)	% ER	Ecrit %	Durée	Oral %	Durée	Responsable
Bloc "Expérience porfessionnelle"																										
MHMADPFE	NC	TC	Internship						30	1	33			67	33	R		33	20 mn	N						Responsables du master
Bloc "contrat de professionnalisation"																										
MHMADPFEC	NC	TC	Internship						28	1	33			67	33	R		33	20 mn	N						Responsables du master
MHMADHIST2	NC	TC	Histoiry of sciences and technologies in the society			25			2	1	0				100		1									Emanuel Bertrand
			TOTAL						30																	

Modalité de Contrôle des Connaissances

Année universaire 2026/2027

Composante

Niveau d'étude *Master 2*

Mention *Sciences et Génie des Matériaux*

Parcours *Microfluidique*

Dispositions particulières

Semestre 1																												
														Session 1														
Code UE	Intitulé UE	Compensable : C Non compensable : NC	Obligatoire (TC) Optionnel (Opt)	Code cours	Intitulé du cours	Volume horaire					ECTS	Contrôle continu			Examen terminal													Responsable
																	Ecrit			Oral							
						CM	TD	TP	Projet	Total		%	TP	CC	% ET	%	Rapport (R) Examen (Ex)	Durée (h)		%	Durée (h)							
UE 1	Microfluidique			UHFLU.MIC							6																	
		C	TC	MHFLU.FAB	Techniques of microfabrication	21	0	15		36	3	50%	100%		50%	100%	R, Ex	3										Jacques FATTACCIOLI
		C	TC	MHFLU.HYD	Micro-hydrodynamique	34	0		0	34	3				100%	100%	R, Ex											Nicolas BREMOND, Josh McGRAW, Stefano AIME
UE 2	Mesoscopic Phenomena			UHFLU.MES							12																	
		C	TC	MHFLU.CAP	Capillarity and Interfaces	14	14			28	3				100%		R, Ex			100%	3h							David QUÉRE, Hélène de MALEPRADE
		C	TC	MHFLU.MAT	Soft Matter	34	0		0	34	3				100%	100%	R, Ex				3h							Corentin TREGOUET
		C	TC	MHFLU.RHE	Rheology	15		15		30	3	50%	60%	40%	50%	100%	R, Ex				3h							Anke LINDNER
		C	TC	MHFLU.ACT	From Soft to Active Matter	24		6		30	3				100%		R, Ex			100%	20 min							Pascal SILBERZAN, Bassam Hajj, Manuel Théry
UE 3	Labs on a chip			UHFLU.LAB							6																	
		C	TC	MHFLU.ANA	Microanalytical Chemistry	18				28	2	20%	100%		80%	100%	R, Ex											Fanny d'Orlyé, Jean BAUDRY, Stéphanie DESCROIX
		C	TC	MHFLU.ORG	Microphysiological systems	20				20	2				100%	100%	R, Ex											Stephanie DESCROIX, Carole AIMÉ
		C	TC	MHFLU.ENE	Blue Energy	9		3		12	1				100%	100%	R, Ex											Corentin TREGOUET
		C	TC	MHFLU.FLO	Flow Chemistry	9		3		12	1				100%	100%	R, Ex											Stéphanie OGNIER
UE 3	Biology			UHFLU.BIO							3																	
		C	TC	MHFLU.BIO	Introduction to Biology	30				30	3				100%	100%	R, Ex											Ludovic TRICOIRE, Joelle VINH, Maxime Ardré, Nicolas Desprat
UE 3	Curriculum Broadening			UHFLU.RES							3																	
		NC	TC	MHFLU.RES	Research Project						2	33%		100%	67%	33%	R, Ex			33%	20 mn							Jacques FATTACCIOLI
		NC	TC	MHFLUPSL	Semaine PSL/ MOOC d'ouverture culturelle					35	1						Fonction de la semaine PSL choisie											Fonction de la semaine PSL choisie
					TOTAL						30																	

Semestre 2																												
														Session 1														
Code UE		Compensable : C Non compensable : NC	Obligatoire (TC) Optionnel (Opt)			Volume horaire					ECTS	Contrôle continu			Examen terminal													Responsable
																	Ecrit			Oral							
						CM	TD	TP		Total		%	TP	CC	% ET	%	Rapport (R) Examen (Ex)	Durée		%	Durée							
UE 3	Research Internship			UHMFLUS4																								
		NC	TC	MHFLU.PFE	Stage en laboratoire ou en entreprise						30	33		100	67	33	R			33	20 mn							Jacques FATTACCIOLI
					TOTAL						30																	

MASTER

MATERIALS SCIENCE AND ENGINEERING

2026-2027

Master 1

First year of the Master SGM-PSL

Master SGM
PSL UNIVERSITÉ PARIS
Materials Science & Engineering

MASTER PROGRAM: *MATERIALS SCIENCE AND ENGINEERING*

PRESENTATION OF THE MASTER

The Master of Materials Science and Engineering from Paris Sciences et Lettres University (PSL-SGM)

The PSL Master "Materials Science and Engineering", namely master SGM, allows students to acquire the experimental and theoretical knowledge necessary to imagine and design the materials of tomorrow, improve the performance of existing materials and predict their service life. Co-led by internationally renowned schools: Chimie ParisTech PSL, MINES Paris PSL and ESPCI Paris PSL, it aims to establish the link between elaboration, synthesis and forming processes, (micro) structure and structural and/or functional properties of materials as varied like polymers, metal alloys, ceramics or biomaterials.

During the first year (M1) of the Master, students develop skills to have an integrative vision of materials with their functionalities in their environment, in their use and in their elaboration. This first year serves as a common base of knowledge to allow students to specialize in the second year (M2). Two tracks are offered for the second year:

- Track "Materials of the Future: Design and Engineering" - MADI
- Track "Microfluidics" - MICROFLU

The experimental approach is particularly highlighted in this Master from the M1, with a training in research "through the practice of research", including literature review, 9 weeks of mandatory immersion in academic or industrial research laboratories, and hours of experimental work during the year of M1.

The M1 is fully taught in English.

Objectives of the M1 training

During the two semesters of M1, students must acquire:

- Scientific knowledge allowing them to analyze a problem in a field related to the improvement of the performance and durability of a material in connection with its structure and chemistry.
- The experimental and theoretical knowledge necessary to imagine and design innovative materials that meet precise specifications and to improve the performance of existing materials and predict their lifespan
- Methods of analysis of a scientific problem: information search and bibliography management; design of experimental protocols.
- Skills for presentation of scientific data and data interpretation (in English).
- The tools necessary for the development of industrial or academic research projects.

Conditions of access

The Master delivering courses in Chemistry, Mechanics and Materials, Physics, and Engineering Sciences, the conditions of access to the Master of Materials Science and Engineering in the first year are specified below:

Access to Master 1

Students must hold one of the following degrees:

- Licence (L3) scientifique (Chimie, Physique-Chimie, Mécanique) ;
- Bachelor of Science (Chemistry, Physico-chemistry, Mechanics) (equivalent to 180 ECTS) ;

Pedagogical and scientific tutoring

Scientific tutoring is an essential part of the training. From Master 1, each student benefits from a particular support by a doctoral student or senior scientist around a research project, with a first phase dedicated to learning bibliographic research in Semester 1, followed potentially by a second phase of laboratory practice in Semester 2.

As many apprenticeships are offered in the form of projects in Master 1 and Master 2, a pedagogical tutoring to learn about team working is also present.

ORGANIZATION OF TEACHING COURSES

Duration of teaching courses

Semester 1: 279 hours over 15 weeks of common base, constituting two blocks of courses:

- One 121-hours block “Basic knowledge in Material Science” counting for 17 ECTS
- One block “Scientific tools and communication” counting for 13 ECTS

Semester 2: From 162 to 188 hours of specialization courses, constituting two blocks of courses:

- One block "Specialization in Material science” from 74 to 100h counting for 12 ECTS
- One block “Scientific tools and communication” of 88h counting for 10 ECTS
- A minimum 2-months internship counting for 8 ECTS

The start of the school year will take place in early September 2025 at Chimie ParisTech, 11 rue Pierre et Marie Curie, 75005 Paris. The schedule will be communicated to students via their personal online access once they have registered.

Language courses are scheduled in the evening from 18:15 to 20:15 at MINES Paris.

The English classes are mandatory and provided at MINES Paris. An English test (oral, written) is conducted at the beginning of the year by the Language teachers (mandatory for all). Students who can demonstrate a sufficient level at the end of this test (typically C1 level) can choose another language, with priority given to French, which is offered by the PSL Language Center.

Master 1: Common Courses

The courses shown in italics are the mandatory courses. Courses written in normal style are optional courses. The language of teaching at the M1 level is English.

Semester 1 **10 mandatory courses (30 ECTS)**		**ECTS**
BASIC KNOWLEDGE IN MATERIAL SCIENCE	161 h	17
Corrosion and Electrochemistry	39 h	
Physical-Chemistry of polymers	24 h	
Crystalline materials	36 h	
Metallic materials	35 h	
Introduction to Mechanics	27 h	
SCIENTIFIC TOOLS AND COMMUNICATION	111 h	13
Machine Learning	18 h	
Experimental methods	31 h	
Literature review: conducting and writing	15 h	
Innovation Project in Group (PIG)	27 h	
Language courses	20 h	
Total S1	279 h	30
Semester 2 **5 mandatory courses (13 ECTS)** **+ 3 Optional courses to choose (9 ECTS)** **Internship of 2 months* (8 ECTS)**		
Specialization in Materials science	92 - 118 h	14
Modeling	15 h	
Materials processing	24 h	
Electronic properties of solids	23 h	
Inorganic assemblies	18 h	
Surface properties and mechanical strength of materials	23 h	
Advanced fluid mechanics	30 h	
From mechanical testing to constitutive law	24 h	
SCIENTIFIC TOOLS AND COMMUNICATION	85 h	8
Language courses	20 h	
Innovation Project (in group)	18 h	
PSL week	35 h	
Internship		8
Total S2	177 -203 h	30
Total M1	439 - 465 h	60

** The duration of the internship indicated constitutes the minimum allowing validation. The internship can be done in France or abroad.*

Content of Teaching Courses

MHM1SGEC: CORROSION AND ELECTROCHEMISTRY

Keywords: Pourbaix diagram, passivation, generalized and localized corrosion

Teachers	Cécilie Duhamel, Viriginie Lair
Coordinator	cecilie.duhamel@minesparis.psl.eu

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
3	20 h	16h	3h		70%	20%	10%		Yes

Description of the teaching module:

The course focuses on aqueous corrosion of metals and metal alloys. First, the basic concepts of aqueous corrosion are presented: Pourbaix diagram, corrosion rate, passivity. These notions are then implemented to describe and explain the different forms of corrosion observed: uniform corrosion, galvanic coupling, localized corrosion. In addition, basics of electrochemistry will be defined in order to apply it to electrochemical energy storage systems. The possibility of electrochemically deposition process for thin films will be presented. The establishment of potential intensity curves will be discussed.

