Department of Materials

Imperial College London

Materials Science and Engineering (MEng)
Biomaterials and Tissue Engineering (MEng)
Materials with Nuclear Engineering (MEng)
Materials Science and Engineering (BEng)
Materials with Management (BEng)

YEAR 1 MODULE AND ASSESSMENT STUDENT HANDBOOK

2018-19

Introduction

This handbook contains specific information for the Year 1 students in the 2018-2019 cohort, including the module details, assessment deadlines and year composition for this academic year. It is to be used in conjunction with the General Handbook for all students for full regulations and guidance on the undergraduate programmes in the Department of Materials.

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1. Programme Information

Key dates 2018–19

Term dates

Autumn term:	29 September - 14 December 2018
Spring term:	5 January - 22 March 2019
Summer term:	27 April - 28 June 2019

Closure dates

Christmas/New year:	24 December 2018 – 1 January 2019
	(College reopens on 2 January 2019)
Easter holiday:	18 April – 23 April 2019
	(College reopens on 24 April 2019)
Early May bank holiday:	6 May 2019
Spring bank holiday:	27 May 2019
Summer bank holiday:	26 August 2019

Year structure

1st year comprises 6 modules: 4 which are primarily lectures courses, 1 which has a significant lab and computer-based component and 1 which is around engineering essential skills. These modules are listed below along with the relative module weighting in the year structure.

MSE 101	Mathematics and computing (19%)
MSE 102	Materials Chemistry and Biology (22%)
MSE 103	Mechanical Behaviour (5%)
MSE 104	Microstructure and Properties of Materials (26%)
MSE 105	Materials Physics (18%)
MSE 106	Materials Engineering (9%)

Progression

Progression criteria for Year 1 are:

- passing every module with a minimum of 40%
- passing the combined coursework from all modules with a minimum of 40%

The combined coursework mark is calculated by summing the module and coursework item weighting.

2. Module Information

MSE 101
Mathematics and Computer Programming

Course Co-ordinator: Prof Andrew Horsfield
Status: First Year Core
Prerequisites: Mathematics to A-level or equivalent

Aims
This course is designed to give students a firm foundation in the aspects of Mathematics and Computing of most relevance to Materials Science and Engineering, especially the topics required in subsequent years of study. The missions of Mathematics and Computer Programming are to provide tools, and sufficient knowledge to use them effectively, for the purpose of understanding and applying the quantitative methods of Materials Science and Engineering. The course content takes into account the broad spectrum of pre-university syllabi.

Learning outcomes
By the end of the course, students should know and understand the following concepts and methods and be able to apply them in solving problems.

Basics (Dr Paul Franklyn)
Fundamental concepts of complex numbers and error analysis.

*V**ectors (Dr Iain Dunlop)***
Vectors as quantities with magnitude and direction; basic rules of vector algebra; basis vectors; Cartesian coordinates as an example of an orthogonal basis; direction cosines. Scalar and vector products: definition; geometric interpretation; applications in science and geometry. The concept of vector area. Triple products. The reciprocal lattice. Equations of lines and planes.

Matrices (Prof A Mostofi)
Basic rules of matrix algebra; simple operations such as transpose and trace; special types of matrix (e.g., orthogonal, symmetric, etc.) and their properties. Suffix notation and Einstein summation convention. Linear transformations: orthogonal matrices as a rotation of basis. Determinants: basic properties; 2×2 and 3×3 cases. Linear equations: homogeneous and inhomogeneous; conditions for solution to exist; solution by Cramer's rule and by inversion; cofactors and adjoint matrices; inverse of 2×2 and 3×3 matrices; singular matrices. Eigenvectors and eigenvalues: 2×2 and 3×3 matrices; quadratic forms and diagonalisation.

Calculus (Prof Peter Haynes)
Differentiation from first principles; chain, product and quotient rules; higher derivatives; location and
characterisation of stationary points; curvature; partial differentiation; definite and indefinite integrals; integration by inspection, partial fractions, substitution and parts; reduction formulae; convergence and divergence of series; power series; Maclaurin series; l'Hôpital's rule.

Data Analysis (Dr Paul Franklyn)
Error analysis. Logarithms, indices and changing base. Simple linear regression; logarithmic scales for power-law and exponential curve fitting; error estimates for coefficients. Stationary points and points of inflection; curve sketching; data plotting. Taylor Series. Newton's method. Non-linear curve fitting

Complex numbers (Dr P Tangney)
The complex plane; polar representation. De Moivre's theorem. In *z* and exp *z*. Complex roots of polynomials. hyperbolic functions: definitions; inverse functions; series expansions; relation

to trigonometric functions. Applications of complex numbers to dissipative oscillatory systems. LCR circuits.

Ordinary differential equations (Prof A Horsfield)

First order equations: separable, integrating factor. Second order equations with constant coefficients: complementary function and particular integral; Initial value boundary conditions. Series solutions.

Computer Programming (Dr Stefano Angioletti-Uberti)

Basic python objects: lists, dictionaries, tuples, sets and their properties. Control flow tools: while and for loops, looping over dictionaries and lists, conditional ("if") statements. Building with python: defining new functions. Python for science: the numpy package, reading and writing data files. Python for plotting: the pylab package.

Recommended textbooks A = required, B = recommended but not essential, C = background reading.

Mathematics

A *Mathematical Methods for Physicists and Engineers*, K. F. Riley, M. P. Hobson and S. J. Bence, CUP 2006

B *Engineering Mathematics Through Applications*, K. Singh, Palgrave Macmillan 2003
Mathematical Methods in the Physical Sciences, M. Boas, Wiley 2006

C *Mathematical Methods for Physicists*, G. Arfken and H. Weber, Academic Press 1995
Practical Physics, G. Squires, CUP 2001

Computer Programming

A Think Python 1st Edition, by Allen B. Downey

Structure, teaching and learning methods

Mathematics

48 lectures: Autumn and Spring terms
9 tutorials: Autumn and Spring terms

Computer Programming

5 practical classes: Autumn term

Assessment

Mathematics

Examination

The course is examined in the summer term. The examination paper, duration 3 hours, is in two sections. Section A is compulsory and consists of four short answer questions on all parts of the course. Section B contains four questions of which students must answer three.

Coursework

There are nine tutorials for which students need to prepare answers to problem sets.

Tests

There are two tests that contribute to the overall mark, one at the start of the Spring term (as part of the first year progress test) and one at the start of the Summer term. Each test covers the material taught over the previous term.

Computer Programming

Marked coursework

During each lab, students will write short programs aimed at solving a total of three sample problems. These programs should then be finished as a homework assignment and used to answer questionnaires which will be marked and evaluated. Questionnaires will have to be handed in starting from the 3rd lab.

