

A review of current undergraduate and postgraduate medical engineering courses in the UK

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Abstract: *This paper reviews mechanical engineering based medical engineering degrees which are currently provided in the UK at undergraduate and postgraduate levels. At present there are fourteen undergraduate degree programmes in medical engineering and there are eighteen institutions which provide postgraduate degree programmes in this area. Nine institutions, namely the Universities of Bath, Bradford, Hull, Imperial College London, Leeds, Nottingham, Oxford, Queen Mary University London and Surrey, offer undergraduate and postgraduate courses in medical engineering. In addition undergraduate courses in medical engineering are offered by the Universities of Birmingham, Cardiff, Sheffield, Southampton and Surrey. At postgraduate level the Universities of Aberdeen, Brunel, Dundee, Keele, King's College London, Liverpool, Strathclyde, Ulster and Warwick also offer courses in medical engineering. While most undergraduate courses are delivered on a full-time basis, more flexible delivery modes appear to be available at MSc level. Over all the courses a very wide range of modules are offered by the various universities.*

Introduction

The medical technology industry has been said to have a worldwide value of €200 billion in 2004 (O'Donnell 2005). Within this sector the medical engineering industry has been valued at £50 billion (IMechE 2008). There is national and international growth in medical technology, due to recognised factors such as an ageing population, increased demand for healthcare, and innovation within the medical field. Moreover, as indicated by data from the Higher Education Statistics Agency, demand for medical and medical related degrees in the UK has increased over the past few years. Given this situation it is expected that employer demand for graduates and postgraduates in the medical engineering field will be strong. Universities in the UK have responded by offering an increased number of MSc qualifications and, more recently, undergraduate degrees in subjects related to medical engineering. As no-one has published such a review before, this paper sets out to document and assess these medical engineering courses which are currently available in the UK. The paper may be of significance to the many academics that have interests in the growing field of medical engineering, and therefore of its teaching, and the findings reported in this paper might benefit course development in medical engineering as well as potentially informing a strategic overview of such provision.

Methods and materials

When searching for appropriate undergraduate courses, the first source of data was the University Central Admissions Service (UCAS) (www.ucas.co.uk). Search terms used on the UCAS website included 'biomedical engineering', 'bioengineering' and 'medical engineering'. From the 'hits', the websites of specific universities were visited and searches made for appropriate courses. This UCAS search was augmented by the author's own knowledge of the academic medical engineering field. Inclusion criteria for undergraduate courses were that the course be an engineering degree (as indicated by a BEng or MEng qualification) and that the degree should have a significant mechanical engineering component. This latter criterion was chosen, not out of any bias against other engineering disciplines, but because it was recognised that most medical engineering undergraduate degree courses in the UK have a significant contribution from mechanical engineering. An example of an undergraduate degree that was excluded was from this review was the BEng in Biomedical Engineering offered by City University London, which is described as an electrical and electronics based discipline (City_University_BEng_BME 2008). Degrees in medical physics were also excluded as were those felt to have a bias towards materials rather than engineering. For example the MEng Materials Engineering in Medicine offered by Queen Mary University London was excluded from this review (Queen_Mary_University_London_MEng_MEM 2008).

For the postgraduate courses the Prospects website was searched (www.prospects.ac.uk). Again search terms included 'medical engineering', 'bioengineering' and 'biomedical engineering'. As with the undergraduate search, individual university websites were then searched for appropriate MSc courses. Again this search was augmented by the author's personal knowledge of the field. Similar exclusion criteria were applied to the postgraduate courses. Therefore some degrees were excluded as they were felt to be materials based rather than engineering based, one example being the recently offered MSc in Medical and Healthcare Devices introduced by the University of Bolton (Bolton_University_MSc_MHD 2008). Similarly, City University London currently offers an MSc in Biomedical Engineering (City_University_MSc_BME 2008). However on investigation it was seen that the degree was linked to programmes grouped with Electrical and Electronic Engineering. Therefore it too was excluded from this review.