Content:

- Definition and introduction to different forms of corrosion
- Electrochemical nature of corrosion
- Thermodynamic aspects: the Pourbaix diagram
- Corrosion rate: Butler-Volmer law, Tafel representation, reactions controlled by the transport of matter
- Passivation
- Uniform corrosion
- Localized corrosion: intergranular corrosion, pitting, cavernous corrosion,...
- Reminder on the notions of oxidation-reduction, half-equations redox
- Nernst Potential
- Electromotive force
- Faraday's Law
- Potential intensity curves: reading, origin and application to energy systems

Electrochemical techniques: application to thin film deposition

Learning Objectives:

At the end of this Training Module, students:

- Will be able to understand the fundamental aspects of electrochemistry
- Will be able to establish the equations of current-potential characteristics under equilibrium conditions
- Will know how to use a Pourbaix diagram

- Will be able to determine a corrosion rate
- Will be able to recognize different forms of corrosion
- understand the fundamental aspects of electrochemistry,
- apply and express basic formulas (Faraday's law, Nernst potential,...)
- read and draw curves i = f (E),
- digitize and describe the different electrochemical techniques
- determine the conditions for the deposition of a material

Language	Course, Exercises, Practical, Tutoring	*Documents*	*Literature*
English	20h course + 16h tutored exercises + 3h practical work	English	English

MHM1SGPOL: PHYSICAL-CHEMISTRY OF POLYMERS

Keywords: Polymers, vitreous transition, mecanics, thermodynamics

Teachers	Kawthar Bouchemal, Joshua McGraw
Coordinator	joshua.mcgraw@espci.fr

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam/ homework*	*Oral Exam*	*Mixed Eval.*
3	24h	Incl.	6h		60%	10%	10%/20%	-	yes

Description of the teaching module:

[1] Conformation of chains (Joshua)
- Ideal chains
- Entropy of ideal chains; free energy; Hooke's law for polymers
- Real chains : Flory
- solutions (concentration regimes)
- c*; blobs -> concentrated solutions

[2] Macroscopic consequences of random walk chains (Joshua)
- Rubber elasticity : affine network model, modulus of a network
- dynamics (Rouse, Zimm, Entanglement)
- rheology (G', G'')

[3] Polymeric gels (Kawthar)
- Introduction
- Classification

[4] Physical chemistry & formulation (Kawthar)
- Polysaccharide-based hydrogels
- Thermosensitive hydrogels
- Supramolecular hydrogels
- Cyclodextrin-based hydrogels

[5] Applications in life sciences (Kawthar)
- Medical devices
- Tissue engineering
- Cosmetology

Learning Objectives:

Students will be exposed to the basic principles governing polymer molecules and materials composed of these macromolecules. Starting from the characteristic dimension of monomers, and going through that of entire chains and networks thereof, along with polymer solutions, solid state materials, and their formulation, the students will acquire a basic knowledge of this important class of materials which are widespread in biology and industry.

Language	Course, Exercises, Practical, Tutoring	*Documents*	*Literature*
English	English	English	English/French

MHM1SGMC: CRYSTALLINE MATERIALS

Keywords: structure, diffraction, symmetry

Teachers	Vanessa Pimenta, Sandrine Ithurria
Coordinator	vanessa.pereira-pimenta@espci.fr; sandrine.ithurria@espci.fr

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
4	14 h	14 h	8h		100%				non

Description of the teaching module:

The aim of this course is to provide students basic tools to describe the structure and properties of crystalline materials. The course starts by the study of symmetries and the classification of crystals. Then, a detailed review of the investigations methods by X-ray diffraction is proposed. The last part of the course deals with the structures of ionic and covalent crystals as well as deviations from the perfect crystal, in order to understand the relationships between the structure of the main crystalline solids and their physical properties.

Content :

- Crystallography: periodic lattices - symmetry - point and space groups
- Radiocrystallography: reciprocal lattice - structural factor - structure resolutions - diffuse scattering - experimental methods
- Crystal structures: ionic and covalent crystal
- Point defects - extended defects - non-stoichiometry - ionic conductivity Disorder in crystals
- Quasi-crystals
- Structure-property relationships: Curie principle
- Piezoelectric and ferroelectric materials

Learning Objectives:

At the end of this course, students:

- will be able to classify crystals according to their symmetry;
- will be able to find structural information from experimental data;
- will be able to recognize different deviations from the perfect crystal;
- will be able to make a link between the structure and properties of crystalline materials.

Language		*Documents*	*Literature*
English	English	English	English

MHM1SGMM: METALLIC MATERIALS

Keywords: structure, reactivity, phase diagram, solidification

Teachers	Frédéric Prima
Coordinator	frederic.prima@chimieparistech.psl.eu

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
4	24 h	4.5 h	6h		100%				

Description of the teaching module:

This course aims to give students a basics in structural metallurgy. It addresses different related aspects

- Microstructures of metal alloys: structural aspects (defects), chemical aspects (diffusion), thermodynamic aspects
- Study of structure/property relations (introduction)
- Solidification of alloys (the genesis of these microstructures)
- Phase diagrams (binary and ternary)
- Phase transformations: kinetic, thermodynamic and crystallographic aspects
- Industrial processes for the manufacture of metallic materials (thermomechanical treatments).

The course is completed by practical work on metallurgy illustrating the relationship between microstructure and mechanical properties (quenching and tensile studies)

Learning Objectives:

At the end of this course, students:

- Will master the different concepts of metallurgy.
- Will know how to relate the thermodynamic aspects to the microstructures of metallic materials.
- Will understand the relationship between the microscopic aspects of a material and its macroscopic properties in terms of mechanical behaviour.
- Could develop a synthesis strategy in relation to the expected properties of an alloy.

Language	Course, Exercises, Practical, Tutoring	*Documents*	*Literature*
English	21h course, 3h supervised exercises	English	English

MHM1SGMEC: INTRODUCTION TO MECHANICS

Keywords: deformation; elasticity; plasticity; damage; mechanical modelling

Teachers	Cristian Ovalle
Coordinator	cristian.ovalle_rodas@minesparis.psl.eu

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
3	15 h	9 h	3h		80%	20 %			yes

Description of the teaching module:

The course begins with the study of the generalities of material properties and the mechanical tests commonly used to characterise their mechanical response. It continues with the study of the construction of material response models and stress state criteria. Then, we focus on linear elastic, thermoelastic and viscoelastic response, followed by the modelling of the plastic domain. The last part of the course deals with the main damage and failure models of materials.

Content

- Experimental observations: Microstructure – Mechanical Testing – Mechanics
- Introduction to mechanics: Material properties – Mechanical properties – Basic formalisms
- Elasticity: linear elasticity – non-linear elasticity – viscoelasticity
- Plasticity: experimental results – theoretical background – mechanical modelling – elastoplastic response
- Damage and fracture: description – Introduction to Fracture mechanics

Learning Objectives:

- Know how to recognize different mechanical tests,
- Know how to build models of behavior,
- know the mechanical behavior of materials to a given stress.

Language	Course, Exercises, Practical, Tutoring	*Documents*	*Literature*
English	English 15h course, 9h supervised exercises	English	English

MHM1SGML : MACHINE LEARNING

Keywords: Machine Learning, Python, Data Analysis, Supervised Learning, Neural Networks

Teachers	Michael KHAIRALLAH
Coordinator	michael.khairallah@minesparis.psl.eu, assaad.zoughaib@minesparis.psl.eu

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
2	9 h		9 h		40%	10%	50%		no

Description of the teaching module:

The field of machine learning is rapidly transforming industries and research, offering powerful tools to extract insights, make predictions, and automate complex decision-making processes. This module provides a comprehensive introduction to the principles, techniques, and practical applications of machine learning. An emphasis will be placed on hands-on implementation using Python, a popular adopted language in the data science community. Students will learn to navigate the Python environment, mastering key scientific libraries (such as NumPy, Pandas, Scikit-learn, Keras/TensorFlow) to pre-process data, build, train, and evaluate various machine learning models. The curriculum covers a broad spectrum of topics, including supervised learning (regression and classification), unsupervised learning (clustering and association rule mining), and an in-depth exploration of artificial, convolutional, and recurrent neural networks. This module aims to equip students with the essential skills to not only understand the theoretical notions of machine learning algorithms but also to confidently apply them to real-world problems, transforming raw data into actionable intelligence.

This Teaching Module is organized in 6 sessions of 3 hours. Most of the sessions take place in two parts: the first devoted to the presentation of concepts and theories and the other to practical work on Python.

The Teaching Module assessment is done in two parts:
- 10% continuous evaluation: participation, involvement in the practical work…
- 40% written exam: multiple choice questions, open questions…
- 50% Python exam: realization of a programming assignment covering some topics.

Learning Objectives:

The objective of this course is to provide students with the necessary knowledge elements in Machine learning, which will subsequently enable them to: Achieve Python expertise for data tasks and utilize key machine learning libraries, Effectively prepare datasets for model development using various techniques, Construct ML pipelines, train models, and evaluate their performance with appropriate metrics, Apply and evaluate regression and classification algorithms, interpret clustering, and gain foundational knowledge of artificial neural network like CNNs (for images), and RNNs/LSTMs (for sequences).

Prerequisites:

This course requires a basic prior knowledge and practice of Python programming. To help you prepare, here are some useful internet links:

How to install Anaconda

- https://www.youtube.com/watch?v=s49fbb1qlE8

MOOC Python

- https://programming-24.mooc.fi/

Python tutorials from Youtube

- Python Full Course – Learn Python in 12 Hours
  - https://www.youtube.com/watch?v=WGJJIrtnfpk
- Python Tutorial for Beginners – Learn Python in 5 Hours
  - https://www.youtube.com/watch?v=t8pPdKYpowI
- Python Basics | Python Tutorial For Beginners | Learn Python Programming from Scratch |
  - https://www.youtube.com/watch?v=woVJ4N5nl_s
- Python for Beginners – Learn Python in 1 Hour
  - https://www.youtube.com/watch?v=kqtD5dpn9C8

Websites for Python Learning

- Python Tutorial
  - https://www.w3schools.com/PYTHON/

Exercises:

- https://www.w3schools.com/python/python_exercises.asp
- https://www.w3schools.com/python/python_quiz.asp

Language English	Course, Exercises, Practical, Tutoring 9 h course,9h exercises	*Documents* English	*Literature* English

MHM1SGTEX : EXPERIMENTAL METHODS

Keywords: Solid Surface Characterization techniques , Image analysis

Teachers	Anouk Galtayries, Frank N'guyen, Mathias Lamari
Coordinator	anouk.galtayries@chimieparistech.psl.eu, frank.nguyen@minesparis.psl.eu, mathias.lamari@minesparis.psl.eu

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
3	24 h		6 h	1h	100%				no

Description of the teaching module:

The aim of this Teaching Module is to introduce experimental methods conventionally used in the field of materials into 2 main parts (mathematical concepts on image analysis and surface analysis of solid materials).

One part of the Teaching Module will be devoted to the introduction of surface characterizations techniques of solid materials (morphology, microstructure, surface chemistry and surface composition). After introductory courses, two half-days of visits/demonstrations are organized in two PSL laboratories.

A second part will introduce the concepts associated with image analysis.