Staffing

	Lectures	Tutorials*	Lab sessions
Dr Dunlop	6		n/a
Dr Paul Franklyn	10		n/a
Prof Haynes	8		n/a
Prof Mostofi	8		n/a
Dr Tangney	8		n/a
Prof Horsfield	8		n/a
Dr Angioletti-Uberti	5		5

Course Material

	Powerpoint Lectures	Lecture Handouts	Tutorial Sheets	Lab Scripts	VLE
		1	1		YES
Dr Dunlop		1	1		YES
Dr Franklyn		1	1		YES
Prof Haynes		1	1		YES
Prof Mostofi		1	1		YES
Dr Tangney		1	1		YES
Prof Horsfield	8	1	1		YES
Dr Angioletti-Uberti	5	5	0	5	YES

* Students will receive 9 tutorials through the year from a mathematics tutor.

MSE 102
Materials Chemistry and Biology

Course Co-ordinator: Dr Martyn McLachlan
Status: First Year Core
Prerequisites: A-level Chemistry or Introduction to Materials Chemistry

Aims
This course is designed to give students the firm foundation in the fundamentals of Materials Chemistry and Biology required in subsequent years of study and to serve as a valuable self-standing unit. The missions of Materials Chemistry and Biology are to deliver a materials science view of fundamental chemistry concepts, as well as introduce a range of soft matter and polymeric materials. The course content takes into account the broad spectrum of pre-university syllabi.

Learning outcomes
Chemical and Aqueous Ionic Equilibrium (Dr M McLachlan)
At the end of this part of the course the student will be able to:
- Define Equilibrium and the concept of dynamic equilibrium
- Understand and calculate equilibrium constants and calculate equilibrium concentrations
- Understand and apply Le Châtelier's principle.
- Define acids and bases; understand dissociation constants and how these relate to strong/weak acids and bases.
- Understand the action of buffers (effectiveness and capacity) and design buffers to operate under given conditions.
- Develop a basic understanding of free-energy and thermodynamics.
- Understand spontaneity and its relationship to rate (chemical kinetics).
- Be able to explain the driving force behind simple chemical reactions.

Chemical Kinetics and Mass Transport (Dr A Cairns)
- Be able to distinguish between chemical equilibrium and chemical kinetics- and how they relate to one another.
- Understand the activation energy of a chemical reaction and the factors that affect reaction rates.
- Understand the molecular collisions and how molecular velocities affect reaction rates
- Be able to determine reaction orders for chemical reactions and describe complex reaction pathways.
- Be able to solve problems involving reaction kinetics.
- Have an understanding of the driving forces for mass transport in solids and liquids (diffusion, migration, convection).
- Understand different areas in which mass transport is important for materials scientists.
- Be able to describe on an atomic scale the mechanisms of these processes.
- Be able to derive differential equations of mass transport.
- Be able to solve simple practical problems involving diffusion in solids.
-

Electrochemistry (Dr S Pedrazzini)
On successfully completing this course unit, students will be able to:
- Write balanced redox reactions
- Describe the distribution of ions at the solid-electrolyte interface
- Explain the development of a potential difference across an electrode/electrolyte interface
- Derive and use the Nernst equation
- Construct an electrochemical cell to investigate a specified redox reaction
- Relate electrochemical and thermodynamic data

- Explain the three-electrode system employed in dynamic electrochemistry experiments
- Discuss the role of supporting electrolytes in electrochemical studies
- Define the terms reversible and irreversible as applied to electron transfer reactions
- Employ the Butler-Volmer equation
- Determine diffusion coefficients of ions using the Cottrell equation
- Explain the shape of a cyclic voltammogram
- Discuss corrosion simply in terms of electrochemical thermodynamics and kinetics

Biological Materials (Prof A Porter)

- To know the basic features of biomaterials: The cell, cell organelles, cell transport mechanisms, structural proteins (silk, collagen, elastin and minerals)
- To describe the function of proteins, to describe the structure of amino acids and the condensation reaction involved in their formation, to understand the difference between simple and conjugated proteins, to describe primary, secondary and tertiary protein structure, to describe the structure of keratin, the a-helix and the b-pleated sheet, to understand protein denaturisation
- To understand the importance of wood as a structural materials and comparison with man-made materials. To know the structure and properties of hardwood and sapwoods.
- To explain mechanisms of biomineralisation in living systems (shells, bone, teeth). How the chemistry, structure, orientation, size, shape and hierarchical assembly of crystalline phases is controlled.
- To understand the structure and mechanical properties of bone, teeth and elastin.
- To know the different common types of materials used in for tissue replacement, to have a basic understanding of joint replacement surgery/ failure mechanisms and the requirements for candidate materials, to know the different fixation methods to the surrounding tissue.

Soft Matter and Self-Assembly (Dr I Dunlop)

- Passively and actively make use of terminology in the field of soft matter and self-assembly. Explain the meaning of the terminology.
- Appreciate the principles of the mathematical derivations given in the course, so as to be able to not only reproduce the derivations given, but also apply the same principles to similar situations.
- Solve problems similar to those on the question sheets.
- Explain the principles that underlie the calculations in the course and in problems, and interpret the results of calculations in physically meaningful ways.

*Po**lymeric Materials (Dr T Georgiou)***

- Be able to differentiate polymer types based on their chemical structure.
- Be able to differentiate polymer types based on their solid state properties.
- Know how to synthesise polymers from their corresponding monomers using addition and condensation reactions.
- Be able to define the glass transition temperature Tg, understand the microscopic processes occurring at Tg, exploit various chemical and physical factors to manipulate Tg in a polymer and explain different techniques that can be used to determine Tg (static and dynamic methods).
- Know the various structures adopted by (semi)crystalline polymers and correlate these to the chemical characterisation of the polymers.
- Be able to tailor the structure and properties of polymers using copolymerisation.
- Be able to name typical polymers and their applications.
- Be able to identify which characterisation technique can be used to determine the molar mass and the diameter in solution of the polymer
- Understand the main challenges in recycling polymeric materials / plastics.

Recommended textbooks A = required, B = recommended but not essential, C = background reading.