Results and Discussion

Undergraduate courses

As can be seen from table 1, fourteen institutions have been listed which currently offer medical engineering related undergraduate degrees. These institutions are the Universities of Bath (University_of_Bath_MEng_MedE 2008), Birmingham (University_of_Birmingham_UG_BME 2008), Bradford (University_of_Bradford_UG_MedE 2008), Cardiff (Cardiff_University_UG_MedE 2008), Hull (University_of_Hull_UG_MecMedE 2008), Imperial College London (Imperial_College_London_UG_BME 2008), Leeds (University_of_Leeds_UG_MedE 2008), Nottingham (University_of_Nottingham_UG_MecEBio 2008), Oxford (University_of_Oxford_MEng_BME 2008), Queen Mary University London (Queen_Mary_University_London_MEng_MedE 2008), Sheffield (University_of_Sheffield_UG_BME 2008), Southampton (University_of_Southampton_MEng_MecEBio 2008), Surrey (University_of_Surrey_UG_MedE 2008) and Swansea

(Swansea_University_UG_MedE 2008). The majority of these, 10 out of 14, specifically the Universities of Birmingham, Bradford, Cardiff, Hull, Imperial College London, Leeds, Nottingham, Sheffield, Surrey and Swansea offer both three-year full-time BEng and four-year full-time MEng degrees. The Universities of Bath, Oxford, Queen Mary University London and Southampton offer four-year MEng degrees only.

Degree titles include 'Medical Engineering' (Universities of Bath, Bradford, Cardiff, Leeds, Queen Mary University London, Surrey and Swansea); 'Biomedical Engineering' (Universities of Birmingham, Imperial College London, Oxford and Sheffield); 'Mechanical and Medical Engineering' (University of Hull); 'Mechanical Engineering (Bioengineering)' (University of Nottingham); and 'Mechanical Engineering/Bioengineering' (University of Southampton).

As can also be seen from table 1 a wide range of modules are offered by the various providers. Some of the more distinctive modules include those in 'life support engineering' (University of Bath), 'human biodynamics' (University of Bradford) and 'forensic bioengineering' (Cardiff University). More common modules include biomaterials, biomechanics and anatomy and physiology. The latter subjects would likely be needed to given engineering undergraduates an appreciation of the muscles, bones and medical terminology associated with the human body. Subjects such as biomaterials and biomechanics could be viewed as the medical-specific developments of traditional engineering subjects. In table 1, undergraduate projects have not been specifically listed but they are all presumed to be medical engineering based.

Table 1 shows that degrees with 'core' first and second years are offered by the Universities of Bath, Birmingham, Hull, Leeds, Nottingham, Southampton and Surrey. Therefore half of the providers of available undergraduate programmes in medical engineering choose to follow this route. Clearly a common core degree will allow a new course to be introduced more rapidly, in that there will be two years of medical engineering related options, compared with a degree in which there are four years of medical engineering related options. Similarly it could be argued that this scheme of having a core first two years allows students time to investigate different aspects of engineering and then to make a decision when, arguably, they are more mature and have greater academic experience. The counter argument is that students who are dedicated to medical engineering could be de-motivated by studying non medical engineering subjects which they may consider extraneous to their interests and career aspirations. Of the seven 'non-core first two years' undergraduate degree programmes, the trend is that more medical engineering modules are introduced as the degrees develop. For example this is seen with the courses offered by the University of Bradford and Queen Mary University London. However it can also be seen that programmes such as that of the University of Surrey and the University of Sheffield do not follow this tendency.

All courses are accredited by the Institution of Mechanical Engineers (IMechE) or, in the case of the newest course, that at Swansea University, accreditation is being sought. As can also be seen from table 1, there is no mention of these degrees being offered on a part-time basis. In terms of variation, Swansea and Surrey Universities mention that a foundation year is available. Sandwich courses are also possible, as specifically mentioned in the course literature of the Universities of Bradford and Cardiff. While exact dates are difficult to find, the number of available undergraduate courses in medical engineering has grown rapidly since the late 1990s. Some of the most recently introduced courses have been those of Oxford University (2004), Hull University and Swansea University (2007). Where information

is available on the number of credits for modules, it can be seen that these appear to be a minimum of 10 and 20 in year 3 at the Universities of Southampton and Leeds respectively, and 10 and 20 credits in year 4 at the Universities of Sheffield and Nottingham respectively. As has been noted, these values neglect credits available for projects, which are assumed to be medical engineering based.