Learning Objectives:

- Know a selection of experimental techniques for surface characterization of materials
- Have the basics in image analysis and data analysis

Language		*Documents*	*Literature*
English	Course, Exercises, Practical, Tutoring	English	English

MHM1SGBIB : LITERATURE REVIEW: CONDUCTING AND WRITING

Keywords : bibliography, state of the art, references…

Teachers

Coordinator Heads of the SGM Master's program

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
3	3 h				66%			33%	no

Description of the teaching module:

This Teaching Module consists of an introduction to the use of digital tools, in particular to carry out a bibliographic study around a defined subject. In order to allow the student to understand the interest of such a work, this bibliographic project might be coupled with a period of experimental work in the laboratory in semester S2 if an internship position is available.

After an introductory session on bibliographic research tools, the student is expected to complete the work on their own time. However, four half-days have been set aside in the schedule to allow the student to work on their bibliographic project and to arrange follow-up meetings with the tutor who proposed the topic. The student is expected to actively engage and interact with this tutor. Work in group to share experience might be also beneficial for students

Learning Objectives:

The objective for the student is:

- To learn how to search for existing and available data on a topic;
- To extract relevant information from a scientific paper;
- To know how to transcribe correctly and without plagiarizing general ideas emanating from several sources;
- To have an overall perspective and synthesize the information collected

Language	Course, Exercises, Practical, Tutoring	*Documents*	*Literature*
English	6h introduction to data search	English	English

MH23TC.PIG and MH24TC.PIG: INNOVATION GROUP PROJECT

Keywords: creativity, innovation, project management, prototype

Teachers	Frederic de Montigny
Coordinator	Frederic.de-montigny@chimieparistech.psl.eu

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
3				27h+18h	50%			50%	yes

Description of the teaching module:

The goal of these innovation group projects is to continue learning project management and teamwork through the development of a technological innovation project. A technological project is a study designed to develop an idea initiated by a client. This must proceed from an innovation approach aimed at creating a new product, a new service, a new good, adding that we can include a new process, a new recipe closer to chemistry.

Project progress:

The projects are carried out in five phases in semester 1 and semester 2:

1. Search for topics and organization of the team and project
2. Study of the state of the art and analysis of resources (patents, publications, internet, customer visit
3. Elaboration of the project and proposal phase to the steering committee. Critical discussion and defense of the project. Possible ordering of the material
4. Technical realization, development
5. Restitution (written report and oral defense of the project.

Learning Objectives:

The goal of learning is to learn how to develop interdisciplinary skills

- in the field of project management (schedule, schedule, programming)
- in the scientific and technical field (state-of-the-art analysis, bibliography, initiative, design and development of an innovative product)

Language	Course, Exercises, Practical, Tutoring	*Documents*	*Literature*
English	27h + 18h tutored project	En/Fr	En

MHM1SGANG : LANGUAGES

Keywords:

Teachers

Coordinator: Claire Allman (claireallmanbazin@gmail.com): English
Javier Casas (Javier.casas@minesparis.psl.eu): French

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
2 + 2	20h+20h				50%			50%	no

Description of the teaching module:

This Teaching Module allows students to learn a foreign language and thus open their horizons to be able to communicate effectively in the scientific world and within a company in France.

This Teaching Module is running during the two semesters

Learning Objectives:

The objective of this Teaching Module is that each student has a minimum level in English or French.

Language	Course, Exercises, Practical, Tutoring	*Documents*	*Literature*
En/Fr	2x20h course	En/Fr	En/Fr

MH24OP.MOD: MODELLING

Keywords: molecular modeling

Teachers	Frédéric Labat
Coordinator	frederic.labat@chimieparistech.psl.eu

ECTS	Course	Exercises	Practical	Tutoring	Written Exam	Continuous Eval.	Practical Exam	Oral Exam	Mixed Eval.
2	3h		12h		100%				no

Description of the teaching module:

This Teaching Module aims to train the student to quantum and classical modeling of complex systems (molecules, solids, biomolecules) of industrial interest. Methods for describing spectroscopic properties (IR, Raman, UV-Vis, NMR and RPE) and chemical reactivity are particularly targeted. Particular interest is given to simulation methods currently used in the industrial and application field.The training is based on alternating courses and practical work sessions, which allow students to put into practice the methods described in class using software of academic and industrial interest.

Learning Objectives:

- know how to choose the most suitable method according to the properties and the system
- know how to interpret the results obtained and their limits

Language		*Documents*	*Literature*
En	Course, Exercises, Practical, Tutoring	En/Fr	En

MH24OP.ELA : INORGANIC MATERIALS ELABORATION

Keywords: inorganic synthesis, ceramic, monocristalline synthesis, thin films

Teachers	Gérard Aka, Domitille Giaume, Odile Majerus
Coordinator	domitille.giaume@chimieparistech.psl.eu

ECTS	Course	Exercises	Practical	Tutoring	Written Exam	Continuous Eval.	Practical Exam	Oral Exam	Mixed Eval.
2	22h	2h			100%				no

Description of the teaching module:

This course presents the fundamentals of materials elaboration.
A first part presents the basics of monocrystalline synthesis, starting from reflexion based on phase diagrams, nucleation-growth concepts and illustrations with various hot-temperature monocrystalline routes. Such routes are predominant in the optic and photovoltaic domains. A second part deals with the physical and chemical principles underlying the solid-state densification and sintering of powders to obtain technical ceramics. Technical ceramics are a wide family of high-value materials for structural or functional applications (magnetic, optic, dielectric…). On the other hand, glass and glass-ceramics are materials prepared from the liquid state. Their elaboration is briefly presented at the end of this part. . The third part concerns the synthesis of such small inorganic materials by low temperature routes. Basics of aqueous precipitation, sol-gel condensation, high-boiling solvent synthesis are thoroughly described. The last part presents the different opportunities and methods for a chemist concerning the specific elaboration of thin or thick films.

Learning Objectives:

At the end of this course, the students will be able to:

1. Identify and understand the various synthesis routes used to elaborate inorganic materials;
2. Evaluate the advantages and limitations of specific synthesis routes;
3. Choose the most appropriate synthesis route for their study;
4. Understand the mechanisms involved in the different synthesis routes;
5. Propose consistent modifications to a given synthesis process.

Language		*Documents*	*Literature*
English	Course, Exercises, Practical, Tutoring	En/Fr	En/Fr

MH24OP.PES : ELECTRONIC PROPERTIES OF SOLIDS

Keywords: band structure, electrical and optical properties, semiconductors, devices

Teachers	Laurent Binet, Pascal Loiseau, Frédéric Wiame
Coordinator	Laurent.binet@chimieparistech.psl.eu

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
3	18 h	4.5h			100%	0%	0%		

Description of the teaching module:

The objective of this course is to describe the electronic structure of solids, the main properties and applications resulting from them, with an overview of the current technological developments.
In the first part, the course introduces the basic concepts (free electron gas and tight-biding models, dispersion curves, density of states) to describe the electronic band structures of solids and shows how these concepts explain the main classes of properties, namely electrical, optical and chemical pf solids.
In the second part, the course focuses on an important class of materials, semiconductors. It thus introduces the specific crystal and electronic structures of the elemental, III-V and II-VI semiconductors, the n-type and p-type dopings and their electrical and optical behaviors. The course then describes in detail the phenomena occuring in a p-n junction. The applications of the p-n junction are described, solar cells, photo-diodes and light-emitting diodes.

Learning Objectives:

The sudent must be able:

To define the features of the two main models of electronic structure of solids and to know in which context to apply them.

To explain the main parameters that govern the electrical and optical properties of materials and the factors that have a positive or negative effect on these properties.

To interpret a band structure diagram of a solid and deduce its electrical and optical behavior.

To describe in detail the electronic processes in the main semiconductor devices and explain the factors controlling their performance.

To establish a structure-property relationship for a given application.

Language		*Documents*	*Literature*
English	Course, Exercises,	En/Fr	En/Fr

MH24OP.NOR : INORGANIC ASSEMBLIES: FROM MOLECULES TO MATERIALS

Keywords:

Teachers	Domitille Giaume, Pascal Loiseau
Coordinator	domitille.giaume@chimieparistech.psl.eu

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
3	10.5h	7.5h			100%				no

Description of the teaching module:

The objective of this course is to give the rules of construction of all inorganic and mineral systems but also to show how much this inorganic chemistry is alive and has many applications in current problems (energy, environment, information storage, nanotechnologies...). An introduction to the industrial mineral chemistry industry completes the course (cements, glasses, aquatic chemistry, batteries). The theoretical part focuses on transition metal and lanthanide complexes and describes their optical and magnetic properties.

Learning Objectives:

At the end of the course:

- The student knows the periodic table and the trends of the different elements (ionization, complexation, orbital levels).
- He can describe a mineral system and choose between two simple approaches to describe inorganic complexes according to two ion binding or covalent binding models.
- He can explain the stability and reactivity of inorganic molecules based mainly on transition elements or elements of the p-block.

Language		*Documents*	*Literature*
English	Course, Exercises, Practical, Tutoring		

Mh24OP.MM: SURFACE PROPERTIES AND ENDURANCE OF MATERIALS

Keywords: surface characterization, electronic spectroscopies, reactivity

Teachers	*Philippe Vermaut, Frédéric Wiame, Anouk Galtayries*
Coordinator	frederic.wiame@chimieparistech.psl.eu

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
3	18h	4.5h			100%				no

Description of the teaching module:

What is a surface? What are the specificities of surfaces compared to bulk? Why and how to study these surfaces? In this course we will try to answer these questions. The concepts of surface energy and stress will be introduced and their effects on the structure and properties of the surface will be studied. The initial stages of reactivity will be characterized in the framework of the adsorption theory. The course will be illustrated by practical examples which will highlight the different information that can be obtained using surface characterization techniques such as photoelectron spectroscopy.

After having seen the relationship microstructure-mechanical properties of metals, we propose to go further by studying the mechanisms that lead to the failure of materials when they are exposed to static, or cyclic mechanical stresses, combined with high temperatures or an aggressive environment. This will allow us to address the issue of the durability of metallic materials under the conditions of use and the solutions to improve their lifetime.

Learning objectives:

At the end of the course the student will be able to:

- identify and explain the main technological issues of the study of surfaces,
- describe the fundamental differences between the properties of a surface and those of the bulk material,
- determine the structure, characteristics and basic properties of a surface of given orientation,
- describe the different adsorption mechanisms and give their main characteristics,
- justify the usefulness of ultra-high vacuum and electronic spectroscopies to answer a given problem,
- highlight, by means of examples, the importance of the structure and the surface composition on the mechanisms and the kinetics of reactivity.
- solve basic problems related to the dimensioning of parts exposed to various conditions of use (fatigue, creep, …)
- propose treatments to improve the life of parts in operation
- choose the appropriate non-destructive testing technique

Language		*Documents*	*Literature*
English	Course, Exercises, Practical, Tutoring	En/Fr	En/Fr

M1FLOWCHEM: ADVANCED FLUID MECHANICS

Keywords: microfluidics, Reynolds number, heat transport, hydrodynamic instability

Teachers: Nicolas Bremond, Philippe Bourrianne, Laurent Duchemin

Coordinator:

ECTS	Course	Exercises	Practical	Tutoring	Written Exam	Continuous Eval.	Practical Exam	Oral Exam	Mixed Eval.
3	30 h				100%				no

Description of the teaching module:

A first part of the course (10h) deals with Microfluidics (AFM-MIC) and focuses on the mechanics of fluids at low Reynolds number in confined systems where interfaces play a major role. The properties of mono-phasic and bi-phasic flows and dispersions, colloidal or otherwise, are presented. The possibility of modifying these flows by controlling pressure, temperature or electromagnetic fields is also discussed. One of the objectives of this course is to show how the combination of microfabrication technologies and basic and applied sciences leads to innovations in areas such as biotechnology or chemistry.