A *Basic Chemical Thermodynamics,* EB Smith, ICP 2004
Physical Chemistry 10th edition, PW Atkins and J De Paula, OUP 2009
B *Electrode Dynamics,* AC Fisher, OUP 1996
Electrode Potentials, RG Compton and GHW Sanders, OUP 1996
Soft Condensed Matter, Richard A. L. Jones, OUP 2002
Molecular biology of the cell. B. Alberts. Garland Science, 2002
Biomineralization. S. Mann Oxford UP, 2001
Structural Biomaterials. Vincent J. Revised edition. Princeton UP, 1991.
Biochemistry H. Champe, Lippincott-Raven Publishers, Philadelphia, USA 1994
Essential Cell Biology An Introduction to the Molecular Biology of a Cell, Alberts and Bray, Garland Publishing, Inc. NY 1998
Introduction to Polymers, R. J. Young, Chapman and Hall, 1981
Polymers: Chemistry and Physics of Modern Materials, J M G Cowie, Blackie, Glasgow, 1991
Biophysics and biochemistry at Low temperatures. Franks F. Cambridge UP, 1985.
C *Electrochemistry,* CH Hamann, A Hamnett and W Vielstich, Wiley 1998
Electrochemical Methods: Fundamentals and Applications, 2nd edition, AJ Bard and LR Faulkner, Wiley 2001
Molecular Driving Forces, K A Dill and S Bromberg, Garland Science, 2010 (or earlier edition)
Physical Biology of a Cell, R Phillips et al, Garland Science 2009

Structure, teaching and learning methods

60 lectures: Autumn, Spring and Summer terms
12 workshops: Autumn, Spring and Summer terms
5 practical classes: Autumn and Spring terms

Assessment

Examination

The course is examined by a 3 hour exam in the summer term. The exam paper consists of Section A all of which is compulsory; and Section B from which 4 questions should be answered.

Coursework

Students are expected to submit a report for each of the laboratories associated with the course:
Iodine Clock; Rheology; Synthesis of Polymers; Gold Nano; Viscosity of Glass; Titration (long lab); and Polymers Processing (long lab).

Tests

Material covered in the Autumn Term will be examined in the Progress Test held in January.
The module contributes 140 marks of the 700 for the first year. 100 exams, 10 January diagnostic exam, 10 spring test plus 20 coursework. The pass mark for the module is 40%.

Staffing

	Lectures	**Tutorials**
Dr T Georgiou	10	(4 × 4) = 16
Dr I Dunlop	10	(2 × 4) = 8
Dr S Pedrazzini	10	(2 × 4) = 8
Dr M McLachlan	10	(4 × 4) = 16
Prof A Porter	10	
Dr A Cairns	10	

MSE 103
Materials Engineering - Mechanics

Course Co-ordinator: Prof A Horsfield

Status: First Year Core

Prerequisites: A-level Maths

Aims

This course is designed to give students the firm foundation in the fundamentals of mechanics (statics) required in subsequent years of study and to serve as a valuable self-standing unit.

Learning outcomes

After this course students should be able to

- Analyse the forces involved in maintaining bodies in equilibrium
- Apply the methods of joints and of frames for force determination in simple structures and frames
- Understand and use the concepts of elastic stresses and strains and their relationships
- Apply the analysis used for thin wall pressure vessels
- Calculate the shear stresses and displacements developed in cylindrical shafts
- Calculate shearing and bending forces, bending moments and elastic deflections developed in beams subjected to loading
- Understand how stress and strain relate to atomic displacement

Topics

Resolution of a Force; Static Friction; Principle of Moments; Resultants; Bodies in Equilibrium; Structures; Frames and Machines; Free Body Diagrams; Categories of Equilibrium; Method of Joints; Method of Frames; Internal Forces and Moments; Sign Convention for Bending; Shearing Force and Bending Moment Diagrams; Torsion; Normal Stress; Shear Stress; Thin Wall Pressure Vessels; Normal Strain; Shear Strain; Stress vs Strain; Hooke's Law; Young's Modulus; Shear Modulus; Poissons Ratio; Plane Stress; Plain Strain; Torsion of Cylindrical Shaft; Relationships Between Loading, Shear Force and Bending Moment; Pure Bending of Beams; Slope and Deflection; Strain and Displacement. Atomic Description of Stress and Strain.

Recommended textbooks

Mechanics of Engineering Materials, P.P. Benham, R.J. Crawford & C.G. Armstrong, Pearson, Prentice Hall

Mechanics of Materials, Riley, Sturges and Morris, Wiley and Sons

The course is primarily based on Benham, Crawford and Armstrong

Structure, teaching and learning methods

10 lectures: Summer term

8 classwork sessions: Summer term

Assessment

Examination

The course is examined by two tests in the Spring term. Both tests are 1 hour long. The first test is an online multiple-choice test covering basic concepts, and is worth 13 marks. The second test is written, covers the whole course, and is worth 25 marks.

Coursework

Students are expected to complete the coursework sheets, though they do not contribute to the overall mark. Time is allocated in the timetable and the lecturer is available during these classwork sessions.

Staffing

	Lectures	**Classwork Sessions**
Prof A Horsfield	10	8

MSE 104
Microstructure and Properties of Materials

Course Co-ordinator: Dr M R Wenman
Status: First Year Core
Prerequisites: A Level Maths and Physics; GCSE Combined Science

Aims

To develop an understanding of basic crystallography and how microstructures are developed in materials, the fundamentals of strength and dislocations, and how microstructures are related to properties. To introduce key conceptual tools of Materials Science and Engineering, especially in structural materials.

Learning outcomes

Crystallography (Prof A Walsh)

The course will provide the skills and concepts that are necessary to enable you to relate the spatial distribution of atoms to other materials properties. You will become familiar with the crystal structures of metals, semiconductors, and ceramics, which will be recurrent themes in other courses.

Crystal structures and geometry

- Define a crystal structure in terms of a basis and a lattice.
- Define a unit cell and identify these in a lattice.
- Identify lattice vectors and define cell angles.
- State the names and identity of the 7 lattice systems and 14 Bravais lattices in 3D.
- Determine the Miller index of a plane in a crystal.
- Draw *hcp* / *fcc* / *bcc* lattices and calculate packing fractions.
- Distinguish between substitutional and interstitial solid solutions.
- Knowledge of common non-metallic structure types including NaCl, ZnS and CsCl.
- Ability to apply radius ratio rules to predict crystal structures.
  Test 1 (50%) – All work up to this point.

Diffraction and structure determination

- Describe the fundamentals of X-ray diffraction.
- State Bragg's law.
- Construct systematic absences for simple lattices.
- Knowledge of stereographic projections.
- Explain advantages and limitations of X-ray, electron, and neutron techniques.
- Knowledge of disorder in crystalline solids.
  Test 2 (50%) – All work up to this point.

Phase Metallurgy (Prof M Shaffer)

The Aim of the course is to examine how microstructures are formed in metals during solidification and heat treatment. To motivate the course, the mechanical properties of structural materials are introduced. A major focus is the thermodynamics of the formation of phases and the construction of phase diagrams. The steels phase diagram is introduced. At the end of the course, students will have a be able to understand how to construct and use binary phase diagrams, including;

- Stress-Strain Curves and the Tensile Test. Aerospace materials property requirements. Basic Structure of Materials; Phases and Crystal Structures. Phase Diagrams.
- Phase Changes, e.g. liquid-solid and latent heat; cooling curves. Phase Diagrams and the lever rule. Interpreting phase diagrams. Continuous solid solutions and eutectics.
- Internal Energy, Gibbs Free Energy, Enthalpy and Entropy.
- Two phase equilibria; the enthalpy and entropy of mixing; the regular solution model.
- Derivation of phase diagrams using free energy - composition curves.
- Solidification and the Scheil equation. Segregation and homogenisation. Al-Cu.