Postgraduate courses

Table 2 shows that eighteen institutions offer postgraduate courses related to medical engineering. These are the Universities of Aberdeen (University_of_Aberdeen_MSc_BioE 2008), Bath (University_of_Bath_MSc_Biomimetics 2008), Bradford (University_of_Bradford_MSc_MedE 2008), Brunel (Brunel_University_MSc_BiomedE 2008), Dundee (University_of_Dundee_MSc_DMT 2008), Hull (University_of_Hull_MSc_MedE 2008), Imperial College London (Imperial_College_London_MSc_EPSM 2008), Keele (Keele_University_MSc_BiomedE 2008), King's College London (King's_College_London_MSc_MEP 2008), Leeds (University_of_Leeds_MSc_MedE 2008), Liverpool (Liverpool_University_MSc_MedE 2008), Nottingham (University_of_Nottingham_MSc_BioE 2008), Oxford (University_of_Oxford_MSc_BiomedE 2008), Queen Mary University London (Queen_Mary_University_London_MSc_BiomedE 2008), Strathclyde (University_of_Strathclyde_MSc_Bio 2008), Surrey (University_of_Surrey_MSc_BiomedE 2008), Ulster (University_of_Ulster_MSc_Eng(BE) 2008) and Warwick (University_of_Warwick_MSc_BiomedE 2008).

Degree titles include: 'Biomedical Engineering' (Universities of Aberdeen, Brunel, Keele, Oxford, Queen Mary University London, Surrey and Warwick); 'Medical Engineering' (Universities of Bradford, Hull, Leeds and Liverpool); 'Bioengineering' (Universities of Nottingham and Strathclyde), MSc 'Engineering (Biomedical Engineering)' (University of Ulster); 'Engineering and Physical Science in Medicine' (Imperial College London); 'Medical Engineering and Physics' (King's College London); 'Design for Medical Technologies' (University of Dundee) and 'Biomimetics and Technical Creativity' (University of Bath).

The majority of the MSc courses are offered as a full-time one year programme, with many also being available as two or three year part-time courses. However there is one exception. The MSc in Medical Engineering at the University of Bradford is offered on a part-time basis only, and only to applicants who are working in the UK. Most course literature states that Postgraduate Diploma and Postgraduate Certificates are also available to students, should they be unable to reach the MSc level. Given that most courses are delivered on a full-time basis, it is worth noting that a number of modules of the Leeds MSc are offered as distance learning (3 courses) and short courses (5 courses). Similarly the University of Nottingham MSc programme is designed to offer its students access to these modules too.

As shown in table 2, a huge range of modules are available. At one end of the spectrum, unique modules include 'Biomimetics' (University of Bath), 'Biomedical Engineering in Urology' (Queen Mary University of London) and 'Population Dynamics of Infectious Diseases' (University of Warwick). In contrast, relatively common topics include Biomechanics (Universities of Bath, Brunel, Dundee, Imperial College London, Keele, King's College London, Leeds, Nottingham, Strathclyde and Surrey) and Biomaterials (Universities of Bath, Bradford, Brunel, Dundee, Hull, Imperial College London, Keele, Leeds, Liverpool, Nottingham, Strathclyde, Surrey, Ulster and Warwick). Perhaps this is unsurprising. Biomaterials and Biomechanics

are recognised as fundamental aspects of medical engineering, just as materials and mechanics are recognised as essential components of mechanical engineering degrees. Moreover, postgraduate degrees in Biomaterials are available at a number of Universities such as University College London which offers an MSc in Biomaterials and Tissue Engineering (University_College_London_MSc_BTE 2008) and Queen Mary University London offers an MSc in Dental Materials (Queen_Mary_University_London_MSc_DentalM 2008), while a Masters degree in Applied Biomechanics is offered by the University of Strathclyde (University_of_Strathclyde_MSc_App_Biomech 2008).

It should also be pointed out that the size of modules, in terms of their credit value, can vary markedly. Therefore it is possible that a large 'bioengineering' module could encompass topics that are identified as single modules at other universities. For example, the University of Oxford offers a large module in 'Biomedical Engineering' while Liverpool University offers smaller, 7.5 credit modules in topics such as 'Blood-Device Interactions' and 'Fluid and Solid Tissue Mechanics'. As shown in table 2, where the data is available, most of the research projects are worth 60 credits although this can increase to 90 credits in the MSc programmes offered by the Universities of Dundee and Warwick. It is presumed that these projects will be medical engineering based and so they have not been specifically listed in table 2.

Several of the MSc programmes share modules with a suite of MSc programmes offered by particular Universities. Examples include: the MSc in Biomedical Engineering at the University of Dundee; the MSc in Cell and Tissue Engineering offered by Keele University; and the MRes in Biomedical Engineering and the MSc in Applied Biomechanics, both offered by the University of Strathclyde. Moreover it should be noted that the University of Aberdeen offers MSc degrees in Medical Physics, Medical Physics Computing and Medical Imaging, as well as the Biomedical Engineering degree listed in table 2. Therefore, at the University of Aberdeen, there is an emphasis on Medical Physics and this is likely part of the reason why their Biomedical Engineering course is accredited by the Institute of Physics and Engineering in Medicine (IPEM).