A second part (10 h) deals with Physics of Transport (AFM-PT) of mass and heat. It will answer a wide variety of questions such as: why does my coffee cool much faster than the sugar diffuses into the cup? How long can I stay on top of Everest without gloves? How many showers can I take per day with a 10 square meter solar water heater? What do cetaceans and heat exchangers have in common? Why is mixing in turbulent flows so effective?

The last part (10h) is a course on Hydrodynamic Instabilities (AFM-HI). After the introduction of the general concepts of stability study, we will focus on the instabilities occurring in a fluid initially at rest: in particular, we will treat the so-called Rayleigh-Taylor instability related to gravity and that of Rayleigh-Bénard observed in a fluid heated from below. Finally, we will focus briefly weakly non-linear instabilities using Landau theory.

Learning Objectives:

- Identify the different microfabrication techniques and select the most relevant
- Solving low Reynolds number problems and electrohydrodynamic problems
- Identify heat and mass exchange mechanisms
- Compare different modes of transport using dimensionless numbers
- Model a diffusion, radiative, or convection transport problem
- Identify the mechanisms of instability of a fluid at rest or flow
- Formulate a linear stability problem with or without a free surface, and establish the dispersion relationship

Language	Course, Exercises	*Documents*	*Literature*
English		En	En/Fr

MHM1SGESS : FROM MECHANICAL TESTING TO MATERIALS BEHAVIOR

Keywords: mechanical behavior, mechanical testing, numerical simulation

Teachers	Pierre Arnaud, Matthieu Rambaudon
Coordinator	pierre.arnaud@minesparis.psl.eu

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
3	12 h		12 h		100%				

Description of the teaching module:

This Teaching Module aims to be an introduction to the design and dimensioning of structures. It is aimed at students with a material profile but wishing to open up to the mechanical behavior of metallic materials and the relationship between microstructure and properties. Its purpose is to provide sufficient bases in materials mechanics and numerical simulation to be able to exchange on these subjects with specialists in the field.

The design and sizing of structures require knowing the mechanical behavior of materials under given conditions but also being able to model it in order to be able to predict it via numerical simulations. For this reason, an introduction to finite element calculations will be proposed.

This Teaching Module will take place in a laboratory over 5 whole days. It will be structured around lectures, tutorials and practical work during which students will be required to instrument, carry out and analyze various mechanical tests. The experimental results obtained will serve as input data for finite element calculations that will make it possible on the one hand to reproduce the experimental tests carried out (identification of laws of behavior), on the other hand, to predict the behavior of the material for other external stresses.

Learning Objectives:

Language		*Documents*	*Literature*
English	Course, Exercises, Practical, Tutoring	En/Fr	En/Fr

MHM1SGSTG: INTERNSHIP IN LABORATORY

Keywords: laboratory training period

Teachers

Coordinator Heads of the master SGM

ECTS	*Course*	*Exercises*	*Practical*	*Tutoring*	*Written Exam*	*Continuous Eval.*	*Practical Exam*	*Oral Exam*	*Mixed Eval.*
8			44 days min.		33%	33%		33%	Yes

Description of the teaching module:

A teaching unit is dedicated to a laboratory internship with a minimum duration of two months in the field of materials science. This internship offers students practical immersion at the heart of research units related to a scientific issue.

This internship can be linked to the bibliographic project of the first semester but can also be on a different topic.

The laboratory internship has a minimum duration of two months. It is possible to extend this duration according to the signed internship agreement, but the evaluation is based on a written report and an oral presentation at the end of the first two months. For your information, beyond two months, the internship must be obligatorily compensated for the entire duration. When the internship is two months long, compensation is not mandatory, which can facilitate its acceptance by a laboratory.

In cases where the bibliographic project does not lead to an internship, the student must independently and voluntarily search for an M1-level internship, potentially based on their project and scientific interests. A platform called "JobTeaser" is available to facilitate this search. However, it is highly recommended to actively seek opportunities by contacting professors involved in the SGM Master's program (M1 and M2) and expanding efforts to numerous laboratories in the Paris region, both within and outside PSL. It is also advisable to anticipate this search.

Learning Objectives:

The main objective of this internship is to allow students to gain hands-on experience in the laboratory by working on real projects and using state-of-the-art equipment. This internship aims to strengthen students' technical and analytical skills while developing their ability to work in a team and manage research projects.

At the end of the two months, students will have to write a detailed report and present their results during an oral defense, which will also allow them to develop their scientific communication skills.

This internship is an excellent opportunity for students to familiarize themselves with the challenges and opportunities in materials science while preparing for their second year of the SGM Master's program

Language	Course, Exercises, Practical, Tutoring	*Documents*	*Literature*
English	Practical work in laboratory	English	English

PRACTICAL INFORMATION

Registration institution

Chimie ParisTech
11 rue Pierre et Marie Curie
75005 PARIS
www.chimie-paristech.fr

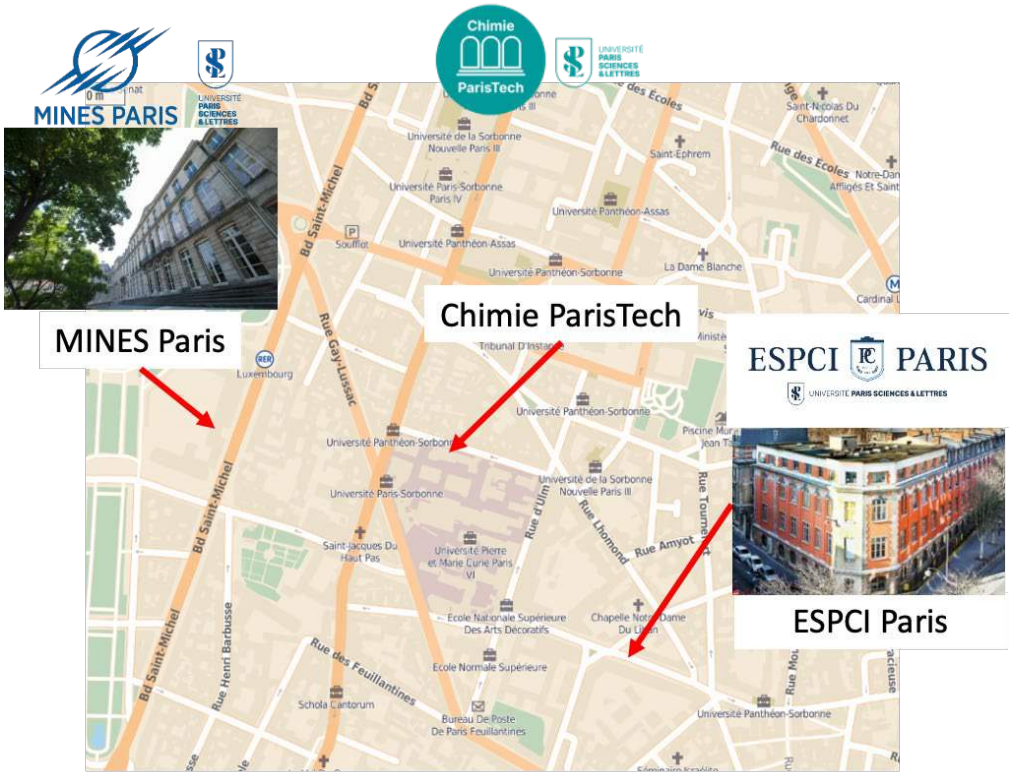
Places for Courses

The vast majority of the courses take place in the three partner institutions of the master's degree: Chimie ParisTech, MINES Paris, ESPCI Paris.

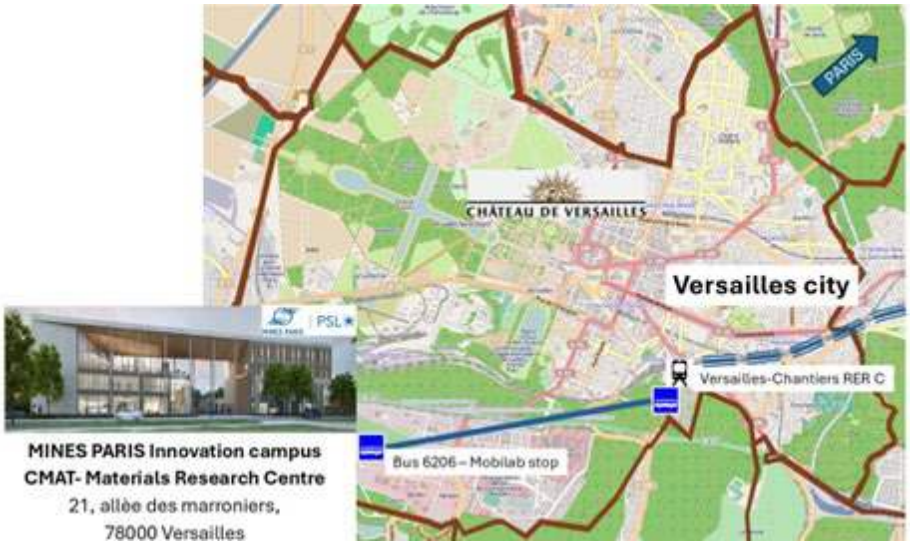
Chimie ParisTech	MINES Paris	ESPCI Paris
11 rue Pierre et Marie Curie 75005 PARIS www.chimie-paristech.fr	60 boulevard Saint-Michel 75006 Paris www.mines-paristech.fr certain courses and practical work sessions are scheduled on the Mines Paris- Versailles Campus site	10 rue Vauquelin 75005 PARIS www.espci.fr

Part of the first year of the M1 is shared with Teaching Courses of the engineering cycles of the partner institutions. Some courses are also transversal to other PSL Masters (in particular the PSL Energy Master), and will be mutualized for a greater richness of the profiles.

- The establishments where the courses are held are all located in the heart of the Paris Latin Quarter.



- Some courses may be offered at the MINES Paris campus in Versailles (4 to 5 days per semester). This campus is easily accessible by public transportation.



