National School of Healthcare Science

NHS
Health Education England

# Modernising Scientific Careers
# Practitioner Training Programme
# BSc (Hons) Healthcare Science

## Clinical Engineering 2016/17

Developing people for health and healthcare

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## CONTENTS

# SECTION 1: INTRODUCTION TO THE PROGRAMME

# READERSHIP

The Practitioner Training Programme (PTP) is an integrated academic and work-based undergraduate BSc (Hons) degree which may be undertaken through an on-site academic programme or through an apprenticeship. This document provides the curriculum (both academic and work-based) for the PTP and will be of interest to:

- academic and administrative staff, including external examiners within Higher Education Institutions (HEIs) which are accountable for the delivery of the curriculum;
- employers who may wish to support apprentices or employees in undertaking the PTP degree programme;
- learners, host departments and managers of services that employ healthcare science (HCS) staff;
- work-based trainers, including all those involved in supervising, mentoring, co-ordinating, assessing and delivering PTP education and training;
- Health Education England (HEE) Local Education and Training Boards (LETBs) and all HCS education and training commissioning organisations in the UK;
- National School of Healthcare Science (NSHCS);
- Academy for Healthcare Science (AHCS);
- patients and the public.

A list of abbreviations and glossary of terms used is provided in the appendices.

# Introduction to Modernising Scientific Careers (MSC) and the Practitioner Training Programme (PTP)

## 1.1 Healthcare Science and the MSC Education and Training Programme

1. The HCS workforce plays a central role in safe and effective patient care across all pathways of care from health and wellbeing to end of life. There are approximately 55,000 employees in the HCS workforce in the NHS in the UK, and approximately 80% of all diagnoses can be attributed to their work.
2. Healthcare science involves the application of science, technology and engineering to health. *Good Scientific Practice* (GSP)[1] sets out the principles and values on which good practice within healthcare science is founded. It makes explicit the professional standards of behaviour and practice that must be achieved and maintained by all those who work in healthcare science. GSP and the Academy for Healthcare Science's (AHCS) Standards of Proficiency[2] and Standards of Education and Training[3] form the basis for all MSC training curricula that contextualise the Standards of Proficiency set down by the Health and Care Professions Council (HCPC) in a way that is accessible to the profession and the public.
3. The HCS workforce and services are grouped into four broad areas called divisions, namely: Life Sciences, Physical Sciences, Physiological Sciences and Clinical Bioinformatics. Within each division there are a number of HCS specialisms. With advances in scientific technology, changes to the delivery of healthcare scientific services and the development of MSC, the boundaries between these divisions have been shifting. MSC recognises this important change and to date has identified seven PTP themes (groupings of specialisms within a HCS division), which define training across a total of 19 HCS specialisms.

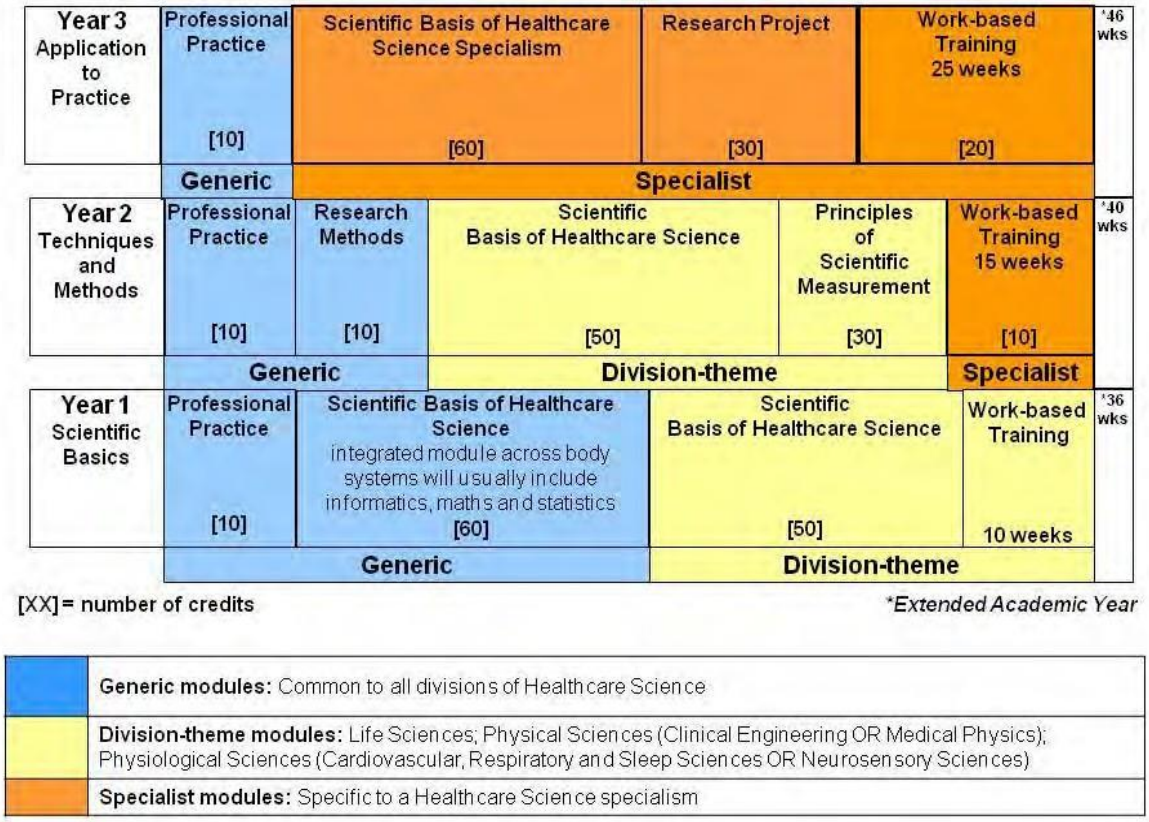
## 1.2 Introduction to the Practitioner Training Programme (PTP)

4. The HCS Practitioner Training Programme (HCS PTP) is a degree programme that has 2 routes of delivery:
   i. *On-site academic route:* an academic degree programme in which the learner[4] undertakes work-based placements but is not employed
   ii. *Apprenticeship route:* an in-service degree where the apprentice is employed whilst undertaking the PTP
5. The PTP typically will take a minimum of 3 years (but may be longer depending on the learner and the requirements of the employer and/or HEI to complete. It leads to a BSc Honours degree qualification that is contextualised for workplace occupational competency as a Healthcare Science Practitioner (HCSP) who provides HCS scientific and technical services within the HCS divisions and specialisms of Life Science, Physiological Science, or Physical Science.

[1] http://ahcs.flinthosts.co.uk/wordpress/wp-content/uploads/2013/09/AHCS-Good-Scientific-Practice.pdf
[2] http://www.ahcs.ac.uk/wordpress/wp-content/uploads/2014/07/AHCS_StandardsofProficiency.pdf
[3] http://www.ahcs.ac.uk/wordpress/wp-content/uploads/2014/08/AHCS_PTPStandardsOfEducationAndTraining.pdf
[4] the term *learner* is generally used to include both students undertaking the PTP through the on-site academic route and the apprenticeship route, except where reference to apprentices is specifically required.

6. The BSc (Hons) PTP is designed to provide the HCSP with a strong science-based, patient-centred education and training in a specialist area of HCS. The overall aim of this HCSP education and training programme is to prepare the learner to fulfil the function of a HCSP working in a clinical HCS setting. The programme combines and integrates both academic and work-based learning and has a strong patient and technical scientific focus. Within the first year learners will experience of number of short placements or 'tasters' within the chosen PTP theme and gain some exposure to other aspects of the patient pathways, for example through clinics, patient education programmes, medical records and other area in which HCS contributes to patient care. This will give the learner a wide appreciation of the many related specialisms within HCS and a more holistic view of the areas that contribute to high-quality patient-centred care.
7. The diagram below depicts the broad framework and credit structure around which all PTP BSc (Hons) degree programmes in HCS are structured. The divisions within the MSC Programme (Life Sciences, Physical Sciences, Physiological Sciences and Clinical Bioinformatics)[5] have interpreted and adapted this framework to fit the range of HCS specialisms within the division/theme. Further refinement has been undertaken by each HEI to develop and deliver BSc (Hons) programmes that enable learners to meet the learning outcomes of the course. There is a strong generic programme that emphasises professional practice, research and the scientific basis of HCS.

**High-level framework for the integrated BSc (Hons) in Healthcare Science**




[5] Although at the current time there is no PTP in Clinical Bioinformatics.

8. Once employed as a HCSP a range of career development options will be available, including structured in-post programmes of continuous personal and professional development (CPPD), provided through Accredited Scientific Practice programmes.[6]
9. PTP degrees can be delivered either as an on-site academic programme with clinical placements, or through an apprenticeship[7], in which the learner is employed whilst the degree is undertaken. HEIs offering the degree apprenticeship must join the Skills Funding Agency's (SFA) Register of Apprenticeship Training Providers (RoATP)[8].
10. HEIs can choose to deliver the degree apprenticeship inclusive of the mandatory end-point synoptic assessment (EPA)[9] through an "integrated" degree, or may choose to only deliver the academic component of the apprenticeship and without including the EPA in its assessment programme – a "non-integrated" degree. Where employers choose the non-integrated degree for an apprentice, they will be required to ensure that the apprentice undertakes the EPA once the degree is obtained through an appropriately accredited Assessment Organisation (AO) that is on the SFA Register of Apprenticeship Assessment Organisations (RoAAO), in order that the apprenticeship is completed.[10] Whichever options are chosen, the PTP will develop the technical, scientific, interpersonal and behavioural skills and knowledge of learners so that they can operate effectively in HCS as a HCSP.

### 1.3 Practitioner Training Programme Outcomes

11. Graduates of the BSc (Hons) will possess the essential knowledge, skills, experience values, behaviours and attitudes required of a newly qualified HCSP. They will have the necessary expertise in applied scientific techniques underpinned by theoretical knowledge within a division or related specialism and will work in a range of healthcare settings. Many will work directly with patients but all HCSPs will work in roles that will have an impact on patient care and outcomes. Learning, therefore, must be in the context of the patient and patient-centred care.
12. On successful completion of the BSc (Hons) (academic and work-based learning outcomes) all graduates should be able to demonstrate the outcomes of the AHCS's Standards of Proficiency for HCSPs,[11] which will enable them to register on its Professional Standards Authority (PSA) accredited register. In addition, Life Science graduates should also be able to demonstrate the outcomes of the HCPC Standards of Proficiency for Biomedical Scientists, which will enable them to register with the HCPC as Biomedical Scientists. Degree programmes must align to the Quality Assurance Agency's (QAA)[12] level 6, but which will have been extended and contextualised to the NHS job role for HCSP.

13. The AHCS Standards of Proficiency cover three key areas:

[6] http://hee.nhs.uk/2015/03/26/modernising-scientific-careers-accredited-scientific-practice-asp/
[7] Less commonly, some individuals will be employed by a trust and undertake the degree on a part-time basis.
[8] https://www.gov.uk/government/collections/register-of-apprenticeship-training-providers
[9] described more fully in Section 1.8
[10] Of significance, it should be noted that the employer will be responsible for the costs attached to the EPA. Employers and HEIs should be aware that the funding cap for this programme is fixed at £27,000. This may therefore require employers to fund the EPA outwith the apprenticeship levy and be an additional cost to the overall apprenticeship.
[11] http://www.ahcs.ac.uk/wordpress/wp-content/uploads/2014/07/AHCS_StandardsofProficiency.pdf
[12] http://www.qaa.ac.uk/en

- professional autonomy and accountability;
- skills required for practice as a HCS Practitioner;
- knowledge of healthcare science.

14. **Entry routes:** Entry into BSc (Hons) on-site academic HCS programmes is through the UCAS application process.[13] Increasingly, employers and patients are expected to be part of and contribute to the selection process, with HEIs using values-based recruitment[14] as an underpinning principle of their selection processes. Those seeking to undertake the PTP through an apprenticeship will be competitively appointed by employers who will involve their local HEIs in the appointment process.
15. **Award titles and mode of delivery:** These degree programmes can be delivered either as on site academic programmes or as in-service apprenticeship programmes. The title of the degree programme should be consistent with current HCS terminology.[15] See http://www.nshcs.org.uk/for-trainees/accreditation/134-accreditation-for-heis for further details.
16. **Apprenticeship Standard:** where employers appoint apprentices to undertake the degree, the apprenticeship standard for HCSPs (Level 6)[16], the PTP degree and the End-point Assessment (EPA) demonstrating achievement of the standard must be achieved, either through an integrated or non-integrated degree.[17]
17. **Relevant Quality Assurance Agency (QAA) Code(s) of Practice:** HEIs must adhere to the current QAA Code of Practice for the Assurance of Academic Quality and Standards in Higher Education.
18. **Accreditation:** A BSc (Hons) HCS programme must hold accreditation from HEE's NSHCS to confirm that it meets the Standards of Accreditation for the HCS BSc (Hons),[18] reflecting the AHCS Standards of Education and Training and those of the HCPC[19], where appropriate.
19. **Accreditation of prior learning (APL):** A process of APL that conforms to the guidelines below must be defined by each HEI provider. This must clearly describe the minimum and maximum level of APL that will be awarded, the timing, costs and process, and align to statutory requirements for HCS. Good practice supports the view that such prior learning should only be used once; double counting is not recommended. This process will be of particular relevance for apprentices who have previously achieved the Level 4 Diploma in HCS.[20]
20. **Progression, compensation, condonation:** Should a clinical placement or the employer in the case of apprentices not deliver the environment/learning that

[13] https://www.ucas.com
[14] http://hee.nhs.uk/work-programmes/values-based-recruitment/
[15] In Scotland a 'full-time-equivalent' model is used to train clinical physiology practitioners who are NES employees, with their work-based learning being integral to the award. The programme timescale is identical to a full-time HEI learner (i.e. 4 years in Scotland).
[16] At the time of publication of the 2016 PTP curricula the Level 6 apprenticeship standard was awaiting publication. Once published it should be available via: https://www.gov.uk/government/collections/apprenticeship-standards#healthcare-standards (see Healthcare Science section)
[17] which will involve an AO for the EPA in the case of a non-integrated degree
[18] http://nshcs.org.uk/images/Accreditation/Proforma-BSc-accreditation-standards-July2014.pdf
[19] http://www.hpc-uk.org/aboutregistration/standards/sets/
[20] http://www.qaa.ac.uk/Publications/InformationAndGuidance/Pages/Higher-education-credit-framework-for-England-guidance-on-academic-credit-arrangements-in-higher-education-in-England-Augu.aspx http://www.qaa.ac.uk/Publications/InformationAndGuidance/Pages/Guidelines-on-the-accreditation-of-prior-learning-September-2004.aspx

supports a learner in achieving the required learning outcomes, the HEI and employer will need to support the learner/apprentice appropriately. While it is recognised that HEIs are likely to have a wide portfolio of degree programmes that fall under a single set of regulations (ordinances), the following conditions are specific requirements of the PTP BSc (Hons) degree programme accreditation process, irrespective of the HEI's own academic regulations:

- all modules are mandatory;
- no condonation or compensation of marks between modules (although there is a measure of compensation within a module) or extended re-sits of modules marks is permitted;
- multiple assessment components in any single module cannot be aggregated to reach a final module mark;
- each assessment within a module should be mandatory and passed at the required level.

21. Where learners do not achieve the module requirements for progression they must follow a 'module retrieval plan', which supports them to recover the failed module(s) as soon as possible so that they can progress with minimum delay.
22. **Programme delivery and monitoring:** It is expected that all BSc (Hons) HCSP programmes should be an integral part of the faculty/school and that opportunities for interprofessional learning are maximised. There should be an appropriate balance between academic staff and visiting specialist staff to ensure teaching reflects current NHS practice, which must be evidenced as part of the programme accreditation by the NSHCS.

### 1.4 Purpose of the BSc (Hons) PTP Curriculum

23. There are three main purposes of this BSc (Hons) curriculum. It:
    i. clearly sets out the expectations of graduates from the programme, including the academic skills, knowledge and understanding, and attitudes and behaviours that each learner will be expected to gain, develop and apply during work-based training;
    ii. signals the importance to employers of the current structure, strategic direction and priorities of healthcare delivery in the UK, e.g. the *NHS Constitution* or equivalent frameworks across the UK, and the requirement to prioritise patients and their care, ensuring that the patient and service provided by HCS is at the centre of all learning, assessment and work-based practice;
    iii. introduces learning in relation to new scientific and technological developments as these become available.
24. **Curriculum development and maintenance:** The first BSc (Hons) curricula in HCS were published in 2010. Recently the NSHCS and the Council for HCS Education in Higher Education and its PTP Special Interest Group, professional bodies and other stakeholders have contributed to updating the scientific and professional content of the curriculum[21], resulting in this 2016 edition of the curricula. Led by the NSHCS, all MSC curricula will be subject to regular review, with all stakeholders given the opportunity to contribute to each review. Current

[21] including taking into account external feedback on the curricula undertaken by the Institute of Education (IOE)

and previous versions of the BSc (Hons) HCS programmes and work-based learning guides can be found on the NHS Networks website.[22]

25. BSc (Hons) HCS programmes leading to an academic award must be aligned to current NHS policy and strategy and equivalent policy documents for the devolved administrations and should be consistent with current professional body guidance. HEIs should ensure they keep abreast of future strategic direction and policy.

### 1.5 Programme Delivery

26. **Programme delivery:** HEIs and employers are expected to ensure that all teaching, learning and assessment is up-to-date and informed by research to ensure that at graduation HCSPs meet the Framework for Higher Education Qualifications (FHEQ) descriptor at level 6. By undertaking a research project learners should become aware of the major contribution the HCS workforce makes to research and innovation to benefit patients, patient outcomes and the delivery of healthcare.
27. Although HEIs will deliver the programme described in this curriculum according to their local requirements, the key principles of programme delivery that underpin the NSHCS accreditation process[23] involve:
    - programmes must deliver all of the BSc (Hons) PTP learning outcomes (and will, de facto, deliver the outcomes required by the Level 6 HCSP apprenticeship standard which maps to the curricula) and indicative content, which the HEE Education and Training Scrutiny Group (ETSG) has advised meets the requirements of *Modernising Scientific Careers: The UK Way Forward* and the Academy for HCS's *Good Scientific Practice;*
    - wherever possible, delivering the principles and knowledge underpinning practice should occur before the work-based learning;
    - ensuring programmes meet current NHS education quality metrics and current AHCS and HCPC Standards of Education and Training;
    - ensuring that employer host departments, patients and the public are involved in the design, implementation, delivery and review;
    - the use of fair, valid, reliable, and clearly articulated assessment programmes for all modules, and the timing and content of which should consider and complement the work-based assessment programme;
    - the provision of a robust learner support and mentoring system, together with clearly defined arrangements to identify and support learners in difficulty (including the support services in place) clearly defined;
    - delivery of the programme within a high-quality teaching and learning environment with appropriate resources and facilities to support teaching and research;
    - teaching staff who are research active with a track record of undertaking high-quality research of national and potentially international standing that is relevant to the practice of HCS and the NHS.
28. Good Scientific Practice (GSP) underpins the PTP and the Level 6 HCSP apprenticeship standard and spans both the academic and work-based

[22] http://www.networks.nhs.uk/nhs-networks/msc-framework-curricula and https://www.nshcs.hee.nhs.uk/

[23] In Scotland NES is responsible for accreditation of PTP programmes.

programmes. Key professional practice learning outcomes are included in the BSc (Hons) programme through its GSP syllabus, thus embedding the standards of professionalism set out in GSP in all aspects of the delivery and assessment of the programme. Learners should be encouraged to develop a range of skills to support their professional life and CPPD spanning communication, leadership, personal reflection, duty of care, duty of candour, critical reflection, giving and receiving feedback, career planning and commitment to lifelong learning, and show development and maturation in these areas through the degree programme.

29. HEIs should ensure that all staff involved in each BSc (Hons) programme have read and are aware of the requirements of *Good Scientific Practice* and the GSP syllabus in the PTP.
30. **Teaching and learning:** It is expected that a blended learning approach will be adopted, based on a model of learner-centred adult learning that balances and integrates face-to-face teaching, e-learning, etc., and considers the broader requirements of each BSc (Hons) programme. It is anticipated that a broad range of teaching and learning activities will be utilised, appropriate to the learning outcomes. Learners should be enabled to gain the skills necessary to manage their own learning, and to exercise initiative and personal and professional responsibility. The learning strategy matrix and proformas outlined in 'Liberating Learning'[24] describe a range of activities that may be appropriate to this BSc (Hons) programme. They are likely to include:
    - Case study/discussions
    - Debate
    - Discussion forums
    - Expert briefings
    - Interactive lectures
    - Individual tutoring
    - Learner-led and tutor-led seminars
    - Library study
    - Personal critical reflection and action planning
    - Problem-based learning
    - Role play
    - Self-assessment
    - Self-directed learning activities
    - Simulation
    - Skills teaching
    - Team projects
    - Tutor-led small group learning
31. It is also expected that e-learning and, where possible, m-learning[25] opportunities will be available to enable to be active participants in a range of learning activities. Work-based learning will also contribute to the academic educational experience of the learner through, for example, seminars, journal clubs, local and national scientific and education meetings.

[24] Liberating Learning, The Report of the Conference of Postgraduate Medical Deans' ad hoc Working Group on the Educational Implications of the European Union Working Time Directive and the subsequent European Working Time Regulations: November 2002 (revised 2009).
[25] JISC TechDis: see **http://www.jisctechdis.ac.uk/technologymatters/mobilelearning** for further information with respect to mobile (m) learning.

32. All academic and NHS staff leading or contributing to the BSc (Hons) programme should be appropriately qualified to teach and assess within the academic and/or work-based environment and have up-to-date knowledge of the requirements of the programme, GSP and the Standards of Proficiency for HCSPs. Further details can be found in the Accreditation Guidance from the NSHCS.[26]
33. **Interprofessional learning:** Opportunities to enable interprofessional and interdisciplinary learning, within and outside HCS, should be a fundamental part of each programme.
34. **Patient-centred care:** The delivery of high-quality, compassionate, patient-centred care should be an integral part of each degree programme, with the emphasis on the contribution of the HCS workforce to ensure that learners are aware that their actions have an impact on the patient and the patient's family. They should make clear and explicit links to new models of service delivery, care and patient pathways. The responsibility of all staff in the NHS to maximise quality, productivity and efficiency and to continually strive to improve services should be stressed. Equally important is the ability of graduates from the PTP to communicate with the general public with respect to HCS, leading to a better-educated public that is encouraged to take responsibility for its own health and wellbeing and have a greater understanding of the role that science plays in society.
35. **Patient and public involvement:** The HEI programme team must have mechanisms in place to ensure that there is meaningful patient and public involvement in the design, delivery, development and quality assurance of each programme. It is expected that patients will be represented on course committees at all levels and contribute to teaching, learning and assessment.
36. The participation of patients and the public in HCS in all aspects of education and training brings a number of benefits, including:
    - active, constructive lay involvement in the training of healthcare scientists;
    - assisting in the development, monitoring and evaluation of HCS training programmes and their outcomes;
    - operating as lay advisors to all professionals, academics, researchers and others involved in the teaching of healthcare scientist trainees (including the private and charity sector);
    - engaging with professionals, academics, researchers, patients/carers and the general public to promote education/publicity about the work and impact of healthcare scientists on the health of the community;
    - developing protocols and training opportunities that involve lay persons in the delivery, analysis and evaluation of training programmes;
    - initiating and supporting ideas/proposals/research questions about HCS and its impact on patients.

## 1.6 Introduction to Work-based Learning

37. The overall aim of the PTP is to prepare the learner to fulfil the function of a HCSP working in a clinical HCS setting. The programme combines and integrates both academic and work-based learning and has a strong patient and clinical focus. Within the first year it is expected that the experiential component

[26] http://www.nshcs.org.uk/for-trainees/accreditation/134-accreditation-for- heis

will start broad with short 'tasters' across a theme, with some exposure to other aspects of patient pathways, for example a clinic, patient education programme, medical records, or other area of healthcare. This will give the learner a wide appreciation of the many specialisms and a more holistic view of the areas that contribute to high-quality care.

38. The work-based programme is divided into modules, all of which are focused on service need, patient/care and continuous service improvement. Each module follows a standard format. The aim and scope of each module is described followed by the:
    - **Learning Outcomes** – high-level descriptors of the required work-based achievements for the module;
    - **Clinical Experiential Learning** – the learning activities that will facilitate learning and achievement of the stated outcomes;
    - **Competences** – further outcome-based statements for each learning outcome;
    - **Knowledge and Understanding** - as applied to appropriate competences.
39. Both the curricula and the apprenticeship standard are based on GSP[27] and HCPC Standards[28], resulting in a direct relationship between the two, ensuring that the curricula deliver the underpinning knowledge, skills and professionalism required by the standard. The learning outcomes of the curricula are clearly focused on employer and service requirements, reflecting patient care and clinical pathways and continuous improvement in a given area of HCS.
40. The work-based training for all learners has three components, which correspond to the academic programme, all of which are underpinned by the professional practice curriculum:
    - induction;
    - theme training;
    - specialist training.
41. It is anticipated that all learners will have an induction period in each employer/host department at the beginning of the apprenticeship and/or of each placement. The duration and timing of work-based placements will vary, depending on the HEI in which the learner studies.

## 1.7 Employing and Training Departments

42. The training and work environment is vital for successful training in the BSc and in this context includes each of the employers, training departments and other healthcare settings facilitating work-based training. The success of the training and the learner experience requires the commitment and enthusiasm from employers and those in the work environment to provide high quality, well-supervised training, underpinned by work-based formative assessment and a close working relationship with the HEI.
43. Training departments and employers should therefore ensure that they are fully familiar with the components of the BSc (Hons) programme, including the work-based training programme, including the required learning outcomes, competences and assessment processes, and have been trained by the HEI in

[27] https://www.ahcs.ac.uk/wordpress/wp-content/uploads/2013/09/AHCS-Good-Scientific-Practice.pdf
[28] http://www.hcpc-uk.org/assets/documents/100004FDStandards_of_Proficiency_Biomedical_Scientists.pdf

each work-based assessment method. Additionally, the responsibilities for mentoring and supervision, whilst the learner is on placement should be clear, including access to HEI learner support services.