A number of the MSc courses state that they have a relatively long history. For example the University of Surrey claims links back to 1964; the University of Dundee literature states that their first MSc course in Biomedical Engineering Science was offered in 1978; the University of Aberdeen claims 1987; while Imperial College London mentions 1991; and King's College London 1992. More recently offered MSc programmes in medical engineering include those at the Universities of Bath, Oxford (January 2006) and Hull (2007).

By comparing tables 1 and 2 it can be seen that undergraduate and postgraduate courses in medical engineering related subjects are offered by the Universities of Bath, Bradford, Hull, Imperial College London, Leeds, Nottingham, Oxford, Queen Mary University London and Surrey. Therefore the majority of institutions (9 out of 14) which offer an undergraduate qualification in medical engineering also offer a postgraduate qualification. This likely implies that modules are shared between undergraduate and postgraduate courses and indeed a comparison of tables 1 and 2 supports this assertion.

Also by comparing the two tables it appears that accreditation is less of an issue at postgraduate level than at undergraduate level. Whereas at undergraduate level most if not all courses are accredited by the IMechE, at postgraduate level accreditation is less commonly mentioned in course literature and accreditation by a

body other than the IMechE, the IPem, occurs in the case of courses offered by the Universities of Aberdeen, King's College London and Surrey.

It is interesting to note that while a number of postgraduate courses are provided, no undergraduate courses in medical engineering are currently offered in Scotland. As has been seen, the growth in the medical engineering market is reflected in the growing number of medical engineering courses at undergraduate and postgraduate level. Due to limitations of space these UK courses are not compared and contrasted with similar programmes available in Ireland, Europe, USA, Canada, Australia and the rest of the world. However it is worth noting that there are differences in emphasis in programmes between different countries. For example, Irish undergraduate medical engineering programmes tend to follow the UK model with their stress on mechanical engineering. In contrast degree programmes such as those in Hong Kong or Malaysia tend to have an emphasis on electrical engineering, while the many medical programmes offered in the United States tend to have a strong commitment to biology and its related disciplines. These differences in emphasis can be debated but it is important to recognise them and this review also aims to allow an overseas readership to appreciate the current situation in the UK.

Conclusion

This is the first review of available undergraduate and postgraduate degree programmes offered in the UK in the field of medical engineering. This field is growing rapidly and such growth has been mimicked by the growth in academic programmes. A range of modules are offered across the eighteen postgraduate courses and the fourteen undergraduate medical engineering degree programmes identified in this review.

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Table 1. Undergraduate Medical Engineering Degree Programmes

University and degree title	Medical engineering modules (and credits, where known)	Notes
University of Bath Medical Engineering, MEng	<u>Years 1 and 2:</u> Core <u>Year 3:</u> <ul style="list-style-type: none"> • Biomechanics (6) • Life support engineering (6) • Biomedical and natural materials (6) • Medical physics (6) optional • Rehabilitation engineering (6) optional <u>Year 4:</u> <ul style="list-style-type: none"> • Advanced biomechanics (6) • Advanced biomaterials (6) • Medical instrumentation (6) • Biomimetics (6) 	4 Year, full-time. Accredited by IMechE
University of Birmingham Biomedical Engineering, BEng and MEng	<u>Years 1 and 2:</u> Core <u>Year 3:</u> <ul style="list-style-type: none"> • Materials design for biomedical applications • Medical device design <u>Year 4:</u> <ul style="list-style-type: none"> • Topics in biomedical engineering • Radiation and medical imaging • Rehabilitation engineering 	BEng, 3 year, MEng, 4 year. Both full-time. Accredited by IMechE
University of Bradford Medical Engineering, BEng and MEng	<u>Year 1:</u> <ul style="list-style-type: none"> • Medical physiology (10 and 10) <u>Year 2:</u> <ul style="list-style-type: none"> • Cell biology for engineering (10) • Human biodynamics (10) 	BEng, 3 year, MEng, 4 year. Both full-time. Accredited by IMechE Optional 'sandwich' course, including year in industry prior to final year (3 rd year for BEng, 4 th for MEng). A BSc degree in