Contacts

Materials Science and Engineering (SGM) Master Program:

Jolanta Swiatowska & Loïc Assaud, co-directors (contact.master-sgm@psl.eu)

https://www.psl.eu/formation/master-sciences-et-genie-des-materiaux

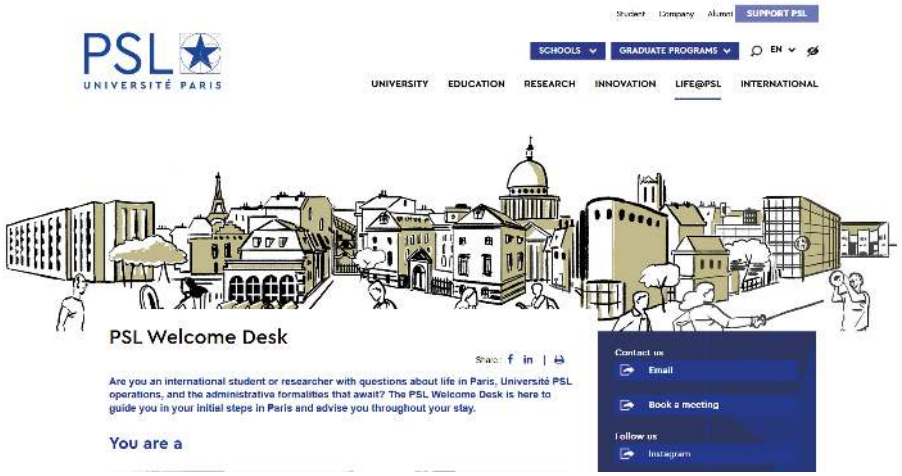
Welcome Desk PSL: welcomedesk@psl.eu / +33 (0)1 75 00 02 91

The Welcome Desk supports newcomer international students in their administrative procedures.

Throughout the year, the PSL Welcome Desk team, composed of bilingual students, also organizes many activities: language tandems, culinary workshops, group jogging, visits to Paris, student evenings, etc.

Every week, the Welcome Desk newsletter will inform you of available activities.

Rejoignez-les sur Facebook : PSL Welcome desk



****

MASTER
MATERIALS SCIENCE AND ENGINEERING

2026-2027

Master 2
Second year of the Master SGM-PSL

Track : MADI

Ver. 2026/06/18

TRACK M2 Materials for the future: Design and Engineering: MADI

Master 2: Track « Materials for the future: Design and Engineering » - MADI

The track "Materials for the future: Design and Engineering" provides an "integrated" perspective of various materials of the future, including synthesis processes, desired structure or architecture, eco-design and lifespan. It delivers strategies to properly design a material from a technical point of view and to answer precise economics and environmental requirements specifications. In such multidisciplinary approach, team work on joint projects (design project, tutored project), gathering students with various backgrounds, is essential.

The MADI track is structured around a specialization elective, to be chosen from among three options, focusing either Materials for Energy, Materials for a Sustainable Lifestyle, and Materials for Transport and Structures. The MADI track emphasizes either an engineering or a design approach, focusing on one or several families of materials and/or on their environmental impact. Additionally, two courses in communication and scientific openness complete the curriculum.
This track can also be pursued under a professional training contract.

TRACK M2 Materials for the future: Design and Engineering: MADI

Elective « Sustainable Energy and Materials » - E1

The elective “Sustainable Energy and Materials” focuses on the phenomena occurring within conversion devices (batteries, fuel cells, photovoltaic systems, etc.). Students will learn how (i) to identify the typical responses of a device based on the underlying chemistry and specific materials involved, (ii) to calculate the energies and power outputs from conventional electrochemical test results, and (iii) to adapt a device according to the specifications of the targeted application. Key issues, challenges, modelling approaches, and recycling strategies will also be addressed.

Elective « Materials for Sustainable Lifestyle » - E2

The elective “Materials for Sustainable Lifestyle” focuses on the elaboration of materials in the framework of sustainable development. It covers a field of techniques starting from the most ancient ones (materials of the cultural heritage) to the most recent ones (materials for housing, for recycling systems). It aims to analyse the constraints associated with resources and environment, social acceptance in order to deliver to the students the technical and scientific knowledge necessary to the fabrication of materials for our everyday life. It analyses the behaviour of materials all along their lifetime (eco-design, durability, recycling).

Elective « Engineering Resilient Materials for Transport and Structures » - E3

The elective “Engineering Resilient Materials for Transport and Structures” focuses on understanding and improving the physico-chemical and mechanical properties of various classes of materials used in infrastructure and transport systems. It addresses the design, performance, durability, and resilience of structural materials, while integrating key considerations of safety, sustainability, and environmental impact.
Students will develop both scientific and applied skills to tackle the challenges of future cities and mobility systems. The course adopts a synergetic approach to explore the fundamental physical and chemical behaviour of major material families — metals, ceramics, inorganic materials, and polymers.
By the end of this elective, students will be able to conceptualize and design innovative materials tailored to specific applications, in alignment with defined scientific, technical, economic, and environmental specifications, and in dialogue with complementary disciplines such as marketing and industrial design.

MASTER MATERIALS SCIENCE AND ENGINEERING

TRACK M2 Materials for the future: Design and Engineering: MADI

Semester 3		ECTS	E1	E2	E3
MATERIAL SCIENCE SPECIALIZATION (ELECTIVE)	**117 h**	**20**			
Selection and design of materials for a sustainable city **(MAD-CHO)**	39h		M	M	M
Sustainable Energy and Materials **(MAD-ENE)**	90 h		M		
Life cycle assessment **(LCA)**	39 h		M	M	
Overview of recycling processes **(MAD-REC)**	51 h		M		M
Materials for everyday life: scientific challenges **(MAD-QUOT)**	36 h			M	
Endurance and durability of metalmaterials **(MAD-AGE)**	36 h				M
Physical metallurgy **(MAD-PHYS)**	36 h				M
Processes and coatings (**MAD-COAT)**	39 h			M	M
Materials of the cultural heritage and durability (**MAD-PAT)**	33 h			M	
INNOVATION APPLICATION CLASSES: Group 1 OR Group 2		**6**			
Group 1		**6**	O	O	O
Managing the unknown **(MAD-INNO)**	30	**3**	M	M	M
Tutored project	27	**3**	M	M	M
Group 2		**6**	O	O	O
Design Thinking (**MAD-THINK**)	14 h	**3**	M	M	M
Design Project (**MAD-DES**)	26.5 h	**3**	M	M	M
COMMUNICATION AND SCIENTIFIC OPENNESS	**57 h**	**4**			
Language (NC)	20 h	2	M	M	M
History of science and technology in society **(***NC) (mandatory for Group 1 students)*	20h	2	M	M	M
PSL week (NC) (mandatory for Group 2 students)	35h	2	M	M	M
Total S3	**294**	**30**			
Semester 4 mandatory internship (5 to 6 months), 30 ECTS *		30			
Total S4		30			
Total M2	294	60			

M: mandatory course for the given elective
0: optional innovation application classes: either group 1 OR Group 2


Courses are taught in English.

TRACK M2 Materials for the future: Design and Engineering: MADI

In case of professionalization contract:

Semester 3 Pro		ECTS	E1	E2	E3
MATERIAL SCIENCE SPECIALIZATION (ELECTIVE)	**117 h**	**20**			
Selection and design of materials for a sustainable city **(MAD-CHO)**	39h		M	M	M
Sustainable Energy and Materials **(MAD-ENE)**	90 h		M		
Life cycle assessment **(LCA)**	39 h		M	M	
Overview of recycling processes **(MAD-REC)**	51 h		M		M
Materials for everyday life: scientific challenges **(MAD-QUOT)**	36 h			M	
Endurance and durability of metalmaterials **(MAD-AGE)**	36 h				M
Physical metallurgy **(MAD-PHYS)**	36 h				M
Processes and coatings **(MAD-COAT)**	39 h			M	M
Materials of the cultural heritage and durability **(MAD-PAT)**	33 h			M	
INNOVATION APPLICATION CLASSES: Group 1bis		**6**			
Group 1*bis*		**6**	M	M	M
Managing the unknown **(MAD-INNO)**	30	**3**	M	M	M
Tutored project	27	**3**	M	M	M
COMMUNICATION AND SCIENTIFIC OPENNESS	**57 h**	**4**			
Language (NC)	20 h	2	M	M	M
Report on the first period in the company (NC)	20h	2	M	M	M
PSL week (NC)	35h	2	M	M	M
Total S3 Pro	**294**	**30**			
Semester 4 Pro - mandatory internship (5 to 6 months), + UE		30			
Mandatory internship (from the end of the semester to the end of the professionalization contract)		28			
History of sciences and technologies in the society	20h	2			
Total S4 Pro		30			
Total M2	294	60			

TRACK M2 Materials for the future: Design and Engineering: MADI

The program starts beginning of September.
Typical week schedule :

	Monday	Tuesday	Wednesday	Thursday	Friday
Morning	*	MAD-QUOT MAD-PHYS	MAD-ENE	MAD-CHO	
Afternoon	MAD-THINK MAD-HIST	MAD-COAT	MAD-ENE	MAD-LCA MAD-AGE	MAD-PAT MAD-REC

Managing the unknown (MAD-INNO) is scheduled during a full week in November.
The project associated with MAD-DES and MAD-THINK takes place during the last week of January.

The cultural openness week is scheduled the last week of November via the PSL weeks.

Language courses are scheduled one evening per week between 18h15 and 20h15.

MAD-CHO	**SELECTION AND DESIGN OF MATERIALS FOR A SUSTAINABLE CITY** *Tags:* composition-microstructure-property relationships, material design, material selection, performance				
Responsible	frederic.prima@chimieparistech.psl.eu				
Teachers	Daniel Caurant, Jean-Baptiste d'Espinose, Alba Marcellan, Fan Sun, Lola Lilensten, Frédéric Prima, Philippe Vermaut				
ECTS 4	*Course* 39 h	*Tutorials*	*Exam*	*Written* 100%	

Course outline:

This course provides a method for selecting the most efficient material for a given application defined by specifications. Ashby's method of material selection strategy is presented in a theoretical way.
The composition-microstructure-property relationships are studied in general terms and through examples relating to housing and urban materials: cements, ceramics, glass and glass ceramics, metal alloys, polymers. Composite materials and architectural materials (whose characteristic dimension is in the order of mm) are approached as materials capable of associating properties that are a priori incompatible, and with the idea of encouraging the student to imagine new possibilities in a functional design approach.
The examples also illustrate the environmental functions of materials: lightening, thermal insulation in particular.

Learning outcomes:

At the end of this course the student must:

- Know the definition and concrete examples of composite or architectural materials
- Know how to design new materials, especially for sustainable cities
  Use the Ashby method of material selection
- Know how to compare the mechanical and thermal properties of the major classes of materials.

MAD-ENE	**SUSTAINABLE ENERGY AND MATERIALS** *Tags: photovoltaics, fuel cells, hydrogen, batteries, thermoelectricity, piezoelectricity…*
Responsible	Armelle Ringuedé armelle.ringuede@chimieparistech.psl.eu
Teachers	

ECTS	*Course*	*Tutorials*	*Exam*		
8	90 h		*Written 100%*		

Course outline:

The increase of the global demand in energy needs to find alternatives to fossil resources. The request for sources of natural but sporadic energies (solar with photovoltaics, wind, hydrodynamics…) is increasing. It is thus necessary to couple these sources with systems allowing the recycling and storage of these energies (batteries, supercapacitors). The strong environmental constraint leads to the development of clean systems of storage such as fuel cells. However, it is time to stop this race towards more and more energy and to limit our consumption. In this module, we'll see which materials can be used to store and recycle energy for the various as-mentioned systems.
For each of them, the mature technologies, new approaches and environmental challenges will be addressed.