44. **Induction**: At the start of the training programme learners should be provided with an induction programme by employers and training units. Initial work-based induction should include an overview of the:
    - hospital/employer/healthcare setting and local policies, including health and safety, confidentiality, data protection, etc., relevant to the employment;
    - range of services provided by the department;
    - range of people who use the services provided by the department;
    - function, operation, and routine and corrective maintenance requirements of equipment appropriate to the section(s) of the department in which the trainee will be working;
    - host trust IT systems, including the library and knowledge service as required.
45. **Supervision**: At the core of successful work-based employer training is appropriate educational and clinical supervision, facilitation and feedback. It is recommended that each learner is allocated to a training officer[29] from within the host/employing department. Learners are advised to ensure that a planned schedule of meetings with their training officer is agreed early in training, commencing with a meeting during the first week.
46. BSc educational and clinical supervision should promote learning, reflective practice and action planning. It will need to ensure that the learner becomes proficient in the specific skills and competences required by the curriculum, helping them to develop self-sufficiency and self-awareness in the ongoing acquisition of skills and knowledge. At every stage, patient safety must be paramount.
47. The first supervision meeting should be set up during the first week of the training programme. At the first meeting the training officer should ensure that the learner is following the agreed induction programme. It is recommended that the following areas should be explored and agreement reached at the first meeting with respect to the:
    - expectations of the training officer and learner;
    - responsibilities of the training officer and learner;
    - confidentiality;
    - boundaries between the training officer and learner;
    - frequency and duration of planned supervision meetings;
    - methods of communication and responsibility for arranging meetings;
    - level of support and arrangements for communications between meetings;
    - models of reflection and action planning;
    - record keeping;
    - content of the work-based training programme;
    - for apprentices, clarity between their employment responsibilities and their learning opportunities (i.e. formal training/learning time)
    - the approach to assessment;

[29] For the purposes of this document training officer has been used; however, the title may vary between departments and may be subject to a title change in England as part of developments for the whole of the professional healthcare workforce.

- sources of help and support.

48. The HEI and employers are responsible for ensuring that learners have access to training opportunities to enable the achievement of all the learning outcomes of the BSc (Hons) and where required, to meet the apprenticeship standard. In return learners are expected to take responsibility for:
    - ensuring that they fulfil their obligations to the HEI, to employers, to departments providing work base training and to patients (especially with regard to patient safety and confidentiality) as healthcare professionals;
    - engaging as active adult learners by initiating work-based assessments; contributing to learning activities; taking into account feedback received from their trainers and assessors; and giving considered and constructive feedback on their experience of their training.

## 1.8 Assessment

49. **Purpose of assessment:** The purpose of assessment is to enable the learner to demonstrate that they have the requisite knowledge, skills, values, behaviours and attitudes to work as a HCSP and meet standards of education and training, professional skills, conduct performance and ethics to provide reassurance to the public and the appropriate regulatory bodies. Given the integrated nature of this academic and work-based degree, each HEI's assessment programme must address both academic and work-based assessment (see Section 1.11 below) and must support assessment for learners undertaking the programme through an on-site academic programme or through an apprenticeship.
50. The full BSc (Hons) HCS assessment programme should support both assessment *for* and assessment *of* learning, and in particular:[30]
    - help clarify what good performance is (goals, criteria, standards);
    - encourage 'time and effort' on challenging learning tasks;
    - deliver high-quality feedback information that helps learners to self-correct;
    - encourage positive motivational beliefs and self-esteem;
    - encourage interaction and dialogue around learning (peer and teacher–learner);
    - facilitate the development of self-assessment and reflection in learning;
    - involve learners in decision making about assessment policy and practice;
    - support the development of learning communities;
    - integrate and complement the work-based assessment programme:
    - help teachers adapt teaching to learner needs;
    - for apprentices, facilitate and ensure readiness for the synoptic EPA.
51. The HEI must have in place a clear, overarching strategic and systematic approach to assessment that fits with the curriculum and delivers assessment methods that are valid, reliable/generalisable, feasible, fair, acceptable and defensible, and is led by assessment experts. The approach to the assessment of the BSc (Hons) HCS should also be cognisant of and complement the work-based assessment programme, which is defined by the NSHCS and which is part of all NSHCS accredited BSc (Hons) programmes. In addition, where an

[30] Nicol DJ (2007) Principles of good assessment and feedback. REAP International Online Conference. www.reap.ac.uk/public/Papers/Principles_of_good_assessment_and_feedback.pdf (accessed 2.12.09).

integrated degree is offered, enabling those undertaking the degree through an apprenticeship route, the end-point assessment (EPA) must conform to Department for Education (DfE) requirements.[31]

52. The assessment programme should be designed to enable the learner to obtain regular and constructive feedback on progress and achievement. It should encourage critical reflection and action planning, identifying both strengths and areas for development and improvement.
53. The approach to assessment should include and be overseen by a central co-ordinating leadership group or assessment-focused group in the HEI. The role of this group is to advise and scrutinise assessment across modules and years in order to build a consistent approach to assessment across the whole programme, involving module/programme leaders as appropriate. The HEI's overall assessment strategy should be documented in a clear and accessible manner with accountabilities clearly allocated. The strategy should also demonstrate how the approach is based on a sound understanding of the evidence base, academic literature and good practice in assessment.
54. Key areas that are required for NSHCS accreditation and which must be covered by an HEI's Assessment Strategy include:
    - a clear statement of accountabilities, including the governance structure for assessment;
    - the balance between academic and work-based assessment;
    - the balance between formative and summative assessment;
    - clarity on the EPA programme for apprentices and preparation for it;
    - the assessment of each module, including the contribution of individual assessments and examinations within the module;
    - progression criteria;
    - the range of valid, reliable and appropriate assessment techniques that will be utilised across the programme and for each module;
    - the process for providing clear and timely information for learners;
    - how all examiners will be selected and trained (including refresher training) and the guidelines that will be given;
    - the mechanisms in place to ensure comparability of standards and to share good practice, including external examiners;
    - how standard setting is undertaken;
    - how opportunities for learner feedback will be maximised, including time lines and importance of developing learners-centred feedback;
    - the arrangements for assessment of learners with a disability, which should be consistent with the ability to undertake this modified practice in the workplace setting;
    - an assessment blueprint demonstrating the relationship between each assessment and the learning outcomes of the programme;
    - exemplar criteria and marking scheme, including critical reflective writing;
    - the process of appointing external examiners;
    - a defined role for external examiners that includes contributing to the review and development of assessment strategies and providing advice from an overarching perspective;

[31] At the time of publication of the 2016 PTP curricula the Level 6 EPA was awaiting publication. Once published it should be available via: https://www.gov.uk/government/collections/apprenticeship-standards#healthcare-standards (see Healthcare Science section)

- the role and contribution of patients and the public to the assessment programme.

55. The on-programme assessment of the degree modules will include a range of formative and summative assessment approaches, for example essays, reports, completion of practical tasks and work-based projects as well as formal summative examinations as the degree progresses. In addition, a programme of formative work-based assessments will support progression through the degree, ensuring that for apprentices, there is adequate opportunity to practise scientific skills, and to gain feedback, as preparation for the EPA for apprentices.
56. For those undertaking the degree through an apprenticeship, the learner must achieve the award of the BSc (Hons) and pass the EPA. HEIs will be required to be on the SFA's RoATP and RoAAO. Where the EPA is not integrated as part of the degree programme, the EPA will be delivered following completion of the degree by an organisation on the RoAAO. In the event of failure to pass either the degree course or the EPA, completion of the apprenticeship cannot be achieved. Employers should be assured that HEIs have robust and well-established assessment and quality assurance processes, incorporating internal moderation and external examiners to ensure independence across the degree programme and consistency between HEIs and that these Honours degrees are all approved by the QAA.

## 1.9 On-programme (work-based) Assessment

57. **Formative assessment** is used to support learners in the workplace by ensuring regular, structured checks on developing competence. The formative assessment tools detailed in Table 1are used by all workplaces to capture evidence of the skills, knowledge, behaviours, attitudes and values required by the apprentice in the workplace, in their enactment of their practitioner role and in their interactions with colleagues, peers, patients and the public (where and as appropriate). Formative assessment helps to uncover performance issues or concerns and the HEI and employer will be able to support the learner and provide extra guidance where such issues might arise to ensure that the learner is fully supported in meeting the outcomes of the degree and the apprenticeship for those required to do so. The delivery of that support is likely to differ across HEIs and workplaces.
58. For apprentices, completion of the formative assessment programme is essential preparation for the synoptic EPA near the end of the programme that is designed to capture evidence of the apprentice's mastery of the skills, knowledge, behaviours and values defined in the standard (see section below for more detail). Table 1 also sets out the arrangements for the summative work based employer assessment competency log that encapsulates the performance of the HCSP learner in the demonstration of competences that have been achieved.
59. The high level learning outcomes and clinical experiential learning required in each of the areas of HCS are set out in the PTP curricula for HCSPs.[32] These detail the work-based learning outcomes that form an integral part of the degree programme for HCSPs should be used to guide the selection of formative assessments. The curricula also provide the templates for each of the work-based assessment tools to ensure assessment standardisation across the work-based programme (see appendices).

[32] and in the Institute of Biomedical Science's (b) Registration Portfolio for those undertaking this degree programme

60. This formative work-based assessment programme should find a balance between what is realistic and achievable for employers and learners and what provides sufficient evidence of progress/competence. It is therefore recommended that learners, in consultation with their clinical supervisor, undertake work-based assessments as set out in the table below:

**Recommended number of assessments per academic year**

| **Year 1** | **Year 2** | **Year 3** |
|---|---|---|
| 2 DOPs<br>1 CBD<br><br>Competence | 4 DOPs<br>1 CPD<br>1 OCE<br>Competence | 4 DOPs<br>2 CBDs<br>2 OCEs<br>Competence |

**Table 1 Summary of On-Programme (work-based) formative assessment methods and the Employer based Competency Log[33]**

| Assessment tool | Direct Observation of Practical skills (DOPs) | Observed Clinical Event (OCE) | Case-based Discussion (CbD) | Work-based/employer based Competency Log |
|---|---|---|---|---|
| **Purpose** | Assessment of a practical skill or procedure, including, where relevant, interaction with a patient through direct observation. Learner and assessor feedback is generated, learning needs identified and an action plan agreed | Observation and assessment of a clinical encounter or interaction with colleagues with respect to an aspect of patient care. The format and approach is similar to DOPs but takes place with a patient present or when the learner is working with clinical colleagues | A clinical case is used as the basis for a discussion to assess the learners application of knowledge and understanding of an aspect of an activity they have been part of, e.g. professional practice, communication, leadership, science, the role of healthcare science in patient care | A record of attainment which demonstrates achievement of each work-based competence and clinical experiential learning (CEL) activity, reflecting the performance of the learner, including the demonstration of achievement of aspects of the apprenticeship standard where this is appropriate |
| **Method** | The assessor observes a practical activity and facilitates learner- centred feedback either during or immediately following the observation. The learner generates an action plan and agrees this with the assessor. | The assessor observes a clinical activity and facilitates learner-centred feedback either during or immediately following the observation. The learner generates an action plan and agrees this with the assessor. | A discussion between the learner and assessor with respect to any aspect of a case, including professional practice/*Good Scientific Practice* | An assessor reviews the evidence provided by the learner to support achievement of each competence and CEL. The expectation is that as the learner progresses the competency log will demonstrate an evidential base of achievement/progression. |

[33] Whilst each individual assessment is formative review of the log as a whole forms part of the summative assessment of the degree and of the EPA.

## 1.10 Work-based/employer based Competency Log

61. All learners will also be required to provide evidence to demonstrate that they have successfully achieved the competences set out in the curriculum and for apprentices, those competences specifically reflected in the apprenticeship standard, through success in the EPA. The learner is expected to provide evidence to demonstrate achievement of each competence, which should then be reviewed and signed off by the trainer in the competency log. Learners will gain competence at their own pace, but in line with the overall delivery of the relevant modules. Each competence will link directly to a specific work-based learning outcome in the curriculum and some competences may be linked to more than one learning outcome. Successful completion of the curriculum and, for an apprentice the standard, cannot therefore be achieved until achievement of *all* work-based learning outcomes have been demonstrated.
62. On-going completion of a competency log (the high level requirements are set out in Table 1 above) is therefore essential for progression within the programme and as a requirement for achievement of the degree and completion of the apprenticeship. The expectation is that as the learner progresses the competency log will demonstrate an evidence base of their achievement. The achievement of each competence and a record of all on-programme work-based assessments must be recorded using a written log, or the HEI's own electronic system. For those in HCS programmes this should be presented within a Portfolio of Evidence that is accumulated by the learner to demonstrate learning, competence and insight into practice and professionalism.[34]

## 1.11 End Point Assessment for apprenticeships

63. All apprentices will have to pass the EPA that is designed as a final check on the apprentice's workplace competence and ability to integrate their learning across all elements of the PTP.
64. Where the EPA has been integrated into the degree programme, the degree obtained will provide verification that both the academic part of the standard and the required synoptic assessment have been met and graded. As described above, some HEIs may choose to deliver a non-integrated degree, which will not include the EPA. If an employer chooses to use such a non-integrated degree programme for an apprenticeship, then it will be required to ensure that the synoptic assessment described below is delivered by an appropriately accredited organisation that is on the SFA's RoAAO. In addition the employer will be responsible for the costs attached to the EPA which is delivered by the AO. Although a funding cap for this degree apprenticeship standard has not yet been allocated, employers and HEIs should be aware that if the full amount is used for the delivery of the degree programme, employers will be required to fund the EPA outwith the apprenticeship levy which will be an additional cost to the overall apprenticeship. For integrated degrees, HEIs are likely to have to pay a

[34] For those learners studying to become healthcare science practitioners through biomedical science degrees, the IBMS Registration Portfolio provides the framework for education and training. This Portfolio enables biomedical science learners to demonstrate their fitness to practice through evidence of competence that can be independently verified against the HCPC Standards of Proficiency. This supports the biomedical science graduate in registering with the HCPC. A combined portfolio reflecting this Registration Portfolio and the HCS Portfolio of Evidence for those undertaking the PTP programme in the Life Sciences is currently under development.

small fee to the AHCS to help support and maintain standardisation of the EPA assessment tools (Situational Judgment Test; Professional Discussion and Research evaluation templates).

65. The formative work-based assessment programme described above supports apprentices in acquiring and building the skills, knowledge, behaviours and values defined in the apprenticeship standard. Underpinned by the academic learning and summative assessment provided by the HEI, this will ensure that the learner is prepared and ready to understanding the synoptic assessment, demonstrating these.
66. All apprentices will therefore have to pass the EPA that is designed as a final check on the apprentice's workplace competence and ability to integrate their learning across all elements of the PTP. In integrated degrees, the EPA is delivered towards the end of the three-year programme; in non-integrated degrees, the EPA is undertaken after the degree is achieved and is administered by a registered AO.
67. The EPA is conducted with an independent assessor towards the end of the degree programme and takes approximately two hours. It consists of the following three components, each of which must be passed independently:
    i. one hour written Situational Judgment Test (SJT) set by the HEI;
    ii. face-to-face Professional Discussion, taking approximately 40 minutes, between the apprentice and the trained independent assessor (who has not been involved in the education or training of the apprentice) and based on questions arising from the assessor's scrutiny of the apprentice's portfolio of workplace-based assessments, experiences and critical reflection;
    iii. a presentation of up to 10 minutes to the assessor, in which the apprentice describes the research project undertaken as part of their degree programme. The presentation is followed by a 15 minute question and answer session with the independent assessor on issues raised by the research.

The link to the full version of the Level 6 HCSP Apprenticeship EPA was not available at the time of publication of the 2016 curricula but should be available via: https://www.gov.uk/government/collections/apprenticeship-standards#healthcare-standards

### 1.12 Learner Support and Mentoring

68. The learner supervision, support and mentoring systems will span the academic and work/employer-based elements of the programme, and the relationship between the two systems must be clear to learners, employers work-based staff and HEI staff. The learner supervision, support and mentoring system must be designed to encourage safe and effective practice, independent adult learning, appropriate professional conduct of the learner, the safety of the patient and quality assurance of all work activities of each learner. Those undertaking the role of supervisor or mentor must have relevant qualifications and experience and have undertaken appropriate and up-to-date training. The HEI will be expected to have an academic supervisory, support and mentoring scheme in place and to provide access to learner support services.
69. **Fitness to practise:** The HEI must have a clear policy with respect to fitness to practice (FtP), which must clearly articulate how staff and learners are made

aware of the policy and how the policy is implemented. The HEI's FtP policy should reflect and be aligned to the FtP policy of the AHCS and the HCPC (for Life Sciences). Alongside this must be a clear policy on how learner whistleblowers are supported. Breaches of professional practice and behaviour identified by the HEI or during HEI activities must be reported and investigated in accordance with this FtP policy and accurate records maintained within the HEI.

### 1.13 Annual Monitoring of Progress and Equality and Diversity

70. **Annual monitoring of progress:** All on-site academic learners will usually be expected to complete the requirements for the BSc (Hons) HCS award within three years after initial registration, in accordance with the regulations of each HEI. For those undertaking the degree through an apprenticeship, employers and the HEI should ensure that good progress is made, although through agreement between the employer, the apprentice and the HEI, the duration of the degree may take longer than 3 years.
71. Programme governance must include annual monitoring of progress that considers the outcome of the review of each module (including learner and patient evaluation) and the handling and consideration of the external examiner's report. This process should enable the programme leaders to identify and propose changes to the programme in response to feedback.
72. **Equality and diversity:** HEE, the AHCS, HEI's, scientific professional bodies and employers are committed to the principle of equality and diversity in employment, membership, academic activities, assessment, examinations and training.
73. As part of this ethos these groups are committed to inspire and support all those who work, train and provide training in HCS to operate in a fair, open and honest manner. The approach taken is a comprehensive one and reflects all areas of diversity, recognising the value of each individual. This means that no one is treated less favourably than another on the grounds of ethnic origin, nationality, age, disability, gender, sexual orientation, race, or religion, in accordance with the Equality Act 2010[35]. This reflects not only the letter but also the spirit of equality legislation, taking into account current equality legislation and good practice.

### 1.14 Critical Reflection and Learning

74. **Critical reflection**: Critical reflection on progress and performance is an integral part of both the BSc and of being a professional. Learners should therefore be taught the theoretical models underpinning reflection and required to regularly critically reflect on their progress and performance, enabling them to develop skills in self-evaluation and action planning.
75. This should be used to support the learner as they learn from experiences gained in the workplace. Reflection should help the learner to understand and learn from work-based situations/experience, bridging the gap between theory and practice. Each learner should be taught about the underpinning evidence for the use of reflection and encouraged to reflect regularly on their progress and performance, developing their skills in self-assessment and action planning.

[35] Equality Act 2010. http://www.legislation.gov.uk/ukpga/2010/15/contents

76. Learners should be encouraged to think about what they are doing as they do it (Reflection *in* Action) and retrospectively to reflect on practice (Reflection *on* Action). The reflective practitioner should describe and analyse experience, considering how the situation might have been handled differently and what other knowledge would have been helpful. When critically reflecting on an experience, learners should use a recognised model of reflection.

### 1.15 Relationships and Partnerships

77. **The National School of Healthcare Science:** The NSHCS is hosted by HEE, West Midlands Local Team. The NSHCS provides a national co-ordinating and oversight function to support the delivery of work-based training for HCS training and education programmes. With respect to the PTPs it is responsible for:
    - holding HEIs to account for the quality, integration, co-ordination and delivery of both the academic programme and work-based training through the accreditation process, ;
    - identification of programme issues that may need to be addressed and resolved and reporting these as part of agreed governance arrangements;
    - liaising with LETBs on local issues and problems and their resolution;
    - providing advice and support to accredited PTP programmes as necessary;
    - overarching review to ensure common standards of delivery and content and recommending ongoing training activities to support the CPD of work-based trainers.

    The School can be contacted at www.nshcs.org.uk

78. **The Academy for Healthcare Science:** The AHCS provides the professional voice for the HCS workforce and quality assurance of HCS training and education.[36] Included in its functions are to:
    - act as a strong and coherent professional voice;
    - be able to influence and inform a range of stakeholders on all matters relating to HCS and scientific services;
    - act as the overarching body for professional issues related to education, training and development in the UK health system, including the provision of UK-wide quality assurance across education and training arrangements[37];
    - provide the infrastructure to support the professional regulation/registration of the HCS workforce, including:
        - a system of professional accreditation of education and training programmes for the regulation/registration of the HCS workforce;
        - setting the professional standards for the delivery of accredited registers as required by the PSA's for Health and Social Care to ensure consistency and coherence across all HCS education and training programmes;
        - taking the central role in the sponsorship of the registers to achieve 'accredited' status as set out by the PSA;
        - being a HCPC education provider for the statutory regulation of Clinical Scientists;

[36] http://www.ahcs.ac.uk/wordpress/wp-content/uploads/2014/08/18th-Feb-2016-AHCSQA-Framework-pdf.pdf

[37] The Institute of Biomedical Science (IBMS) also has a role in approving laboratories for training and accrediting healthcare science degrees in the Life Sciences.

- offering a system for equivalence across the HCS workforce to enable those who can demonstrate evidence of training, experience and qualifications equivalent to the required outcomes of HCS training programmes to support entry on to the PSA accredited ACHS register www.academyforhealthcarescience.co.uk/

### 1.16 Programme Outcomes

79. On completion of the BSc (Hons) all graduates should be able to demonstrate the following outcomes that align to QAA level 6, extended and contextualised to the NHS job role for HCSP.

**Professional Practice**

i. Professional practice that meets the professional standards of conduct, performance and ethics defined by *Good Scientific Practice*[38] and is safe, lawful and effective, and within the scope of practice for the role undertaken, while maintaining fitness to practice.
ii. Personal qualities that encompass communication skills, self-management, self-awareness, acting with integrity and the ability to take some responsibility for self-directed learning, maintaining their own health and wellbeing, critical reflection and action planning to maintain and improve performance.
iii. The ability to be an independent self-directed learner acting autonomously in a non-discriminatory manner when planning and implementing tasks at a professional level.
iv. The ability to work, where appropriate, in partnership with other professionals, often as part of a multidisciplinary team (MDT), supporting staff, service users and their relatives and carers while maintaining confidentiality.
v. The ability to work with the public, service users, patients and their carers as partners in their care, embracing and valuing diversity.
vi. A range of transferable generic academic skills and capabilities to the exercise of initiative and personal responsibility, decision making in complex and unpredictable contexts spanning study skills, independent learning, reflective practice, communication, team working, research and leadership skills.
vii. A conceptual understanding that enables the learner to devise and sustain arguments and/or to solve problems, using ideas and techniques, some of which are at the forefront of a specialism of HCS.
viii. The ability to apply problem-solving skills, evaluate evidence, arguments and assumptions, to reach sound judgements and to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.

**Scientific and Clinical Practice**

ix. An understanding of a complex body of knowledge, some of it at the current boundaries of an academic discipline, and the ability to apply the scientific principles, method and knowledge to HCS.

[38] and the HCPC in the Life Sciences

x. The ability to apply scientific method and approaches to analytical techniques, HCS research, development and innovation.
xi. The ability to perform technical investigations/skills and technical reporting of quality assured tests, investigations and interventions on patients/samples safely and skillfully, adhering to applicable legislation and in compliance with local, national and international guidelines.
xii. The ability to provide therapeutic interventions, some of which may be specialist, in a number of specialisms.
xiii. A systematic understanding of key aspects of their field of study, including acquisition of coherent and detailed knowledge, at least some of which is at, or informed by, the forefront of defined aspects of HCS.
xiv. High-quality clinical and scientific practice that applies core scientific knowledge, skills and experience in a healthcare setting, places the patient/public at the centre of care, prioritising patient safety and dignity and reflecting NHS/health service values and the NHS Constitution.

**Research, Development and Innovation**

xv. An appreciation of the uncertainty, ambiguity and limits of knowledge, the ability to manage their own learning, and to make use of scholarly reviews and primary sources (for example refereed research articles and/or original materials appropriate to HCS).
xvi. To apply the methods and techniques that they have learned to review, consolidate, extend and apply their knowledge and understanding, and to initiate and carry out projects.
xvii. An understanding of the strengths, weaknesses and opportunities for further development of healthcare and HCS as applicable to their own clinical practice, research, audit, innovation and service development, which either directly or indirectly leads to improvements in patient experience, clinical outcomes and scientific practice.

**Clinical Leadership**

xviii. Scientific and clinical leadership appropriate to the HSCP job role based on the continual advancement of their knowledge, skills and understanding through the independent learning required for CPPD.

## 1.17 Transferable Skills

80. It is expected that all BSc (Hons) HCS programmes will meet the descriptors for a higher education qualification at level 6 (Bachelor's degree with honours) outlined by the Framework for Higher Education Qualifications in England, Wales and Northern Ireland (FHEQ) and the Scottish Credit and Qualifications Framework (SCQF) Level 10. On graduation all will have gained a range of transferable generic academic skills and capabilities, including study skills, independent learning, problem solving, reflective practice, communication skills, team working, research, innovation and leadership skills. These transferable skills should be embedded in the curriculum developed by each HEI. For those undertaking the apprenticeship programme, employers will be further assured that apprentices have gained the transferable skills required, given the successful completion of the EPA as part of or in addition to the degree programme.