	<ul style="list-style-type: none"> • Biomechanics (10) <u>Years 3 and 4:</u> <ul style="list-style-type: none"> • Medical ethics and regulations (10) • Biomaterials (10) • Physiology measurement (10) • Biotribology (10) • Rehabilitation engineering (10) • Medical instrumentation and imaging (10) • Implant design and technology (10) 	Clinical Technology is also offered.
Cardiff University Medical Engineering, BEng and MEng	<u>Year 1:</u> <ul style="list-style-type: none"> • Anatomy/Physiology (10) <u>Year 2:</u> <ul style="list-style-type: none"> • Clinical engineering I (10) • Biomechanics I (10) <u>Year 3:</u> <ul style="list-style-type: none"> • Biomechanics II (10) • Clinical engineering II (10) • Clinical Engineering III (10) • Orthopaedic and Rehabilitation Engineering (10) <u>Year 4:</u> <ul style="list-style-type: none"> • Sports biomechanics (10) • Forensic bioengineering (10) • Digital medical imaging (10) • Medical ultrasound (10) 	BEng, 3 year, MEng, 4 year. Both full-time. Accredited by IEE, IMechE Optional 'sandwich' course, including year in industry prior to final year (3 rd year for BEng, 4 th for MEng)
University of Hull Mechanical and Medical Engineering, BEng and MEng	Full details not available. First two years appear to be core, followed by modules in biomechanics, biomaterials and implant design.	BEng, 3 year, MEng, 4 year. Both full-time. Accredited by IMechE. The University also offers a 3 year full-time Degree entitled Medical Product Design
Imperial College, London Biomedical Engineering,	<u>Year 1:</u> <ul style="list-style-type: none"> • Molecules, cells and tissues • Medical science I 	BEng, 3 years, MEng, 4 years. Both full-time. For the MEng courses, years 1 and 2 are the same. Year 3 is then replaced

BEng and MEng	<u>Year 2:</u> <ul style="list-style-type: none"> • Medical science II <u>Year 3 (BEng only) and Year 4 (MEng only):</u> <ul style="list-style-type: none"> • Medical imaging • Biomechanics • Artificial organs and tissue engineering • Physiological monitoring and data analysis • Modelling of physiological and pathological processes 	by a specialty year offered by either electrical or mechanical engineering. Year 4 is then the BEng year 3. Website mentions 'total expected student intake 50'
University of Leeds Medical Engineering, BEng and MEng	<u>Years 1 and 2:</u> Core <u>Year 3:</u> <ul style="list-style-type: none"> • Biomedical engineering (20) <u>Year 4:</u> <ul style="list-style-type: none"> • Biotribology (distance learning) (15) • Biomaterials (short course) (15) • Functional joint replacement technology (short course) (15) • Tissue engineering (15) • Movement analysis (10) • Mechanics of sport and performance (10) 	BEng, 3 years, MEng, 4 years. Both full-time.
University of Nottingham Mechanical Engineering (Bioengineering), BEng and MEng	<u>Years 1 and 2:</u> Core <u>Year 3:</u> <ul style="list-style-type: none"> • Human structure and function for engineers (10) • Cell structure and function for engineers (10) • Biomechanics (10) • Engineering biomaterial structures <u>Year 4:</u> <ul style="list-style-type: none"> • Biomedical applications of biomaterials (20) 	BEng, 3 years, MEng, 4 years. Both full-time. Accredited by IMechE Note: credits taken from values given for modules on MSc Bioengineering. A BSc in Biomedical Material Science is also offered
Oxford University Biomedical Engineering MEng	First year core, second, third and fourth years have one biomedical engineering option each.	4 year full-time Degree. Accredited by IMechE. Introduced in October 2004.

<p>Queen Mary University London Medical Engineering, MEng</p>	<p><u>Year 1:</u></p> <ul style="list-style-type: none"> • Medical engineering I <p><u>Year 2:</u></p> <ul style="list-style-type: none"> • Aspects of medical engineering II • Functional materials in medical engineering <p><u>Year 3:</u></p> <ul style="list-style-type: none"> • (Aspects of) medical engineering III • Tissue engineering • Principles and applications of medical engineering <p><u>Year 4:</u></p> <ul style="list-style-type: none"> • Biomechanical aspects of rehabilitation engineering <p>Options:</p> <ul style="list-style-type: none"> • Urology • Clinical measurements • Advanced biofluids • Implant design • Medical ethics 	<p>4 years, full-time. Accredited by IMechE A MEng Materials Engineering in Medicine as well as a BEng in Biomedical Materials Science and Engineering are also offered.</p>
<p>University of Sheffield Biomedical Engineering, BEng and MEng</p>	<p><u>Year 1:</u></p> <ul style="list-style-type: none"> • Biology and chemistry of living systems (20) • Circuits and signals for biomedical engineers (10) • Introduction to bioengineering (10) • Introduction to human anatomy and physiology (10) • Physics of living systems II (10) <p><u>Year 2:</u></p> <ul style="list-style-type: none"> • The physiology of the musculoskeletal system (10) • Biomedical instrumentation (10) • Cell and molecular biology (10) • Processing of physiological signals I (10) <p><u>Year 3:</u></p> <ul style="list-style-type: none"> • Clinical engineering and computational mechanics (10) • Management of bioengineers (10) 	<p>BEng, 3 years, MEng, 4 years. Both full-time. Accredited A BEng/MEng in Biomaterial Science and Tissue Engineering is also offered.</p>

