1. Mathematics – BE1-HMath1

When alerting the MEng first year about a formative Mathematics assessment in the first week of term, I also mentioned a College provided learning resource called METRIC. This provides a bridge between pre-university and junior year mathematics. This is a useful standalone learning resource, but it can also be used prior to arrival on campus to reveal some of the Mathematics content that you may not have studied. If you want to explore some new subjects then I suggest you look at some of the following areas: Complex Numbers, Integration, Differential Equations, Mechanics and anything else that intrigues you. You will find useful taught content, and formative assessments to consolidate understanding. Needless to say, you can use METRIC as an additional learning resource during your studies.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
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<tbody>
<tr>
<td>Algebra (Metric)</td>
<td>This class covers the definition of the derivative, from first principles, differentiation of key functions, sums, products, quotients and composites, and using differentiation to sketch curves and solve.</td>
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<tr>
<td>Complex Numbers (Metric)</td>
<td>Learn, or review, what complex numbers are, how to do calculations with them, how to use them to solve trig problems, how to define functions on them and how to represent shapes in the plane.</td>
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<tr>
<td>Coordinate Geometry (Metric)</td>
<td>This class covers straight lines, circles, curves given by parametric equations and curves given by polar equations. The early topics are likely to be revision; you'd have not met the later ones if you've...</td>
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<tr>
<td>Differential Equations (Metric)</td>
<td>Learn, or review, solving first order differential equations by various methods, solving second order differential equations with constant coefficients, and classifying the critical points of...</td>
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<tr>
<td>Differentiation (Metric)</td>
<td>Learn, or review, differentiation from first principles, techniques of differentiation and using differentiation to sketch curves and solve problems.</td>
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<tr>
<td>Functions and Graphs (Metric)</td>
<td>Learn, or review, techniques of integration (parts, substitution, partial fractions, reduction formulae) and applications to areas in the plane and volumes of revolution.</td>
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<tr>
<td>Integration (Metric)</td>
<td>Learn, or review, determinants, matrix inverses, Gaussian elimination and eigenvalues/eigenvectors.</td>
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<tr>
<td>Fourier Theory (Metric)</td>
<td>Learn, or review, Fourier series and sines and cosines half-range series.</td>
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<tr>
<td>Laplace Transforms (Metric)</td>
<td>Learn, or review, Laplace transforms and inverses Laplace transforms.</td>
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<tr>
<td>Limits (Metric)</td>
<td>Learn, or review, limits of sequences and functions, including special cases and L'Hopital's Rule.</td>
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<tr>
<td>Matrices (Metric)</td>
<td>Learn, or review, prime factorization, laws of indices, series and inequalities.</td>
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<tr>
<td>Numerical Methods (Metric)</td>
<td>Learn, or review, numerical integration, iterative solution of equations, fitting curves to data and numerical solution of differential equations.</td>
</tr>
<tr>
<td>Partial Differentiation (Metric)</td>
<td>Learn, or review, the principles and techniques of partial differentiation.</td>
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<tr>
<td>Permutations and Combinations (Metric)</td>
<td>Learn, or review, permutations and combinations, an the binomial theorem.</td>
</tr>
<tr>
<td>Statistics and Probability (Metric)</td>
<td>Learn, or review, basic stats, probability, hypothesis testing, estimation, regression and correlation.</td>
</tr>
<tr>
<td>Trigonometry (Metric)</td>
<td>Learn, or review, trigonometrical functions (and their reciprocals and inverses) and trigonometrical identities.</td>
</tr>
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Vectors (Metric)
Learn, or review, vector quantities, the scalar product and the vector equations of lines and...
2. Programming – BE1-HProg1

In the first year you will learn how to program in C, and in the second year you will learn how to program in C++ which is a superset of C. You will also learn how to program in Matlab in the first year.

Programming is not one of the prescribed subjects we seek on admission, which means, very few first years are admitted with programming competence, and fewer still have a principled understanding of programming i.e. Software Engineering. Therefore, do not feel compelled to do any pre-arrival work, we will teach everyone on the assumption that you have been admitted with no prior programming knowledge. However, the sooner you get used to the software development cycle, the easier the transition from zero to non-zero knowledge will become. Perhaps, this is an activity to be explored during the Autumn term as the computing module is scheduled for the Spring term.

You can gain a gentle introduction to C programming by learning how to use the Arduino starter kit. This is a micro-controller development kit that is sits at the interface between hardware and software. The kit is designed to encourage the novice to start programming (in C) and to use diverse digital and analogue electronic devices, without any theoretical knowledge. The kit encourages learning by doing, the theory comes later. You will also gain some useful basic skills including electronic prototyping with breadboard.

Although, you have to purchase the starter kit, it does provide all the hardware and software needed for all the projects specified in the project book. Whilst the projects are designed to be fun and frivolous they do demonstrate a common Bioengineering solution architecture i.e. Sensor – Processor – Actuator. This architecture is the basis of many Bioengineering solutions, for example, an implant where something is monitored continuously until some condition arises resulting in some consequent action e.g. insulin injection in response to a critical blood sugar level.

The projects are supported by online videos which describe each project activity, and there is extensive online support. The Arduino kit is often used in degree level project activities, starting with the 2nd year group project.