# SECTION 2: BSc(Hons) IN CLINICAL ENGINEERING

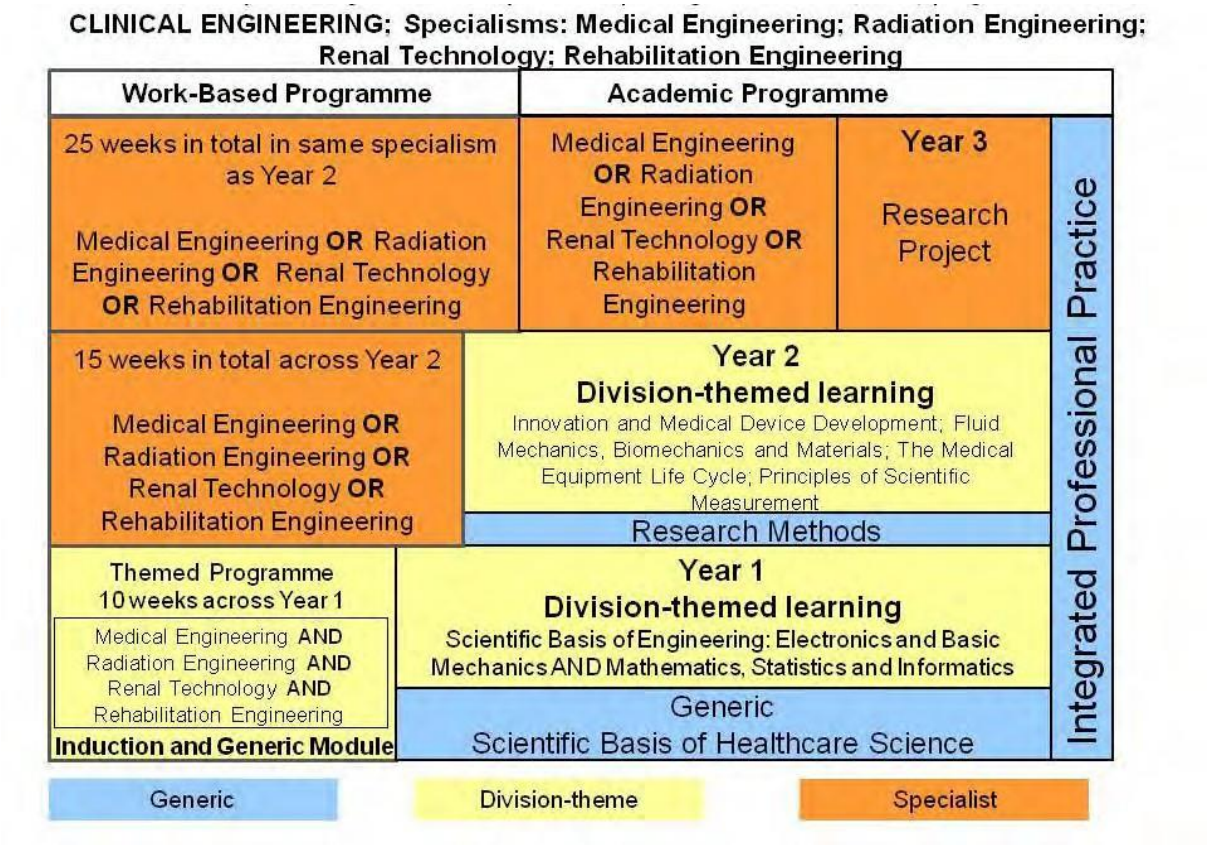
## 2.1 Details of the PTP Curriculum in Clinical Engineering

The BSc (Hons) in Healthcare Science for the Practitioner Training Programme will begin with an induction programme provided by the academic provider. All HCS students will then complete a generic introductory module entitled 'Scientific Basis of Healthcare Science' and will begin to develop their knowledge and understanding of professional practice. Later in Year 1 they will study Mathematics, Statistics and Informatics followed by the Scientific Basis of Clinical Engineering, and during Year 1 students will undertake 10 weeks of work-based learning focusing on a core specialist area, while gaining an insight into the work of all four specialisms within Clinical Engineering. For students who are part time or already in NHS employment it is recognised the 10 weeks may be aggregated over a longer period.

In Year 2, the students will then develop their learning in areas that are common across Clinical Engineering, namely Innovation and Medical Device Development; Fluid Mechanics, Biomechanics and Materials; The Medical Equipment Life Cycle; and Principles of Scientific Measurement. In addition, they will study the generic modules Research Methods and Professional Practice before specialising in one area of Clinical Engineering in Year 3. In Year 3, they will continue to build their professional practice and research skills, including completing a research project in their chosen specialism. The emphasis will be on developing and building knowledge and skills as they move through the programme consistently demonstrating the requisite attitudes, behaviours and skills.

The diagram overleaf summarises the training programme for Clinical Engineering.

**Modernising Scientific Careers: Practitioner Training Programme (PTP): Diagrammatic representation of the full-time, three-year, pre-registration, integrated academic and work-based BSc (Hons) in Healthcare Science**




*The programme can be delivered part-time through employment.*
*Note: The 10-week work-based experience in Year 1 does not require equal time to be spent in each specialism; however, the students should become acquainted with the breadth of Clinical Engineering by the end of the first year*

## 2.2 List of Modules

| Year | Module Title | Credits |
|---|---|---|
| 1 | Professional Practice | 10 |
| 1 | Scientific Basis of Healthcare Science – integrated module across body systems | 60 |
| 1 | Mathematics, Statistics and Informatics | 10 |
| 1 | Scientific Basis of Engineering: Electrical and Electronic Systems, including work-based training | 25 |
| 1 | Scientific Basis of Engineering: Basic Mechanics, including work-based training | 15 |
| 2 | Professional Practice | 10 |
| 2 | Research Methods | 10 |
| 2 | Innovation and Medical Devices | 25 |
| 2 | Fluid Mechanics, Biomechanics and materials | 10 |
| 2 | The Medical Equipment Life Cycle | 25 |
| 2 | Principles of Scientific Measurement | 30 |
| | **MEDICAL ENGINEERING** | |
| 2 | Work-based Training | 20 |
| 3 | Professional Practice | 10 |
| 3 | Science and Principles supporting Medical Engineering | 30 |
| 3 | Medical Engineering in the Clinical Environment | 30 |
| 3 | Research Project in Medical Engineering | 30 |
| | **RADIATION ENGINEERING** | |
| 2 | Work-based Training | 20 |
| 3 | Professional Practice | 10 |
| 3 | Science and Principles supporting Radiation Engineering | 30 |
| 3 | Radiation Engineering in the Clinical Environment | 30 |
| 3 | Research Project in Radiation Engineering | 30 |
| | **RENAL TECHNOLOGY** | |
| 2 | Work-based Training | 20 |
| 3 | Professional Practice | 10 |
| 3 | Science and Principles supporting Renal Technology | 30 |
| 3 | Renal Technology in the Clinical Environment | 30 |
| 3 | Research Project in Renal Technology | 30 |
| | **REHABILITATION ENGINEERING** | |
| 2 | Work-based Training | 20 |
| 3 | Professional Practice | 10 |
| 3 | Science and Principles supporting Rehabilitation Engineering | 30 |
| 3 | Rehabilitation Engineering in the Clinical Environment | 30 |
| 3 | Research Project in Rehabilitation Engineering | 30 |

# SECTION 3: GENERIC GOOD SCIENTIFIC PRACTICE SYLLABUS

**Introduction**

The Academy for Healthcare Science (AHCS) has set out the principles, values and the standards of behaviour and practice for the HCS workforce in the document *Good Scientific Practice* (GSP). These standards and values must be achieved and maintained in the delivery of work activities, the provision of care and personal conduct. In addition, the AHCS hold a Professional Standards Authority accredited register for Healthcare Science Practitioners (HCSP) not covered by statutory regulation.[39] The Health and Care Professions Council (HCPC) sets out the Standards of Proficiency, which must be achieved for statutory registration as a Biomedical Scientist on completion of the Life Sciences Practitioner Training Programme (PTP).

Key professional practice learning outcomes are included in the BSc (Hons) programme through its GSP syllabus, thus embedding the standards of professionalism set out in GSP in all aspects of the delivery and assessment of the programme. The GSP syllabus is a common component of all PTP curricula and must be followed throughout the whole training period, with engagement at the appropriate level, depending on the stage of training.

The syllabus is divided into five domains. These align with the five domains of *Good Scientific Practice* (GSP):

- Domain 1: Professional Practice
- Domain 2: Scientific Practice
- Domain 3: Clinical Practice
- Domain 4: Research, Development and Innovation
- Domain 5: Clinical Leadership

Each domain contains an overall learning objective, which is described by a number of competence statements. These are presented as:

- knowledge to be acquired and applied;
- practical skills to be demonstrated;
- attitudes and behaviours to be consistently displayed.

As students progress through the three-year programme they are expected to critically reflect on their performance as they build on and extend the depth and complexity of the knowledge, skills and experience (spiral learning) that underpins professional practice as a HCSP.

[39] Practitioners who have completed an HCPC-approved PTP course in Life Sciences are eligible to apply for Statutory Regulation as Biomedical Scientists.

**Domain 1: Professional Practice**

| Topic | Professional Practice | GSP reference |
|---|---|---|
| **Learning objective** | By the end of the course the student will be able to practise as an autonomous professional, usually within the context of the MDT, applying their knowledge appropriately, exercising their own professional judgement, practising within the legal and ethical boundaries of the role of a HCSP, and critically reflecting on and developing their professional practice. | |
| **High-level learning outcome(s)** | By the end of the course, the student will be able to:<br>• Demonstrate verbally, in written form and in practice, the knowledge and understanding of the professional requirements of a HCSP in the provision of patient-centred care and healthcare service(s) as described in GSP. | |
| **Knowledge** | By the end of the course students will know, comprehend and apply their knowledge and will be able to:<br>1. Discuss the standards of proficiency of the AHCS and the HCPC and the role of regulation for healthcare professions.<br>2. Explain the importance of placing the patient at the centre of care and consider services from a user's point of view.<br>3. Explain the importance of keeping professional knowledge and skills up to date, working within the limits of personal competence.<br>4. Analyse the ethical, legal and governance requirements arising from working as a HCSP across a range of situations.<br>5. Summarise and evaluate the evidence to support the high levels of probity required when working at the level of HCSP.<br>6. Justify the importance of personal health and wellbeing in order to ensure that personal performance and judgement are not affected by their own health.<br>7. Analyse NHS organisation, policy, values and practice as it affects the provision of healthcare, healthcare science ,and the patients and populations it serves.<br>8. Discuss theories of teaching and learning to underpin the role of the HCS workforce in education as a learner, teacher or trainer, according to the best contemporary clinical and educational standards.<br>9. Explain a range of strategies to ensure that the voice of patients and the public is embedded in all aspects of healthcare, healthcare science and healthcare science education in the academic and work-based setting. | 1.1.1<br>1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>1.2<br>1.2.5<br>1.4.1<br>1.4.2<br>2.3.2 |

| Topic | Professional Practice | GSP reference |
|---|---|---|
| | 10. Understand the need, where appropriate, to hold indemnity insurance. | |
| **Technical procedures and clinical skills** | By the end of the course, the student will be expected to apply in practice a range of professional, technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. They will be able to:<br>1. Work within their agreed scope of practice.<br>2. Apply their understanding of professional practice with conduct that places the patient at the centre of care in a manner that promotes patient wellbeing and self-care in all academic and work-based activities.<br>3. Apply their understanding of the role and importance of Continuing Personal and Professional Development (CPPD) to ensure that their professional knowledge and skills are kept up to date.<br>4. Respond to the ethical, legal and governance requirements arising from working at the level of a HCSP, applying and accruing knowledge and evidence.<br>5. Work in a manner that demonstrates probity in every aspect of professional practice at all times.<br>6. Make appropriate judgements to ensure they limit their work or stop practising if their performance or judgement is affected by their health, and raise any concerns about the performance of colleagues with their supervisor.<br>7. Maintain records accurately, comprehensively and comprehensibly in accordance with applicable legislation, protocols and guidelines.<br>8. Raise concerns through appropriate channels if they have evidence to believe that the practice or judgements of colleagues are impaired and are a matter of concern in relation to patient safety.<br>9. Work in accordance with relevant current NHS policy, guidelines and practice. | 1.1.1<br>1.1.2<br>1.1.3<br>1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>1.1.8<br>1.1.10<br>1.2.2<br>2.2.3<br>2.2.6<br>2.2.7<br>2.3.2<br>3.2.2<br>4.1.2 |
| **Attitudes, values and behaviours** | By the end of the course, the student will be expected to demonstrate the attitudes, values and behaviours of a HCSP and will be able to:<br>1. Apply evidence-based personal and team professional practice that places the patient at the centre of care.<br>2. Apply knowledge, experience and critical reflection to identify personal development needs using a range of tools, and develop and update action plans to ensure that they keep skills and knowledge up to date.<br>3. Display a professional commitment to ethical practice, consistently operating within national and | 1.1.1–<br>1.1.10<br>1.2<br>1.3.1<br>2.2.3<br>2.2.6<br>2.2.7<br>2.2.8<br>4.1.2 |

| Topic | Professional Practice | GSP reference |
|---|---|---|
| | local ethical, legal and governance requirements.<br>4. Apply the principles of GSP and its professional standards, performing to the highest standards of personal behaviour in all aspects of professional practice.<br>5. Consistently operate in accordance with relevant current NHS policy and practice.<br>6. Operate consistently within a sphere of personal capability and level of authority, managing personal workload and objectives to achieve quality of care. | 4.1.6 |

**Domain 2: Scientific Practice**

| Topic | Scientific Practice | GSP reference |
|---|---|---|
| **Learning objective** | By the end of the course, the student will establish and maintain a safe environment in which healthcare science is delivered, drawing on the knowledge, skills, attitudes and behaviours required for safe and effective practice. They will be able to deliver high-quality scientific services in a safe and secure working environment. They will also be able to reflect on their performance or situations and record their action plans as they continually evaluate, review and improve their practice. | |
| **High-level learning outcome(s)** | By the end of the course, the student will be able to:<br>• Explain and apply the knowledge, skills, values and behaviours required of a HCSP in the delivery of high-quality, evidence-based and patient-centred services in a safe and secure working environment to which they effectively contribute. | |
| **Knowledge** | By the end of the course, the student will know, comprehend and apply the key concepts of the knowledge base relevant to healthcare science and will be able to:<br>*1.* Describe information and communication technologies (ICT) appropriate to the HCS specialism.<br>*2.* Explain the principles and practice of quality control, external quality assessment and quality management as applied to relevant areas of healthcare science.<br>*3.* Explain the role of audit and the audit cycle and how it is used as a tool to facilitate continuous quality improvement.<br>*4.* Discuss and justify relevant health and safety legislation and guidance for the workplace. | 1.4.5<br>2.2.2<br>2.2.7<br>2.2.9<br>2.3.1-2.3.4<br>3.1.17<br>3.2.1<br>4.1.2 |
| **Technical procedures and clinical skills** | By the end of the course, the student will be expected to apply in practice a range of professional, technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. They will be able to:<br>1. Apply evidence-based practice, both current and new/emerging, in determining the use of scientific investigations and methods.<br>2. Apply the appropriate HCS knowledge and skills required for safe and effective practice.<br>3. Perform a range of routine technical and clinical skills relevant to the HCS division and theme in which they are training. | 1.1.5<br>1.4.5<br>2.1.2<br>2.1.3<br>2.2.2<br>2.2.3<br>2.2.4<br>2.2.6<br>2.2.7 |

| Topic | Scientific Practice | GSP reference |
|---|---|---|
| | 4. Master the use of ICT in relevant areas of healthcare science.<br>5. Apply and maintain quality standards and related quality control, assessment and management techniques to assure the validity of scientific and technical investigations routinely and assure the quality of personal practice.<br>6. Participate in scientific and technical audit to determine that investigations and methods are fit for purpose.<br>7. Practise and promote the importance of health and safety standards in the workplace, prioritising patient safety and the safety of all those working in or accessing the specialism and identify actions that will improve health and safety, including reducing the risk of infection. | 2.2.8<br>2.2.9<br>2.3<br>3.1.5<br>3.2.1<br>4.1.2<br>4.1.6 |
| **Attitudes, values and behaviours** | By the end of the course, the student will be able to:<br><br>1. Consistently practise in accordance with the values described in *Good Scientific Practice* and the NHS Constitution to ensure high-level, safe, effective and compassionate patient-centred care. | 1.1.1-1.1.11<br>1.2 |

**Domain 3: Clinical Practice**

| Topic | Clinical Practice | GSP reference |
|---|---|---|
| **Learning objective** | By the end of the course, the student will be able to deliver high-quality, effective and safe technical clinical services, performing a range of clinical and/or laboratory skills consistent with the required roles, responsibilities and values of a HCSP within their scope of practice. | |
| **High-level learning outcome(s)** | By the end of the course, the student will be able to:<br>• Explain and demonstrate the need for and the ability to deliver high-quality technical and clinical services in the investigation and management of patients as part of a MDT.<br>• Apply and demonstrate those skills, attitudes, values and behaviours, in a variety of settings and with regard to a variety of political, social, technical, economic, organisational and professional contexts required of a HCSP delivering consistently high-quality technical and clinical services that are targeted to meet the needs of the individual and group needs of patients. | |
| **Knowledge** | By the end of the course, the student will know, comprehend and apply their knowledge and be able to:<br>1. Describe the pathophysiology of common diseases that result in a referral to HCS services in a specific area of practice.<br>2. Evaluate the contribution of the MDT to patient care, patient safety and quality outcomes, and consider barriers to effective MDT working.<br>3. Describe the key roles of the healthcare professions that contribute to the MDT in your area of practice.<br>4. Discuss their role within the MDT and evaluate the clinical effectiveness of the team, reflecting and suggesting as appropriate areas for improvement.<br>5. Describe typical behaviours of team members and evaluate the clinical effectiveness of the team and suggest areas for improvement as appropriate.<br>6. Discuss and evaluate the principles and practice of clinical audit as a tool to evaluate the effectiveness of services. | 1.1.4<br>1.1.5<br>1.3.2<br>1.3.6<br>2.2.2<br>2.3.4<br>4.1.2<br>4.1.10 |
| **Technical procedures and clinical skills** | By the end of the course, the student will be expected to apply in practice a range of professional, technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. They will be able to:<br>1. Deliver high-quality technical clinical procedures in the investigation and management of patients. | 1.3.2<br>1.3.6<br>2.1.3<br>2.1.4 |

| Topic | Clinical Practice | GSP reference |
|---|---|---|
| | 2. Apply in practice consistently high standards in the technical skills required in the investigation and management of patients and critically reflect on their performance.<br>3. Assist and, where appropriate, perform a range of equipment management skills, e.g. preventative maintenance, fault finding and calibration.<br>4. Attend and, if appropriate, actively participate in MDT meetings.<br>5. Assist in the design, data collection, data analysis and reporting within the clinical audit cycle. | 2.1.5<br>2.1.6<br>2.2.1-2.2.4<br>2.2.6-2.2.9<br>4.1.10 |
| **Attitudes, values and behaviours** | By the end of the course, the student would be expected to demonstrate the attitudes and behaviours necessary for the role of a HCSP and will be able to:<br>1. Commit to the provision of high standards of technical clinical services, taking account of the political, social, technical, economic, organisational and professional environment, and act as a positive role model.<br>2. Promote the importance of active participation of HCSPs in MDT meetings.<br>3. Advocate clinical audit as a tool to evaluate and optimise clinical services and communicate ideas and aspirations. | 1.1.4<br>1.1.5<br>1.1.6<br>1.1.11<br>1.2.5<br>1.3.2<br>2.3<br>4.1.10 |

**Domain 4: Research, Development and Innovation**

| Topic | Research, Development and Innovation | GSP reference |
|---|---|---|
| **Learning objective** | By the end of the course, the student will be able to justify the need for evidence-based practice, audit and innovation to support the development and improvement of patient services and patient safety and will demonstrate the necessary knowledge, skills, attitudes, values and behaviours in relation to research, development and innovation in the pursuit of improved patient safety and care. | |
| **High-level learning outcome(s)** | By the end of the course, the student will be able to:<br>• Explain the need for evidence-based practice, audit and innovation within appropriate governance and ethical frameworks, in the delivery, development and improvement of patient-centred services.<br>• Undertake or participate in personal or collaborative research, audit, development (professional or service) and innovation, applying the knowledge, skills, attitudes, values and behaviours required of a HCSP. | |
| **Knowledge** | By the end of the course, the student will know, comprehend and apply their knowledge and be able to:<br>1. Know the principles and applications of scientific enquiry, including the evaluation of treatment efficacy, the research process and research methodologies.<br>2. Know the value of research to the critical evaluation of practice research.<br>3. Describe and justify how and why research and development is undertaken within governance and ethical frameworks.<br>4. Explain ways in which the individual HCSP can support the wider healthcare team in the spread and adoption of innovative technologies and practice. | 1.1.5<br>4.1.1<br>4.1.2<br>4.1.3<br>4.1.6<br>4.1.7<br>4.1.8<br>4.1.9<br>4.1.10 |
| **Technical procedures and clinical skills and procedures** | By the end of the course, the student will be expected to apply in practice a range of professional, technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. They will be able to:<br>1. Apply research methods and techniques to initiate and complete a research project, development or innovation project.<br>2. Evaluate research and other evidence to inform own practice. | 4.1.3<br>4.1.6<br>4.1.8<br>4.1.9 |
| **Attitudes, values and behaviours** | By the end of the course, the student would be expected to demonstrate the attitudes and behaviours necessary for the role of a HCSP and will:<br>1. Work with appropriate research and development governance, legal and ethical frameworks. | 1.1.4<br>1.1.5<br>4.1.1 |

| Topic | Research, Development and Innovation | GSP reference |
|---|---|---|
| | 2. Promote the need for evidence-based practice to support the provision of high-quality care.<br>3. Be flexible and adaptable to the introduction of new scientific, technical, diagnostic, monitoring, treatment and therapeutic procedures into routine practice.<br>4. Keep up to date as part of a commitment to CPPD. | 4.1.2<br>4.1.4<br>4.1.6 |

**Domain 5: Clinical Leadership**

| Topic | Clinical Leadership | GSP reference |
|---|---|---|
| **Learning objective** | The NHS Leadership Academy states that: '*The Healthcare Leadership Model is to help those who work in health and care to become better leaders. It is useful for everyone – whether you have formal leadership responsibility or not, if you work in a clinical or other service setting, and if you work with a team of five people or 5,000.*' By the end of this course the student should therefore begin to develop an understanding of the key concepts of leadership; the skills, qualities and abilities of effective leaders and how their personal qualities affect the experiences of patients and service users, the organisation, the quality of care provided and the reputation of the organisation itself. They will be introduced to assessment tools to measure their personal qualities and critically reflect on performance to identify their own personal qualities, including values, principles and assumptions, developing action plans to adapt personal behaviour as necessary. | |
| **High-level learning outcome(s)** | By the end of the course, the student will:<br>• Understand the principles underpinning the current NHS clinical leadership frameworks[40] and the associated personal qualities and the impact of personal qualities on the culture and climate within which the student, their colleagues and teams work. | |
| **Knowledge** | By the end of the course, the student will know, comprehend and apply their knowledge and be able to:<br>1. Explain the difference between leadership and management.<br>2. Discuss the skills, qualities and abilities of effective leaders.<br>3. Describe the impact of personal qualities on the culture and climate the student, their colleagues and teams work in.<br>4. Discuss how what the student does and how they behave affects the experiences of patients/service users, the organisation, the quality of care provided, and the reputation of the organisation itself. | 5.1.1-5.1.6<br>5.1.10<br>5.1.12 |
| **Technical procedures and clinical skills** | By the end of the course, the student will be expected to apply in practice a range of professional, technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. They will be able to:<br>1. Identify and develop skills in listening, observing and using feedback.<br>2. Identify conflict style and develop skills in negotiating and mediating conflicts. | |

[40] http://www.leadershipacademy.nhs.uk/wp-content/uploads/dlm_uploads/2014/10/NHSLeadership-LeadershipModel-colour.pdf

| Topic | Clinical Leadership | GSP reference |
|---|---|---|
| **Attitudes, values and behaviours** | By the end of the course, the student would be expected to demonstrate the personal qualities that underpin the practice of a HCSP, namely self-awareness, e.g. self-confidence; self-control; self-knowledge; personal reflection; resilience and determination. Students should be aware of their strengths and limitations in these areas and how these will have a direct effect on how they behave and interact with others. Students will be expected to critically reflect on performance to identify their own personal qualities, including values, principles and assumptions, developing action plans to adapt personal behaviour as necessary. | 1.3.1<br>1.3.2<br>1.3.3<br>1.3.4<br>1.3.5<br>1.3.6 |

# SECTION 4: GENERIC PROFESSIONAL, SCIENTIFIC AND TECHNICAL MODULES

This section covers the three generic modules that will be studied by all students undertaking an MSC accredited BSc (Hons) Healthcare Science integrated degree.

