PROGRAMME SPECIFICATION

KEY FACTS

Programme name	MSc in Biomedical Engineering with Data Analytics
Award	*MSc*
Exit Awards	*PG Dip, PG Cert.*
School	School of Science and Technology
Department or equivalent	Engineering
Programme code	PSBEDA
Type of study	*Full-Time*
Total UK credits	180
Total ECTS	90

PROGRAMME SUMMARY

The MSc in Biomedical Engineering with Data Analytics (BioDAT) will prepare you for a successful career as a professional Biomedical Engineer. Biomedical Engineering, one of the leading and most exciting sectors of engineering, is a multidisciplinary topic that combines biology and engineering, applying engineering principles and materials to interfacing with humans for improving medicine and healthcare. Its significant growth over the last couple of decades has been driven by the medical challenges brought by aging populations, the need for new treatments for chronic and often untreatable conditions such as cancer, diabetes or cardiovascular disease and the need for in-situ, rapid diagnoses and interventions to address new disease challenges as they arise. Further to medical devices, biomedical engineering also directly relates to technology or interfacing with humans through wearable devices for fitness, wellbeing, and sports.

The programme covers the study and integration of advanced methods and techniques with emphasis on biomedical electronics for the design and development of medical devices. More specifically insights will be offered on biological functions and structures generating physical responses that can be detected by specific sensors. Such sensors will be extensively studied with special mention on wearable and implantable versions. Medical instrumentation in terms of understanding and designing advanced analogue and digital electronic circuits and systems for bio-interfacing will be the core of the programme. This will be coupled with programming for interfacing with devices with specific emphasis on smart device interfacing and developing apps. A significant part of the programme will focus on data analytics for processing, analysing and securely storing medical data, with elements of ethics and big data management. The knowledge offered is uniquely interdisciplinary and MSc BioDAT adopts a wholistic approach in providing you with specialisation that combines electronics, biology and data processing and analytics with elements of programming, ethics and security.

The programme is designed for new graduates and professionals with an engineering background who want to significantly advance their understanding of the field or are interested in either developing a medical device or handling biomedical data or both. The programme is offered full time for entry at the beginning of the academic year. The full-time programme follows a normal 12- month pattern with two terms of taught modules followed by a 3-month individual design project/dissertation. The curriculum consists of 8 core modules and a dissertation.

The MSc BioDAT programme will include hands-on, lab-based tutorials and coursework and the use of tools and technologies which will equip you to pursue a practical project in the biomedical engineering area of your choice. Our laboratory facilities, both for taught courses and the specialised ones belonging to the Research Centre for Biomedical Engineering will allow you to work on designing, fabricating and testing devices, sensors and stimulators; simulating muliphysics and biophysical interfaces and functions; developing mathematical and computational models; work on advanced data processing and analytics algorithms; and develop apps for interfacing with smart devices. Some of the projects will be done within the research facilities and some projects will be in the form of placement in collaboration with biomed-tech companies that we collaborate with, often in the form of placements.

Aims

This programme aims to provide you with the knowledge, skills and values needed for a technical career in Biomedical Engineering by

(a) Equipping you with a breadth of knowledge, skills and techniques needed as a professional in biomedical engineering.
(b) Developing your knowledge in specialised and advanced topics in diagnostic device technology, with an emphasis in medical electronics, sensors and data analytics
(c) Enabling you to work with and learn from active researchers in Biomedical Engineering
(d) Training you to critically evaluate the technical, ethical and data management dimensions of Biomedical Engineering systems and technologies.

There are three types of awards that you can get (please see the section “WHAT AWARD CAN I GET?”).

Postgraduate Certificate in BioDAT

For all of you completing the Postgraduate Certificate you will have had the opportunity to examine the theories - and to gain practical skills through laboratory- based work if chosen - related to the analysis, design, and evaluation of Biomedical Engineering, and demonstrated sufficient ability in at least four taught modules (60 credits).

Postgraduate Diploma in BioDAT

For all of you completing the Postgraduate Diploma, you will have acquired a theoretical knowledge on various aspects of Biomedical Engineering with Data Analytics with an emphasis on medical devices, biomodelling and programming, wearable and diagnostic devices, and data processing, analytics and security. You will also have demonstrated practical skills through laboratory- based work during coursework of each module, which equates to passing all eight taught modules, worth 120 credits.