	<ul style="list-style-type: none"> • Research seminars in bioengineering (10) <p><u>Year 4:</u></p> <ul style="list-style-type: none"> • Fundamental biomechanics (10) 	
University of Southampton Mechanical Engineering/Bioengineering, MEng	<p><u>Years 1 and 2:</u> Core</p> <p><u>Year 3:</u></p> <ul style="list-style-type: none"> • Orthopaedic biomechanics (10) <p><u>Year 4:</u></p> <ul style="list-style-type: none"> • Biological flows (10) • Biomaterials (10) • Computer methods in orthopaedic bioengineering (10) 	4 years, full-time. Accredited by IMechE
University of Surrey Medical Engineering, BEng and MEng	<p><u>Year 1:</u> Core</p> <p><u>Year 2:</u></p> <ul style="list-style-type: none"> • Human biology (10) • Biomechanics (10) • Healthcare practice (10) <p><u>Year 3:</u></p> <ul style="list-style-type: none"> • Analysis of human movement (10) • Biomedical microengineering (10) • Prosthetics and orthotics (10) <p><u>Year 4:</u></p>	BEng, 3 years, MEng, 4 years. Both full-time. Accredited by IMechE No details of year 4 modules available on website. A foundation year allowing access to the BEng is also offered.
Swansea University Medical Engineering, BEng and MEng	Precise details not available, however it is stated that 'In levels 1 and 2 you will encounter the fundamentals of engineering science and design, alongside introductory material in fields such as cell biology, human physiology and medical diagnostics. In levels 3 and 4 the clinical content of the course will increase, with modules offered in areas such as implant and prosthetic technology, tissue engineering and cell and immuno-biology. Further modules will also be available in areas such as bio-nanotechnology, nano-materials and bio/ergonomic factors in engineering'.	3 year BEng and 4 year MEng, full-time only. Foundation year available. First entry 2007. Accreditation being sought from IChemE, IMechE, IPEM

Table 2. Postgraduate medical engineering degree programmes

University and degree title	Relevant modules (and credits where known)	Notes
University of Aberdeen MSc in Biomedical Engineering	Compulsory <ul style="list-style-type: none"> • Ionising Radiations • Non-Ionising radiations and Other Modalities • Bioengineering • Biomedical Studies Choose three from: <ul style="list-style-type: none"> • Medical electronics and instrumentation • Rehabilitation engineering • Radiotherapy and Radiation Physics • Magnetic Resonance Imaging • Medical Image Processing and Analysis • Biomedical Computing 	Full-time, 1 year, part-time 2 years Accredited by Institute of Physics and Engineering in Medicine (IPEM). Started 1987. A number of MSc degrees are offered by the department of Medical Physics, which is part of the College of Life Sciences and Medicine. The other MSc degrees are in Medical Physics, Medical Physics Computing, and Medical Imaging. 60 credit research project
University of Bath MSc in Biomimetics and Technical Creativity	Compulsory <ul style="list-style-type: none"> • Biomimetics Options <ul style="list-style-type: none"> • Biomechanics • Biomedical and Natural Materials 	Full-time 1 year, part-time 3 years. Postgraduate Diploma and Certificate also available. 6 students in 2006.
University of Bradford MSc in Medical Engineering	<ul style="list-style-type: none"> • Medical Ethics and Regulations (10) • Physiological Measurement (10) • Biomaterials (10) • Biotribology (10) 	1 year part-time, UK working applicants only. Postgraduate Diploma also available. Accreditation being sought. 60 credit research module
Brunel University MSc in Biomedical Engineering	Compulsory: <ul style="list-style-type: none"> • Signal Processing and Biomedical Instrumentation (15) • Biomechanical Engineering Principles (15) • Biomechanics and Biomaterials (15) • Artificial Organs and Biomedical Applications (15) • Biofluid Mechanics (15) 	Full-time 1year. Accredited by IMechE