If you are unable to invest the time or money in the Arduino, then consider watching a video introducing the C programming language. Don’t go any further than the 10’th page, and don’t worry if it does not yet make any sense, it will give you the heads-up on concepts described in the first year programming course.

If you are one of the few that has done some programming in the past, and you would like to go a little further then please do contact me directly.
3. Medical Science – BE1-HMS1

The most frequently asked question I receive is about what Biology reading should be done prior to arrival, typically from those that have not studied Biology recently.

We will teach you, what you need to know from human biology. Many of your predecessors were in exactly the same situation and did not suffer. In fact, the typical pre-university Biology qualification has a wider scope than human biology, and does not cover our analytical approach to Biology. As you will soon discover the path from human biology to mathematics is rapid.

The purpose of the remainder of this document is to provide some insight into human anatomy (i.e. form) and physiology (i.e. function) for new undergraduate and postgraduate students, prior to starting your degree programme. Specifically, for those who have never studied human biology or have not studied the subject recently or did not cover much human biology in their previous studies in Biology. The work is optional, and serves only to introduce some vocabulary and concepts.

If you are an undergraduate then you should focus on sections one to three (at least) and if you are a taught postgraduate then focus on all the sections i.e. one to five.

- If your time is limited, then only watch the section (a) video lecture extracts.
- If you have more time, then
  - Skim read the section (b) extracts from the wikibook, which will go in to far more detail than you need initially. Note you may find it helpful as a reference during your taught modules.
  - Watch the short videos in section (c) which will help to visualise concepts. Explore related videos if you have the time.

This is not meant to be an onerous task, nor is it homework, and you are not expected to memorise the content referenced below. The purpose of working through the sections below, before arrival on campus, is that it will give you the heads-up on concepts that will might be new to you. Therefore, you should find that it will be easier to understand the same concepts on a second hearing, and as the course is being delivered. The three online resources used below may be useful during your studies.

1. Introduction:
   a. Watch the first 8min 40s of Lecture 1, and the first 2min 41s of Lecture 2.
   b. Read Human Physiology/Physiology Introduction
   c. Go to http://blausen.com/en/ and search on the follow suggested phrases and watch the resultant short video:
      - levels of organisation (muscular system),
      - structure of an atom,
      - dna,
      - primary and secondary protein structure,
      - organelle,
      - overview of cellular anatomy,
      - white blood cell: neutrophil,
      - muscle tissue,
      - fluid connective tissue.
2. **The Respiratory system:**
   a. Watch the first 2min 14s of Lecture 18.
   b. Read *Human Physiology/The respiratory system*
   c. Go to http://blausen.com/en/ and search on the follow suggested phrases and watch the resultant short video:
      o respiratory system,
      o respiration,
      o overview of the respiratory tract,
      o lung function,
      o the trachea.

3. **The Cardiovascular system:**
   a. Watch the first 4min 30s of Lecture 15, the first 2min 57s of Lecture 8, and the first 1min 58s of Lecture 17.
   b. Read *Human Physiology/The cardiovascular system*
   c. Go to http://blausen.com/en/ and search on the follow suggested phrases and watch the resultant short video:
      - circulatory system,
      - cardiovascular system,
      - how the heart works,
      - overview of heart anatomy and physiology,
      - stress test / ecg,
      - blood pressure.

4. **The Neurological system:**
   a. Watch the first 3min 37s of Lecture 9, the first 1min 20s of Lecture 10 and the first 4min 58s of Lecture 16.
   b. Read *Human Physiology/The Nervous System*
   c. Go to http://blausen.com/en/ and search on the follow suggested phrases and watch the resultant short video:
      - nervous system,
      - central nervous system,
      - peripheral nervous system,
      - autonomic nervous system,
      - nervous system function,
      - spinal cord: sensory and motor signals,
      - neuron structure in CNS.

5. **Musculoskeletal system:**
   a. Watch the first 1min 42s of Lecture 4 and the first 2min 57s of Lecture 8.
   b. Read *Human Physiology/The Muscular System*
   c. Go to http://blausen.com/en/ and search on the follow suggested phrases and watch the resultant short video:
      - skeletal system (male),
      - spinal anatomy,
      - cervical spine anatomy,
      - spinal cord and spinal canal,
      - osteoarthritis,
      - osteoporosis.
The material above is derived from two public domain resources and one proprietary resource:

- The public domain resources are the Blausen website and the Wikibook Human Physiology. The former also includes videos describing Bioengineering technologies.

- The extracts from the proprietary website Educator.com are in the public domain and are adequate for boot-strapping you into a new subject area. Note: The taught modules in your degree programme will develop your knowledge and understanding of human biology in a way that does not mirror the lectures on this particular website. Therefore, do not feel compelled to pay for full access to the lecture content on the website – unless you want to.

Note: A full set of course materials will be provided on Blackboard for all your taught modules. As a module is being delivered you should use the provided course materials as your primary study resource. If you are not sure about the merits of an Internet based resource, then please ask your module leader for guidance.

If you have any questions about the above, then please do contact me.

Best wishes,

Liam Madden (l.madden@imperial.ac.uk)