- Year 1–3: Professional Practice [10 credits per year developing learning at Level 4, Level 5 and Level 6]
- Year 1: Scientific Basis of Healthcare Science [60 credits]: Level 4
- Year 2: Research Methods [10 credits]: Level 5
- Year 3: Research Project [30 credits]: Level 6

## GM(i): Professional Practice (Years 1, 2 and 3)

| Topic | Professional Practice<br>[10 credits per year] | GSP reference |
|---|---|---|
| **Learning objective** | The overall aim of this module is to ensure that the student has the underpinning knowledge, understanding and skills and consistently demonstrates the values, attitudes and behaviours to perform a range of technical and clinical skills working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC.<br><br>Professional practice should be embedded in every aspect of the three-year programme to enable the student to develop and build their professional practice as they progress through the programme. In line with the concept of a spiral curriculum, students will encounter the same subject in different parts of the curriculum, but across the three-year programme the complexity will increase and the student will reinforce previous learning, gradually increasing their knowledge, skills and confidence. | |
| **Knowledge** | On successful completion of this programme the student will:<br><br>**Professional practice**<br>1. Describe the values and principles that underpin the shared UK NHS and Social Care services culture, including the HEE five key workforce characteristics and the NHS Constitution, especially the values relating to compassion, transparency, candour, openness and leadership.[41,42]<br>2. Describe the role of the HCSP and how HCSPs contribute to the delivery of high-quality healthcare.<br>3. Explain the importance of placing the patient at the centre of care and discuss how this translates into practice.<br>4. Discuss the impact of culture, equality and diversity on practice.<br>5. Discuss how HCS services can work in partnership with patients and service users to ensure the views of patients are central to delivering, develop and maintaining high-quality, safe services.<br><br>**Legal and ethical boundaries of practice**<br>6. Analyse the ethical, legal and governance requirements arising from working at the level of a HCSP across a range of situations. | 1.1<br>1.2<br>1.3<br>2.3.4<br>4.1.1<br>5.1.2<br>5.1.4 |

[41] Investing in People – Workforce Plan for England.
[42] Maps to Francis Report, Recommendation 2 – also to The Speaking Up Charter.

| Topic | Professional Practice<br>[10 credits per year] | GSP reference |
|---|---|---|
| | 7. Discuss the principles, guidance and law with respect to medical ethics, patient confidentiality (the limits of the concept of confidentiality), informed consent, equality and diversity, safeguarding, use of chaperones.<br>8. Summarise the procedures to follow if cautioned, charged with a criminal offence, suspended, or have restrictions placed on personal scientific, clinical or professional practice.<br>9. Justify the importance of personal health and wellbeing to ensure personal performance and judgement is not affected by their own health.<br><br>**Patient safety and quality**<br>10. Explain the importance of protecting patients from risk or harm presented by another person's conduct, performance, or health and what to do when concerns are identified or raised.<br>11. Discuss how to share information appropriately with patients, carers, colleagues and other services to support the quality of care.<br>12. Explain the common causes of error and understand the critical incident reporting process, recognising the importance of promoting a no-blame culture.<br>13. Explain approaches to procedures for identifying and reporting critical incidents and receiving and responding to complaints.<br>*14.* Explain current national and local policy issues as they affect the service provided by HCSPs and the HCS workforce.<br>15. Discuss your role in healthcare science and its contribution to the delivery of high-quality healthcare.<br>16. Explain why it is important that the HCS workforce takes reasonable care of health and safety at work for themselves, members of their team and others.<br><br>**Communication skills**<br>17. Explain the principles that underpin effective verbal and written communication within your role, including those who do not have English as a first language and communication with people with sensory and cognitive impairments.<br><br>**Leadership**<br>18. Explain the concept of shared leadership and the associated personal qualities and behaviours | |

| Topic | Professional Practice<br>[10 credits per year] | GSP reference |
|---|---|---|
| | that promote shared leadership and apply this knowledge within the work-base.<br><br>**Continuing personal and professional development**<br>19. Explain the importance of keeping professional knowledge and skills up to date and working within the limits of their personal competence.<br>20. Justify the rationale for engaging in CPPD and critical reflective practice, and evaluate methods for recording, learning, developing and evaluating action plans. | |
| **Technical skills and procedures** | By the end of the course, the student will be expected to apply in practice a range of professional, technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. | 1.1<br>1.2<br>1.3 |

**GM(ii): Scientific Basis of Healthcare Science (Year 1)**

| Topic | Scientific Basis of Healthcare Science [60 credits] | GSP reference |
|---|---|---|
| **Learning objective** | The overall aim of this introductory module is to provide all students with a broad knowledge and understanding of clinical science and scientific knowledge, contextualised to the practice of healthcare science and the services provided by their HCS division/specialism. Central to this is the contribution of healthcare science to patient care, patient safety, service delivery, research and innovation, often at the cutting edge of science, for example genomics, personalised medicine and clinical bioinformatics. All members of the HCS workforce must understand the impact of their work on patients and patient care and remember that their work has a direct or indirect impact on patient care.<br><br>As an introductory module it will provide an overview and reinforcement of key concepts with respect to the organisation, structure and function of the body, and important areas such as the psychosocial aspects of health and disease, clinical pharmacology and therapeutics, genomics, personalised/precision medicine and clinical bioinformatics. Achievement of each learning outcome provides the building blocks for the division- and specialism-specific learning to follow, ensuring a common starting point for all students.<br><br>This module is designed to provide students with broad scientific knowledge to underpin their future practice to provide the foundations for study in any area of healthcare science. | |
| **Knowledge** | On successful completion of this module the student will:<br><br>1. Describe the structural, chemical, cellular and tissue organisation of the body and explain the cellular, tissue and systems responses to diseases.<br>2. Explain the structure and function of all body systems and the effects of common diseases.<br>3. Explain the principles and core concepts of clinical genetics, genomics and personalised/precision medicine and discuss in the context of patients referred to HCS services.<br>4. Explain the basis of epidemiology, public health, health prevention and health protection, and discuss in relation to the role of the public health function and HCS services.<br>5. Explain the principles of clinical pharmacology and therapeutics and discuss in relation to patients referred to HCS services.<br>6. Explain the principles and core concepts of the sociology of health and illness and discuss those relevant to patients typically referred to HCS services.<br>7. Explain the basic principles of physics and clinical engineering that underpin healthcare science | 1.1.4<br>1.1.5<br>1.1.6<br>2.1.6 |

| Topic | Scientific Basis of Healthcare Science [60 credits] | GSP reference |
|---|---|---|
| | and discuss in relation to patients referred to HCS services.<br>8. Explain the principles of clinical bioinformatics and health informatics and discuss their impact on healthcare, health and HCS services.<br>9. Explain a range of mathematical and statistical techniques that underpin the practice of healthcare science.<br>10. Keep up to date with developments in healthcare and healthcare science, identifying new and innovative scientific and technical developments and their application in healthcare science. | |
| **Technical skills and procedures** | By the end of this module the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC.<br><br>Students will be expected to apply and develop their knowledge as they progress through the programme in their academic and work-based learning. They will also be expected to develop a range of study skills, including time management, organisational skills, using the library, search engines, self-directed learning, critical analysis and avoiding plagiarism. | 1.1.4<br>1.1.5<br>1.1.6<br>2.2.4 |

**GM(iii): Research Methods (Year 2)**

| Topic | Research Methods<br>[10 credits] | GSP reference |
|---|---|---|
| **Learning objective** | The overall aim of this module is to ensure that the student has the knowledge, skills and experience of the place of research, development and innovation in the NHS in improving patient care, including prevention, diagnostics, treatment and service delivery. On completion of this module and the research project, students should be able to generate ideas; assess, plan, conduct, evaluate, interpret and report research and innovation projects, which includes original research; and disseminate the findings and, where appropriate, the adoption of the findings.<br><br>Students will extend their knowledge and application of mathematics, statistics and data presentation techniques gained in Year 1. This module will provide the underpinning knowledge to support the final year research project. | |
| **Knowledge** | On successful completion of this module the student will:<br><br>1. Explain and justify the process and importance of research, innovation and audit to the NHS and healthcare science.<br>2. Explain the current UK ethical, legal and governance frameworks within which human and animal research can be conducted.<br>3. Explain the principles of evidence-based medicine, literature and systematic review, and the development of clinical guidelines.<br>4. Describe a range of study designs and discuss the appropriate use of each method.<br>5. Describe and justify the use of statistical techniques to analyse data and a range of dissemination methods to share research findings. | 4.1.1<br>4.1.7 |

**GM(vi): Research Project (Year 3)**

| Topic | Research Project<br>[30 credits] | GSP reference |
|---|---|---|
| **Learning objective** | The overall aim of this module, building on the Research Methods module, is for the student to apply the methods and techniques that they have learned to review, consolidate, extend and apply their knowledge and understanding as they initiate and complete a research project. The research project may span scientific or clinical research, translational research, operational and policy research, clinical education research, innovation, service development, service improvement, or supporting professional service users.<br><br>Research projects should be designed to take into account the current research programmes of the academic and/or work-based departments in which the research is to be conducted. | |
| **Knowledge** | By the end of this module the student will:<br><br>1. Discuss the range of research undertaken in health and healthcare science and how these are applied in the specialism in which the student is based.<br>2. Describe the ethical and governance approval processes required to undertake the planned research project. | 1.1.4<br>1.1.5<br>4.1.1<br>4.1.2 |
| **Technical skills and procedures** | On successful completion of this module and working within legal and ethical frameworks the student will be able to:<br><br>1. Work with a supervisor to design, plan and undertake a research project to test a hypothesis from conception to completion/archiving in accordance with ethical and research governance regulations, drawing on expert advice where necessary and involving patients and service users.<br>2. Analyse the data using appropriate methods and statistical techniques and interpret, critically discuss and draw conclusions from the data.<br>3. Prepare a project report that describes and critically evaluates the research project, clearly identifying the strengths and weaknesses.<br>4. Present a summary of the research project, responding to questions appropriately.<br>5. Prepare a summary of the research project suitable for non-specialist and lay audiences. | 4.1.1<br>4.1.2<br>4.1.3<br>4.1.6<br>4.1.8<br>4.1.9 |
| **Technical skills and procedures** | On successful completion of this module and working within legal and ethical frameworks the student will be able to:<br><br>*1.* Undertake an evidence-based literature review, critically appraise the output, draw appropriate | 2.1.6<br>2.2.4<br>4.1.1 |

| Topic | Research Project<br>[30 credits] | GSP reference |
|---|---|---|
| | conclusions and prepare a written report the findings, and where appropriate, use the findings to inform the 3rd year research project.<br>*2.* Present the outcome of the literature review to a non-scientific and scientific audience. | 4.1.2<br>4.1.7<br>4.1.9 |

# SECTION 5: DIVISION-THEME SCIENTIFIC AND TECHNICAL SYLLABUS

### 5.1 Attitudes, Behaviours and Values

The student will be expected to critically reflect on their professional practice and consistently demonstrate the professional attributes and insights required of a HCSP.

The following learning outcomes should be achieved, as appropriate to the modules within the Clinical Engineering syllabus:

- Work within the Standards of Conduct, Performance and Ethics set by the AHCS in *Good Scientific Practice*.
- Show respect and behave in accordance with *Good Scientific Practice*.
- Treat patients, carers and their families with respect, kindness and compassion, putting them at their ease.
- Show understanding of the patient's anxiety and be sympathetic and kind, respecting and understanding individuals' beliefs and ways of coping with illness.
- Appreciate the empathy and sensitivity needed when dealing with the patient experience of long-term conditions and terminal illness.
- Appreciate the impact of engineering services on the patient pathway and outcome.
- Appreciate the emotional and psychological impact the patient, relatives and carers might experience when undergoing investigations, diagnosis and treatment.
- Act in a calm, controlled and reassuring manner.
- Behave in a professional manner in matters of attendance and appearance.
- Recognise the limits of professional competence, seeking help and support and referring to colleagues appropriately.
- Maintain confidentiality of patient information and data.
- Value social diversity and its relationship to service provision in healthcare.
- Work effectively within a MDT, developing and maintaining professional relationships.
- Develop a balance between reflective practice and active exploration in personal learning and take responsibility for personal learning.
- Develop, maintain and improve personal knowledge and skills.
- Consistently work safely, demonstrating being precise and paying attention to detail.
- Communicate effectively within the healthcare environment and clinical team, adapting communication to meet varying needs and overcoming barriers to understanding.
- Communicate scientific and engineering information at a level appropriate to the audience, including the public.

- Use correct terminology appropriate to healthcare, healthcare science, Clinical Engineering and the specialist areas where work placements are undertaken.
- Listen and extract relevant information.
- Encourage feedback from the public, patients and staff, welcome it and use it to improve services.
- Establish and influence the culture of health and safety in the workplace.
- Recognise, where necessary, the urgency of a situation and seek help and advice.
- Show a positive attitude to lifelong learning and professional development.
- Bring the highest levels of knowledge and skill at times of basic human need when care and compassion are what matters most.

The PTP syllabus for Clinical Engineering follows.

## 5.2 Division-theme Modules

This section covers the seven division-theme modules that will be studied by all students undertaking the Clinical Engineering PTP.

CE(i): Mathematics, Statistics and Informatics (Year 1)
CE(ii): Scientific Basis of Engineering: Electronics (Year 1)
CE(iii): Scientific Basis of Engineering: Basic Mechanics (Year 1)
CE(iv): Innovation and Medical Device Development (Year 2)
CE(v): Fluid Mechanics, Biomechanics and Materials (Year 2)
CE(vi): The Medical Equipment Life Cycle (Year 2)
CE(vii): Principles of Scientific Measurement (Year 2)

**Year 1**
**CE(i): Mathematics, Statistics and Informatics**
**[10 credits]**

| Topic | Mathematics, Statistics and Informatics<br>[10 credits] | GSP reference |
|---|---|---|
| **Learning objective** | The overall aim of this module is to ensure that the student has the underpinning knowledge of mathematics, statistics and informatics required for their role. | |
| **Knowledge** | By the end of this module the student will be able to:<br>*1.* Explain the need to apply the appropriate mathematical and statistical tools for tasks they are required to perform within the clinical environment.<br>*2.* Explain the need for data security and confidentiality within their clinical environment.<br>*3.* Discuss the essential issues associated with computing technologies and their management as appropriate to either Clinical Engineering, Medical Physics or Clinical Photography. | 2.1.2<br>2.1.5<br>3.1.6<br>3.1.9 |
| **Technical skills** | By the end of this module, the student will be expected to apply in practice a range of technical skills in the academic environment and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and will be able to:<br>*1.* Analyse and interpret data within a work-based context.<br>*2.* Manipulate, analyse and present technical and clinical information appropriately, using spreadsheets, databases and presentation software.<br>*3.* Solve problems by applying appropriate mathematical and statistical techniques to clinical data, e.g. algebra, trigonometry, exponential, graphs and linear relationships.<br>*4.* Use data securely, respecting confidentiality and maintaining consent in the use of data.<br>*5.* Present data appropriately and communicate technical computing issues effectively. | 2.2.1<br>2.2.9<br>4.1.9 |

**Year 1**
**CE(ii): Scientific Basis of Engineering: Electronics**
**[25 credits]**

| Topic | Scientific Basis of Engineering: Electrical and Basic Electronics, including work-based training<br>[25 credits] | GSP reference |
|---|---|---|
| **Learning objective** | This module will provide a foundation from which the student will build their knowledge, skills, experience and attitudes throughout the three-year programme of study and transfer these skills to employment in healthcare science. It is expected that this period of initial work-based training will provide the opportunity to begin to integrate and embed many of the professional practice learning outcomes and enable the student to practise safely in the workplace. The overall aim of the module is to enable the student to gain an understanding and working knowledge of essential electrical and electronic theory as applied to Clinical Engineering.<br><br>The overall aim of the work-based placements within Year 1 is to provide the student with a broad appreciation of the range of work undertaken within healthcare science. Students will begin the process of the development of the skills and attitudes relevant to the HCSP, building on learning in the academic environment, including practical sessions, clinical skills sessions, reflection on development, etc. Additionally, it should help students learn in the context of practice and real-life experience and have a motivational element as they work towards a career in the NHS.<br><br>Students will be expected to begin to maintain a portfolio of evidence and relevant sections of the Learning Guide. | |
| **Knowledge** | By the end of this module the student will be able to:<br><br>*1.* Explain the basic laws that underpin electricity and magnetism.<br>*2.* Explain power supply systems, earth bonding and electrical safety, and the principles that underpin them.<br>*3.* Explain analogue and digital electronic components, circuits and systems, including awareness of typical transducers used in medical equipment.<br>*4.* Explain amplifier circuits for linear and non-linear applications.<br>*5.* Explain a range of factors that can influence the signal quality, e.g. noise, bandwidth and impedance.<br>*6.* Describe signal processing and signal manipulation. | 1.1.4<br>1.1.5<br>3.1.5<br>2.2.3 |

| Topic | Scientific Basis of Engineering: Electrical and Basic Electronics, including work-based training<br>[25 credits] | GSP reference |
|---|---|---|
| | 7. Describe the architecture of microprocessors and programmable devices.<br>8. Explain the basic principles of interfacing a device to a microprocessor or programmable device. | |
| **Technical and clinical skills** | By the end of this module the student, with respect to technical skills, will be able to:<br>1. Write a very simple microprocessor/programmable device program.<br>2. Interpret basic circuit diagrams, recognising some common configurations.<br><br>**Work-based training to be achieved across the modules Scientific Basis of Engineering Electronics [CE(ii)] and Mechanics [CE(iii)]**<br><br>By the end of this module, the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and will be able to:<br>1. Perform a range of generic skills, including infection control, basic life support, communication and team working, adhering to health and safety regulations, and behaving in a professional manner in accordance with *Good Scientific Practice*.<br>2. Work safely in the clinical environment relevant to each work-based placement and treat patients with respect.<br>3. Maintain the highest standards of person-centred care, treating every person with compassion, dignity and respect.<br>4. Observe, assist and perform under direct supervision, a range of basic routine procedures while working in accordance with local rules and safety regulations, including a minimum of **two** of the following activities, within one specialism:<br>(a) routine assessment of gait;<br>(b) the assessment of a patient requiring assistive technology;<br>(c) the provision of appropriate aids for daily living;<br>(d) maintenance on a simple wheelchair under direct supervision;<br>(e) basic equipment functional tests and calibration under direct supervision;<br>(f) basic equipment commissioning under direct supervision;<br>(g) measuring the performance characteristics of an X-ray tube or linear accelerator; | 1.1.1<br>1.1.2<br>1.1.3<br>1.1.9<br>1.1.10<br>1.2.1<br>1.2.5<br>2.3.1<br>2.2.8<br>3.1.4<br>2.1.3<br>2.2.4<br>3.2.2<br>3.2.4 |

| Topic | Scientific Basis of Engineering: Electrical and Basic Electronics, including work-based training<br>[25 credits] | GSP reference |
|---|---|---|
| | (h) the maintenance of an X-ray or radiotherapy installation;<br>(i) the maintenance of renal dialysis equipment;<br>(j) the maintenance of a water treatment plant.<br>5. Communicate effectively with the healthcare environment and clinical team, adapting communication to meet varying needs and overcoming barriers to understanding.<br>6. Communicate scientific and engineering information at a level appropriate to the audience, including the public. | |

**Year 1**
**CE(iii): Scientific Basis of Engineering: Basic Mechanics**
**[15 credits]**

| Topic | Scientific Basis of Engineering: Basic Mechanics, including work-based training [15 credits] | GSP reference |
|---|---|---|
| **Learning objective** | The overall aim of the academic element of this module is to enable the student to gain a working knowledge of essential engineering mechanics as applied to the field of Clinical Engineering.<br><br>The overall aim of the work-based placements within Year 1 is to provide the student with a broad appreciation of the range of work undertaken within healthcare science. Students will begin the process of the development of the skills and attitudes relevant to the HCSP, building on learning in the academic environment, including practical sessions, clinical skills sessions, reflection on development, etc. Additionally, it should help students learn in the context of practice and real-life experience and have a motivational element as they work towards a career in the NHS.<br><br>This module will provide a foundation from which the student will build their knowledge, skills, experience and attitudes throughout the three-year programme of study and transfer these skills to employment in healthcare science. It is expected that this period of initial work-based training will provide the opportunity to begin to integrate and embed many of the professional practice learning outcomes and enable the student to practise safely in the workplace. | |
| **Knowledge** | By the end of this module the student will be able to:<br>1. Explain the fundamental principles of applied mechanics and solve basic mechanical problems using the application of force.<br>2. Explain how a range of simple machines use a single applied force to do work against a single load force.<br>3. Describe Simple Harmonic Motion in terms of the action of forces.<br>4. Know how to select the appropriate tools to perform basic mechanical tasks.<br>5. Explain safe working practice applied to basic mechanical processes. | 1.1.4<br>1.1.5<br>1.1.6<br>2.2.4<br>2.3.1<br>2.2.7 |
| **Technical and clinical skills** | **Work-based learning to be achieved across the modules Scientific Basis of Engineering Electronics [CE(ii)] and Mechanics [CE(iii)]. Further details can be found in the work-based syllabus.** | |

| Topic | Scientific Basis of Engineering: Basic Mechanics, including work-based training [15 credits] | GSP reference |
|---|---|---|
| | By the end of this module, the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and will be able to: | |
| | 1. Work safely in the clinical environment relevant to relevant to each work-based placement and treat patients with respect. | 1.1.1 |
| | 2. Maintain the highest standards of person-centred care, treating every person with compassion, dignity and respect. | 1.1.2<br>1.1.3 |
| | 3. Observe, assist and perform under direct supervision a range of basic routine procedures while working in accordance with local rules and safety regulations, including a minimum of **two** of the following activities, within one specialism: | 1.1.9<br>1.1.10<br>1.2.1 |
| | (a) routine assessment of gait; | 1.2.5 |
| | (b) the assessment of a patient requiring assistive technology; | 2.3.1 |
| | (c) the provision of appropriate aids for daily living; | 2.2.8 |
| | (d) maintenance on a simple wheelchair under direct supervision; | 3.1.4 |
| | (e) basic equipment functional tests and calibration under direct supervision; | 2.1.3 |
| | (f) basic equipment commissioning under direct supervision; | 2.2.4 |
| | (g) measuring the performance characteristics of an X-ray tube or linear accelerator; | 3.2.2 |
| | (h) the maintenance of an X-ray or radiotherapy installation; | 3.2.4 |
| | (i) the maintenance of renal dialysis equipment; | |
| | (j) the maintenance of a water treatment plant. | |
| | 4. Communicate effectively with the healthcare environment and clinical team, adapting communication to meet varying needs and overcoming barriers to understanding. | |
| | 5. Communicate scientific and engineering information at a level appropriate to the audience, including the public. | |

**Year 2**
**CE(iv): Innovation and Medical Device Development**
**[25 credits]**

| Topic | Innovation and Medical Devices<br>[25 credits] | GSP reference |
|---|---|---|
| **Learning objective** | The overall aim of this module is to ensure that students understand the clinical, technical and transfer of liability implications that must be considered when customising and modifying medical devices. | |
| **Knowledge** | By the end of this module the student will be able to:<br>*1.* Describe the scientific principles that support the customisation and modification of devices both within and outside of the manufacturers' guidelines.<br>*2.* Know the legislation, standards and guidelines applicable to medical devices, explain the purpose of CE marking and implications when changing devices.<br>*3.* Review equipment that has been modified or customised and explain the application of quality management and risk management systems to the process.<br>*4.* Systematically and methodically review basic medical device designs, assessing the implications and risks associated with the modification of an existing medical device.<br>*5.* Explain the general requirements for safety of medical electrical equipment and systems during the design, manufacturing and implementation of medical electrical equipment.<br>*6.* Explain the concept of manufacturers' intended use and the implications of using devices outside of their intended use. | 1.1.3<br>1.1.4<br>1.1.7<br>4.1.2<br>2.1.1<br>3.1.5<br>2.2.3<br>2.1.6<br>2.3.2<br>3.1.7 |
| **Technical and clinical skills** | **The Year 2 and 3 work-based learning outcomes can be found in the work-based syllabus.** | |

**Year 2**
**CE(v): Fluid Mechanics, Biomechanics and Materials**
**[10 credits]**

| **Topic** | **Fluid Mechanics, Biomechanics and Materials [10 credits]** | **GSP reference** |
|---|---|---|
| **Learning objective** | By the end of this module the student will understand the essential engineering principles and practice applied to fluid mechanics, biomechanics and materials used in clinical engineering practice. | |
| **Knowledge** | By the end of this module the student will be able to:<br>1. Explain the principles of fluid dynamics and gases.<br>2. Explain the structure, mechanical and physical properties of materials used in engineering and bioengineering.<br>3. Discuss biocompatibility and its significance in the selection of materials for use in healthcare engineering.<br>4. Explain biomechanical movements and the use of electromyography techniques to assess disorders of movement.<br>5. Explain kinetics and kinimatics and techniques for analysing human movement. | 1.1.4<br>1.1.5<br>2.2.3<br>2.2.4<br>3.1.5<br>3.1.4<br>3.1.6 |
| **Technical and clinical skills** | **The Year 2 and 3 work-based learning outcomes can be found in the work-based syllabus.** | |

**Year 2**
**CE(vi):The Medical Equipment Life Cycle**
**[25 credits]**

| Topic | The Medical Equipment Life Cycle<br>[25 credits] | GSP reference |
|---|---|---|
| **Learning objective** | By the end of this module the student will understand the medical equipment life cycle and how this is used within clinical engineering practice in a range of healthcare settings. This module will also consider how the medical equipment life cycle underpins patient safety and quality assurance and management systems. | |
| **Knowledge** | By the end of this module the student will:<br>1. Describe each stage of the equipment management life cycle and discuss how it is implemented in healthcare settings.<br>2. Explain how quality assurance and quality management systems support the provision of high-quality, safe services in healthcare settings.<br>3. Explain the principles that support the selection of a medical device to ensure it is fit for purpose, including the ability to develop and evaluate basic specifications to meet user and service requirements.<br>4. Apply engineering principles using systematic and logical methodology to maintain, calibrate and quality assure a wide range of commonly used equipment within healthcare.<br>5. Explain a range of safety critical examinations to ensure that the medical device is and will remain fit for purpose, taking into account the environment in which it will be used.<br>6. Explain the importance of control of infection and decontamination within the equipment management life cycle.<br>7. Know the processes and regulations relating to the safe decommissioning and disposal of medical devices. | 1.1.3<br>1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>1.2.1<br>2.3.3<br>2.3.1<br>3.1.3<br>3.1.4<br>3.1.5<br>3.1.8<br>2.2.7<br>2.2.8 |
| **Technical and clinical skills** | **The Year 2 and 3 work-based learning outcomes can be found in the work-based syllabus.** | |

**Year 2**
**CE(vii): Principles of Scientific Measurement**
**[30 credits]**

| Topic | Principles of Scientific Measurement<br>[30 credits] | GSP reference |
|---|---|---|
| **Learning objective** | By the end of this module the student will understand and apply the engineering principles and practice that underpin and ensure the accurate measurement of signals in the biomedical setting. | |
| **Knowledge** | By the end of this module the student will:<br>1. Explain the scientific principles that underpin the biomedical measurements.<br>2. Evaluate a wide range of biomedical measurement methods used in clinical engineering, identifying the impact and potential causes of artefacts.<br>3. Describe the source and nature of physiological signals and how they are typically displayed.<br>4. Critically evaluate the choice of transducer and equipment to measure specific physiological signals.<br>5. Evaluate how different signal processing techniques affect signals.<br>6. Explain measurement errors, propagation of errors, calibration and tolerances.<br>7. Discuss essential items of test equipment linked to one clinical engineering specialism, including the requirements for calibration or verification.<br>8. Explain a range of methods to display, store and transfer physiological data within confidentiality and governance requirements.<br>9. Explain how to control hazards in the patient/clinical environment.<br>10. Discuss the impact of developing and emerging science on patient safety and care. | 1.1.4<br>1.1.5<br>1.1.6<br>2.3.3<br>2.3.1<br>3.1.3<br>3.1.4<br>3.1.5<br>3.1.8<br>2.2.7<br>2.2.8<br>3.1.2 |
| **Technical and clinical skills** | **The Year 2 and 3 work-based learning outcomes can be found in the work-based syllabus.** | |