- The Fe-C phase diagram; martensite; transformation kinetics; **TTT** diagrams; tempering.

Glasses, Ceramics and Composites (Prof E Saiz)

The aim of this course is to describe typical chemical compositions, structures, properties and uses – and their inter-relationships – for simple glasses, ceramics and composite materials. Topics that students will be able to discuss and analyse at the end of the course are:

- Silicates – structures and transformations
- Silica – crystalline, glass and gel
- Silicate-based glasses – fabrication, composition and structure
- Glass ceramics – fabrication and structure
- SiO_2-Al_2O_3 system and porcelains
- Sintering: solid state, liquid state
- Ceramics and glasses: fracture-toughness
- Composite materials – components, structure and stress-strain relationships of fibrous composites

Strength and Deformation (Dr P J Franklyn)

The aim of this aspect of the course is to understand the nature of plastic and elastic deformation in crystalline materials. The approach ranges from the scale at the atomic to the micro to the macroscopic. At the end of this section, the student will be able to:

- Define the fundamental mechanical response of materials, with particular emphasis on metallic materials (stress/strain, strength, Young's modulus, Shear modulus).
- Relate applied external stress to internal stress, and the concepts of tension and shear.
- Give a quantitative description of elastic response and theoretical strength using simple atomic models.
- State why the theoretical strength differs from typical experimental data, introducing the concept of dislocations.
- Describe in overview the (structural) defects from 0D to 3D and their relationship to dislocations and strengthening.
- Explain evidence of dislocations (e.g. TEM, modelling).
- Relate a stress-strain curve from a uniaxial tensile test to microscopic phenomena, e.g. dislocation motion, source activation and strengthening mechanisms.
- Characterise dislocation types (edge, screw, mixed), slip plane and define the Burgers vector.
- Characterise a dislocation using a Burgers circuit construction, and define a slip system.
- Resolve applied stress onto a single slip system using Schmid's law
- Understand the concept and impact of critical resolved shear stress.
- Realise that there is a stress at which dislocation motion occurs (Peierls-Nabarro stress).
- Describe basic strengthening mechanisms (dislocation-dislocation and dislocation-microstructure interactions)
- Describe the mechanism of dislocation multiplication (Frank-Reed source).
- Describe and understand macroscopic effects of these mechanisms with regards to microstructure, e.g. grain size strengthening
- Describe the effect of reduced ductility in some crystal systems, and alternative deformation mechanisms (e.g. twinning in Tin)

The Metals Life Cycle – From Processing to Performance (Dr M R Wenman)

The Aim of this aspect of the course is to introduce the concept of engineering metallurgy from cradle-grave and how metals properties can be altered by the engineer to give the desired response by manipulation of the microstructure.

- Gibbs energy variation with temperature for a pure metal, describing the melting point and the latent heat of fusion.

- Derive an expression for the free energy change due to nucleation of a solid in a pure metal.
- Describe the difference between homogeneous and heterogeneous nucleation and why homogenous nucleation is rarely observed.
- Explain why undercooling is usually necessary for solidification.
- Derive an equation for the critical radius and ΔG^* for homogeneous nucleation.
- Explain why crystals of pure metal have preferred orientations for growth and state what they are for cubic and hexagonal systems.
- Describe the conditions necessary for planar and dendritic growth of a pure metal.
- Describe the solidification of a casting and draw a section through a casting labelling the chill, columnar and equiaxed regions.
- Describe how the mechanical properties of a casting are related to the secondary dendrite arm spacing.
- Describe how the mechanical properties of a casting can be improved by inoculation of a melt.
- List some typical inoculants and what makes a good inoculant.
- Describe the process of cold working and its influence on the microstructure, ductility and tensile strength of a metal.
- Define the terms recovery and recrystallisation with reference to a metal. Understand stored strain energy due to plastic deformation in a deformed piece of metal.
- Calculate the stress/pressure acting on a grain boundary during grain growth and derive the drag force on grain boundaries due to particles.
- Describe with the aid of diagrams the recrystallisation process.
- Describe the polycrystalline state of metals and state the Hall-Petch relationship for grain size.
- Describe why a turbine blade is made as a single crystal.
- Describe and explain the different hardening/strengthening mechanisms used in steel and aluminium-copper alloys.
- Describe why a peak ageing time/temperature exists for aluminium-copper alloys.
- Recap how tensile tests are performed, calculate the 0.2% proof stress, ultimate tensile stress, ductility and where appropriate the upper and lower yield points.
- Explain why some metals exhibit yield phenomena and others do not.
- Calculate the binding energy of a foreign atom to a dislocations elastic field with position.
- Describe both temperature and strain rate effects on yield stress for different metals.
- Describe in basic terms the concept of dynamic strain ageing and why it can be a problem for metal forming operations.
- State Inglis solution for an elastic stress concentration in an infinite plate.
- State the definition of K_{IC} and use the equation to calculate a critical stress or crack length.
- Describe the influence of specimen thickness on fracture toughness.
- Explain why some alloys show a ductile-to-brittle transition.
- Describe the Charpy impact test.
- Describe the phenomenon and micromechanism of fatigue.
- Draw an S-N curve.
- State the Paris equation and use it to calculate the cycles to failure, critical crack length and time to failure of a component.
- Describe factors that affect fatigue life of a component and methods for mitigation.

Recommended textbooks: All below are recommended but not essential,

A Cottrell. An Introduction to Metallurgy, 2nd Ed, Institute of Materials, 1995.

RE Smallman. Modern Physical Metallurgy, 4th Ed, Butterworths, 1985.

DA Porter and KE Easterling. Phase Transitions in Metals and Alloys, 2nd Ed, Chapman and Hall, 1992.
WD Kingery, HK Bowen and DR Uhlmann. Introduction to Ceramic Science, 2nd Ed, Wiley 1975.
MW Barsoum. Fundamentals of Ceramics, Taylor & Francis, 2003.
CB Carter and MG Norton. Ceramic Materials, Science and Engineering, Springer, 2013.
D Hull and DJ Bacon. Introduction to Dislocations, Butterworth-Heinemann, 2011.
RJ Young. Introduction to Polymers, Chapman and Hall, 1981.
GE Dieter. Mechanical Metallurgy, McGraw-Hill, 1989.
JMG Cowie. Polymers: Chemistry and physics of modern materials, Blackie, 1991.
JE Gordon. The New Science of Strong Materials, Pelican, 1968.
AM Glazer. Crystallography: A Very Short Introduction, Oxford University Press, 2016.