MSc in BioDAT

For all of you completing the MSc in Biomedical Engineering with Data Analytics, in addition to the above you will have demonstrated original application of knowledge in the area, through either the analysis, design and evaluation of a Medical Technology artefact or the

design and implementation of medical devices design and solutions, biomodelling and programming, wearable and diagnostic devices, and data processing, analytics and security. In either case, you should keep in mind how a biomedical engineering solution, hardware or software, fulfils a business or market need. You will also be able to critically evaluate and extend your knowledge in the area through a research-led project, which can involve the development of hardware and/or software artefacts as well. This will be achieved through your individual project, a substantial module worth 60 credits that you can commence once you have successfully passed all your taught modules.

WHAT WILL I BE EXPECTED TO ACHIEVE?
On successful completion of this programme, you will be expected to be able to:

Knowledge and understanding:

1. Synthesise the acquired knowledge to demonstrate the ability to use Biomedical Engineering and Data Analytics methods and techniques (e.g. in biomedical sensors, medical electronics and instrumentation, diagnostic devices, biomedical data analytics, ethics and security) (AHEP4 M1-5, M12, M13).
2. Review and critically evaluate the literature and current developments and challenges in biomedical engineering such as sensor biocompatibility, implantable and wearable devices, and early diagnostic technologies (AHEP4 M1, M2, M3).
3. Analyse and solve problems and develop innovative solutions, processing real disease diagnostic data generated by cutting-edge bio-interfaces through specialised, data processing and data analytics algorithms, designing, implementing and testing biomedical data processing and secure storage methods and tools (AHEP4 M2, M3, M12).
4. Critically evaluate professional, legal, social, cultural and ethical issues related to biomedical engineering, both in terms of medical device and bio-interfacing ethics as well as ethics of handling medical data (AHEP4 M7, M8, M10, M11).
5. Identify and manage scientific and technical risks associated with Biomedical Engineering and its technological applications (AHEP4 M2, M9).

Skills:

1. Analyse, develop and select biomedical instrumentation circuits and tools that can interface with biological tissue and biosignals sources (AHEP4 M2, M3, M5, M13, M15).
2. Specify, design, build and evaluate biomedical data analytics programs, algorithms and associated Biomedical Engineering systems (AHEP4 M2, M3, M5, M13, M15).
3. Use cutting-edge hardware and software methods to create biomedical interfacing systems and to apply them to medical diagnostics, implantable and wearable devices, biomedical data analytics and therapeutic technologies (AHEP4 M2, M3, M5, M13, M15).
4. Use technologies to communicate topics in Biomedical Engineering effectively to technical and non-technical audiences (AHEP4 M17).

Values and attitudes:

1. Embrace technical challenges as an opportunity for personal development (AHEP4 M13, M17).

2. Rationally exploit both traditional and novel technological approaches (AHEP4 M1, M2, M7, M13).
3. Rigorously assess alternative approaches and novel designs (AHEP4 M2, M5).
4. Gain skills about professional ethics and privacy in the context of Biomedical Engineering (AHEP4 M8, M17).

This programme has been developed in accordance with the QAA Subject Benchmark for Engineering, especially when it comes to "bringing together different engineering disciplines or sub-disciplines in the study of a particular topic, or engineering application" and in being "truly multidisciplinary"*. M3,*

HOW WILL I LEARN?

The teaching and learning methods used are such that the levels specialisation of content increase as you progress through each module and the programme, with the modules each contributing to different elements of specialisation covering all the range from the biology to the technology and finally to the data and its management. This progression will be guided by active researchers in Biomedical Engineering, from the Research Centre for Biomedical Engineering (RCBE), Institute of Sensors and Instrumentation in the Department of Engineering, culminating with an individual project containing an original piece of research conducted largely independently with appropriate academic supervision and, where appropriate, in collaboration with industrial partners.

The standard format is that taught modules are delivered through a series of lectures and tutorials/laboratory sessions –the exact number of which will depend on the nature of the module, for instance, practical modules involving intensive programming will consist mainly of laboratory sessions, whereas modules which focus on theory will be delivered mostly through lectures.

Lectures are normally used to: (a) present and exemplify the concepts underpinning a particular subject; (b) highlight the most significant aspects of the syllabus; and (c) indicate additional topics and resources for private study.

Tutorials are used to help you develop skills in applying the concepts covered in the lectures, normally in practical problem-solving contexts.

Laboratory sessions serve a similar purpose as the tutorials, but their purpose is to demonstrate application of concepts and techniques through the use of state-of-the-art laboratory instruments, software development tools and environments.

Your learning will be supported by an online learning environment Moodle which will provide resources for independent learning, such as further reading, links to wider sources of information and resources for self-assessment.