# SECTION 6: SPECIALIST MEDICAL ENGINEERING SYLLABUS

### 6.1 Specialist Modules for Medical Engineering

**Interpretation of the high-level framework: Clinical Engineering specialising in Medical Engineering**

| | Module Title | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year 3 Application to Practice** | Professional Practice [10] | Science and Principles supporting Medical Engineering [30] | | Medical Engineering in the Clinical Environment [30] | | Research Project [30] | | | | Work-based training 25 weeks [20] | | |
| **Year 2 Technologies and Methodologies** | Professional Practice [10] | Research Methods [10] | Innovation and Medical Device Development | | Medical Equipment Life Cycle [25] | Fluid Mechanics, Biomechanics and Materials [10] | | Principles of Scientific Measurement [30] | | Work-based training 15 weeks [10] | | |
| **Year 1 Scientific Basics** | Professional Practice [10] | Scientific Basis of Healthcare Science – integrated module across body systems [60] | | | | Mathematics, Statistics and Informatics [10] | | Scientific Basis of Engineering – Electronics [25] and Basic Mechanics [15] to include 10 weeks of work-based training | | | | |

Generic modules: Common to all divisions of Healthcare Science

Division-theme modules: Shared by a group of specialisms, usually within a Healthcare Science division

Specialist modules: Specific to a specialism

**[XX] = Number of credits**

**Year 3**
**CEME(i): Science and Principles supporting Medical Engineering**
**[30 credits]**

| Topic | Science and Principles supporting Medical Engineering [30 credits] | GSP reference |
|---|---|---|
| **Learning objective** | By the end of this module the student will understand the source of physiological signals and their methods of measurement, together with the key features of systems used to measure and analyse them. They will also gain an appreciation of the physiological effects of electricity on the human body. | |
| **Knowledge** | By the end of this module the student will:<br>1. Discuss the production, characteristics and propagation of physiological signals.<br>2. Explain the passage and effects of electric current through the human body.<br>3. Explain the construction and principles of operation of a range of medical devices.<br>4. Explain and evaluate the safety and functional testing of devices or systems.<br>5. Critically analyse the purpose and types of safety and functional tests performed in a range of clinical environments and discuss the suitability of the procedures used for both individual devices and systems.<br>6. Critically appraise a range of current medical device standards and guidelines.<br>7. Explain the process of evaluation and selection of equipment, justifying the need to keep accurate records.<br>8. Describe the impact of infection control on the purchase, use and disposal of medical devices.<br>9. Discuss how the equipment management life cycle, is applied by clinical engineers.<br>10. Explain the collection, processing, storage and transfer of data across a range of medical devices, including governance and data confidentiality. | 1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>2.2.3<br>2.2.4<br>2.1.6<br>2.3.3<br>2.3.1<br>2.2.6<br>2.2.9<br>3.1.2 |
| **Technical and clinical skills** | **The Year 2 and 3 work-based learning outcomes can be found in module CEME (ii): Medical Engineering in the Clinical Environment, and further detail can be found in the work-based syllabus.** | |

**Year 3**
**CEME(ii): Medical Engineering in the Clinical Environment, including work-based learning [30 credits] plus work-based learning [30 credits]**

| Topic | Medical Engineering in the Clinical Environment [30 credits] plus work-based learning [30 credits] | GSP reference |
|---|---|---|
| **Learning objective** | By the end of this module the student will understand the principles and practice associated with the use of specific medical devices and the associated risk of use in the clinical environment. Students will analyse potential risks to patients, visitors and staff from the introduction of new equipment and misuse of medical devices, including unauthorised modifications and failure to follow correct procedures. The students will also develop their knowledge of quality management systems and be expected to consider how medical devices are used within clinical care pathways, including patient perspectives. | |
| **Knowledge** | By the end of this module the student will:<br>1. Discuss the clinical use of a range of medical devices and the implications of equipment being used in a range of different settings.<br>2. Critically analyse the effects of introducing different medical devices into a clinical environment.<br>3. Explain the principles and process of safety and functional testing of devices or systems within a range of clinical environments.<br>4. Analyse the potential risks to patients, visitors and staff from the use and misuse of medical devices.<br>5. Critically analyse the purpose and types of safety and functional tests performed in a range of clinical environments and discuss the suitability of the procedures used for both individual devices and systems.<br>6. Review common causes of interference and artefacts associated with medical devices.<br>7. Evaluate a range of current standards and guidelines used in the clinical environment.<br>8. Discuss how different types of technologies may be used to enable the delivery of modern healthcare and technical services.<br>9. Discuss the requirements for working within a quality management system, including quality control and keeping accurate records.<br>10. Discuss the advantages and disadvantages of equipment libraries and how they impact on technical services. | 1.1.1<br>1.1.2<br>1.1.3<br>1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>1.2.1<br>1.2.5<br>2.2.4<br>2.2.7<br>3.1.3<br>2.2.6<br>2.3.2<br>2.2.5 |

| Topic | Medical Engineering in the Clinical Environment<br>[30 credits] plus work-based learning [30 credits] | GSP reference |
|---|---|---|
| **Technical and clinical skills** | By the end of this module, the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and will be able to:<br><br>**Safe working practice in Medical Engineering**<br>1. Apply health and safety and risk management principles to all aspects of the medical engineering technologist's role.<br>2. Observe and perform a range of risk assessments appropriate to Medical Engineering.<br>3. Observe and perform a range of equipment management processes.<br><br>**Equipment management, quality management systems and processes**<br>4. Operate equipment management and quality management systems (QMS), both electronic and manual, to support all aspects of equipment management activities.<br>5. Apply equipment management processes to assist in the management of rental and loan equipment.<br><br>**Medical device acquisition, acceptance testing and installation**<br>6. Observe and undertake the procurement process from working with the user to define the user specification through to the procurement process adhering to trust processes.<br>7. Complete equipment acceptance procedures and, where appropriate, additional installation procedures for a range of medical devices managed by medical engineering technologists.<br>8. Perform a range of electrical safety tests and calibration checks and adjustments on medical devices with and without patient-applied parts.<br><br>**Planned preventative maintenance (PPM), equipment repairs and decommissioning of medical devices**<br>9. Perform PPM procedures on a range of medical devices.*<br>10. Recognise and identify common artefacts, hazards, interference and faults that are associated with medical devices and suggest and/or perform corrective action.<br>11. Perform repair procedures on a range of medical devices.*<br>12. Decommission and dispose of equipment in a safe and appropriate manner, according to local | 1.1.1<br>1.1.2<br>1.1.3<br>1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>1.2.1<br>1.2.5<br>2.2.7<br>2.2.3<br>2.2.4<br>2.2.9<br>3.1.5<br>3.1.4<br>3.2.2<br>3.1.5<br>3.1.4<br>3.2.2<br>3.2.1<br>4.1.5 |

| Topic | Medical Engineering in the Clinical Environment<br>[30 credits] plus work-based learning [30 credits] | GSP reference |
|---|---|---|
| | procedures.<br><br>**Equipment design and safe use in Medical Engineering**<br>13. Specify, design and build a simple electronic device using appropriate test and development equipment, with reference to the relevant standards.<br>14. Teaching/training healthcare staff how to operate equipment, use accessories and store a number of simple medical devices.<br><br>**The range of medical devices may include, but is not limited to, anaesthetic and ventilation equipment, blood pressure monitors, defibrillators, gas analysis and monitoring equipment, multi-parameter monitors, single or multi-parameter display equipment, electrocardiogram machines or other recording equipment, infusion devices, pulse oximeters and temperature measuring equipment.* | |

# SECTION 7: SPECIALIST RADIATION ENGINEERING SYLLABUS

### 7.1 Specialist Modules for Radiation Engineering

**Interpretation of the high-level framework: Clinical Engineering specialising in Radiation Engineering**

| | Module Title | | | | | | |
|---|---|---|---|---|---|---|---|
| **Year 3 Application to Practice** | Professional Practice [10] | Science and Principles supporting Radiation Engineering [30] | Radiation Engineering in the Clinical Environment [30] | Research Project [30] | Work-based training 25 weeks [20] | | |
| **Year 2 Technologies and Methodologies** | Professional Practice [10] | Research Methods [10] | Innovation and Medical Device Development | Medical Equipment Life Cycle [25] | Fluid Mechanics, Biomechanics and Materials [10] | Principles of Scientific Measurement [30] | Work-based training 15 weeks [10] |
| **Year 1 Scientific Basics** | Professional Practice [10] | Scientific Basis of Healthcare Science – integrated module across body systems [60] | | | Mathematics, Statistics and Informatics [10] | Scientific Basis of Engineering – Electronics [25] and Basic Mechanics [15] to include 10 weeks of work-based training | |

Generic modules: Common to all divisions of Healthcare Science

Division-theme modules: Shared by a group of specialisms, usually within a Healthcare Science division

Specialist modules: Specific to a specialism

**[XX] = Number of credits**

**Year 3**
**CERE(i): Science and Principles supporting Radiation Engineering**
**[30 credits]**

| Topic | Science and Principles supporting Radiation Engineering<br>[30 credits] | GSP reference |
|---|---|---|
| **Learning objective** | By the end of this module the student will understand the scientific principles underpinning radiation engineering in a range of healthcare settings. This will include: ionising radiation; non-ionising radiation; clinical sources of radiation; environmental requirements and the use of medical resonance imaging (MRI). The student will also understand the principles of radiation protection, emphasising the safety and quality assurance requirements and local radiation protection rules. This module provides an opportunity to look to the future and evaluate new technology used in imaging or therapeutics in healthcare settings. | |
| **Knowledge** | By the end of this module the student will:<br>1. Explain the principles of ionising radiation physics and clinical sources of radiation.<br>2. Discuss the technologies used to generate electromagnetic energies, e.g. microwave, radio frequency, etc., to include an understanding of the working of high-voltage systems.<br>3. Discuss the underpinning science and differences between ionising and non-ionising radiation.<br>4. Describe radiation protection principles, practices and protocols, including safety requirements, radiation scatter and leakage.<br>5. Know the current legislation, standards and guidance relating to the production and use of ionising radiation, including local radiation protection rules.<br>6. Explain the effects of different types of radiation on the human body.<br>7. Describe the principles that underpin the operation of radiation imaging and radiotherapy treatment equipment, including the characteristics and choice of appropriate radiation fields used for treatment.<br>8. Identify the basic environmental requirements needed to support ionising radiation imaging and treatments, e.g. room design, shielding, interlocks.<br>9. Explain the principles, including the advantages and disadvantages, of MRI technology and its use in the imaging process.<br>10. Evaluate new technology and applications of existing technologies to be used in imaging or therapeutics in healthcare settings. | 1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>2.2.3<br>2.2.4<br>2.1.6<br>2.3.3<br>2.3.1<br>2.2.6<br>2.2.9<br>3.1.2 |
| **Technical** | By the end of this module the student will be expected to apply in practice a range of technical and | |

| Topic | Science and Principles supporting Radiation Engineering [30 credits] | GSP reference |
|---|---|---|
| **and clinical skills** | clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and will be able to:<br>1. Apply and comply with and apply local radiation protection rules.<br>2. Assist with the assessment of the quality of the imaging and treatment processes.<br>**The Year 2 and 3 work-based learning outcomes can be found in module CERE (ii): Radiation Engineering in the Clinical Environment and further detail can be found in the work-based syllabus** | |

**Year 3**
**CERE(ii): Radiation Engineering in the Clinical Environment**
**[30 credits] plus work-based learning [30 credits]**

| Topic | Radiation Engineering in the Clinical Environment<br>[30 credits] including work-based learning [30 credits] | GSP reference |
|---|---|---|
| **Learning objective** | By the end of this module the student will extend their knowledge and understanding of the role of radiation engineering in the clinical environment, including radiotherapy and imaging, with emphasis on the equipment construction, installation, use, machine procedures and computer networks. An emphasis will be placed on quality systems. The student will also be expected to consider how radiotherapy and imaging equipment is used within clinical care pathways, including patient perspectives. | |
| **Knowledge** | By the end of this module the student will:<br>1. Appraise safe working practice in a range of clinical setting where radiation is used.<br>2. Explain the structure of radiotherapy treatment and imaging equipment associated with ionising radiation.<br>3. Explain the construction of ionising radiation imaging and radiotherapy equipment by identifying key component areas and the explaining the part they play in the operation of the equipment.<br>4. Describe and evaluate the practical operation of a range of systems used to modify or target the delivery of treatment.<br>5. Discuss the installation of imaging and treatment equipment.<br>6. Describe machine procedures.<br>7. Explain the use of computers in the delivery of radiation imaging and treatment services.<br>8. Explain the importance of quality systems and justify the need for accuracy in documentation and records.<br>9. Discuss problems that may be encountered when bringing other medical devices into the clinical environment.<br>10. Review new technologies and materials and appraise the appropriateness for use in clinical settings where radiation is used. | 1.1.1<br>1.1.2<br>1.1.3<br>1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>1.2.1<br>1.2.5<br>2.2.4<br>2.2.7<br>3.1.3<br>2.2.6<br>2.3.2<br>2.2.5 |
| **Technical and clinical skills** | By the end of this module, the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and will be able to: | |

| Topic | Radiation Engineering in the Clinical Environment<br>[30 credits] including work-based learning [30 credits] | GSP reference |
|---|---|---|
| | **Safe working practice in radiation engineering**<br>1. Observe and assist radiation engineers in a range of environments, including diagnostic X-ray rooms and radiotherapy treatment rooms, adhering to safety restrictions and regulations.<br>2. Perform health and safety risk assessments in accordance with standard operating procedures.<br>3. Produce and critically review a radiation equipment incident report, applying the relevant processes and procedures.<br><br>**Radiation equipment management, calibration, quality systems and processes**<br>4. Perform radiation equipment management procedures in accordance with standard operating procedures.<br>5. Operate diagnostic X-ray equipment, computed tomography (CT) scanners and radiotherapy treatment equipment, performing radiation equipment calibration and equipment quality assurance/control processes in accordance with standard operating procedures.<br><br>**Radiation equipment acquisition, installation and commissioning**<br>6. Interpret a specification for radiation equipment and its associated accessories or parts and explain the procurement processes in accordance with standard operating procedures.<br>7. Assist in the installation, commissioning and bringing into service of radiation equipment in accordance with standard operating procedures.<br><br>**Planned preventative maintenance (PPM), equipment repairs and decommissioning of radiation equipment**<br>8. Perform planned maintenance procedures, equipment modification activities and control checks and adjustments on radiation equipment in accordance with standard operating procedures.<br>9. Investigate and rectify a radiation equipment breakdown in accordance with standard operating procedures.<br>10. Assist in the decommissioning and disposal of equipment in accordance with relevant legislation, regulations and guidance. | 1.1.1<br>1.1.2<br>1.1.3<br>1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>1.2.1<br>1.2.5<br>2.2.7<br>2.2.3<br>2.2.4<br>2.2.9<br>3.1.5<br>3.1.4<br>3.2.2<br>3.1.5<br>3.1.4<br>3.2.2<br>3.2.1<br>4.1.5<br>2.3.4 |

# SECTION 8: SPECIALIST RENAL TECHNOLOGY SYLLABUS

### 8.1 Specialist Modules for Renal Technology

**Interpretation of the high-level framework: Clinical Engineering specialising in Renal Technology**

| | Module Title | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year 3 Application to Practice** | Professional Practice [10] | Science and Principles supporting Renal Technology [30] | | Renal Technology in the Clinical Environment [30] | | Research Project [30] | | | Work-based training 25 weeks [20] | | | |
| **Year 2 Technologies and Methodologies** | Professional Practice [10] | Research Methods [10] | Innovation and Medical Device Development | | Medical Equipment Life Cycle [25] | Fluid Mechanics, Biomechanics and Materials [10] | | Principles of Scientific Measurement [30] | | | Work-based training 15 weeks [10] | |
| **Year 1 Scientific Basics** | Professional Practice [10] | Scientific Basis of Healthcare Science – integrated module across body systems [60] | | | | Mathematics, Statistics and Informatics [10] | | Scientific Basis of Engineering – Electronics [25] and Basic Mechanics [15] to include 10 weeks of work-based training | | | | |

Generic modules: Common to all divisions of Healthcare Science

Division-theme modules: Shared by a group of specialisms, usually within a Healthcare Science division

Specialist modules: Specific to a specialism

**[XX] = Number of credits**

**Year 3**
**CERT(i): Science and Principles supporting Renal Technology**
**[30 credits]**

| Topic | Science and Principles supporting Renal Technology [30 credits] | GSP reference |
|---|---|---|
| **Learning objective** | By the end of this module the student will develop their knowledge and understanding of renal disease and renal technology in adults and/or children, including the use of renal replacement therapy (RRT), e.g. haemodialysis and peritoneal dialysis. The areas covered include anatomy, physiology and pathophysiology of the urinary system; principles, methods and limitations of dialysis; dialysis equipment and dialysis performance assessment tools. Students will also be expected to consider the impact of renal disease, illness, disability and dialysis complications on patients and their families and the role of the clinical engineer working in renal technology. | |
| **Knowledge** | By the end of this module the student will:<br>*1.* Explain the anatomy, physiology and pathophysiology of the urinary system, including common renal diseases and the impact on the patient.<br>*2.* Discuss the principles, methods and limitations of dialysis equipment and obtaining vascular access to support haemodialysis.<br>*3.* Compare and contrast the modalities of RRT.<br>*4.* Discuss and evaluate the standards that apply to water quality available through the municipal systems, and those that apply to dialysis fluids.<br>*5.* Explain and evaluate water and dialysis fluid quality monitoring and testing procedures, including the implications of changes in the water quality due to supply changes.<br>*6.* Describe and evaluate dialysis performance assessment tools and how they influence treatment.<br>*7.* Explain the reasons that influence choice of dialysis fluid composition.<br>*8.* Appraise the current renal dialysis standards and guidelines and their application in healthcare environments.<br>*9.* Discuss the impact of renal disease, illness, disability and dialysis complications on patients and their families. | 1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>2.2.3<br>2.2.4<br>2.1.6<br>2.3.3<br>2.3.1<br>2.2.6<br>2.2.9<br>3.1.2 |
| **Technical and clinical skills** | **The Year 2 and 3 work-based learning outcomes can be found in module CERT (ii): Renal Technology in the Clinical Environment, and further detail can be found in the work-based syllabus.** | |

**Year 3**
**CBRT(ii): Renal Technology in the Clinical Environment**
**[30 credits] plus work-based learning [30 credits]**

| Topic | Renal Technology in the Clinical Environment<br>[30 credits] including work-based learning [30 credits] | GSP reference |
|---|---|---|
| **Learning objective** | By the end of this module the student will have developed their knowledge and understanding of the role of renal technology engineering services on the clinical pathways and outcome. Emphasis will be placed on the impact of renal disease on the patient and their families and NHS services. | |
| **Knowledge** | By the end of this module the student will:<br>1. Describe and evaluate the impact of renal technology engineering services on the clinical pathway and outcome.<br>2. Evaluate the implications of introducing different equipment into RRT environments.<br>3. Discuss, justify and critically appraise safety and functional testing procedures for devices used within the RRT environment and the implications of providing RRT in different settings. Electrical safety of haemodialysis equipment is unusual in that most haemodialysis machines are Type 1 class B, but they need to fulfil the electrical safety requirements of type CF equipment. This requires particular consideration that may not be adequately covered in the generic teaching of electrical safety testing and should be given emphasis in the renal technology module.<br>4. Discuss the role of dietary control in the management of renal disease.<br>5. Discuss the use of online therapies.<br>6. Critically appraise current standards and guidelines applicable to RRT and the impact of the choice of RRT on the patient and renal services.<br>7. Discuss the potential psychological and social implications of RRT and the support services available.<br>8. Explain the specific health and safety procedures within the RRT environment, including the risks to staff and patients, ensuring these encompass infection control issues and how to minimise the totality of risks.<br>9. Evaluate new technologies and materials and appraise the appropriateness for use in RRT environments. | 1.1.1<br>1.1.2<br>1.1.3<br>1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>1.2.1<br>1.2.5<br>2.2.4<br>2.2.7<br>3.1.3<br>2.2.6<br>2.3.2<br>2.2.5 |
| **Technical and clinical** | By the end of this module the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of | |

| Topic | Renal Technology in the Clinical Environment<br>[30 credits] including work-based learning [30 credits] | GSP reference |
|---|---|---|
| **skills** | Proficiency set by the AHCS and will be able to:<br><br>**Safe working practice in renal technology**<br>1. Apply health and safety and risk management principles to all aspects of the renal technologist's role.<br>2. Observe and perform a range of risk assessments appropriate to renal services.<br>3. Observe how the equipment life cycle applies to renal services and the role of the renal technologist.<br><br>**Equipment management, quality management systems and processes**<br>4. Operate equipment management and quality management systems both electronic and manual to support all aspects of equipment management activities that apply to renal services.<br>5. Apply equipment management processes to assist in the management of rental and loan equipment.<br><br>**Medical device acquisition, acceptance testing and installation**<br>6. Observe and undertake the procurement process from working with the user to define the user specification through to the procurement process adhering to trust processes.<br>7. Complete equipment acceptance procedures and where appropriate additional installation procedures for a range of medical devices managed by renal technologists.<br>8. Perform a range of electrical safety tests and calibration checks and adjustments on medical devices with and without patient-applied parts used within renal services.<br><br>**Planned preventative maintenance (PPM), equipment repairs and decommissioning of medical devices in renal service**<br>9. Perform PPM procedures on a range of dialysis equipment and associated devices.*<br>10. Recognise and identify common artefacts, hazards, interference and faults that are associated with medical devices and suggest and/or perform corrective action.<br>11. Perform repair procedures on dialysis equipment and associated devices.*<br>12. Decommission and dispose of equipment in a safe and appropriate manner according to local procedures.<br><br>**Maintenance, repair and quality control of water treatment systems for renal dialysis**<br>13. Perform PPM and repair procedures on water treatment plants.<br>14. Take water samples from water treatment plants for quality control purposes and review and interpret quality control | 1.1.1<br>1.1.2<br>1.1.3<br>1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>1.2.1<br>1.2.5<br>2.2.7<br>2.2.3<br>2.2.4<br>2.2.9<br>3.1.5<br>3.1.4<br>3.2.2<br>3.1.5<br>3.1.4<br>3.2.2<br>3.2.1<br>4.1.5 |

| Topic | Renal Technology in the Clinical Environment<br>[30 credits] including work-based learning [30 credits] | GSP reference |
|---|---|---|
| | results.<br><br>**Equipment design and safe use in renal services**<br>15. Specify, design and build a simple electronic device using appropriate test and development equipment with reference to the relevant standards.<br>16. Teach/train healthcare staff on the use, operation, accessories and storage of RRT equipment and consumables. | |

# SECTION 9: REHABILITATION ENGINEERING TECHNICAL AND SCIENTIFIC SPECIALIST MODULES

### 9.1 Specialist Modules for Rehabilitation Engineering

**Interpretation of the high level framework: Clinical Engineering specialising in Rehabilitation Engineering**

<table>
<tr><th></th><th colspan="8">Module Title</th></tr>
<tr><td>Year 3<br>Application to Practice</td><td>Professional Practice<br><br>[10]</td><td colspan="2">Science and Principles supporting Rehabilitation Engineering<br><br>[30]</td><td colspan="2">Rehabilitation Engineering in the Clinical Environment<br><br>[30]</td><td colspan="2">Research Project<br><br>[30]</td><td>Work-based training<br><br>25 weeks<br><br>[20]</td></tr>
<tr><td>Year 2<br>Technologies and Methodologies</td><td>Professional Practice<br><br>[10]</td><td>Research Methods<br><br>[10]</td><td colspan="2">Innovation and Medical Device Development</td><td>Medical Equipment Life Cycle<br><br>[25]</td><td>Fluid Mechanics, Biomechanics and Materials<br><br>[10]</td><td colspan="2">Principles of Scientific Measurement<br><br>[30]</td><td>Work-based training<br><br>15 weeks<br><br>[10]</td></tr>
<tr><td>Year 1<br>Scientific Basics</td><td>Professional Practice<br><br>[10]</td><td colspan="4">Scientific Basis of Healthcare Science – integrated module across body systems<br><br>[60]</td><td>Mathematics, Statistics and Informatics<br><br>[10]</td><td colspan="2">Scientific Basis of Engineering – Electronics [25] and Basic Mechanics [15] to include 10 weeks of work-based training</td></tr>
</table>

Generic modules: Common to all divisions of Healthcare Science

Division-theme modules: Shared by a group of specialisms, usually within a Healthcare Science division

Specialist modules: Specific to a specialism

**[XX] = Number of credits**

**Year 3**
**CERhE(i): Science and Principles supporting Rehabilitation Engineering**
**[30 credits]**

| Topic | Science and Principles supporting Rehabilitation Engineering [30 credits] | GSP reference |
|---|---|---|
| **Learning objective** | By the end of this module the student will develop their knowledge and understanding of the main disabling conditions affecting people. They will consider the role of the rehabilitation engineer and rehabilitation services and of a MDT approach to providing high-quality, patient-centred and safe rehabilitation services. The principles and use of assistive technology (assistive, adaptive and rehabilitative devices for people with disabilities, including the process used in selecting, locating and using them) will be explored linked to the materials, design of assistive technologies and workshop practice. | |
| **Knowledge** | By the end of this module the student will:<br>1. Describe the anatomy, physiology and pathophysiology associated with conditions resulting in referral to rehabilitation services.<br>2. Discuss the role of the rehabilitation engineering in a multidisciplinary approach to providing high-quality, patient-centred and safe rehabilitation services.<br>3. Describe and analyse human movement and solve quantitative biomechanical problems.<br>4. Discuss and evaluate the basic principles that underpin assistive technology in a range of areas such as mobility, posture control, environmental controls and communication aids.<br>5. Explain the use of biomechanical analysis in assessment and assistive technology design.<br>6. Describe manufacturing techniques and compare and contrast the properties of materials used in rehabilitation engineering and assistive technology.<br>7. Explain the key elements of design practice in rehabilitation technology.<br>8. Explain workshop practice applied to the field of rehabilitation engineering.<br>9. Discuss, compare and contrast properties of a range of commonly used materials used in rehabilitation engineering technology. | 1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>2.2.3<br>2.2.4<br>2.1.6<br>2.3.3<br>2.3.1<br>2.2.6<br>2.2.9<br>3.1.2 |
| **Technical and clinical skills** | **The Year 2 and 3 work-based learning outcomes can be found in module CERE (ii): Rehabilitation Engineering in the Clinical Environment and further detail in the work-based syllabus.** | |