Learning outcomes:

Students will be able to:

- understand the phenomena occurring inside batteries
- recognize typical responses of a storage device as a function of the involved chemistry
- calculate the provided energy and power from results of classical electrochemical tests
- adapt a storage device as a function of the requirements of the application

MAD-LCA	**LIFE CYCLE ASSESSMENT** *Tags: circular economy, life cycle analysis*						
Responsible	Daye Lee daye.lee@espci.fr						
Teachers							
ECTS 4	*Course* 9 h	*Tutorials* 30 h	*Exam*	*Written* 50%	*C.A.*	*Oral* 50%	

Course outline:

This course introduces the principles, frameworks, and practical methodologies of Life Cycle Assessment – a fundamental approach for quantifying and understanding the environmental impacts of products, materials, and processes across their entire life cycle, from raw material extraction to end-of-life treatment.
Students learn how to structure an LCA study, define system boundaries, select appropriate impact assessment methods, and critically interpret results. By engaging with several case studies and hands-on LCA tools, students develop the ability to identify environmental hotspots, evaluate trade-offs, and propose science-based strategies for process optimization.
The course places particular emphasis on how LCA supports eco-innovation, sustainable materials design, and responsible decision-making within engineering contexts. By the end of the course, students will be equipped to apply LCA as a decision-support tool to improve environmental performance and contribute to sustainability challenges in materials and process engineering.

Learning outcomes:

- Understand the principles, scope, and methodology of Life Cycle Assessment (LCA) as defined by international standards (ISO 14040/44);
- Identify and describe the stages of a product's life cycle and their associated environmental impacts;
- Use LCA tools and software to model products and processes, and to interpret quantitative results;
- Critically assess the environmental performance of materials, products, or technologies based on LCA results;
- Propose strategies to reduce environmental impacts and improve sustainability in materials selection and process design;

Prerequisites:

- Notions in all fields of chemistry at the level of a M1 in chemistry
- A good understanding of materials science and industrial processes;
- Familiarity with environmental or sustainability concepts;
- Basic skills in data analysis and the use of Excel or similar tools;

MAD-REC	**OVERVIEW OF RECYCLING PROCESSES** *Tags: circular economy, recycling*
Responsible	Frédéric Rousseau frederic.rousseau@chimieparistech.psl.eu
Teachers	Grégory Lefèvre, Domitille Giaume, Vincent Semetey, Virginie Lair, Julien Comel, Valerie Massardier, Michael Bozlar

ECTS	*Course*	*Tutorials*	*Exam*	*Written*	*C.A.*	*Oral*	
4	39 h	12 h				100%	

Course outline:

This course offers a comprehensive exploration of the principles, processes, and challenges involved in recycling engineering materials. It spans the entire recycling chain—from collection and sorting to material recovery, refining, and reuse—while addressing both technological and environmental dimensions. Through case studies on batteries, solar panels, metallic alloys, polymers, and packaging materials, students will examine the increasing complexity and diversity of modern waste streams. The course provides an in-depth comparison of mechanical, pyrometallurgical, and hydrometallurgical recycling methods, evaluating their efficiency, environmental impact, and economic viability. Key topics include material contamination, property degradation, energy demands, and the critical role of eco-design in enhancing recyclability and promoting circularity. The oral evaluation is based on an inverted pedagogy approach: developing the 'Introduction, General Principles, and Examples' section of a Materials Recycling course

Learning outcomes:

- Understand the main principles and driving forces of materials recycling and their role in the circular economy;
- Identify and describe the key stages of recycling processes - collection, sorting, separation, recovery, and reuse;
- Compare different recycling routes (mechanical, pyrometallurgical, hydrometallurgical) and assess their advantages, limitations, and environmental impacts;
- Analyze specific case studies such as batteries, photovoltaic modules, metallic alloys, and packaging materials;
- Evaluate the quality, efficiency, and sustainability of recycling strategies;
- Propose innovative and realistic approaches to improve material recovery and reduce resource losses.

Prerequisites:

- A solid foundation in materials science (structure, properties, and processing);
- Basic knowledge of chemistry, thermodynamics, and phase equilibria;
- An understanding of industrial processes for materials production and transformation;
- Interest in environmental issues, sustainability, and circular economy concepts;

MAD-QUOT	**MATERIALS FOR EVERYDAY LIFE: SCIENTIFIC CHALLENGES** *Tags:*			
Responsible	Corinne Soulié-Ziakovic, professeure, ESPCI corinne.soulie@espci.psl.eu			
Teachers				
ECTS 4	*Course* 36 h	*Tutorials*	*Exam*	*Written (reports)* 100%

Course outline :

This course aims to address present and future challenges in the field of material design through everyday life materials in various applications. Through some selected materials, this course shows the link between requirements of physical and chemical properties imposed by a given application or societal context and its translation in terms of scientific issues to solve to fulfil them. Fabrication processes are also addressed.

The course relies on examples of advanced formulations required to elaborate materials that respect multiple constraints that can by opposite (comfort, legislation, environment) to show materials evolution with time.

Examples of materials selected to illustrate the course :

- Building materials (cement)
- Glass and its optical properties
- Packaging : mechanical properties of polymers

Learning outcomes:

- Link physical properties to chemical structures and constraints on elaboration processes-
- Choose science levers that lead to evolutions of materials properties (chemistry, shaping)
- Propose scientific approaches that help to design materials with improved or combined properties, or even new properties.

TRACK M2 Materials for the future: Design and Engineering: MADI

MAD-COAT	**PROCESSES AND COATINGS** *Tags: coatings, thin films, surface treatments*
Responsible	Frédéric Rousseau, Chimie ParisTech frederic.rousseau@chimieparistech.psl.eu
Teachers	

ECTS	*Course*	*Practicals*	*Exam*	*Oral*	
4	33 h	3h + 3h of project	*Poster : 50%*	50%	

Course outline:

Examples of surface treatments as well as organic and inorganic coatings are introduced to the students. These examples come from literature data, industrial processes or research activities led by the research teams of the three engineering schools.
Properties and techniques of surface treatments either by wet (sol gel, electrochemistry, colloidal dispersion) or dry (physical or chemical techniques of coating by vapour or plasma deposition) processes. The course includes quick demonstrations and illustrated case studies (e.g. electrodes for solar cells). Additional practical work in the lab is proposed: reactor driving, surface treatments or coatings / thin films, physic-chemical characterizations of the as-treated materials…). In addition, a training to a simulation software (COMSOL) used to model coating processes can be proposed.

Learning outcomes:

The students will:

- understand the importance of surface treatments to provide new properties to a material (resistance to corrosion, insulation, electrical conductivity, wetting, catalytic properties…)
- know the physical and chemical phenomena involved during deposition for various wet and dry processes
- be able to choose a type of coating (thin, thick) depending on the application
- be able to propose relevant techniques to diagnose to study and characterize the coupling process / surface treatments
- be able to select techniques of analysis of the material that allow to validate the surface modification or the coating that was produced.

MAD-AGE	**ENDURANCE AND DURABILITY OF METAL MATERIALS** *Tags: durability, damage, oxidation*				
Responsibles	Cécilie DUHAMEL / Anne-Françoise GOURGUES-LORENZON cecilie.duhamel@minesparis.psl.eu; anne-francoise.gourgues@minesparis.psl.eu				
Teachers					
ECTS 4	*Course* 18 h	*Tutorials* 18 h	*CC (25%)*	*Final exam : Written* 75%	

Course outline:

This course deals with mechanical and/or chemical phenomena that lead to the damage and failure of metal materials.

The first part of the course focuses on the interaction of metals and metal alloys with a corrosive environment at high temperature. First, the basic concepts of high temperature corrosion are introduced: thermodynamics, oxidation kinetics, oxidation mechanisms. These concepts are then used to describe and explain various forms of oxidation observed in metal alloys. Damage modes associated with the formation of an oxide layer at the surface of a material are then treated. Finally, solutions of prevention and protection against high temperature corrosion will be introduced. The course mainly focuses on high temperature oxidation, i.e., corrosion by reaction with gaseous oxygen. However, other forms of corrosion will be addressed during tutorials and case studies.

The second part of the course focuses on the mechanisms of failure due to mechanical loading, and on failure analysis methods. The course starts by an initiation to the failure analysis process (approach, tools and case studies) and reminders on simple mechanical tools (both experimental and numerical) available for the metallurgist. During lectures and tutorials based on real case studies, various modes of damage and fracture will be addressed: ductile fracture (deformable materials), brittle fracture (intra- and intergranular), time-dependent fracture due to cyclic (fatigue) or long-time (creep) loading. Each of these situations will be treated by considering both the physical mechanisms and quantitative design criteria.

Learning outcomes:

The students will be able to identify failure modes of metal materials and to propose a process to follow to solve the problem.

They will be able to appreciate quickly the risks of failure that may be encountered by a given class of materials in given conditions of application and to conduct the preliminary studies necessary the select appropriate materials for a given application.

MAD-PHYS	**PHYSICAL METALLURGY** *Tags: diffusion, phase transformation, plasticity, dislocations*				
Responsible	Mathias LAMARI, Abdelali OUDRISS mathias.lamari@minesparis.psl.eu				
ECTS 4	*Cours* 18 h	*Tutorials* 18 h	*CC (25%)*	*Final exam : Written* 75%	

Course outline:

This advanced course of physical metallurgy deals (i) with phase transformations and microstructure evolution in metal alloys, (ii) the mechanisms of plastic deformation and hardening.

The first part focuses on the basic concepts of physical metallurgy such as diffusion and thermodynamics of phase equilibrium that allow the description of phase transformations during solidification and precipitation. Nucleation, growth and coarsening of precipitates as well as displacive transformations are addressed from various aspects: thermodynamics, kinetics, physical mechanisms. The specificity of solidification microstructure (dendritic microstructure) is discussed as well. The mechanism of recovery and recrystallization will complete the notions required to understand the evolution of microstructures.

In a second part, the concepts of the theory of dislocations in crystals will be developed to allow the description of the physical aspects of plastic deformation in crystalline materials. Thus, the physical principles of lattice friction, interactions between dislocations or with a foreign atom, or with the interface with a precipitate or another grain are used to interpret the yield strength first for a single crystal of a pure metal, then for a polycrystalline and multiphase material. The various hardening mechanisms can then be correlated to the composition and the microstructural characteristics of the metal alloys such as precipitate distribution (volume fraction, size, distance between precipitates) or grain size. The optimization of a metal alloy in terms of yield stress is then obtained by monitoring the parameters of the thermal treatment of the alloy.