You are expected to undertake independent study and do substantial coursework assignments for each module, amounting approximately to 120 hours per module. The research project/dissertation aims to provide you with the opportunity to deal with problems in areas where new perspectives and insightful ways of combining focal areas of specialised knowledge is required. This involves literature search, assessment of the relevance of previous work, the development of the research task, self- directed research, and the presentation of research results. Online and self-directed learning will be supported with appropriate resources, including documentation, experiments and exercises.

Considerable time should be dedicated to develop software and hardware solutions that will lead to prototypes.

In addition to lecture, laboratory and tutorial support, you will be assigned a personal tutor, and the programme is supported by City's Moodle learning environment, which will contain resources for each of the modules. This includes materials such as lecture notes and lab sheets, as well as interactive components, such as a discussion forum.

WHAT TYPES OF ASSESSMENT AND FEEDBACK CAN I EXPECT?

Modules will be assessed through coursework and written examination or through coursework only, with up to two assessments per module. These will take the form of laboratory, simulation, programming or design-based exercises and associated theoretical questions, including small essays, and practical assignments requiring the analysis and exemplifying of Biomedical Engineering methods and techniques. The output of each module's overall coursework will be marked along with an oral presentation of the work done. For each module assessed through both coursework and examination, the overall mark will be a combination of the module's coursework and examination results. In all other cases the overall mark will be the coursework's overall mark for that module.

Teamwork is an integral part of the programme and will be promoted through grouping you with some of your colleagues in teams for the laboratory experiments and for the modelling / computational exercises: Real-life research and practice in Biomedical Engineering involves working in groups of experts with interdisciplinary backgrounds.

The individual project is a substantial task that develops a research related topic and is performed under the supervision of academic staff. The assessment of projects relies on a project report and an oral presentation. During the project, you will be given an opportunity to solve a real problem e.g., collecting and processing real data, and designing and implementing Biomedical Engineering systems, and applying and evaluating them.

The individual project can be carried out as a 3-month internship e.g. in the RCBE research centre or with one of the companies with which City has a long-standing relationship and history of collaboration (for instance, Genetic Microdevices, Mediwise, Icenilabs or Bio-nano Consulting).

<u>Assessment and Assessment Criteria</u>

Assessment Criteria are descriptions, based on the intended learning outcomes, of the skills, knowledge or attitudes that you need to demonstrate in order to complete an assessment successfully, providing a mechanism by which the quality of an assessment can be measured. Grade-related Criteria are descriptions of the level of skills, knowledge or attributes that you need to demonstrate in order achieve a certain grade or mark in an assessment, providing a mechanism by which the quality of an assessment can be measured and placed within the overall set of marks. Assessment Criteria and Grade-related Criteria will be made available to you to support you in completing assessments. These may be provided in programme handbooks, module specifications, on the virtual learning environment or attached to a specific assessment task.

The research project is assessed through a dissertation, which is significant written report on an independent piece of work that will enable you to apply knowledge, critical thinking

and analysis to a topic which has either not been covered in the taught modules or not in such depth. The topic of the projects may be inspired by current research within Biomedical Engineering, Biomedical Data Analytics or by the needs of industry collaborators.

Feedback on assessment

Feedback will be provided in line with our Assessment and Feedback Policy. In particular, you will normally be provided with feedback within three weeks of the submission deadline or assessment date. This would normally include a provisional grade or mark. For end of module examinations or an equivalent significant task (e.g. an end of module project), feedback will normally be provided within four weeks. The timescale for feedback on final year projects or dissertations may be longer. The full policy can be found at: https://www.city.ac.uk/__data/assets/pdf_file/0009/452565/Assessment-and-Feedback-Policy...pdf

Assessment Regulations

In order to pass your Programme, you should complete successfully or be exempted from the relevant modules and assessments and will therefore acquire the required number of credits. You also need to pass each Programme Stage of your Programme in order to progress to the following Programme Stage.

The pass mark for each module is 50% for the overall sum of the assessment components, i.e. for the Coursework of that module and for the Examination, if the latter applies.

If you fail an assessment component or a module, the following will apply:

1. Compensation: Compensation is not allowed.

2. Resit: where you are not eligible for compensation at the first attempt, you will be offered one resit attempt.

If you are successful in the resit, you will be awarded the credit for that module. The mark for each assessment component that is subject to a resit will be capped at the pass mark for the module. This capped mark will be used in the calculation of the final module mark together with the original marks for the components that you passed at first attempt.

If you do not meet the pass the requirements for a module and do not complete your resit by the date specified you will not progress and the Assessment Board will require that you be withdrawn from the Programme.

If you fail to meet the requirements for the Programme, the Assessment Board will consider whether you are eligible for an Exit Award as per the table below.