**Year 3**
**CERhE(ii): Rehabilitation Engineering in the Clinical Environment**
**[30 credits] plus work-based learning [30 credits]**

| Topic | Rehabilitation Engineering in the Clinical Environment<br>[30 credits] including work-based learning [30 credits] | GSP reference |
|---|---|---|
| **Learning objective** | By the end of this module the student will develop their knowledge and understanding of medical and social models of rehabilitation. They will also know and understand the quality management systems used in the rehabilitation engineering environment, including audit to underpin safe and high-quality services. This module will focus on the needs of patients and how to assess and support patients to make decisions about the use of assistive technologies. | |
| **Knowledge** | By the end of this module the student will:<br>1. Explain medical and social models of rehabilitation and discuss the implications of working within the field of rehabilitation engineering and assistive technology.<br>2. Describe the quality managements systems, including quality control and audit used to ensure quality standards are met and maintained.<br>3. Critically appraise a range of assistive technology solutions, including mobility, posture control, environmental controls and communication aids.<br>4. Critically appraise the benefits and risks of alternative assistive technology solutions.<br>5. Critically evaluate a range of assistive devices designed to improve movements, postural and functional control, lower limb disorders and communication.<br>6. Explain the limitations in the functionality and application of rehabilitation engineering equipment commonly used in clinical practice.<br>7. Explain how to assess clinical needs/patient goals and generate options for suitable assistive technology and interventions, which are within the scope and limitations of the individual patient's capabilities.<br>8. Discuss the process of adjustment and adaptation of rehabilitation engineering equipment.<br>9. Appraise the risks to patients resulting from the modification or non-correct usage of standard assistive devices and propose a plan for reducing patient risk.<br>10. Critically evaluate the applied methodology to ensure assistive technology solutions are fit for | 1.1.1<br>1.1.2<br>1.1.3<br>1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>1.2.1<br>1.2.5<br>2.2.4<br>2.2.7<br>3.1.3<br>2.2.6<br>2.3.2<br>2.2.5<br>2.2.1<br>3.1.4<br>3.1.9 |

| Topic | Rehabilitation Engineering in the Clinical Environment [30 credits] including work-based learning [30 credits] | GSP reference |
|---|---|---|
| | purpose.<br>12. Discuss the range and use of measurement technologies used in assessment and explain how assistive technology solutions contribute to patient care as part of a multidisciplinary approach.<br>13. Review new technologies and materials and appraise the appropriateness for use in rehabilitation engineering and assistive technology. | |
| **Technical and clinical skills** | By the end of this module, the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and will be able to<br><br>**Safe working practice in rehabilitation engineering**<br>1. Select and use appropriate test equipment and service tools.<br>2. Perform and monitor PPM across a range of equipment used in rehabilitation engineering.<br>3. Diagnose equipment faults, determine appropriate action and repair equipment.<br>4. Plan for and teach users, carers and other healthcare staff within the rehabilitation engineering environment.<br>5. Produce appropriate technical and user documentation for use within the rehabilitation engineering environment.<br><br>**Assistive technology in rehabilitation engineering**<br>6. Identify a wide range of assistive technology equipment and make the appropriate choice of equipment/procedure for a range of mobility, posture, environmental and communication equipment and a range of patient assessment procedures.<br>7. Perform and document appropriate risk analysis to the patient's needs, assistive technology and the environment.<br>8. Set up and adjust equipment to ensure it meets the needs of the individual, including mobility, posture, environmental and communication equipment, for a range of mobility, posture, environmental and communication equipment.<br>9. Use the controls of the equipment to produce the highest quality patient outcome across a range of mobility, posture, environmental and communication equipment. | 1.1.1<br>1.1.2<br>1.1.3<br>1.1.4<br>1.1.5<br>1.1.6<br>1.1.7<br>1.2.1<br>1.2.5<br>2.2.7<br>2.2.3<br>2.2.4<br>2.2.9<br>3.1.5<br>3.1.4<br>3.2.2<br>3.1.5<br>3.1.4<br>3.2.2<br>3.2.1<br>4.1.5<br>1.4.1<br>3.1.8 |

| Topic | Rehabilitation Engineering in the Clinical Environment [30 credits] including work-based learning [30 credits] | GSP reference |
|---|---|---|
| | 10. Perform patient assessments, interventions and equipment handovers in a safe manner while undertaking appropriate infection control techniques and other health and safety best practice.<br>11. Assess equipment to ensure it meets or continues to meet individual needs and the equipment remains fit for purpose.<br><br>**Design assistive technology in rehabilitation engineering**<br>12. Perform measurements, checks and tests required in order to prescribe or design assistive technology solutions.<br>13. Specify, design and facilitate the manufacture of new devices or modification to an existing device.<br>14. Assess the solution identified against outcome requirement, financial viability time constraints and resource implications.<br><br>**Equipment management and repair in rehabilitation engineering**<br>15. Operate equipment management and quality management systems (QMS) both electronic and manual to support all aspects of equipment management activities.<br>16. Apply equipment management processes to assist in the management of rental and loan equipment.<br>17. Perform any appropriate electrical or mechanical safety testing procedures for a range of mobility, posture, environmental and communication equipment.<br>18. Perform audit and checks on the work of third-party service providers. | 2.3.2<br>2.1.6<br>2.2.5 |

# SECTION 10: INDICATIVE CONTENT: KNOWLEDGE

## 10.1 Generic Professional Practice, Technical and Scientific Modules

### GM(i): Professional Practice

**Professional Practice**

- The role of regulation
- Regulation of the HCS workforce by the AHCS and HCPC
- NHS Constitution
- HEE five key workforce characteristics
- Values relating to compassion, transparency, candour, openness and leadership
- Current national NHS policies and practice, including policy relevant to the area of practice
- How service delivery aligns to current NHS policy and practice
- The HCS workforce
  - structure into four divisions and specialisms within each division
  - education and training programmes
  - leadership of the HCS profession (e.g. the role of the Chief Scientific Officer)
  - Modernising Scientific Careers (MSC)
  - the contribution of the HCS workforce to health and healthcare services
- The role of the HCSP
- Patient–professional partnerships, with the patient at the centre of care
- Patient and carer perspectives and the diversity of the patient experience
- Use of chaperones
- Current safeguarding regulations relevant to practice as a HCSP
- Culture, equality and diversity and how this can affect practice
- Disability, including learning disabilities
- Mental health
- Patient wellbeing and self-care, including how to support self-care
- How to work in partnership with patients and service users to ensure that the views of patients are central to delivering, developing and maintaining high-quality, safe services
- The role of patient support groups
- The importance of the patient voice in education and training for the HCS workforce, including the structures within each BSc programme to promote the patient voice

**Legal and Ethical Boundaries of Practice**

- Sharing of information and advice between peers in order to encourage a consistent approach to the implementation of NHS policy
- Ethical, legal and governance requirements arising from working at the level of HCSP
- Principles, guidance and law with respect to medical ethics
- Principles, guidance and law with respect to patient confidentiality
- Principles, guidance and law with respect to informed consent and how to gain informed consent
- The limits of the concept of confidentiality
- The importance of introducing yourself and explaining your role to every patient
- Principles, guidance and law with respect to equality and diversity
- Principles, guidance and law with respect to safeguarding, including the use of chaperones
- The procedures to follow if cautioned, charged with a criminal offence, suspended, or have restrictions placed on personal scientific, clinical or professional practice
- The importance of personal health and wellbeing to ensure personal performance and judgement is not affected by their own health
- Information governance and be aware of the safe and effective use of health and social care information
- The need to manage records and all other information in accordance with applicable legislation, protocols and guidelines

**Patient Safety and Quality**

- NHS Constitution
- The wider context of safety in the NHS, including the culture of an organisation
- How effective communication underpins high-quality and safe patient services/patient care, including shared decision making
- The role of national organisations, e.g. NHS England; NHS Improving Quality
- Definition of terms
  - Quality management
  - Quality control
  - Quality assurance
  - Quality improvement
  - Quality methodologies
  - Quality processes and procedures
- Principles of Quality Management Systems (QMS):
  - Quality management; quality assurance; quality control

    - The role of the United Kingdom Accreditation Service
    - Current HCS accreditation programmes, e.g. Improving Quality in Physiology Sciences
- British, European and International Standards that govern and affect pathology laboratory practice
- Safety – prioritisation of patient safety in practice
- Safety – team working and patient safety
- Safety – equipment management
- Calibration, action levels
- Infection control
- Equipment life cycle, including specification, procurement commissioning, preventative maintenance, fault finding and repair, calibration, safety testing and decommissioning for equipment relevant to the specialism
- Strategies to improve patient safety
- Critical Incident reporting, review and action
- 'Never' events and strategies to reduce them
- Improving quality of life
- Improving quality of the patient experience of healthcare
- Processes for the distribution of documentation, e.g. Department of Health (DH), Central Alerting System (CAS), Medical Device Alerts (MDA)
- Quality, risk and audit
- Regulatory frameworks such as EU directives and Medicines and Healthcare products Regulatory Agency (MHRA) requirements
- Standard operating procedures, guidelines and protocols
- The contribution to the delivery of high-quality healthcare of the:
    - HCS workforce
    - HCS student
    - HCSP
- Why it is important to monitor and evaluate the quality of practice and the value of contributing to the generation of data for quality assurance and improvement programmes

**Communication Skills**

- Principles of effective verbal communication
- Principles of effective written communication

- Communication with those who do not have English as a first language
- Communication with people with sensory and cognitive impairments
- When and how to adapt communication methods
- Communication with patients across the age spectrum
- Use of patient leaflets and other appropriate media methods to engage with patients, donors and carers and the public

**Leadership**
- The concept of leadership and its application to practice
- The NHS Leadership Framework
- Leadership within the NHS, healthcare science, HCS teams and the multiprofessional team

**Teaching and Learning**
*Students should be introduced to key theories of teaching and learning, including teaching and learning practical skills to begin to support their personal development and provide a base for their future career.*

**Continuing Personal and Professional Development (CPPD)**
- The role and importance of CPPD to ensure that their professional knowledge and skills are being kept up to date

**ATTITUDES, BEHAVIOURS AND SKILLS**

**Professional Practice**
- Develop and maintain appropriate professional and patient–professional relationships in practice
- Treat patients with compassion and promoting patient wellbeing and self-care
- Work with colleagues, patients and carers in a respectful and non-discriminatory manner
- Provide safe, high-quality care at all times and in all settings
- Consistently bring the highest levels of knowledge and skill at times of basic human need when care and compassion are what matters most
- Create and justify open and non-discriminatory professional working relationships with colleagues, using critical reflection to review personal behaviour and responses to challenging issues
- Develop and maintain appropriate coping mechanisms for a range of potential issues, including stress, and seeking help if appropriate and evaluating the impact of an intervention
- Support and contribute to a culture in which innovation and developments are identified, discussed, evaluated and potentially introduced to improve service delivery

- Recognise and exploit learning opportunities in the workplace
- Acting in accordance with the principles and practice of patient-centred care, regularly reflecting on their personal practice and revising judgements and changing behaviour in the light of new evidence
- Practise as an autonomous professional, applying knowledge appropriately and exercising their own professional judgement within their scope of practice and with support from the team
- Promoting professional attitudes and values at all times
- Recognise the need to be truthful and to admit to and learn from errors
- Seek advice in the event of ethical dilemmas, including disclosure and confidentiality
- Accept and comply with the requirements for professional regulation

**Legal and Ethical Boundaries of Practice**

- Consistently operate in accordance with relevant current NHS policy and practice and recognise the limits of their own competence and scope of practice in order to make safe, informed and reasonable decisions about their practice
- Respond to the ethical, legal and governance requirements arising from working at the level of a HCSP, applying accrued knowledge and evidence
- Recognise the factors influencing ethical decision making, including religion, personal and moral beliefs, and cultural practices, and make informed decisions taking these into account.
- Share information in accordance with the regulations, encouraging such behaviour in other members of the healthcare team and taking action where breaches of the guidelines may occur.
- Ensure confidentiality is maintained, e.g. removal of patient names where appropriate, reviewing and analysing published literature, and considering the impact of such measures on the clinical service
- Recognise the problems posed by disclosure without consent of the patient, in the public interest
- Ensure patients, relatives and carers are aware of the need for appropriate information distribution within members of the immediate healthcare team
- Use appropriate methods of ethical reasoning to justify a decision where complex and conflicting issues are involved, calling on the support of others where needed
- Act in a manner that demonstrates probity in all aspects of professional practice
- Act in accordance with GSP at all times so that their conduct justifies the trust of patients and colleagues and maintains public trust in healthcare science
- Ensure that personal practice is always provided in line with the legal framework, acting with integrity at all times
- Apply appropriately the principles, guidance and laws regarding medical ethics and confidentiality and demonstrating the ability to gain informed consent

- Complete any/all documentation honestly and accurately and sign appropriately
- Apply honesty and accuracy about personal qualifications, experience and position in the scientific community
- Act honestly with respect to written and verbal information provided to any formal or legal enquiry, including recognition of the limits of scientific knowledge and experience
- Keep records in accordance with current best practice requirements, including accuracy of information recording within patient records and the framework that underpins data security practice in the NHS

**Patient Safety and Quality**

- Respond in an open, constructive and timely manner to critical incidents or complaints about their own or team performance, influencing the response, and using self-reflection to review personal behaviour and response to challenging issues
- Take appropriate action if it is suspected that they or a colleague may not be fit to practise, always putting patient safety at the forefront of practice
- Practise within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC
- Make appropriate judgements to ensure they limit work or stop practising if performance or judgement is affected by their health
- Recognise when personal health takes priority over work pressures, seeking appropriate advice and support, and taking appropriate action
- Co-operate with employers to ensure compliance with health and safety requirements

**Leadership**

- Recognise the importance of leading by example in setting high standards of personal behaviour, and in acting with openness, candour, fairness and integrity, listening and respecting the views of others

**Continuing Personal and Professional Development (CPPD)**

- Contribute to a culture that values CPPD in recognising strengths and identifying areas for improvement and supporting others to do the same
- Continue to develop their own learning and reflective practice by maintaining personal records of CPPD, providing evidence of critical reflection, including action planning, with respect to technical and clinical practice and professional development in a form suitable for audit by a professional body or regulator, and demonstrate continuing fitness to practise
- Apply knowledge, experience and critical reflection to identify personal development needs using a range of tools, and develop and update action plans
- Act as a self-motivated professional HCSP, being willing to learn from self-reflection and others, responding positively to constructive and meaningful feedback

- Record critically reflective notes demonstrating how participation in CPPD has contributed to learning and led to improvements in personal and service performance
- Monitor their own performance by a variety of methods
- Respond constructively to feedback and provide feedback when asked to support personal development and the development of others
- Prioritising and organising academic and work-based tasks in order to optimise their own work and the work of the department

**Communication Skills**

- Effective verbal communication
- Effective written communication
- Frameworks underpinning communication
- Adapting communication skills
- Giving and receiving feedback, including feedback frameworks

**Teaching and Learning**

- Introduction to how people learn
- Teaching and learning practical skills
- Transforming experience into knowledge and skills by reflection and action and linking this to the skills of feedback (see above) and work-based learning

**GM(ii): Scientific Basis of Healthcare Science (Year 1)**

Students should be introduced to every subject area described by each learning outcome and associated indicative content to provide a broad foundation of scientific and HCS knowledge on which to build their knowledge, skills and professional practice. Following the broad overview, learning should then being developed in the context of individual BSc (Hons) Healthcare Science programmes providing the flexibility to study specific areas in more depth.

1. **Introduction to the organisation of the human body**
    - Structural
    - Chemical
    - Cellular
    - Tissue

- Skin
- Cellular, tissue and systems responses to disease:
  - cell death
  - inflammation
  - neoplasia, e.g. carcinoma
  - hypertrophy
  - hyperplasia
  - tissue responses to injury and repair
- How the body changes from birth to old age

**2. Introduction to the structure and function of body systems: embryology, anatomy, physiology, pathology**

- Embryology
- Skeletal system
- Nervous system:
  - spinal cord and spinal nerves
  - brain and cranial nerves
  - sensory and motor systems
- Endocrine system
- Vision, hearing and equilibrium
- Cardiovascular system, including blood and blood vessels
- Respiratory system
- Lymphatic system
- Immune system
- Gastrointestinal tract, including digestion and absorption of food, nutrition, the liver and liver function tests
- Renal system
- Electrolyte and acid-base balance
- Hormonal mechanisms and control
- Metabolism
- Reproductive system
- Abdomen, pelvis and perineum
- Histology and cytology
- Microbiology, including infection control,

- Treatment regimens, including antibiotics and antibiotic resistance
- Virology
- Biochemistry
- Haematology
- Immunology and histocompatibility

**3. Introduction to clinical genetics, genomics and personalised medicine**

- Meiosis and Mendelian inheritance
- Nucleic acid structure and function
- Chromosome structure and function
- Nomenclature used to describe the human genome
- Common genetic disorders
- Impact of genetic disorders on the patient and their families
- Genomic technology and role of the genome in the development and treatment of disease
- The role of genomic counselling

**4. Introduction to epidemiology and public health**

- Local, national and international role of the public health function, e.g. Public Health England and related UK organisations
- Infectious disease services
- International partnership working for control of infection
- Principles of epidemiology
- Basis of health protection:
  - principles of surveillance
  - infectious disease control and emergency planning
- Screening:
  - screening programmes: purpose, design, outcomes
  - screening programmes: typical screening programmes in healthcare science
- Using epidemiological data to plan health services
- Factors affecting the health of the population
- Strategies and methods to improve health
- Factors affecting health and their contribution to inequalities in health between populations
- Changes in population demographics, including ageing

**5. Introduction to clinical pharmacology and therapeutics**

- Difference between pharmacology, clinical pharmacology, therapeutics and prescribing and medicine management
- Principles of pharmacology, pharmacokinetics and therapeutics:
  - drug names
  - classifications
  - definitions of terms and basic mechanisms
- Role of the pharmacist in primary and secondary care

**6. Sociology of health and illness**

- Patients' responses to illness and treatment:
  - the impact of psychological and social factors, including culture, age, ethnicity, gender, socioeconomic status and spiritual or religious beliefs, on health and health-related behaviour
- Health belief models
- Diversity of the patient experience
- Disability, including learning disabilities
- Mental health
- Potential health inequalities
- Self-care
- Impact of life-threatening and critical conditions
- Patient involvement in decisions regarding their healthcare

*This topic area should include the underpinning theoretical foundations and models, e.g. Health Belief Model, World Health Organization (WHO) model of activity limitation (disability)*

**7. Introduction to medical physics and clinical engineering**

- Structure of matter (atomic and nuclear models)
- Radiation: nature and its measurement and radiation safety
- Radiation dosimeters – personal dosimetry
- Basic physics and mathematics of image formation
- Imaging Techniques
  - Ultrasound
  - Magnetic Resonance Imaging (MRI)
  - Computerised Tomography (CT)

    - Positron Emission Computed Tomography
    - Single Photon Emission Computed Tomography
- Basic electricity and magnetism as it relates to the measurement of physiological signals
- Viscous and inertial flow of simple liquids
- Use of radiotherapy

**8. Introduction to clinical bioinformatics and health informatics**

*Clinical bioinformatics brings together the disciplines of computer science, mathematics, statistics and physics/engineering to influence, analyse and inform clinical and biological practice, so helping to maintain patient safety and the integrity and security of data. Students should be introduced to the three specialisms of clinical bioinformatics within healthcare science (genomics, health informatics science and physical sciences) in the context of: (i) innovation, translation and interpretation of complex genomic data, optimising the benefits this brings to patient care, including personalised medicine; (ii) the development and adoption of technology solutions and biomedically motivated methods for the collection, management, movement, analysis and use of health information in line with government legislation to improve the quality and safety of health care practice and delivery; and (iii) devices that may have therapeutic, diagnostic, or patient monitoring functions and they generate ever-increasing amounts of data that contribute to patient management. Teaching should be tailored to the student group using examples relevant to health and healthcare science.*

- Contribution of clinical bioinformatics genomics, health informatics sciences and physical sciences to:
    - patient safety
    - patient care
    - healthcare
    - healthcare science
- Governance and ethical frameworks
- Storage and sharing of images, Digital Imaging and Communications in Medicine (DICOM)
- Picture Archiving and Communications Systems (PACS)
- Clinical information systems and applications
- Clinical information systems and applications, e.g. Health Level 7 (HL7)
- Database management
- Direct patient access to test results

**9. Introduction to mathematical and statistical techniques**

- Data interpretation, including the variability of biological data and application of statistics

- Generation of reference ranges and their limitations

**10. Introduction to innovation in health and healthcare science**

- Identifying, reading and evaluating the literature
- Innovation in the NHS
- Using innovation to improve services
- Scientific and technical developments and their application in healthcare science
- The role of the HCS workforce in innovation

**GM(iii): Research Methods (Year 2)**

**1. Research, innovation and audit**

- Process and importance of research, innovation and audit to the NHS and healthcare science
- Role of healthcare science in research, innovation and audit
- NHS Research and Innovation Strategy
- Difference between research, audit and service improvement
- User/patient involvement
- Peer review
- Role of statutory, advisory regulatory bodies and funding bodies, including:
  - National Institute for Health and Care Excellence (NICE)
  - National Institute for Health Research (NIHR)
- Evidence-based practice
- Clinical guideline development
- Quality assurance frameworks:
  - quality improvement
  - patient care
  - patient safety
  - improved treatments
- The role of the HCS workforce in undertaking research and innovation and applying findings
- Use of research and audit to interpret and apply new knowledge in the NHS and healthcare science

**2. Current ethical and legal frameworks**

- Good Clinical Practice (GCP)
- Health and safety
- Risk assessment
- Human research
- Animal research
- Innovation
- Audit
- Ethical frameworks, including informed consent
- Legal frameworks
- Confidentiality
- Archiving
- Research governance framework for health and social care research
- Data Protection Act
- Intellectual property regulations
- Informed consent
- Roles and responsibilities of the research team

**3. Principles of literature searching**

- Evidence-based practice
- Principles of a literature search
- Process of literature searching
- Critical review of literature
- Systematic review
- Publication impact factor
- Reference manager systems

**4. Introduction to study design**

- Cohort studies
- Qualitative
- Quantitative
- Case control
- Systematic review

- Meta-analysis
- Sampling techniques
- Clinical trials (pre-clinical to translational)
- Epidemiological studies
- Hypothesis generation and testing
- Clinical trials

5. **Data analysis, statistical techniques and dissemination**
   - Data validity, reliability and appropriateness
   - Application and interpretation of statistical techniques:
     - parametric
     - non-parametric
   - Power calculations/sample size
   - Methods to disseminate research output
   - Impact factor
   - Scientific poster design
   - Writing for scientific journals
   - Writing scientific abstracts
   - Preparing research presentations for time-limited scientific meetings

**GM(iv): Research Project (Year 3)**

1. **Research in health and healthcare science, including:**
   - Scientific or clinical research
   - Translational research
   - Operational and policy research
   - Clinical education research
   - Innovation, service development
   - Service improvement
   - Supporting professional service users
2. **Ethical and governance approval process**

- The student must know the ethical approval and governance process required to undertake the proposed project including initial approval; monitoring; reporting; data storage and archiving

## 10.2 Division-Theme Modules

### CE(i): Mathematics, Statistics and Informatics (Year 1)

**Mathematics and Statistics**

- *Numerical representation and scientific calculator use*: standard form, negative numbers, percentages, accuracy and precision, conversion of units of measure
- *Algebra*: review of basic concepts
- *Graphs*: linear and non-linear graphs in the x-y plane, plotting a graph of the function, solving equations using graphs, solving simultaneous equations graphically
- *Logarithmic expressions*: indices, laws of indices, laws of logs, combinations of logs, natural logs and base 10 logs, solving equations with logarithms, properties and graph of ln and Log function
- *Angles and trigonometry*: degrees, radians, trigonometry ratios (sine, cosine, tangent), solving trigonometric equations, maxima and minima, graphs and waves generated by trigonometry
- *Exponential functions*: exponential expressions, exponential function and its graph, solving equations involving exponential terms using a graphical method
- Determinants, matrices and vectors
- *Differentiation*: gradient function, rules for differentiation, higher derivatives, maximums, minimums, points of inflection, differentiation of sums, differentiation of differences
- *Advanced differentiation*: products, quotients, exponential functions, logarithmic functions, function of a function
- *Indefinite integration*: indefinite integration, some rules for indefinite integration, constant of integration
- *Definite integration*: areas under curves, areas bounded by lines and curves, finding areas where some or all lie below the x-axis
- *Types of data*: discrete and continuous data
- *Summarising data graphically*: dot plot, stem and leaf, box and whisker, grouped frequency distribution, histogram, cumulative frequency distribution, cumulative frequency polygon, bar chart, one and two
- *Summarising data numerically*: mean, median, mode, samples, when to use various averages, standard deviation, error, inter-quartile range, box and whisker plots, variance, range, measures of skewness

- *Normal distribution*: mean, standard deviation, areas under the curve, standard normal transformation, solution of problems
- *Simple probability, samples and population distributions*: reasons for sampling sample size, random sampling, biased sampling, quota sampling, systematic sampling and stratified sampling, relationship to normal distribution, primary and secondary data