Structure, teaching and learning methods
Autumn and Spring terms:
60 lectures
10 laboratory sessions
8 workshops

Assessment
Examination
The course is examined in the summer term in a single 3 hour examination paper composed of five questions, which will reflect the balance of lectures across the course. Students answer 3 questions from a choice of 4, plus students must complete a compulsory question covering all the topics. Each question is worth 20 marks giving a total of 80 for the paper (scaled to 100).
Progression Test
Tests
Material covered in the Autumn Term (excluding the portions from crystallography) will be examined in the Progress Test held in January. However crystallography is considered as being understood.
Laboratories
The metals labs course runs through the year and help embed basic practical skills and support the lectures. A report is written within one week of each lab, marked and returned. Each report is worth five marks in the year (10 reports in total)

The module contributes 100+10+5x10=160 marks towards the first year in both the BEng and MEng assessment schemes, with a pass mark of 40%.

Staffing

	Lectures	Tutorials	Lab sessions
Prof M Shaffer	10	2	
Dr P J Franklyn	10	2	1
Prof A Walsh	20	(classwork)	
Dr M Wenman	10	2	3
Prof E Saiz	10	2	

MSE 105
Materials Physics

Course Co-ordinator: Prof J Riley
Status: First Year Core
Prerequisites: A-level Physics and Mathematics

Aims

This course is designed to give students a firm foundation in the fundamentals of Materials Physics required in subsequent years of study and to serve as a valuable self-standing unit. The mission of Materials Physics is to explain the physical origins of materials properties. The course content takes into account the broad spectrum of pre-university syllabi.

Learning outcomes

Statistical Mechanics (Prof J Riley)

This course will introduce the basic concepts that allow Materials Scientists and Engineers to predict whether particular reactions occur. A molecular based approach will be employed throughout. We will start looking at the pressure exerted by an ideal gas and how it is related to the speed of the molecules in the gas. We will then ask the question: why does a gas occupy all the space available to it? A relationship between the multiplicity of a configuration (the number of ways it is possible to achieve a particular arrangement) and it entropy will be presented. Consideration of systems with limited energy will allow us to demonstrate that the units of entropy are $J\ mol^{-1}\ K^{-1}$. The Second Law of thermodynamics will then be discussed with consideration of the multiplicity of a system coupled to its surroundings. The Gibbs equation, that relates to entropy change of the system and the heat exchanged to the surrounding, will then be derived. It will be shown that for most chemical systems the heat transferred to the surroundings is given by enthalpy. Finally the equations derived through the course will be employed to predict the progress and the equilibria for some simple processes.

Atoms and waves (Dr D Payne)

From this part of the Materials Physics module the students will be able to:

- Understand the wave properties of light and of matter (including x-ray diffraction and spectroscopy).
- Build up a picture of the atomic orbitals needed to understand simple bonding.
- Define penetration and shielding, the building-up principle, atomic parameters, atomic and ionic radii, ionization energy, electron affinity, electronegativity and polarizability.
- Describe the Born-Oppenheimer Approximation, Valence bond (VB) theory, Molecular-orbital (MO) theory, linear combination of atomic orbitals (LCAO).
- Understand ionic bonding including extending heteronuclear MO theory to the bulk and Born-Haber cycles. Define the bulk modulus.
- Describe different types of chemical forces, covalent bonding, ionic bonding, ion-dipole forces, dipole-dipole forces, instantaneous-dipole -- induced-dipole interactions, hydrogen bonding.
- Study covalent solid elements, e.g. carbon (diamond, graphite, graphene), hybridization of MO's! – $BeCl_2$ C_2H_4).
- Understand conjugation e.g. butadiene, extending the model to forming bands in metals and insulators. Summary of all band structures types.

Electrical Behaviour (Dr F Xie)

On successfully completing this section of the course students will:

- Know the definitions of resistance, resistivity, conductivity and mobility. They will understand that conductivity can arise from the motion of free electrons, holes and ions and they will understand the key equation $\sigma = \Sigma\, nq\mu$.
- Be able to state the main experimentally observed properties of semiconductors.
- Be able to reproduce a simple one-dimensional band theory that includes the Fermi level. They will be able to state the Fermi-Dirac distribution function and to explain the origins of intrinsic conductivity.
- Be able to explain the effects of p and n type doping in silicon and to draw band diagrams that include the position of the Fermi level and the donor and acceptor levels. They will know the law of mass actions.
- Be able to explain the origin of the built-in potential at a p-n junction in terms of carrier diffusion and in terms of the band diagrams. They will be able to explain the current:voltage characteristics of the p-n junction diode.
- Be able to state the main experimentally observed properties of metals.
- Have a basic understanding of the classical and quantum free electron theories of metals and of the concept of wave particle duality.
- Be able to state the electrical properties of the materials at the extreme ends of the conductivity range of materials, namely superconductors and insulators.

Dielectric and Magnetic Behaviour (Dr A Regoutz)

On successfully completing this course, students will be able to:

- Understand what is a dielectric material and the parameters such as polarizability, dielectric constant, and dielectric susceptibility.
- Describe the induced dipole moments in dielectric materials and permanent dipole moments in ferroelectric materials.
- Calculate the electric field caused by a single dipole moment as well as by a polarized material.
- Describe the behaviour of a dielectric material in the presence of an external field and the electric field of charges in a dielectric medium.
- Understand the ac response of a dielectric material including the dielectric loss factor.
- Describe the magnetic response of diamagnetic, paramagnetic, and ferromagnetic materials and parameters such as magnetic susceptibility.
- Describe the microscopic origin of magnetism in magnetic materials.
- Explain what is a magnetic dipole moment and calculate the magnetic field from a magnetic dipole moment as well as from a magnetized material.
- Understand the types of magnetic ordering and distinguish between ferro-, ferri-, and anti-ferromagnetic behaviour.
- Understand the origin of magnetic domains in magnetically ordered systems and describe the development of a B-H loop in terms of the evolution of the magnetic domain structure.

Introduction to wave and quantum mechanics, applications and molecules (Prof N Klein)

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

- Understand the concepts of classical mechanics; Newton's laws, energy, momentum, angular momentum
- Explain the phenomena related to classical waves like running and standing waves, interference, transversal and longitudinal waves
- Describe the different types of sound waves that propagate through gas, solids and liquids
- Explain the spectrum of electromagnetic waves, relation between photon energy, frequency and wavelength, blackbody radiation
- Explain the particle wave dualism and calculate the de Broglie wavelength from the relativistic kinetic energy

- Explain the concepts of quantum mechanics; uncertainty relation, Pauli exclusion principle and Schroedinger equation
- Calculate the eigenstates of a quantum mechanical particle in a box
- Explain the energy levels of the hydrogen atom and the quantum numbers related to the angular momentum
- Explain why the periodic table is constructed as it is, in particular the relationship to the four quantum numbers
- Construct molecular and hybridized orbitals from hydrogen orbitals that describe simple molecules and understand how these lead to band structures.
- Calculate the properties of simple ionic molecules from pair potentials.