If you would like to know more about the way in which assessment works at City, please see the full version of the Assessment Regulations at: https://www.city.ac.uk/__data/assets/pdf_file/0007/453652/Senate-Regulation-19-Assessment-Regulations-2022-23-v2.5.pdf

WHAT AWARD CAN I GET?

Master's Degree:

	HE Level	Credits	Weighting (%)
Taught	7	120	67%
Dissertation	7	60	33%

Class	% required
With Distinction	70
With Merit	60
Without classification	50

Postgraduate Diploma:

	HE Level	Credits	Weighting (%)
Taught	7	120	100

Class	% required
With Distinction	70
With Merit	60
Without classification	50

Postgraduate Certificate:

	HE Level	Credits	Weighting (%)
Taught	7	60	100

Class	% required
With Distinction	70
With Merit	60
Without classification	50

WHAT WILL I STUDY?

This MSc offers a complete overview of how an engineer can look into the physics of biology as well as its inherent signal generating properties and build instrumentation and interfacing software to make a medical device and finally translate the biological data into useful data traits. Thus, the narrative flows from tissue properties and biosignals to devices (including sensors, instrumentation & applications in healthcare, interface software and medical device market and regulation overview) and finally to data (including data processing, biostatistics and data management and ethics).

The modules are detailed below:

Module Title	SITS Code	Module Credits	Core/ Elective	Compensation Yes/No	Level
Biomedical Signals	EEM408	15	Core	No	7
Wearable and Implantable Devices	EEM414	15	Core	No	7
Biomedical Sensors and Systems	EEM407	15	Core	No	7
Healthcare App Design	EEM412	15	Core	No	7
Medical Device Entrepreneurship	EEM413	15	Core	No	7
Machine Learning	EPM106	15	Core	No	7

Data Analytics in Biomedical Engineering	EEM409	15	Core	No	7
Biodata Management: Ethics and Security	EEM411	15	Core	No	7

Dissertation component

Module Title	SITS Code	Module Credits	Core/ Elective	Compensation Yes/No	Level
Dissertation	EPM949	60	Core	N	7

You are normally required to complete all the taught modules successfully before progressing to the dissertation

TO WHAT KIND OF CAREER MIGHT I GO ON?

As a Biomedical Engineering student, you can expect to achieve employment in a range of businesses related to healthcare, from the traditional healthcare industry like Siemens, Philips or General Electric, to new players on the market like Google or Apple. Opportunities will be available with employers focused on topics ranging from medical electronics and diagnostic devices to jobs that benefit from a deep understanding of cutting-edge data analytics techniques and tools in, for instance, healthcare technology, biomedical diagnostics, therapeutic devices, as well as in biomedical technology consultancy, or in government. The emphasis of this programme on the wholistic understanding of medical devices and data analytics, and City's internships and links with industrial partners (e.g., GMD, Mediwise, BioNano Consulting, etc) will particularly enable you to gain appointments as a specialist in biomedical technology companies, and institutions.

If you decide to start a new business once you graduate in this field, you can benefit from City 's London City Incubator, providing support for start-up businesses.

If you would like more information on the Careers support available at City, please go to: https://www.city.ac.uk/careers/your-career

WHAT STUDY ABROAD OPTIONS ARE AVAILABLE?

- *Study Abroad is not offered in this Programme.*

WHAT PLACEMENT OPPORTUNITIES ARE AVAILABLE?

Information on placement opportunities, including: Project placement with Genetic Microdevices, Mediwise, BioNano Consulting and Icenilabs.

- Rules/constraints: A written agreement between the company and the university will ensure confidentiality (potentially through signing an NDA), ip protection and assurances that the material in the your thesis will not be compromised academically in the above context. Your supervisor and the industrial representative will have regular (at least monthly) contacts/meetings to ensure academic progress.

- Where to go for further information: The project supervisor and SST's Corporate Relations and Employability Unit: https://www.city.ac.uk/about/schools/science-technology/about-the-school/placements-and-internships

WILL I GET ANY PROFESSIONAL RECOGNITION?

- *Not relevant currently. IPEM accreditation will be pursued in the near future.*

HOW DO I ENTER THE PROGRAMME?

- Qualifications: Minimum Lower Second Class (2:2) degree or equivalent overseas qualification in Biomedical Engineering, Electronic Engineering, Medical Physics, Physics or equivalent degree.
- For those overseas applicants, whose first language is not English or their country has not been exempted from the English language requirement by the UK Home Office, they will need to provide one of the following English test qualifications:
- IELTS: 6.5 in all categories
- TOEFL 92 (minimum of 21 in Listening, 23 in Reading, 22 in Speaking, and 24 in Writing)

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Information is provided subject to Terms and Conditions for study at City, University of London.