Learning outcomes:

Handle the advanced concepts of physical metallurgy that are at the origin of the microstructure formation and of the plastic deformation of metal alloys

MAD-PAT	**MATERIALS OF THE CULTURAL HERITAGE AND DURABILITY** *Tags: alteration, complex materials, conservation, cultural heritage, elaboration, multi-scale analytical methods*					
Responsible	Odile.majerus@chimieparistech.psl.eu					
Teachers	O. Majérus, P. Volovitch, G. Wallez, A. Michelin					
ECTS 4	*Course* 27h	*Practicals* *3h*	*Tutorials* *6h*	*Exam*	*Written* *75%*	*Oral* *25%*

Course outline

The dominance of materials contributes to drive human civilizations. Materials of the Cultural heritage have been first produced by humans in a given historical context, then they have evolved in their conservation environment. These materials keep the memory of their origin and of their evolution, which is printed in their multi-scale structure (nano to macro). They are witnesses of our history and should be conserved for the future generations. Studying these materials also helps in anticipating the evolution of current modern materials. This course is multi-materials and multi-disciplinary, encompassing the domains of materials sciences, analytical physical chemistry, human and social sciences. It enriches the general knowledge of students about materials and gives them tools and examples to predict and evaluate the long-term durability of materials in relationship with their environment. It consists in interactive lectures relying on the basic knowledge of students on materials, several tutorials and in a series of research conferences.

Learning outcomes:

At the end of the course, students:

- Have a consolidated knowledge of the historical development of different classes of materials: glass and ceramics, metals, polymers
- Can propose an analytical approach adapted to a specific material, in order to assess its composition, microstructure and degradation state
- Can anticipate the probable evolution of a material in a given environment.

These abilities are evaluated by a final written examination containing the resolution of a few simple case studies from the literature. In addition, students conduct a bibliography study in groups of two students, which they summarize in an oral presentation and a questions/answers session to the other students.

TRACK M2 Materials for the future: Design and Engineering: MADI

MAD-THINK + MAD-DES	**DESIGN THINKING** *Tags:* **design, innovation**						
Responsible	faustine.vanhulle@gmail.com						
Teachers	Khaoula Bya, Faustine Vanhulle						
ECTS 3	*Course* 14h	*Tutorials* 10.5h + 16h of project work	*Exam*	*Written* 50%	*C.A.*	*Oral* 50%	

Course outline:

During this course, we will introduce and apply the "Design Thinking" approach to a real issue proposed by a company (e.g. LVMH, Vicat …).

Design Thinking is a human-centred, iterative approach to problem solving that emphasizes empathy, creativity and experimentation. It focuses on understanding the needs of users, challenging assumptions and redefining problems to identify alternative strategies and solutions. The process encourages collaboration across diverse teams and promotes the exploration of many ideas aiming for innovative, user centred outcomes.

Hence, in the frame of the course, students will start from the initial formulation of the issue (challenge), observe and interact with stakeholders and users or customers to understand and gain insights on their needs and define the problem. They will then find options to propose an innovative solution (MAD-THINK).
Intermediary sessions will be devoted to an iteration of the process, refinement of the positioning, definition of the technical feasibility and of the business model and control of the sustainability of the proposed solution.

The solution(s) selected for their innovative potential will be developed during the Design Project (MAD-DES), that will give the groups the opportunity to prototype and test their ideas, before presenting them.

This course is built on both lectures and practical workshop conducted by coaches in innovation, designers and scientists.

Learning outcomes:

- Identify innovation in a given field (difference between innovation and invention)
- Use the tools of Design thinking to generate innovative ideas, prototype and test them, and confront them to the market
- Evaluate technical feasibility, and business viability

MAD-HIST	**History of Science and Technology in Society** *Tags:*
Teachers	Emanuel Bertrand
Responsible	emanuel.bertrand@espci.psl.eu

ECTS	*Course*	*Tutorials*	*Project*		*Exam*	*Written*
2	18 h		2 h		X	100 %

Course outline:

This course, entitled "History of Science and Technology in Society", takes an interdisciplinary approach in the humanities and social sciences (history, philosophy, sociology, political science) to the place of natural science and technology in society - past and present. The aim is to help Master's students take a step back from natural science and technology, and from the various issues involved in their deployment in society.

The "History of Science and Technology in Society" course involves a graded assessment of students (1.5-hour final table exam).

The following topics will be discussed:

- Can we define "science"? What is a scientific "proof"? Illustration with the case of electromagnetic wave propagation (1888-1893).
- What influence does the social and historical context have on the establishment of a scientific statement? What is scientific "truth"? An example of scientific controversy in society: spontaneous generation (1859-1864).
- Is science gender biased? What has been the role of women within science?
- What are the links between hydrocarbon energies (coal, oil) and democracy in the 19th and 20th centuries? How has oil gradually shaped the contemporary world?

Learning outcomes:

The aim of this course is to contribute to the training of future Master's graduates who do not have a naive view of natural science and technology, and who have a professional (and personal) awareness that is open to the causes and consequences of scientific practices.

The course will develop students' critical thinking and intellectual autonomy.

TRACK M2 Materials for the future: Design and Engineering: MADI

MAD-INNOV	**MANAGING THE UNKNOWN** *Tags: innovation, engineering, design*			
Responsible	Pascal Le Masson Pascal.le_masson@mines-paristech.fr			
ECTS	*Course*	*Practicals/case studies*	*Exam*	*Written*
3	15 h	15h	*X*	100%

Course outline:

This 30-hour face-to-face course, held during PSL Week in November 2024 (25.11 to 29.11), is an in-depth introduction to managing the unknown with the support of design theory. Contemporary issues of managing transitions (climate, energy, mobility, digitial…) and managing crisis (pandemia, inflation, energy prices, war…) call for a capacity to organize collective action in the unknown – this capacity is expected from all kinds of managers, and in particular scientists, engineers, and designers. The capacity is today more easily acquired thanks to the advances in design theory. Design theory brings solid foundation for designing transition and designing resilient solutions to face contemporary crises. These approaches are essential today for those who wish to train in the management of innovation, scientific entrepreneurship, and the management of contemporary transitions.

The course alternates between theoretical lessons in the morning and practical workshops in the afternoon. Practitioners are invited to speak about their experience of design in various areas (business, science, art).

Main notions:
In the end of the course, participants should have acquired the following capacities:

- On design reasoning: capacity to build a simple C-K; capacity to evaluate a C-K (main notions: C-space, K-space, operators, double expansion)
- On knowledge for generativity: capacity to learn and develop knowledge for generativity (main notions: independent knowledge, splitting knowledge)
- On leadership for defixation: capacity to give relevant input to help team members to overcome their own fixation (main notions: fixations, defixation)
- On economic evaluation in design: capacity to rely on economics criteria for improved exploration (main notions: design of decision, design for genericity, the value of knowledge in design activity)
- On organization of collective design: capacity to rely on and make relevant use of R&D capacities in companies, capacity to organize innovative design processes (main notions: organization principles of rule-based and innovative design, dominant design, KCP processes)
- On design and ecosystems: introduction to “double impact” research and “mission-driven” companies.

Practical information

Host institution

Chimie ParisTech
11 rue Pierre et Marie Curie
75005 PARIS
www.chimie-paristech.fr

Teaching places

Most of the courses take place in the three engineering schools : Chimie ParisTech, MINES Paris, ESPCI Paris.

MINES Paris
60 boulevard Saint-Michel
75006 Paris
www.minesparis.psl.eu

ESPCI Paris
10 rue Vauquelin
75005 PARIS
www.espci.fr

Part of the courses is common to the graduate engineering program of the partner schools.

TRACK M2 Materials for the future: Design and Engineering: MADI

Contacts

Mention Materials Science and Engineering:

Jolanta Swiatowska & Loïc Assaud, heads of MASTER SGM (contact.master-sgm@psl.eu)

https://www.psl.eu/formation/master-sciences-et-genie-des-materiaux

Alexandr Oshchepkov, head of MADI (alexandr.oshchepkov@espci.psl.eu)

Track MADI :

- Elective E1 « Sustainable Energy & Materials » Armelle Ringuedé
- Elective E2 « Materials for Sustainable Lifestyle » Corinne Soulié
- Elective E3 « Engineering Resilient Materials for Transport and Structures » Cécilie Duhamel

Welcome Desk PSL:

https://psl.eu/vie-de-campus/services-etudiants/psl-welcome-desk

welcomedesk@psl.eu / 01 75 00 02 91

The Welcome Desk helps international students for administrative procedures and boosts up their everyday life.

A bilingual team organizes different activities throughout the year. Touristic joggings, cultural visits...there is something for everyone! At these events international students meet other students, both internationals and Parisians who are part of the PSL network, improve their French and discover the different parts of Paris.

For more information, Facebook page: Welcome to Paris and to PSL!

MASTER
MATERIALS SCIENCE AND ENGINEERING

2026-2027

Master 2
Second year of the Master SGM-PSL

Track : Microfluidics

MASTER MATERIALS SCIENCE AND ENGINEERING
Track : Microfluidics

The **Microfluidics and Miniaturization** track is offered within the Master 2 in Materials Science and Engineering of Université PSL, and is supported by the Institut Pierre-Gilles de Gennes (IPGG). It is a one-year interdisciplinary program at the crossroads of physics, chemistry, and biology, jointly accredited by Sorbonne Université, Université PSL, Université Paris Cité, and Université Paris-Saclay.

The track is built around a dual ambition: scientific excellence and direct exposure to innovation. The first semester (30 ECTS) combines advanced interdisciplinary courses spanning microfabrication, soft matter physics, lab-on-chip technology, biochemistry, and organ-on-chip approaches, with intensive hands-on training on the IPGG technological platform and a short research project carried out in one of the institute's laboratories. The second semester (30 ECTS) is devoted to a five- to six-month research internship, conducted in an academic or industrial setting in France or abroad, and defended before an examination jury.

Teaching is provided by an internationally recognized faculty drawn from the leading research institutions of the Paris scientific cluster, including ESPCI Paris, Institut Curie, École Normale Supérieure, Chimie ParisTech, and the four partner universities. Students benefit from access to state-of-the-art research platforms and from the track's strong ties to the microfluidics start-up ecosystem, through regular interactions with PC'Up, the IPGG technology transfer office, and companies that have emerged directly from IPGG laboratories.

The program is located in the Latin Quarter, within walking distance of Sorbonne Université, Institut Curie, ENS, and ESPCI Paris. Graduates go on to careers in academia, industrial R&D, and the rapidly growing deep-tech microfluidics sector, in France and internationally.

Course units overview

	UE	UE title	UE ECTS	Code	Course title
S1	UE 1	**Microhydrodynamics and Microfabrication**	6	HYDRO	Micro-hydrodynamics
				MICROFAB	Microfabrication
	UE 2	**Physics at the Mesoscale**	12	CAPILLARITY	Capillary and wetting phenomena
				SOFTMATTER	Soft matter
				RHEOLOGY	Rheology
				ACTIVE	From soft to active matter
	UE 3	**Biology**	3	INTROBIO	Introduction to biology and single molecule imaging
	UE 4	**Lab on a Chip**	6	ANACHEM	Analytical chemistry
				FLOWCHEM	Flow chemistry
				BLUENERGY	Blue energy
				OOC	Organ on chip
	UE 5	**Research Project + PSL Week**	3	PROJECT	Part-time research project – Lab discovery
Semester 1		**Total**	**30**		
S2	**UE 1**	**Research Internship**	30	THESIS	
Semester 2		**Total**	**30**		
Total			**60**		

HYDRO	**Micro-hydrodynamics**		
Tags: microfluidics, hydrodynamics, low Reynolds number, interfacial flows, lubrication			
Responsible	N. Bremond	**Teachers**	N. Bremond (LCMD, ESPCI), J. McGraw (LCMD, ESPCI), S. Aimé (C3M, ESPCI)
Teaching hours			
Course	***Tutorials***	***Lab***	
31 h			

Course outline:

This course covers the fundamentals of micro-hydrodynamics relevant to microfluidic systems. Topics include the Navier-Stokes equation, low-Reynolds number hydrodynamics, and modes of transport (diffusion, convection, electro-osmosis). Intermediate Reynolds number phenomena such as Dean flows are discussed. The course also addresses interfacial hydrodynamics, the physics of emulsions and sprays, and Stokes flows in the lubrication approximation with applications to micro and nanofluidics. Velocity field measurement techniques (PIV, PTV) are introduced.