Crystal Defects (Dr A Aguadero)

From this part of the course students will be able to:

- Define the simple point defects which can form in crystalline lattices
- Use the derived definitions of point defects to define ionic Schottky, Frenkel and anti-Frenkel ionic and electronic intrinsic disorder in materials.
- Describe extrinsic disorder in terms of incorporation of dopants and redox processes in the crystal lattice.
- Calculate the equilibrium concentrations of vacancies at any temperature in an oxide when the enthalpy of vacancy formation is known.
- Describe defects in terms of Kröger-Vink notation, noting the defect type, location and charge, and use this to write defect chemical equations.
- Express the neutrality condition for a material in terms of intrinsic and extrinsic point defect concentrations.
- Solve a defect problem and obtain an algebraic expression for the concentration of defects at any temperature given the intrinsic disorder type and concentration of extrinsic impurities.
- Relate point defects to specific materials properties such as conductivity, diffusivity and colour.

Recommended textbooks A = required, B = recommended but not essential, C = background reading.

A P. A. Tipler, "Physics for Scientists and Engineers", W. H. Freeman and Company, ISBN 1-57259-673-2

B Materials Science, J.C. Anderson, K.D. Leaver, R.D. Rawlings and J.M. Alexander, Van Nostrand Reinhold (UK) Co. Ltd., ISBN 0 442 30626 1.
The Science And Engineering Of Materials, D.R. Askeland, Van Nostrand Reinhold (International), ISBN 0 278 00057 6.
Properties Of Materials', L. Solymar and D. Walsh, Clarendon Press (Oxford), 19 851117 5.
Physics Of Semiconductor Devices, S.M. Sze, John Wiley and Sons,
Introduction To Solid State Physics, C. Kittel, John Wiley and Sons
Introduction to ceramics, W.D. Kingery, H.K.Bowen, D.E.Uhlmann, John Wiley (1976)
Thermodymamics of Solids, R.A.Swalin, John Wiley (1976)
Basic Solid State Chemistry, A.R.West, John Wiley (1988)
Physical Ceramics Y-M.Chiang, D.Birnie, W.D.Kingery, John Wiley & Sons (1997)
The Defect Chemistry of Metal Oxides, D.M.Smyth, OUP (2000)
Electroceramics, A.J.Moulson and J.M.Herbert, John Wiley, 2003
Electronic Materials, N.Braithwaite and G.Weaver, Open University Materials in Action Series, Butterworths, 1990
Physical Chemistry, 8th Edition, PW Atkins and J de Paula, Oxford 2006, Chapters 1 - 5,7, 16-17
Electricity and Magnetism, E. M. Purcell, McGraw Hill (1985).

Chemical Bonding (Oxford Chemistry Primers), Mark J. Winter, Oxford University Press (1994).
Introduction to Quantum Theory and Atomic Structure (Oxford Chemistry Primers), P. A. Cox, Oxford University Press (1996).
Shriver and Atkins' Inorganic Chemistry, 5th Edition, P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Oxford University Press (2009).
Atkins' Physical Chemistry, 9th Edition, P. Atkins, J. de Paula, Oxford University Press (2009).

Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edition, J.E. Huheey, Prentice Hall (1997).

Structure, teaching and learning methods
Autumn, Spring and Summer terms:

60 lectures
12 Workshops
5 practical classes

Assessment

Examination
The course is examined in the summer term. The examination paper, duration 3 hours, contains 6 questions of which students must answer 5 questions.

Progress Test
Material covered in the Autumn Term will be examined in the Progress Test held in January.

Laboratories associated with this module:
PEO; B-H Loop; and Crystal Radio and FET (long lab).

The module contributes 130 marks of the 700 for the first year. 100 for the exam, 10 for the January diagnostic test plus 20 for coursework. The pass mark for the module is 40%.

Staffing

	Lectures	Feedback Sessions	Lab Sessions
Prof N Klein	10	2	
Dr F Xie	10	2	
Dr A Aguadero	10	2	
Prof J Riley	10	2	
Dr D Payne	10	2	
Dr A Regoutz	10	2	
			5

3. Assessments

Coursework, tests and laboratory exercises make up the coursework mark that is used in the calculation of the year mark. The tables in this section will help you to be able to plan your study and revision timetable based on the due dates for the various elements. Each of the items here have a corresponding assessment description sheet that is included at the end of the handbook. This also includes a rough rubric for each assessment that can be used to guide the preparation of the item.

Coursework elements (excluding laboratory exercises)

Module	Due Date	% Contribution to Module
MSE 106: Engineering drawing	Tue 14 May 2019	23%
MSE 106: Presentation Exercise Draft	Week 1, Term 3	4%
MSE 106: Presentation Exercise	Week 3, Term 3	11%

Coursework tests

Module	Due Date	% Contribution to Module
MSE104: Crystallography Test 1	06/11/2018	5%
MSE104: Crystallography Test 1	13/12/2018	5%
MSE101/102/104/105: Progress test	07/01/2019	MSE101 (7%); MSE102 (7%); MSE104 (5%); MSE105 (8%)
MSE 103: Mechanics Test 1	07/02/2019	34%
MSE 103: Mechanics Test 2	12/03/2019	66%
MSE 106: Solidworks Test	22/03/2019	62%
MSE101: Maths Progress test	08/05/2019	7%

Your academic performance in the laboratory sessions from autumn term will be used to determine your lab groups for the Spring Term. However your lab group will not affect your personal tutorial group, nor will it affect the afternoon on which you do a lab in the Spring term.

Autumn term laboratory deadline

Experiment	Monday Lab Groups									
Metallography	A1:09-Oct	B5:16-Oct	B4:23-Oct	B3:30-Oct	B2:06-Oct	B1:13-Nov	A5:20-Nov	A4:27-Nov	A3:04-Dec	A2:11-Dec
Steels	A2:09-Oct	A1:16-Oct	B5:23-Oct	B4:30-Oct	B3:06-Oct	B2:13-Nov	B1:20-Nov	A5:27-Nov	A4:04-Dec	A3:11-Dec
Cooling Curve	A3:09-Oct	A2:16-Oct	A1:23-Oct	B5:30-Oct	B4:06-Oct	B3:13-Nov	B2:20-Nov	B1:27-Nov	A5:04-Dec	A4:11-Dec
Titration (7 days report)	A4:15-Oct	A3:22-Oct	A2:29-Oct	A1:05-Nov	B5:12-Nov	B4:19-Nov	B3:26-Nov	B2:03-Dec	B1:10-Dec	A5:07-Jan
Gold nano	A5:09-Oct	A4:16-Oct	A3:23-Oct	A2:30-Oct	A1:06-Oct	B5:13-Nov	B4:20-Nov	B3:27-Nov	B2:04-Dec	B1:11-Dec
PEO	B1:09-Oct	A5:16-Oct	A4:23-Oct	A3:30-Oct	A2:06-Oct	A1:13-Nov	B5:20-Nov	B4:27-Nov	B3:04-Dec	B2:11-Dec
Tensile 1&2	B2:09-Oct	B1:16-Oct	A5:23-Oct	A4:30-Oct	A3:06-Oct	A2:13-Nov	A1:20-Nov	B5:27-Nov	B4:04-Dec	B3:11-Dec
Glass transition	B3:09-Oct	B2:16-Oct	B1:23-Oct	A5:30-Oct	A4:06-Oct	A3:13-Nov	A2:20-Nov	A1:27-Nov	B5:04-Dec	B4:11-Dec
Fracture impact (7days report)	B4:15-Oct	B3:22-Oct	B2:29-Oct	B1:05-Nov	A5:12-Nov	A4:19-Nov	A3:26-Nov	A2:03-Dec	A1:10-Dec	B5:07-Jan
Viscosity of glass	B5:09-Oct	B4:16-Oct	B3:23-Oct	B2:30-Oct	B1:06-Oct	A5:13-Nov	A4:20-Nov	A3:27-Nov	A2:04-Dec	A1:11-Dec