<p>University of Dundee MSc in Design for Medical Technologies</p>	<p>Compulsory:</p> <ul style="list-style-type: none"> • Imaging and Instrumentation for Medicine and Surgery (30) • Biomechanics and Biomaterials (30) • Advanced Medical and Surgical Instrumentation (30) 	<p>Full-time 1 year, includes a 90-credit research project. The University also offers a MSc in Biomedical Engineering. However this degree is primarily aimed at Chinese students who have completed 60 credits of appropriate modules in China prior to completing the course in Dundee. First MSc course in Biomedical Engineering Science offered in 1978.</p>
<p>University of Hull MSc in Medical Engineering</p>	<p>Specific details not given on-line. However the course flyer states that the key subjects covered in the programmes include: anatomy and physiology, biomaterials and biological materials, cardiovascular devices, medical device innovation, medical device standards and regulations, medical imaging, medical statistics, musculoskeletal modelling, orthopaedic devices, regenerative medicine, tissue engineering and visualization of medical data.</p>	<p>First offered 2007</p>
<p>Imperial College London MSc in Engineering and Physical Science in Medicine</p>	<p>Compulsory:</p> <ul style="list-style-type: none"> • Medical Science • Image Processing • Radiation Physics • Physiological Monitoring • Introductory Medical Imaging <p>Options:</p> <ul style="list-style-type: none"> • Biomechanics in Medicine • Biomaterials/Tissue Engineering • Health Economics • Computational Neuroscience • Advanced Medical Imaging • Radiotherapy Physics/Radiobiology • Nuclear Medicine 	<p>Full-time 1 year. Started 1991. Offer two 'pathways': Medical Physics and Bioengineering.</p>
<p>Keele University</p>	<p>Compulsory:</p>	<p>Full-time and part-time, start dates</p>

MSc in Biomedical Engineering	<ul style="list-style-type: none"> • Physiological Measurements and Medical Imaging (20) • Biomedical Signal Processing and Modelling (20) • Medical Electronics and Equipment Management (20) • Seminar Programme (20) <p>Options:</p> <ul style="list-style-type: none"> • Physiology and Anatomy (10) • Biosensors (10) • Orthopaedics and Rehabilitation (10) • Healthcare Technology Assessment (10) • Cell biomechanics (10) • Healthcare Informatics (10) • Cell and Tissue Engineering (20) • Biomechanics (20) • Biomaterials (20) 	September and January. Also offer an MSc in Cell and Tissue Engineering, which is based on the same modules, though a different group are compulsory to those for the Biomedical Engineering course. 60 credit research module
Kings College London MSc Medical Engineering and Physics	<p>Compulsory:</p> <ul style="list-style-type: none"> • Basis of Medical Technology (15) • Basis of Human Anatomy and Physiology (15) • Medical Data Processing (30) • Radiation Physics (15) <p>Options include:</p> <ul style="list-style-type: none"> • Biomechanics and Ergonomics (15) • Management of Medical Equipment (15) • Medical Instrumentation (15) • Physics of Medical Imaging with Ionising Radiation (15) • Physics of Medical Imaging with Non-ionising Radiation (15) • Radiation Protection (15) • Radiotherapy Physics (15) • Rehabilitation Engineering (15) 	Part-time 2 years and full-time 1 year, accredited by IPEM. Introduced 1992. Two streams are offered: Medical Engineering and Medical Physics. 60 credit research project
University of Leeds MSc Medical Engineering	<ul style="list-style-type: none"> • Basic Orthopaedic Engineering (5) • Physiological Measurement and Assessment (15) • Cardiovascular Mechanics and Devices (15) 	Full-time 1 year, part-time also available. Some modules can be taken as short courses and others by distance learning.