Learning outcomes:

- ☐ Apply the Navier-Stokes equation to microfluidic geometries
- ☐ Analyze transport phenomena at low Reynolds number
- ☐ Describe interfacial hydrodynamics in droplet and emulsion systems
- ☐ Use lubrication theory to model thin-film and bearing flows
- ☐ Interpret PIV/PTV velocity measurements

MICROFAB	**Microfabrication**		
Tags: microfabrication, lithography, PDMS, surface functionalization, clean room			
Responsible	J. Fattaccioli	**Teachers**	J. Fattaccioli, M. Morel, B. Cinquin
Teaching hours			
Course	***Tutorials***	***Lab***	
25 h		12 h	

Course outline:

This course covers the fundamentals of silicon microfabrication, including photolithography, etching, thin-film deposition, and mask alignment. Soft lithography techniques using PDMS and NOA are presented. The course includes surface functionalization strategies. Lab classes provide hands-on training in CAD-based chip design, lithography, and single- and multiphase microfluidic flow experiments (diffusion, gradients, droplet generation).

Learning outcomes:

- ☐ Describe and apply silicon microfabrication processes
- ☐ Fabricate microfluidic chips using PDMS and NOA soft lithography
- ☐ Design chip layouts using CAD tools
- ☐ Perform surface functionalization
- ☐ Run single-phase and multiphase microfluidic experiments

INTROBIO	Introduction to biology and single molecule imaging		
Tags: molecular biology, genomics, transcriptomics, proteomics, gene editing, single molecule imaging, fluorescence microscopy, super-resolution			
Responsible	L. Tricoire	**Teachers**	L. Tricoire, W. Keil, B. Hajj, N. Desprat, M. Ardré
Teaching hours			
Course	***Tutorials***	***Lab***	
30 h			

Course outline:

This course provides non-biologist students with the foundations of molecular and cell biology required for interdisciplinary microfluidics research. Topics include DNA structure, gene expression (RNA and transcription), protein translation and structure, and conventional analytical methods for DNA, RNA and proteins. Microfluidic approaches for genomics, transcriptomics and proteomics are introduced, along with gene editing methods and an overview of common model organisms.

The course also introduces advanced optical microscopy methods for studying single molecules in biological systems. Starting from the basic principles of photonic microscopy (brightfield and fluorescence), it covers fluorescent markers, single molecule detection criteria, single molecule imaging and tracking, and super-resolution microscopy techniques.

Learning outcomes:

- ☐ Describe the central dogma of molecular biology
- ☐ Explain conventional methods for nucleic acid and protein analysis
- ☐ Connect microfluidic methods to genomic and proteomic applications
- ☐ Identify major model organisms and their relevance to biological research
- ☐ Explain the principles of fluorescence and brightfield microscopy
- ☐ Select appropriate fluorescent markers for single molecule experiments
- ☐ Design single molecule detection and tracking experiments
- ☐ Interpret super-resolution microscopy data

ACTIVE	**From soft to active matter**		
Tags: active matter, cell mechanics, cytoskeleton, microswimmers, collective behavior			
Responsible	P. Silberzan	**Teachers**	P. Silberzan (Institut Curie), M. Thery (ESPCI)
Teaching hours			
Course	***Tutorials***	***Lab***	
9h		6h	

Course outline:

This course addresses the physics of living and active matter systems. Topics include the collective dynamics of cell monolayers, microswimmers and chemotaxis, collective behavior of bacteria and cells, and the mechanics of the cytoskeleton. The course bridges soft matter physics and cell biophysics, emphasizing emergent phenomena arising from out-of-equilibrium processes.

Learning outcomes:

- ☐ Describe the mechanical and dynamic properties of cell monolayers
- ☐ Explain chemotaxis and microswimmer motility
- ☐ Analyze collective behaviors in bacterial and cellular systems
- ☐ Connect cytoskeletal mechanics to cellular force generation

CAPILLARITY	**Capillary and wetting phenomena**		
Tags: capillarity, wetting, soft matter, interfaces, surface tension			
Responsible	D. Quéré	**Teachers**	D. Quéré, H. de Maleprade
Teaching hours			
Course	***Tutorials***	***Lab***	
14 h	14 h		

Course outline:

This course introduces the key concepts of soft matter through the lens of interfaces. Starting from the definition of interfacial energy, it explores adsorption, wetting, entropic forces, and osmosis, alongside the toolbox of continuous-medium physics (capillarity, wetting, hydrodynamics, elasticity, electrodynamics of interfaces) and statistical physics (phase transitions, fluctuations, Langevin equation). The course uses scaling laws and key experimental demonstrations to span macroscopic properties to microscopic foundations.

Learning outcomes:

- Define interfacial energy and derive its consequences for wetting and capillarity
- Apply scaling law analysis to soft matter problems
- Describe adsorption, wetting transitions, and entropic forces
- Connect statistical physics concepts to macroscopic soft matter phenomena

SOFTMATTER	**Soft matter**		
Tags: soft matter, polymer physics, interfaces, phase separation, acoustofluidics			
Responsible	C. Trégouët	**Teachers**	Corentin Trégouët, T. Derkenne
Teaching hours			
Course	***Tutorials***	***Lab***	
14h	14h		

Course outline:

This course covers the physical foundations of soft matter systems. Topics include thermodynamics and statistical physics, molecular and Knudsen diffusion, Henry's law, boundary layers, solid/liquid interfaces (surface forces, van der Waals, hydrophobic forces, Debye length), polymer physics (random walk, brushes, solvent affinity, elasticity, microcapsules), mechanical waves (capillary waves, acoustic streaming, acoustofluidics), and phase separation (binodal/spinodal, LCST/UCST).

Learning outcomes:

- ☐ Apply thermodynamic and statistical physics principles to soft matter systems
- ☐ Describe interfacial forces at solid/liquid interfaces
- ☐ Analyze polymer conformation, elasticity, and brush behavior
- ☐ Explain phase separation phenomena and acoustic actuation in soft matter

RHEOLOGY	**Rheology**		
Tags: rheology, non-Newtonian fluids, viscoelasticity, complex fluids, microfluidic rheometry			
Responsible	A. Lindner	**Teachers**	A. Lindner
Teaching hours			
Course	***Tutorials***	***Lab***	
21 h		15 h	

Course outline:

This course covers classical and microfluidic rheometry for simple and complex fluids. Non-Newtonian properties are studied in depth, including shear-thinning, normal stresses, viscoelasticity, and yield stress. Typical complex fluids are discussed: polymer solutions, biological fluids, suspensions, active fluids, and gels. Lab classes provide hands-on rheometry experience.

Learning outcomes:

- ☐ Perform and interpret classical and microfluidic rheometry measurements
- ☐ Characterize non-Newtonian flow behavior including viscoelasticity and yield stress
- ☐ Identify the rheological properties of polymer solutions, gels and biological fluids

ANACHEM	**Analytical chemistry**		
Tags: analytical chemistry, immunoassays, miniaturization, biosensors			
Responsible	F. d'Orlye (ChimieParisTech), K. Perez-Toralla (CEA), J. Baudry (ESPCI)	**Teachers**	F. d'Orlye (ChimieParisTech), K. Perez-Toralla (CEA), J. Baudry (ESPCI), J. Vinh (ESPCI)

Teaching hours		
Course	***Tutorials***	***Lab***
24		

Course outline:

This course addresses miniaturization strategies in analytical chemistry. Topics include the physical and physicochemical principles governing microfluidic analytical systems, the physics of immunoassays, and the design of immunoassay platforms from basic to advanced configurations.

Learning outcomes:

- Explain the physical basis of miniaturization in analytical chemistry
- Describe the principles and kinetics of immunoassay formats
- Design basic and advanced microfluidic immunoassay systems

FLOWCHEM	**Flow chemistry**		
Tags: flow chemistry, millifluidics, mass transfer, thermal transfer, synthesis			
Responsible	S. Ognier	**Teachers**	S. Ognier (ChimieParisTech)
Teaching hours			
Course	***Tutorials***	***Lab***	
9		3	

Course outline:

This course introduces flow chemistry at the millifluidic scale. Topics include mass and thermal transfer in millifluidic reactors, reactor design principles, and industrial case studies of chemical syntheses performed using continuous flow methods.

Learning outcomes:

- Analyze mass and thermal transfer in millifluidic reactors
- Design millifluidic reactor configurations for specific chemical processes
- Evaluate industrial examples of continuous flow synthesis

BLUENERGY	**Blue energy**		
Tags: blue energy, osmosis, reverse electrodialysis, capacitive mixing, renewable energy			
Responsible	C. Trégouët	**Teachers**	Corentin Trégouët
Teaching hours			
Course	***Tutorials***	***Lab***	
9	3		

Course outline:

This course introduces blue energy — the harvesting of salinity-gradient energy at the interface of fresh and salt water — as a renewable energy source. The physics of osmosis and mixing entropy are presented, followed by two key technologies: capacitive mixing and reverse electrodialysis. The course covers the underlying mechanisms of charge separation, transport and energy conversion (Debye length, Gouy-Chapman theory, Butler-Volmer equation) and surveys current scientific challenges and emerging technologies.

Learning outcomes:

- ☐ Explain the thermodynamic origin of blue energy from salinity gradients
- ☐ Describe capacitive mixing and reverse electrodialysis technologies
- ☐ Apply Gouy-Chapman theory and Butler-Volmer equation to energy conversion
- ☐ Identify current challenges and opportunities in blue energy research

OOC	Organ on chip		
Tags: organ-on-chip, extracellular matrix, collagen, pharmacology, tissue models			
Responsible	S. Descroix	**Teachers**	S. Descroix, C. Aimé, L. Muller, S. Coscoy
Teaching hours			
Course	***Tutorials***	***Lab***	
20h			

Course outline:

This course covers the principles and applications of organ-on-chip (OoC) systems. Topics include the properties of collagen and the extracellular matrix, the rationale for using OoC devices as organ models in pharmacology and basic science, and specific examples including intestine, heart, and lung-on-chip. Non-animal applications (plant and fungi on chip) are also introduced.

Learning outcomes:

- ☐ Describe the properties of collagen and extracellular matrix components
- ☐ Justify the use of organ-on-chip models in pharmacological and basic research
- ☐ Compare design and application of intestine, heart and lung-on-chip devices
- ☐ Describe emerging OoC applications beyond mammalian organ models