Experiment	Thursday Lab Groups									
Metallography	C1:09-Oct	D5:16-Oct	D4:23-Oct	D3:30-Oct	D2:06-Oct	D1:13-Nov	C5:20-Nov	C4:27-Nov	C3:04-Dec	C2:11-Dec
Steels	C2:09-Oct	C1:16-Oct	D5:23-Oct	D4:30-Oct	D3:06-Oct	D2:13-Nov	D1:20-Nov	C5:27-Nov	C4:04-Dec	C3:11-Dec
Cooling Curve	C3:09-Oct	C2:16-Oct	C1:23-Oct	D5:30-Oct	D4:06-Oct	D3:13-Nov	D2:20-Nov	D1:27-Nov	C5:04-Dec	C4:11-Dec
Titration (7days report)	C4:18-Oct	C3:25-Oct	C2:01-Nov	C1:08-Nov	D5:15-Nov	D4:22-Nov	D3:29-Nov	D2:06-Dec	D1:13-Dec	C5:07-Jan
Gold nano	C5:09-Oct	C4:16-Oct	C3:23-Oct	C2:30-Oct	C1:06-Oct	D5:13-Nov	D4:20-Nov	D3:27-Nov	D2:04-Dec	D1:11-Dec
PEO	D1:09-Oct	C5:16-Oct	C4:23-Oct	C3:30-Oct	C2:06-Oct	C1:13-Nov	D5:20-Nov	D4:27-Nov	D3:04-Dec	D2:11-Dec
Tensile 1&2	D2:09-Oct	D1:16-Oct	C5:23-Oct	C4:30-Oct	C3:06-Oct	C2:13-Nov	C1:20-Nov	D5:27-Nov	D4:04-Dec	D3:11-Dec
Glass transition	D3:09-Oct	D2:16-Oct	D1:23-Oct	C5:30-Oct	C4:06-Oct	C3:13-Nov	C2:20-Nov	C1:27-Nov	D5:04-Dec	D4:11-Dec
Fracture impact (7days report)	D4:18-Oct	D3:25-Oct	D2:01-Nov	D1:08-Nov	C5:15-Nov	C4:22-Nov	C3:29-Nov	C2:06-Dec	C1:13-Dec	D5:07-Jan
Viscosity of glass	D5:09-Oct	D4:16-Oct	D3:23-Oct	D2:30-Oct	D1:06-Oct	C5:13-Nov	C4:20-Nov	C3:27-Nov	C2:04-Dec	C1:11-Dec

Spring term laboratory deadline

Experiment	Monday Lab Groups									
B-H loop	A1:08-Jan	B5:15-Jan	B4:22-Jan	B3:29-Jan	B2:05-Feb	B1:12-Feb	A5:19-Feb	A4:26-Feb	A3:05-Mar	A2:12-Mar
Brass rolling	A2:08-Jan	A1:15-Jan	B5:22-Jan	B4:29-Jan	B3:05-Feb	B2:12-Feb	B1:19-Feb	A5:26-Feb	A4:05-Mar	A3:12-Mar
Bubble raft	A3:08-Jan	A2:15-Jan	A1:22-Jan	B5:29-Jan	B4:05-Feb	B3:12-Feb	B2:19-Feb	B1:26-Feb	A5:05-Mar	A4:12-Mar
Casting	A4:08-Jan	A3:15-Jan	A2:22-Jan	A1:29-Jan	B5:05-Feb	B4:12-Feb	B3:19-Feb	B2:26-Feb	B1:05-Mar	A5:12-Mar
Crystal radio & FET (7days report)	A5:14-Jan	A4:21-Jan	A3:28-Jan	A2:04-Feb	A1:11-Feb	B5:18-Feb	B4:25-Feb	B3:04-Mar	B2:11-Mar	B1:18-Mar
Creep	B1:08-Jan	A5:15-Jan	A4:22-Jan	A3:29-Jan	A2:05-Feb	A1:12-Feb	B5:19-Feb	B4:26-Feb	B3:05-Mar	B2:12-Mar
Iodine clock	B2:08-Jan	B1:15-Jan	A5:22-Jan	A4:29-Jan	A3:05-Feb	A2:12-Feb	A1:19-Feb	B5:26-Feb	B4:05-Mar	B3:12-Mar
Rheology	B3:08-Jan	B2:15-Jan	B1:22-Jan	A5:29-Jan	A4:05-Feb	A3:12-Feb	A2:19-Feb	A1:26-Feb	B5:05-Mar	B4:12-Mar
Synthesis of polymers	B4:08-Jan	B3:15-Jan	B2:22-Jan	B1:29-Jan	A5:05-Feb	A4:12-Feb	A3:19-Feb	A2:26-Feb	A1:05-Mar	B5:12-Mar
Polymer processing (7days report)	B5:14-Jan	B4:21-Jan	B3:28-Jan	B2:04-Feb	B1:11-Feb	A5:18-Feb	A4:25-Feb	A3:04-Mar	A2:11-Mar	A1:18-Mar