	<ul style="list-style-type: none"> • Spinal Biomechanics and Instrumentation (15) • Medical Device Engineering and Innovation (15) • Biomedical Engineering Simulation (15) • Biomaterials and Biotribology (15) • Innovation in Medical Devices (15) • Biotribology (15) • Biomaterials (15) • Functional Joint Replacement Technology (15) • Introductory Medical Device Engineering (15) • Human Anatomy and Physiology (15) • Tissue Engineering (15) • Rehabilitation Engineering (15) 	60 and 75 credit research projects are available.
Liverpool University MSc in Medical Engineering	Options include: <ul style="list-style-type: none"> • Structural Biomaterials (15) • Tissue Device Interactions (7.5) • Cell Biology and Tissue Engineering (15) • The Medical Device Industry 1 (7.5) • Blood Device Interactions (7.5) • Fluid and Solid Tissue Mechanics (7.5) • Medical Instrumentation and Devices (15) • The Medical Device Industry 2 (7.5) 	Full-time 1 year. Postgraduate Certificate and Postgraduate Diploma also available. 60 credit research project.
University of Nottingham MSc in Bioengineering	Core <ul style="list-style-type: none"> • Human Structure and Function (10) • Cell Structure and Function for Engineers (10) • Biomedical Applications of Biomaterials (20) • Biomechanics (10) Options include: <ul style="list-style-type: none"> • Advanced Biomaterial Structures (10) • Cell Material Interactions (10) • Spinal Biomechanics and Instrumentation (10) 	Full-time 1 year, part-time 2-3 years. Individual modules can be taken as Continuing Professional Development (CPD) short courses. Part-time courses offer access to modules at Strathclyde and Leeds Universities. 60 credit research project
Oxford University	Modules include Biomedical Engineering, Applied Biomedical	The MSc began admitting students in

MSc in Biomedical Engineering	Engineering, and the Healthcare Industry.	January 2006. Accreditation to be sought from IPEM
Queen Mary University of London MSc in Biomedical Engineering	<p>Core</p> <ul style="list-style-type: none"> • Medical Ethics, Law and Regulation in Bioengineering <p>Options include:</p> <ul style="list-style-type: none"> • Advanced Tissue Engineering • Advanced Biofluid Mechanics • Biomechanics and Motion Analysis • Biomedical Engineering in Urology • Medical Imaging • Implant Design Technology • Clinical Measurements 	
University of Strathclyde MSc Bioengineering	<p>Conversion module:</p> <ul style="list-style-type: none"> • Medical Science or Engineering Science (18) <p>Compulsory module:</p> <ul style="list-style-type: none"> • Bioengineering and Health Care (12) <p>Options include:</p> <ul style="list-style-type: none"> • Biomedical Electronics (12) • Materials and their Biomedical Application (12) • Medical Device Technology for Organ Replacement (12) • Biomechanics (12) • Biomedical Instrumentation (12) • Biosignal Processing and Analysis (12) • Assessment of Biomedical Materials (12) • Prosthetics and Orthotics (12) • Orthopaedic and Cardiovascular Devices (12) • Biomedical Engineering Case Studies (12) 	Full-time 1 year, part-time 2 years. Also offered are an MRes in Biomedical Engineering, which includes 108 credits of 'satisfactory completion of research project requirements'. Comprises conversion classes, compulsory classes and advanced study class options'. MSc, Postgraduate Diploma, Postgraduate Certificate in Applied Biomechanics by Distance Learning is also available. Duration normally 24-36 months.
University of Surrey MSc in Biomedical Engineering	<p>Core Modules</p> <ul style="list-style-type: none"> • Human Biology • Biomechanics • Professional topics 	Full-time 1 year. Part-time available. Accredited by IPEM. Founded in 1964. 60 credit research project.

	<p>Specialist modules</p> <ul style="list-style-type: none"> • Physiological Measurement • Principles of Biomaterials • Microengineering in Medicine • Orthopaedic Biomechanics and Biomaterials • Gait Analysis and Human Movement • Rehabilitation Engineering (Physical) • Rehabilitation Engineering (Sensory) 	
University of Ulster MSc Engineering (Biomedical Engineering)	<p>Compulsory:</p> <ul style="list-style-type: none"> • Biomaterials (15) • Tissue Engineering (15) • Bioinstrumentation (15) 	Full-time 1 year and part-time 3 years available. 60 credit research project.
University of Warwick MSc in Biomedical Engineering	<p>Compulsory: (5 modules including)</p> <ul style="list-style-type: none"> • Physiological and Compartmental Modelling (12) • Biomedical Signal Analysis (12) • Biomedical Materials (12) <p>Options: (1 from 10 including the following)</p> <ul style="list-style-type: none"> • Applications of Physical Principles in Medicine (12) • Ultrasonic and Biomedical Instrumentation (12) • Population Dynamics of Infectious Diseases (12) • Data Acquisition – Biophysical Techniques and Instrumentation Design (12) 	Full-time 1 year. 90 credit research project.