Experiment	Thursday Lab Groups									
B-H loop	C1:11-Jan	D5:18-Jan	D4:25-Jan	D3:01-Feb	D2:08-Feb	D1:15-Feb	C5:22-Feb	C4:01-Mar	C3:08-Mar	C2:14-Mar
Brass rolling	C2:11-Jan	C1:18-Jan	D5:25-Jan	D4:01-Feb	D3:08-Feb	D2:15-Feb	D1:22-Feb	C5:01-Mar	C4:08-Mar	C3:14-Mar
Bubble raft	C3:11-Jan	C2:18-Jan	C1:25-Jan	D5:01-Feb	D4:08-Feb	D3:15-Feb	D2:22-Feb	D1:01-Mar	C5:08-Mar	C4:14-Mar
Casting	C4:11-Jan	C3:18-Jan	C2:25-Jan	C1:01-Feb	D5:08-Feb	D4:15-Feb	D3:22-Feb	D2:01-Mar	D1:08-Mar	C5:14-Mar
Crystal radio & FET (7days report)	C5:17-Jan	C4:24-Jan	C3:31-Jan	C2:07-Feb	C1:14-Feb	D5:21-Feb	D4:28-Feb	D3:07-Mar	D2:14-Mar	D1:21-Mar
Creep	D1:11-Jan	C5:18-Jan	C4:25-Jan	C3:01-Feb	C2:08-Feb	C1:15-Feb	D5:22-Feb	D4:01-Mar	D3:08-Mar	D2:14-Mar
Iodine clock	D2:11-Jan	D1:18-Jan	C5:25-Jan	C4:01-Feb	C3:08-Feb	C2:15-Feb	C1:22-Feb	D5:01-Mar	D4:08-Mar	D3:14-Mar
Rheology	D3:11-Jan	D2:18-Jan	D1:25-Jan	C5:01-Feb	C4:08-Feb	C3:15-Feb	C2:22-Feb	C1:01-Mar	D5:08-Mar	D4:14-Mar
Synthesis of polymers	D4:11-Jan	D3:18-Jan	D2:25-Jan	D1:01-Feb	C5:08-Feb	C4:15-Feb	C3:22-Feb	C2:01-Mar	C1:08-Mar	D5:14-Mar
Polymer processing (7days report)	D5:17-Jan	D4:24-Jan	D3:31-Jan	D2:07-Feb	D1:14-Feb	C5:21-Feb	C4:28-Feb	C3:07-Mar	C2:14-Mar	C1:21-Mar

Lab module contributions:

Module	Experiment name	Wt	Module	Experiment name	Wt
MSE.102	Gold nano	3%	MSE.104	Cooling Curve	3%
MSE.102	Iodine clock	3%	MSE.104	Creep experiment	3%
MSE.102	Polymer processing	5%	MSE.104	Fracture Impact	6%
MSE.102	Rheology	3%	MSE.104	Glass transition	3%
MSE.102	Synthesis of polymers	3%	MSE.104	Metallography	3%
MSE.102	Titration	5%	MSE.104	Steels	3%
MSE.102	Viscosity of glass	3%	MSE.104	Tensile 1&2	3%
MSE.104	Brass Rolling	3%	MSE.105	B-H loop	5%
MSE.104	Bubble raft experiment	3%	MSE.105	Crystal radio set experiment	7%
MSE.104	Casting and Heat treatment	3%	MSE.105	PEO	5%

Individual Coursework Information form

Module code	MSE 106
Year of Study	1st Year
Assignment Name	MSE 106: Engineering drawing
Academic in Charge	Prof Andrew Horsfield
Marker	Xin Wang and Russell Stracey
Assignment presented to the students	Week 1 of Term 3
Method of submission	Hard copy
Student's self-study hours	9 hours of self-study required
Deadline date	Tuesday 14th May 2019 9am

Assignment details

Engineering drawing coursework consists of three exercises:

a) Sketching: produce a free-hand sketch of an object or a component which students can choose from science museum or everyday life.
b) Engineering (projection) drawing: produce projection drawing (i.e., elevation, plan and end view) and dimensioning of the object which has been chosen for sketching exercise
c) 3D reconstruction: produce 3D pictorial view of two objects based on the engineering drawings provided.

Other requirements

Please put your full name and CID on the front page.
For exercise a) one A4 page, pencil and eraser are needed but no ruler or compass.
For exercise b) one A4 or A3 page, pencil, eraser, ruler and compass are all necessary.
For exercise b) two A4 pages, pencil, eraser, ruler and compass are all necessary.

Guide Rubric:

The engineering drawing coursework consists of three exercises:

1) Sketching: produce a free-hand sketch of an object or a component which students can choose from science museum or everyday life. This should be one A4 page. A pencil and eraser are needed but no ruler or compass.
   Marking will be based on: a) quality of the sketch 60% (accuracy 30%, neatness 15% and clarity 15%); b) complexity of the chosen object 40 %.
2) Engineering (projection) drawing: produce projection drawing (ie., elevation, plan and end view) and dimensioning of the object which has been chosen for sketching exercise. This should be one A4 or A3 page. A pencil, eraser, ruler and compass are all necessary.
   Marking will be based on: a) complexity of the object 20%; b) Quality and accuracy of projection drawing (elevation view plus plan view and/or end view) 50%; c) dimensioning 20%; d) understanding and indication of used projection system in the drawing 10%.
3) 3D reconstruction: produce 3D pictorial view of two objects based on the engineering drawings provided. This should be two A4 pages. A pencil, eraser, ruler and compass are all necessary.
   Marking will be based on: a) correctness and consistency of the projection used in the drawing 20%; b) accuracy of the drawing (including the consistency of scale used) 50%; c) neatness and clarity 30%.

Individual Coursework Information form

Module code	MSE 106
Year of Study	1st Year
Assignment Name	MSE 106: Presentation exercise
Academic in Charge	Dr Paul Franklyn
Marker	Personal tutors
Assignment presented to the students	At the beginning of Spring term
Method of submission	Presentation in tutor group
Student's self-study hours	5-10 hours of self-study required
Deadline date	Draft: 1st week of Summer term Presentation 3rd week of Summer term

Assignment details

You are required to prepare and deliver a presentation to your tutor group during the summer term – your tutor will award a mark based on your performance. Your tutor will ask each of you to prepare a short, 10-minute presentation using PowerPoint.

Your tutor will prepare or help refer you to articles from science magazines of significant discoveries. You will be asked to pick one. You are to present a 10-minute talk to the group on the topic as if you are the scientist who just made the discovery, re-enacting presenting this research as if for the first time.

Other requirements

The presentation is to last no more than 10 minutes.

Recommended Marking Rubric

Item \ score	0-1	1-3	3-5	5-8	8-10
Quality of draft	No draft submitted	Poor effort, a few slides put together without thought	Fair effort. Slides not well prepared or thought through	Good effort Slides well put together. Several corrections required	Excellent. Very few corrections.
Quality of final presentation	Not done	Poor, changes from draft not effected	Fair effort, some changes effected, overall still poor though	Good effort. Slides well formatted. Most corrected effected	Excellent. All corrections effected. Well assembled
Content	Not done / lacking	Poor effort, did not interpret the paper	Fair effort, some of the main points included from the paper, but off target	Good effort, most of the points included, mostly on target. Some superfluous information	Excellent, all key points included. Well summarised. On target to the point of the paper.
Presentation skills	Not done	Poor, read/ mumbled. Poor body language	Fair effort. Needs work to gain skills of presenting.	Good effort. Generally well presented. Good body language.	Excellent. Confident and clear in presentation