**Informatics**

- Informatics and clinical practice
- Basics of databases
    - Create a database
    - Understand the basic principles of database
    - Interrogate and produce reports
    - Evaluate and amend the database
- Interpreting and presenting data using spreadsheet software
- Presentation software
    - Create a short presentation
    - Apply appropriate techniques and slides for presentation
    - Evaluate and amend the presentation

**Essential issues associated with computing technologies and their management as appropriate to either Clinical Engineering, Medical Physics or Clinical Photography**

- Networking of medical devices
- Effective system management
- Patient safety and confidentiality

**CE(ii): Scientific Basis of Electronics, including work-based training (Year 1)**

- Concepts of electricity and magnetism, structures of matter and its properties
- SI units and laws associated with electrical and electronic engineering
- Conductors and insulators
- Semiconductor theory
- Circuit components and associated symbols
- Elementary analogue circuits
    - Resistive, capacitive and inductive, oscillators, amplifiers including op amps, power amplifiers, power circuits including transformers
- Feedback, stability and noise

- Basic transducer theory
  - Thermocouple, bridges, etc
- Motors – alternating current (AC), direct current (DC), stepping, pumps and their control, and feedback circuits and systems

**Elementary digital systems**

- Logic theory
- Digital circuits, functions
- Programmable devices
- Microprocessor/microcontroller
- Interfacing with microprocessor/microcontroller
- Programming of microprocessor/microcontroller
- Application to simple control problems

**Signal processing and manipulation**

- Signal conditioning
  - Amplification, filtering, clipping, modulation
- Signal sampling – simple sample-and-hold/track-and-hold devices
- Analogue-to-digital and digital-to-analogue converters
- Voltage-to-frequency and frequency-to-voltage converters
- Signal isolation principles
- Analogue line drivers and receivers

**CE(iii): Scientific Basis of Engineering: Basic Mechanics, including work-based training (Year 1)**

- Fundamental concepts; units of measurements; international system of units; numerical calculations
- Force, mass and acceleration
- Work, energy and power
- Effects of force on materials
- Moments
  - Equilibrium of a particle; free body diagram; force system resultants; principle of moments; moment of a force; moment of a couple; resultant forces and couples; equilibrium of planar system of forces; graphical and analytical method
- Internal forces
  - Shear and moments; relation between distributed load, shear and moment; stress and strain; tensile and compressive stress and strain; factor of safety

- Hooke's Law and elastic constants
- Friction
  - Dry friction; frictional forces on screws, belts and bearing, rolling resistance, lubrication
- Moment of area
  - First and second moments; polar second moment of area; centroids; theorem of perpendicular axis
- Bending of beams
  - Stresses due to bending, neutral axis, radius of curvature, moment of resistance, general bending formula
  - Principles of finite element analysis
- Torsion of shafts
  - Stresses due to top twisting, angle of twist, general torsion formula, power and work
- Simple harmonic motion
- Rigid body dynamics
- Simple machines
- Heat, energy and transfer
- Tools
  - Tool types, selection and use
- Safe working mechanical engineering practice

**CE(iv): Innovation and Medical Device Development (Year 2)**

**Guidelines, regulations and legislation relevant to the design and development of medical devices**

- Legislation (UK Law and European Directives)
- Standards: International Electrotechnical Commission (IEC), International Standards Organisation (ISO), European Normal (EN) and British Standards (BS)
- MHRA guidelines and alerts
- CE marking and routes to compliance
- Available product review
- Good equipment design
  - Interpret and evaluate a basic specification for a medical device
  - The basic component parts used when constructing a piece of equipment to be used in a clinical environment and how they interact

- Electromagnetic interference (EMI) and the effect it can have in a clinical environment
- The methods, principle of operation and limitations in displaying results
- Fail safe principles
- Risk management

- Quality Management Systems relating to medical devices and systems design
- Safety requirements for programmable medical electrical systems
  - Risk concepts relating to software-controlled devices
- Specifications
  - Establishing a user specification
  - Establishing a technical and environmental specification
  - Determining applicable standards and legislation
- Design evaluation
  - Analysing designs
  - Failure modes and effects analysis
- Design, manufacture, testing and documentation
  - Design techniques, including for electromagnetic compatibility (EMC)
  - Computer-aided design tools
  - Prototyping, simulating, experimentation, modelling
  - Use of advanced test equipment
  - Engineering drawings
    - Electrical
    - Mechanical
  - Printed circuit manufacture
  - Constructional issues
    - Materials, components, wiring, physical layout
  - EMC testing
  - Type testing
  - Functional calibration and safety testing
    - What, how and when
  - Design verification and validation testing
- Appropriate mathematical methods that can be used to analyse design
  - Systematic methodology that can be applied to solve problems in design

        - Application of basic principles and tools used in analysis of design
        - Systematic analysis of design
    - Documentation
        - Specification, operational manual, technical file, test documents
- Circuit analysis
    - Appropriate mathematical methods that can be used to analyse circuit behaviour and describe electrical signals
    - Systematic methodology that can be applied to solve problems in circuit design
    - Application of electronic principles and tools used in analysis of circuits
    - Systematic analysis of analogue circuit design
    - Systematic analysis of digital circuit design
- Modifications of existing device
    - Risk and implications and requirements

**CE(v): Fluid Mechanics, Biomechanics and Materials (Year 2)**
**Fluid mechanics**

- Basic properties, viscosity
- Hydrostatics: definition of pressure and shear stress
- Piezometer tube, barometer, use of manometers
- Introduction to fluid flow: general principles and common simplifications in fluid flow
- Laminar flow
- Bernoulli's equation, flow measurements
- Turbulent flow in pipes
- Friction loss in pipe systems, pumping power

**Gases**

- Ideal gas laws

**Materials**

- Introduction to the selection and classification of materials
- The basic properties of materials, including chemical, electrical, mechanical, physical and durability properties
- The relative importance of various material properties in different applications
- The microstructure of materials and its effect on chemical, electrical, mechanical and physical properties

- Introduction to material selection and the concept of choosing an appropriate material for a design application
- Biocompatibility of materials
- Use of new materials in healthcare

Biomechanics

- Classification and nomenclature of directions, planes, axes and human movement
- Identification of key bones, classification of joint types, their structure and motion
- Identification of muscle types and key muscle groups
- Muscle function, power, fatigue
- Classification of joint types, their structure and motion
- Mass, gravity, weight, force, moment, velocity, acceleration
- Linear and angular movement, momentum, inertia
- Temperature, energy, work, efficiency, physiological cost index
- Biomechanical analysis
- Biomechanical models
- Qualitative kinematics – systematic description of human movement and identification of pathology
- Quantitative kinematics – techniques for quantifying movement and applications of kinematics
- Introduction to gait analysis – the gait cycle, key measurements, clinical applications
- Electromyography (EMG)

**CE(vi): The Medical Equipment Life Cycle (Year 2)**

- Quality systems
  - General requirements; control of documentation; control of records; responsibility, authority and communication; planning of activities and resources; protocols and processes; identification and traceability; analysis and improvement; audit
- Record keeping – applies to all aspects of the equipment life cycle (electronic or paper)
  - Equipment information, including:
    - warranty documents, manuals, certificates of conformity, protocols, safety test records, acceptance test records maintenance and repair records, decontamination records, risk assessments
- Pre-purchase
  - Assessment of need
  - Defining or evaluation of specification
  - Relevant standards

    - Compliance with legislation
    - Identification of suitable equipment
    - Application of risk management to selection
- Purchase
    - Purchasing processes
    - Purchasing authority
- Acceptance and safety testing
    - Stages of acceptance, visual inspections, electrical safety testing, mechanical safety tests, appropriate test equipment, functional testing, purpose of measurements, performing measurements, assessing results
- Planned preventative maintenance and repair
    - Basic maintenance techniques
    - Repair process and post-repair quality control requirements
    - Range of planned technical support activities relevant to the equipment
    - Relevant engineering principles and concepts
    - Basic engineering principles on which the medical device operation is based
    - Basic engineering terminology
    - Factors affecting decisions on maintenance activity, including urgency, time, impact on services and the availability of other equipment
- Calibration/Quality assurance
    - Calibration procedures
    - Measurement principles
        - Reliability, repeatability, validity, limitations
    - Appropriate calibration equipment
    - Quality systems, audit, documentation
- Decontamination
    - Infection control
    - Decontamination techniques
        - Disinfection, sterilisation and cleaning
    - Specialist advice
- Decommissioning and disposal
    - Decommissioning protocols
    - Legislation

- Waste management
  - Special waste, clinical waste, radioactive waste, waste electrical and electronic equipment (WEEE), restriction of hazardous substances (RoHS)
- Disabling equipment
- Removal/disposal of data and data storage
- Importance of documentation

- Incident investigation/reports through evaluation of factual evidence

**CE(vii): Principles of Scientific Measurement (Year 2)**

- For a range of commonly measured physiological signals, understand the origin, nature, transmission and characteristics of the signal, including the magnitude and normal frequency range
  - Electrical origin (electrocardiogram [ECG], electromyogram [EMG], electroencephalogram [EEG], evoked responses, etc.)
  - Non-electrical in origin (blood pressure, temperature, oxygen saturation, etc.)
- Anatomical measurements
- Hazards in the patient environment
  - Electrical hazards
    - Electrical safety principles
    - Effects of electricity on the human body
    - Electrical safety limits
    - Measurements and Methods
  - Mechanical and other physical hazards
    - Loading
    - Stability
    - Surface measurements
- Origin of artefacts, methods of reduction
- Basic principles and technology employed in a range of commonly used transducers
- Factors influencing the selection of appropriate transducers
- Measurement of errors, propagation of errors and practical use of tolerances
- Factors that impact on the quality, accuracy reliability and repeatability of any measurement being taken
- Measurements that allow critical analysis/evaluation of equipment

- How taking and processing measurements may fundamentally change what is being measured
- Effects of applying a signal/ source of stimulation to the human body considering
  - Magnitude, frequency, transmission and limitations and restrictions
- Impact of taking measurements
  - On the patient, carers and other healthcare staff
  - On the patient pathway
- Data collection and storage
- Displaying physiological data – advantages, disadvantages and limitations associated with each method
- Impact of developing and emerging sciences
  - What is measured: scientific developments – complicated techniques made more available, new techniques
  - How measurements are taken: automation, introduction of new equipment – implications, telemedicine
  - Where scientific measurements are performed: e.g. hospitals, satellite units, poly-clinics, care establishments, schools, home

### 10.3 Medical Engineering (Year 3)

**CEME(i): Science and Principles supporting Medical Engineering**

- Propagation of electrical signals in the human body
- Effects of electrical current on the human body
- Biomedical signals frequency and bandwidth
- Common mode rejection
- Isolation – importance and impact on design, data signals, power supplies and patient safety
- Sample and hold circuits and their importance in the collection of biomedical signals
- Detection and control systems used in medical devices
- Advantages and disadvantages of analogue and digital signal processing
- Display techniques
- Data storage and retrieval
- Electronic systems in clinical engineering
- Mechanical systems in clinical engineering
- Clinical engineering terminology
- Fault finding methodology
- Principles of safety tests

- Range of principles used by medical equipment that underpins their operation. A typical list of the types of equipment that should normally be considered is
  - Pressure measurement
    - Invasive
    - Non-invasive
  - Temperature measurement
  - Monitoring or recording of physiological signals that are electrical in origin
    - Electrocardiogram (ECG), electroencephalogram (EEG), electromyogram (EMG)
  - Pulse oximetry
  - Electrosurgery
  - Infusion devices
  - Suction devices
  - Gas analysers and monitors
  - Endoscopic systems
  - Physiotherapy equipment
  - Life support equipment
    - Defibrillators, ventilators, anaesthetic equipment
- Parameters being measured
  - Normal ranges
  - Limits
  - Use of alarms
  - External influences
- Principles of operation of telemedicine applied to clinical engineering applications
- Principles equipment networking applied to clinical engineering applications
- Principles of remote equipment monitoring applied to clinical engineering applications
- Storage and transfer of data for analysis and reporting

**CEME(ii): Medical Engineering in the Clinical Environment**

- The clinical use of a range of medical devices and the common faults or problems that may be experienced
- Typical clinical uses
  - Pressure measurement

        - Invasive
        - Non-invasive
    - Temperature measurement
    - Monitoring or recording of physiological signals that are electrical in origin
        - Electrocardiogram (ECG), electroencephalogram (EEG), electromyogram (EMG)
    - Respiratory measurements
    - Pulse oximetry
    - Electrosurgery
    - Infusion procedures
    - Gas analysis and monitoring
    - Endoscopic procedures
    - Physiotherapy treatments
    - Life support procedures
        - Defibrillators, ventilators, anaesthetic equipment
- Safety controls and systems associated with the device operation
- Typical set-up procedures, including, limits and alarms, and how they may affect the practical operation of the equipment
- Installation, maintenance, repair, testing, calibration and environmental issues encountered with equipment in a range of clinical environments, including knowledge of the electrical infrastructure, the requirement of uninterruptable power supplies and possible sources of interference and interaction between devices. Example of the type of clinical areas that may be considered
    - Accident and Emergency
    - Wards
    - Clinics
    - Operating theatres
    - MRI suite
    - Intensive care unit
    - Paediatric environments
    - Maternity
    - Polyclinics
    - General practice (GP) surgeries
    - Outreach clinics
- Safety testing of portable medical devices, complex medical devices and systems
- Safety testing fixed installations of complex medical devices and systems

- Principles of wireless technologies applied to clinical engineering applications
- Technical implications and challenges associated with equipment being brought into the clinical environment
- Sources of interference/artefacts
- Quality systems applied to clinical engineering
  - Documentation, audit, information storage and retrieval
- Interactions between equipment in the clinical environment
- Practical application of networking, wireless and other technologies
- Working with third parties service providers
  - Contractual agreements, monitoring, auditing
- Practical risks associated with medical devices in clinical settings
  - Installation
  - Environment, including physical risks, services (e.g. electricity, gases)
  - Safety testing
  - Functional testing
  - Interference
  - Sources of artefacts
  - Systems
  - Additional equipment
- Training and competence – user, technical and functional
- Practical application of legislation and guidance and other information, including
  - Controls assurance systems

### 10.4 Radiation Engineering (Year 3)

**CERE(i): Science and Principles supporting Radiation Engineering**

- Ionising radiation physics
  - Atomic structure
  - The laws of radioactive decay
  - Mechanism of radioactive decay
  - Interaction of radiation with matter
  - Natural sources of radiation

- Clinical sources of radiation
  - Production of X-rays
  - Types of X-ray tube and design features
  - X-ray generators
  - Sealed sources
  - Unsealed radioactive materials
- Other technologies used to generate radiation, etc.
  - Microwave
  - Radio frequency
  - Ultrasound
  - Optical
  - Management of high-voltage systems
- Radiation Protection
  - As low as reasonably achievable (ALARA)
  - Principles of dose limitation
  - Net positive benefit, dose limits
  - National and international legislation and recommendations
  - Controlled and supervised areas, classified persons
  - Roles and responsibilities of staff, including the radiation protection advisor (RPA) and radiation protection supervisor (RPS)
  - Hospital organisation of radiological protection; radiation safety policies and local rules
  - Personnel and environment dose monitoring
  - Instrument calibrations
  - Registration, safe custody, transport, use and disposal of radioactive sources
  - Notification of radiation accidents and incidents
  - Contingency plans, including radiation emergencies
  - Biological and effective half-life
  - Record keeping
  - Design considerations
- Radiobiology
  - Effects of radiation on cells and tissues
  - Cell survival concepts of tissue tolerance, fractionation, oxygenation, cell proliferation
  - Radiation hazards: early and late reactions; genetic and carcinogenic risks

- Diagnostic radiology techniques
  - Diagnostic radiography
  - Fluoroscopy: over-couch and under-couch system, fluorography
  - Computed tomography (CT)
  - Digital systems (radiography, subtraction and enhancement techniques)
  - Mobile units, dental units, dental panoramic tomography, cephalometry
  - Mammography
  - Room layouts, control cubicles, shielding
  - Primary beam, scatter, leakage
  - Image processes
  - Factors affecting patient dose
- Radiotherapy treatment
  - Room design, shielding
  - Linear accelerators, technology applications to treatment
    - X-ray beam therapy, electron beam therapy, intensity modulated radiotherapy (IMRT), image guided radiotherapy (IGRT), proton therapy, arc therapy, tomotherapy hybrid systems (combined imaging and treatment machines)
  - Superficial therapy
  - Beam generation, energy and delivery
  - Active source therapy
    - Brachytherapy, cobalt therapy
  - Imaging techniques
    - X-ray, CT, MRI, nuclear medicine
  - Hybrid systems
  - Treatment planning systems and process
- Dose distribution
- Dose measurement
- Immobilisation devices and their purpose in radiotherapy treatment or diagnostic radiology
- Quality assurance
  - Field quality and alignment, use of phantoms, measurements and measuring equipment

**CERE(ii): Radiation Engineering in the Clinical Environment**

- Practical safety that applies when working in a radiotherapy department
  - Radiation safety standards and hazards that apply when working with ionising and non-ionising radiation – national and local rules
  - Electrical
  - Mechanical
  - Radiotherapy and related equipment
- Structure of equipment – major component parts
- Operation of linear accelerator technology
  - Beam generation
    - Flatness, focusing, symmetry, energy, dose rate and dose accuracy, alignment
  - Waveguide
  - Radio Frequency (RF) system
  - Cooling systems
  - High Tension systems
  - Vacuum systems
  - Interlocks systems and how they affect the operation of the equipment
  - Control systems applied to the operation of radiation equipment
- Operation and use of
  - Laser-centering systems
  - Multi-leaf collimation (MLC)
  - Wedges
  - Image generation equipment
- Computer systems used in diagnosis and treatment
  - Principles of operation
  - Importance in the modern radiotherapy departments
  - Patient verification systems
- Operation of superficial treatment
- Operation of imaging equipment
  - Diagnostic X-ray equipment
  - Simulators
  - CT

    - MRI
    - Positron emission tomography
- Machine procedures
    - Start, run-up and shut-down procedures
    - Maintenance and fault-finding protocols and procedures
    - Calibration
    - Safety testing
- Use of computer practice within the specialism
    - Networking of devices and their management
    - System recovery
    - System upgrades
    - System backup
- Quality systems
    - Procedures and work instructions
    - Importance of accurate recording of results, reports, certificates of serviceability and other documentation
    - Quality control of measuring equipment
- Introduction of other medical equipment into a Ionising or non-ionising radiation environment
    - Risks
    - Artefacts
    - Interference
    - Possible impact on patient outcomes
- Review the application of new and impending technology and techniques

### 10.5 Renal Technology (Year 3)

**CERT(i): Science and Principles supporting Renal Technology**

**Urinary system and the effect of disease and RRT**

- Chemistry
- Biochemistry
- Microbiology
- Virology

- Pathology
- Renal disease
  - Epidemiology of renal disease
  - Consequences of renal failure
- Anatomy
- Physiology, including:
  - The movement and control of body water and electrolytes
  - Formation of urine, renal perfusion
  - Glomerular filtration, tubular function; absorption and secretion
  - Homeostasis
  - Functions of the kidney
  - Metabolism in cells
  - Control of body water distribution
  - Fluid and chemical transport
  - Equilibrium and acid dissociation
  - Hydrogen ion regulation
  - Electrolytes and buffers
- Pharmacology
- Chemicals in the renal environment

**Principles, methods and limitations of obtaining vascular access**

- Fistula and other forms of access
- Permanent and temporary catheters
- Recirculation and its measurement
- Blood flow rates
- Assessment techniques
- The impact of stenoses

**Renal replacement therapy**

- The history and development of dialysis
- The artificial kidney
- Current dialysis techniques and technology

**Treatment regimens and monitoring**

- Selection of treatment: indications, contraindications, patient involvement in decision making
- Blood temperature and low temperature treatments
- Measurement of blood pressure and the importance of monitoring blood pressure data
- Blood volume monitoring
- Dialysis adequacy tools
- Low- and high-flux dialysis
- Middle molecule clearance
- Degenerative bone disease and dialysis complications
- Dialysis treatment options, long hour, short hour, frequent, alternate day, daily
- Water sources and treatment – municipal systems
    - Municipal water supplies
    - Municipal water supply treatments
    - Municipal water supply standards
    - Sampling and testing
- The importance of water quality
- Legislation, standards and guidance
- RRT treatment scientific developments
    - Transplant, dialysers developments, impact of stem cell research and genetics, service delivery options

**The impact of renal disease for patients and their families**

- Quality of life
- Cardiovascular disease
- Economic (including the NHS)
- Disability

**CERT(ii): Renal Technology in the Clinical Environment**
**Impact of engineering services on the patient pathway and outcome**

**General operating principles of RRT equipment**

- Haemofiltration (HF)

    - History, configuration of blood and substitution fluid circuits, differences from haemodialysis, bag and online systems with pre- and post dilution, Gibbs-Donnan effects, impact on sodium balance, fluid balance controlling systems, heating systems for substitution fluids, requirements on microbiological quality of the substitution fluid, efficiency assessment (mathematical description included)
- Haemodiafiltration (HDF)
    - Configuration of blood and dialysate circuits, differences from haemofiltration, bag and online systems with pre- and post dilution, fluid balance controlling systems, requirements on microbiological quality of the substitution fluid
    - Efficiency assessment (mathematical description included), special haemodiafiltration techniques – paired filtration dialysis (PFD), acetate-free biofiltration, push-pull haemodiafiltration
- Haemoperfusion
    - Principles, scope of use, differences in sorbent materials, efficacy, anticoagulation, combined haemodialysis/haemoperfusion
- Plasma exchange
- Risks associated with medical devices in the RRT setting
    - Installation
    - Environment, including physical risks, services (electricity, water)
    - Safety testing
    - Functional testing
    - Interference
    - Sources of artefacts
    - Systems
    - Additional equipment
- Use of failsafe devices and alarms

**Safety and functional testing procedures**

- Safety and functional testing
- Implications of providing RRT in different settings.
- Water treatment and quality, biochemistry microbiology and virology at the point of dialysis
    - Hospital dialysis unit, satellite unit, home

**Current RRT techniques**

- Current RRT techniques:
    - Peritoneal dialysis
    - Haemodialysis

- Advantages and disadvantages of each therapy
- Alternative therapies and modalities
- Daily dialysis, including short hour and long hour regimes
- Principle of operation of dialysis equipment, including the role of buffers and electrolytes in dialysis fluids; the consumables used; the artificial kidney and the membrane characteristics; dialysis adequacy
- Transplantation

**Online therapies and dietary control**

- Online therapies and factors that influence their use
- Importance of dietary control
- How to identify situations and conditions that might influence diet
- Apheresis, plasmafiltration, cascade plasmafiltration
  - Principles, scope of use, differences in membrane materials, efficacy, heparinisation, specific requirements on plasmafiltration technology (such as accuracy of fluid balance system)
- Online therapies and associated technologies
  - Continuous blood volume monitoring, including automated ultrafiltration (UF) control
  - Temperature and thermal balance monitoring and control
  - Ionic dialysance
  - Electrolyte balance
  - Urea concentration and dialysis dose monitoring
  - Basic physiology of peritoneal transport
  - Peritoneal dialysis clearance and schedules – intermittent peritoneal dialysis (IPD), continuous ambulatory peritoneal dialysis (CAPD), nightly peritoneal dialysis (NPD), tidal peritoneal dialysis (TPD)
  - Peritoneal dialysis cyclers – flow diagram, construction, monitoring and safety systems
- Risks associated with RRT to both patients and staff
  - Contaminants, blood borne viruses, equipment/resource failure

**Standards and guidelines applicable to RRT**

**Psychological and social implications of RRT**

- Pre-dialysis clinic and preparation for treatment
- Transplantation and transplant failure
- Communication skills to facilitate clinical investigations

- Interpersonal and listening skills
- Clinical history recording
- Communication methodology using written and oral techniques

**Psychosocial aspects of disease**

- Altered status awareness
- Substance abuse
- Transmissible diseases
- Chronic illness
- Links between lifestyle and health and disease
- Stress and disease
- Cognitive behaviour therapy
- Coping mechanisms
- Stress management
- Relaxation techniques
- Disability awareness

**Health promotion awareness and strategies for delivery to clients**

**Health and safety procedures within the RRT environment**

## 10.6 Rehabilitation Engineering (Year 3)

**CERhE(i): Science and Principles supporting Rehabilitation Engineering**

**Scope of practice**

- Scope of rehabilitation engineering
- Scope of assistive technology
- Range and roles of MDT

**Technology (design and manufacture, materials and equipment)**

- Rehabilitation technology design
- Mobility, wheelchairs and special seating systems
- Prosthetics and orthotics

- Electronic assistive technology (environmental control systems, functional electrical stimulation [FES], augmentative and alternative communication systems [AAC], switches, integrated systems, etc.)
- Architectural barriers and design
- Aids to daily living
- Information technology (IT) in rehabilitation engineering
- Materials and manufacturing

**Measurement technology**

- Gait measurement
- Tissue interface measurement
- Outcome measurement
- Digital photography
- Physiological measurement
- Transducers

**Biomechanics**

- Biomechanical analysis
- Biomechanical models
- Biomechanics of major musculoskeletal structures
- Tissue biomechanics
- Wheelchair biomechanics
- Biomechanics of seating
- Biomechanics of gait
- Prosthetic and orthotic biomechanics

**Disabling pathologies**

- International Classification of Functioning, Disability and Health (ICF)
- Sensation and sensory loss
- Congenital pathologies
- Diabetes
- Pressure sores
- Spinal pathologies

- Continence and control
- Joint and muscle pathologies
- Neurological disorders
- Ageing
- Cardiovascular disease

**Workshop practice**

- Workshop safety
- Production planning and processes
- Hand tools, machine tools and computer aided manufacture
- Fixing and fastening
- Materials
  - Metals, plastics, wood, ceramics, biomaterials
- Use drawing packages
- Engineering drawings
- Device fabrication methods
- Device construction processes
- Engineering tests

**Health and Safety in Rehabilitation and Assistive Technology**

- Control of Substance Hazardous to Health (COSHH)
- Manual handling
- Infection control

**CERhE(ii): Rehabilitation Engineering in the Clinical Environment**

- Equipment management applied to rehabilitation engineering and assistive technology
- Quality systems and controls
- Product knowledge
  - Researching methods
  - Principles of device operation
  - Manuals, protocols and training information
  - Accessories

    - Availability
    - Costing
    - Construction of device, including transportation requirements
    - Controls
    - Control of infection
    - Operation implications
        - Safety, suitability, running costs, additional resource implications
- Clinical practice
    - Rehabilitation engineering in the health service
    - The rehabilitation engineer in the professional healthcare team
    - Psychosocial aspects and classification of disabilities (including the International Classification of Functioning)
    - Assessment methods
    - Other professional roles (occupational therapist, physiotherapist, speech therapist, consultant in rehabilitation medicine)
    - Communication with client and carer
    - Postural management
    - Development and prevention of deformity
- Assessment
    - Disabling pathologies and prognosis
    - Psychological state
    - Communication abilities/limitations
    - Physical abilities/limitations
    - Musculoskeletal abilities/limitations
    - Neuromuscular abilities/limitations
    - Social goals/limitations
    - Mobility goals/limitations
    - Postural management/needs
    - Carer needs/abilities
- Measurements
    - Types and range of measurements
    - Measurement limitations
    - Anatomical measurements
    - Specialist measuring equipment

    - Use of photography
- Prescribing
    - Limitations
    - Multidisciplinary team
        - Roles, scope of practice
    - Funding
    - Services ability to deliver solution
- Trialling devices
- Modification
    - Risk assessments
    - Specification
    - Designing
    - Manufacture
    - Legislation, regulations and guidance
    - Testing
    - Documentation
    - CE marking
    - Outsourcing
    - Inspection
    - Acceptance
- Repairs
    - Protocols
    - Knowledge of equipment
    - Outsourcing
    - Monitoring
    - Inspection
    - Acceptance
    - Documentation
- Testing
    - Mechanical tests
    - Electrical tests
    - Functional tests

- Risk assessments
  - Environment, local, wider
  - Users/Carers
  - Device specific
  - In relation to other devices

## SECTION 11: WORK-BASED SYLLABUS: CLINICAL ENGINEERING

This section describes the Learning Frameworks for the Generic and Theme Components of work-based learning covering the Learning Outcomes, Clinical Experiential Learning, Competence, and Applied Knowledge and Understanding.

| | |
|---|---|
| **DIVISION** | Physical Sciences |
| **THEME** | Clinical Engineering |
| **SPECIALISM** | Medical Engineering |
| **SPECIALISM** | Radiation Engineering |
| **SPECIALISM** | Renal Technology |
| **SPECIALISM** | Rehabilitation Engineering |

**Students are expected to spend 10 weeks in Year 1 undertaking work-based learning in the workplace.**

### 11.1 Generic Introduction to Work-Based Learning

| MODULE TITLE | Generic Introduction to Work-based Learning | Component | Generic Year 1 |
|---|---|---|---|
| AIM | The aim of this module is to introduce the student to the workplace and enable them to apply and contextualise the knowledge and skills they have gained in the module 'Scientific Basis of Healthcare Science' and the Year 1 modules in each HCS theme. Students will be expected to perform some routine skills and develop and build their professional practice in accordance with *Good Scientific Practice*. | | |
| SCOPE | On completion of this module the student will be able to perform basic life support and infection control techniques and use effective communication skills in the context of patient-centred care and recognising the role of the specialism in patient care. They will also be expected to adhere to health and safety procedures and work safely in the workplace adhering to the trust procedures and governance, including patient confidentiality and the Data Protection Act. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Perform a range of generic skills, including infection control, basic life support, communication and team working, adhering to health and safety regulations, and behaving in a professional manner in accordance with *Good Scientific Prac*tice.

## CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Observe how staff in the workplace communicate with patients and reflect on the importance of effective communication in the workplace with respect to patient-centred compassionate care.
- Shadow a qualified HCSP and discuss the role of the practitioner in Clinical Engineering and their contribution to healthcare and multiprofessional teams.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Control infection risks in accordance with departmental protocols, always washing hands in accordance with the six-stage hand-washing technique when necessary. | • Protocols and requirements for hygiene and infection control related to the relevant range of investigations, including preparation, conduct and completion of investigation.<br>• Protocol for hand washing and how effective hand washing contributes to control of infection and local trust requirements. |
| 1 | Perform basic life support in accordance with current Resuscitation Council (UK) guidelines. | • Current Resuscitation Council (UK) guidelines. |
| 1 | Use effective communication skills within the healthcare environment. | • The principles of effective communication, including written and electronic, verbal and non-verbal.<br>• The importance of introducing yourself and your role as a student HCSP as part of the process of introduction and consent.<br>• Patient-centred care and the importance of informed consent and involving patients in decisions about their healthcare.<br>• The importance of ensuring the patient is aware of the role of the member of the HCS workforce.<br>• The way effective communication can assist in identifying problems accurately, increase patient satisfaction, enhance treatment adherence, and reduce patient distress and anxiety.<br>• The importance of some key ideas, for example signposting, listening, language, non-verbal behaviour, ideas, beliefs, concerns, expectations and summarising in communication. |
| 1 | Adheres to safe working practice in the workplace. | • The relevant health and safety regulations specific to the workplace and investigations undertaken, the potential hazards and risks, and the actions to be taken to minimise these. |
| 1 | Work professionally in the workplace at all times. | • *Good Scientific Practice*. |

### 11.2 Introduction to Clinical Engineering

| MODULE TITLE | Introduction to Clinical Engineering | Component | Year 1 Theme |
|---|---|---|---|
| AIM | This module will provide a foundation from which students will build their knowledge, skills, experience and attitudes throughout the three-year programme of study and enable them to transfer these skills to employment in healthcare science. It is expected that this period of initial work-based training will provide the opportunity to apply their learning from the modules 'Scientific Basis of Engineering – Electronics and Mechanics' and 'Professional Practice' and begin to integrate and embed many of the professional practice learning outcomes, and enable students to practise safely in the workplace. | | |
| SCOPE | This module will enable students to begin to gain skills and experience of Clinical Engineering by observing, assisting and performing under direct supervision, some basic routine procedures while working in accordance with local rules and safety regulations. On completion of this module the student will be able to perform basic clinical engineering procedures under direct supervision. Students will also apply knowledge and develop and build their professional practice safely. | | |

**LEARNING OUTCOMES**
**On successful completion of this module, in routine adult patients, the student will:**

1. Observe, assist and perform under direct supervision, some basic routine procedures while working in accordance with local rules and safety regulations, including:
   (a) observe a routine assessment of gait;
   (b) observe the assessment of a patient requiring assistive technology;
   (c) observe the provision of appropriate aids for daily living;
   (d) under direct supervision perform maintenance on a simple wheelchair;
   (e) under direct supervision perform basic equipment functional tests and calibration;
   (f) under direct supervision perform basic equipment commissioning;
   (g) observe and assist in measuring the performance characteristics of an X-ray tube or linear accelerator;
   (h) observe the maintenance of an X-ray or radiotherapy installation;
   (i) observe the maintenance of renal dialysis equipment;
   (j) observe the maintenance of a water treatment plant/
2. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

## CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Observe a routine assessment of gait and discuss the importance of informed consent, record keeping, data protection, confidentiality in accordance with trust procedures and governance process, and identify examples of good practice with respect to professionalism and patient-centred care with your training officer.
- Observe the assessment of a patient requiring assistive technology and discuss the potential benefits to the patient with your training officer.
- Observe a range of maintenance procedures undertaken in a clinical engineering department and reflect on the importance of routine maintenance to support service provision and the importance of completing maintenance records. This should include:
  - maintenance of an X-ray or radiotherapy installation;
  - maintenance of renal dialysis equipment;
  - maintenance of a water treatment plant.
- Attend a multidisciplinary or department meeting and reflect on the way the MDT contributes to the care of patients referred to the department.
- Observe the provision of appropriate aids for daily living and, with permission, discuss with the patient how aids for daily living have affected their daily life.
- Observe the process for handling work requests from the receipt of the request to completion, map the process and reflect on waits and delays within the process.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1, 2 | Control infection risks in accordance with departmental protocols. | • Protocols and requirements for hygiene and infection control related to the clinical measurements, including preparation, conduct and completion of investigation.<br>• Protocol for hand washing and how effective hand washing contributes to control of infection. |
| 1, 2 | Use effective communication skills within the healthcare environment. | • The principles of effective communication, including written and electronic, verbal and non-verbal.<br>• The way effective communication can assist in identifying problems accurately, increase patient satisfaction, enhance treatment adherence, and reduce patient distress and anxiety.<br>• The importance of some key ideas, for example signposting, listening, language, non-verbal behaviour, ideas, beliefs, concerns, expectations and summarising in communication. |
| 1, 2 | Adhere to safe working practice in the workplace. | • The relevant health and safety regulations specific to the workplace and investigations undertaken, the potential hazards and risks and the actions to be taken to minimise these. |
| 1, 2 | Work professionally in the workplace at all times. | • *Good Scientific Practice*. |
| 1 | Perform, under direct supervision, maintenance of a simple wheelchair. | • Concepts of electricity and magnetism, structures of matter and its properties.<br>• SI units and laws associated with electrical and electronic engineering.<br>• Conductors and insulators.<br>• Circuit components and associated symbols.<br>• Feedback, stability and noise.<br>• Basic transducer theory.<br>• Thermocouple, bridges, etc.<br>• Motors – alternating current (AC), direct current (DC), stepping, pumps |
| 1 | Perform, under direct supervision, basic equipment functional tests and calibration. | |
| 1 | Perform, under direct supervision, basic equipment commissioning. | |
| 1 | Observe and assist in measuring the performance characteristics of an X- ray tube or linear accelerator. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Observe and assist in the maintenance of an X-ray or radiotherapy installation. | and their control and feedback circuits and systems.<br>• Elementary digital systems.<br>• Signal processing and manipulation.<br>• Moments.<br>• Internal forces.<br>• Hooke's Law and elastic constants.<br>• Friction.<br>• Moment of area.<br>• Bending of beams.<br>• Torsion of shafts.<br>• Simple harmonic motion.<br>• Rigid body dynamics.<br>• Simple machines.<br>• Heat, energy and transfer.<br>• Production of X-rays for diagnostic imaging and radiotherapy.<br>• Radiation safety.<br>• Tool types, selection and use.<br>• Safe working in workshop and radiation environments. |
| 1 | Observe and assist in the maintenance of renal dialysis equipment. | |
| 1 | Observe and assist in the maintenance of a water treatment plant. | |
| 2 | Reflect on your practice during this period of work-based training and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

## SECTION 12: WORK-BASED SYLLABUS: MEDICAL ENGINEERING

This section describes the Learning Framework for **Specialist Component** of work-based learning covering the Learning Outcomes, Clinical Experiential Learning, Competence, and Applied Knowledge and Understanding.

| | |
|---|---|
| **DIVISION** | Physical Sciences |
| **THEME** | Clinical Engineering |
| **SPECIALISM** | **Medical Engineering** |

| Module 1 | Safe Working Practice in Medical Engineering | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| **AIM** | The aim of this module is to ensure the student is able to work safely in the medical engineering environment, with the emphasis on health and safety, risk management, risk assessment and equipment management. During this first module of specialist work-based training students will apply their learning from the generic, division-theme and specialist modules 'Science and Principles Supporting Medical Engineering' and 'Medical Engineering in the Clinical Environment'. | | |
| **SCOPE** | On completion of this module the student will be able to work safely in the medical engineering environment. They should be able to perform a range of risk assessments and tasks within the equipment management life cycle. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Apply health and safety and risk management principles to all aspects of the medical engineering technologist's role.
2. Observe and perform a range of risk assessments appropriate to medical engineering.
3. Observe and perform a range of equipment management processes.
4. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

*Note: When performing a risk assessment all risk elements must be considered.*

**CLINICAL EXPERIENTIAL LEARNING**

The clinical experiential learning for this module is:

- Observe the use of medical devices and participate in the safe deployment of equipment in a variety of clinical environments.
- Observe and participate in the acceptance testing and PPM of a broad range of medical devices.
- Undertake risk assessments on the working environment and the deployment, acceptance testing and PPM of medical device.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.
The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Complete all generic health and safety and mandatory training contextualised to the work placement and observe the range of medical devices handled by the department and their clinical use. | • Local health and safety policy covering work-based activities.<br>• Risks associated with lone working, working on live equipment and the steps that are in place or need to be put in place to mitigate these risks.<br>• Fire escape routes, location of alarms and extinguishers, hand washing facilities, etc.<br>• Practical risks associated with medical devices in clinical settings:<br>  ○ installation<br>  ○ environment, including physical risks, services (e.g. electricity, gases)<br>  ○ safety testing<br>  ○ functional testing<br>  ○ interference<br>  ○ sources of artefacts<br>  ○ systems<br>  ○ additional equipment.<br>• The clinical use of a range of medical devices and the common faults or problems that may be experienced. |
| 2 | Review a local risk assessment and comment on how it applies in the workplace. | • Theory of risk assessment using current statutory and professional guidance.<br>• The kind of risk assessments that are performed, where they are kept and how to access them.<br>• The types of symbols, their meaning and implications these have, covering:<br>  ○ equipment classifications<br>  ○ electrical symbols<br>  ○ biological hazards<br>  ○ chemical hazards.<br>• Control of Substances Hazardous to Health (COSHH) assessment and |
| 2 | Perform **two** environmental risk assessments on areas where work activities are performed, one workshop based and one in a clinical setting (e.g. intensive care unit [ICU]). | |
| 2 | Perform a risk assessment of the acceptance testing procedure. | |
| 2 | Perform **two** risk assessments on | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | the PPM procedure for medical devices,* one in a lab-based setting and one in a clinical environment (e.g. theatre, high dependency unit [HDU]). | comment on application in the workplace.<br>• Hazards in the patient environment:<br>  ○ electrical hazards:<br>  ▪ electrical safety principles<br>  ▪ effects of electricity on the human body<br>  ▪ electrical safety limits<br>  ▪ measurements and methods<br>  ○ mechanical and other physical hazards:<br>  ▪ loading<br>  ▪ stability<br>  ▪ surface measurements.<br>• The clinical use of a range of medical devices and the common faults or problems that may be experienced.<br>• Installation, maintenance, repair, testing, calibration and environmental issues encountered with equipment in a range of clinical environments, including knowledge of the electrical infrastructure, the requirement of uninterruptable power supplies, and possible sources of interference and interaction between devices.<br>• Technical implications and challenges associated with equipment being brought into the clinical environment.<br>• Interactions between equipment in the clinical environment.<br>• Acceptance and safety testing.<br>• Planned preventative maintenance and repair.<br>• Decontamination:<br>  ○ infection control<br>  ○ decontamination techniques<br>  ▪ disinfection, sterilisation and cleaning. |
| 2 | Perform **two** risk assessments covering repair procedures for medical devices. | |
| 2 | Perform a risk assessment covering decontamination procedure(s). | |
| 2 | Perform a COSHH assessment. | |
| 3 | Identify record and comment on any appropriate documentation that may | • Structure of the department, noting the main features, including any controlled, restricted, or storage areas. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | apply to each stage of a range of equipment management processes. | • Key roles within the department and who performs them.<br>• Range of healthcare staff that medical engineering staff will liaise and work with while performing their duties.<br>• Organisational policies that apply to the medical engineering technologist.<br>• Locations where equipment life cycle duties are performed and any restrictions that may apply.<br>• Passage of central alerting system through the department and explain the processes that are followed.<br>• Actions that would be taken in the event of an untoward incident involving medical equipment. |
| 4 | Work within their own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary, complying with relevant guidance and laws, to include those relating to:<br>• your scope of practice<br>• probity<br>• fitness to practise<br>• maintaining your own health. | • Principles, guidance and law with respect to:<br>○ *Good Scientific Practice*<br>○ probity<br>○ fitness to practise.<br>• The importance of maintaining your own health. |
| 4 | Follow data protection policy and local procedures to maintain data records and confidentiality. | • Principles, guidance and law with respect to:<br>○ confidentiality<br>○ information governance<br>○ informed consent<br>○ probity<br>○ fitness to practise.<br>• The importance of maintaining your own health. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 4 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 4 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |
| 4 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 4 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

**Medical devices may include, but are not limited to, anaesthetic equipment, blood pressure measuring equipment, defibrillators, gas analysis and monitoring equipment, multiparameter monitors, single or multiparameter display equipment, electocardiogram or other recording equipment, infusion devices, pulse oximetry, temperature measuring equipment, ventilation equipment.*

| Module 2 | Equipment Management, Quality Management Systems and Processes | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| **AIM** | The aim of this module is to introduce the student to equipment management and quality management systems, and their use in the medical engineering environment to manage the range of equipment used within a healthcare setting. During this specialist work-based module students will be able to apply their learning from the generic, division-theme and academic specialist modules 'Science and Principles Supporting Medical Engineering' and 'Medical Engineering in the Clinical Environment'. | | |
| **SCOPE** | On completion of this module the student will be able to operate equipment management and quality management systems, including the management of rental and loan equipment. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Operate equipment management and quality management systems (QMS), both electronic and manual, to support all aspects of equipment management activities.
2. Apply equipment management processes to assist in the management of rental and loan equipment.
3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

## CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Attend a multiprofessional meeting where clinical audit, research, or innovation is presented and consider how audit, research and innovation contribute to service improvements.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Log on to an electronic inventory (or obtain paper record) system and locate:<br>• an individual item of equipment;<br>• particular types/groups of equipment;<br>• appropriate manuals, maintenance, calibration and repair standard operating procedures (SOPs) or SOPs/protocols. | • The specialist roles and individuals associated with them with respect to the equipment management and quality management systems and processes.<br>• Manuals, maintenance, calibration and repair SOPs or SOPs/protocols within an electronic inventory.<br>• Manuals, maintenance, calibration and repair SOPs or SOPs/protocols within a paper-based inventory system.<br>• Document version control system in use and how to work within this system.<br>• Quality systems:<br>○ general requirements, control of documentation, control of records, responsibility, authority and communication, planning of activities and resources, protocols and processes, identification and traceability, analysis and improvement, audit.<br>• Record keeping – applies to all aspects of the equipment life cycle (electronic or paper).<br>• Equipment information, including:<br>○ warranty documents, manuals, certificates of conformity, protocols, safety test records, acceptance test records, maintenance and repair records, decontamination records, risk assessments.<br>• Data storage and retrieval.<br>• Electronic systems in Clinical Engineering.<br>• How to access any work schedules on the electronic records system. |
| 1 | Complete electronic records for new entries on to the inventory system after PPM, repair, calibration, decontamination, decommissioning, etc., updating records as necessary. | |
| 1 | Operate stock control systems that are in place, participating in the management of spares and consumables, including the maintenance of stock levels. | • How to maintain adequate stock levels.<br>• Electronic stock control systems:<br>○ purchase of spares and consumables<br>○ purchasing processes<br>○ purchasing authority. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 2 | Access indemnity forms and NHS delivery forms and select the appropriate indemnity form to be completed for given circumstances. | • Major types of equipment obtained on loan/rental basis.<br>• NHS standards for loan equipment and indemnity. |
| 2 | Access the register of suppliers through the Department of Health (DH) website and interpret and use the information appropriately. | • How to access the register of suppliers through the DH website. |
| 2 | Use record systems to determine:<br>• equipment on rental or loan and rental/loan period that applies;<br>• the responsibilities of the organisation with regard to rental/loan equipment. | • Level of maintenance/repair activity, consumable replacements, decontamination, etc., in equipment in relation to rental/loan equipment. |
| 3 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 3 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |
| 3 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 3 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | commitment to your CPD. | • How continuous personal development can improve personal performance. |

| Module 3 | Medical Device Acquisition, Acceptance Testing and Installation | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is to introduce the student to the medical equipment procurement process from user specification through to safety checking and installation. The student will be able to perform a range of tasks to support the process and will apply the knowledge from the modules 'Medical Engineering in the Clinical Environment' and 'Science and Principles Supporting Medical Engineering'. | | |
| SCOPE | On completion of this module the student will be able to undertake the procurement process from the initial definition of the user specification to the acceptance and installation procedures. They should also be able to perform a range of electrical safety tests and calibration checks. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Observe and undertake the procurement process from working with the user to define the user specification through to the procurement process adhering to trust processes.
2. Complete equipment acceptance procedures and, where appropriate, additional installation procedures for a range of medical devices managed by medical engineering technologists.
3. Perform a range of electrical safety tests and calibration checks and adjustments on medical devices with and without patient applied parts.
4. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

**CLINICAL EXPERIENTIAL LEARNING**

The clinical experiential learning for this module is:

- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Draw up a basic specification detailing the main features required from the equipment. | • **Medical equipment life cycle**<br>• Quality systems:<br>  ○ General requirements, control of documentation, control of records, responsibility, authority and communication, planning of activities and resources, protocols and processes, identification and traceability, analysis and improvement, audit.<br>  ○ Record keeping – applies to all aspects of the equipment life cycle (electronic or paper).<br>  ○ Equipment information, including:<br>  ▪ warranty documents, manuals, certificates of conformity, protocols, safety test records, acceptance test records maintenance and repair records, decontamination records, risk assessments.<br>  ○ Pre-purchase.<br>  ○ Information required to establish the need for the equipment, including the necessary equipment functions.<br>  ○ Key legislation or standards applying to the equipment.<br>  ○ Technical implications and challenges associated with equipment being brought into the clinical environment.<br>  ○ Identification of suitable equipment.<br>  ○ Application of risk management to selection.<br>  ○ Purchase.<br>  ○ Purchasing processes.<br>  ○ Purchasing authority.<br>  ○ Acceptance and safety testing.<br>  ○ Stages of acceptance, visual inspections, electrical safety testing, mechanical safety tests, appropriate test equipment, functional testing, purpose of measurements, performing measurements, assessing results. |
| 1 | Use the available record systems to determine if there is any suitable equipment within the organisation that is available to meet the identified requirement. | |
| 1 | Obtain manufacturer and/or other literature or data to select suitable equipment options for further consideration. | |
| 1 | **For equipment that has a direct electrical patient connection:** interpret, compare and contrast commercial specifications of a medical device to meet the user requirements, explaining why they are or are not appropriate devices to meet the user requirements. | |
| 1 | **For equipment that does not have a direct electrical patient connection:** interpret, compare and contrast commercial specifications of medical device to meet the user requirements and explain why they are or are not appropriate devices. | |
| 1 | Review a pre-purchase questionnaire form and make a | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | judgement on the suitability of the information presented. | • Installation, maintenance, repair, testing, calibration and environmental issues encountered with equipment in a range of clinical environments, including knowledge of the electrical infrastructure, the requirement of uninterruptable power supplies and possible sources of interference and interaction between devices.<br>• Use of record systems.<br>• Manufacturer literature/data relevant to the specific procurement process.<br>• Evidence-based evaluations.<br>• How to critically review data and select equipment options from available data.<br>• Manufacturer and/or other literature or data (including evidence-based evaluations) to select suitable equipment options for further consideration.<br>• Other sources of expert advice.<br>• Reasons why a pre-purchase questionnaire (PPQ) form may or may not be required for a particular purchase.<br>• Differing requirements for devices that have a direct electrical patient connection and those that do not.<br>• Major ongoing costs, e.g. consumables, maintenance, repair, parts (including batteries, probes, etc.).<br>• Manufacturer and/or other literature or data (including evidence-based evaluations) to select suitable equipment options for further consideration.<br>• Other sources of expert advice.<br>• Reasons why a PPQ form may or may not be required for a particular purchase.<br>• Major ongoing costs, e.g. consumables, maintenance, repair, parts |
| 1 | Assess any installation requirements. | |
| 1 | Participate in the procurement of equipment, accessories, or consumables following the procurement procedures, including:<br>• completion of documentation, e.g. requisitions with order codes;<br>• authorisation process;<br>• submission of the order. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | (including batteries, probes, etc.).<br>• Structure and purpose of a PPQ.<br>• Procurement procedures and regulations.<br>• How to complete documentation, including requisitions and the relevant order codes.<br>• Authorisation procedures.<br>• Procedure for processing equipment orders. |
| 2 | Make a risk assessment of the acceptance task. | • Theory of risk assessment using current statutory and professional guidance.<br>• The importance of risk assessing the acceptance task.<br>• How to risk assess the acceptance task for a range of common items of medical equipment. |
| 2 | Examine packaging for damage, and identify, collect and record appropriate information from packaging and delivery notes, comparing it against the initial order. | • The actions to be taken in the event of a package being damaged.<br>• The importance of comparing the delivery note with the initial order. |
| 2 | Unpack equipment in a safe manner and check and confirm all items are as per the delivery note and the original order. | • Relevant health and safety regulations.<br>• The importance of comparing the delivery note with the contents of the package.<br>• Actions to be taken in the event of missing or damaged items. |
| 2 | Examine equipment, cables, accessories and consumables for damage, ensuring the equipment has appropriate markings, e.g. model, serial number, CE mark, electrical type and classification, etc. | • Relevant health and safety regulations.<br>• Type and purpose of markings on new equipment, including CE mark.<br>• Actions to be taken in the event of damaged items, inappropriate CE mark, etc. |
| 2 | Complete acceptance | • The importance of completing acceptance documentation in an |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | documentation, collecting all relevant information for inventory system. | accurate and timely manner. |
| 2 | Where necessary assemble equipment and fit any consumables according to instructions. | • Tests or checks necessary for new equipment.<br>• How to select appropriate test equipment. |
| 2 | Select test equipment and perform any appropriate electrical safety test procedures, following manufacturer or locally agreed SOPs/protocols. | • Relevant SOPs for electrical safety testing.<br>• Relevant protocols procedures for electrical safety testing.<br>• Safety testing of portable medical devices, complex medical devices and systems.<br>• Safety testing fixed installations of complex medical devices and systems. |
| 2 | Perform any appropriate mechanical safety tests procedures, following manufacturer or locally agreed SOPs/protocols. | • Relevant SOPs for mechanical safety testing.<br>• Relevant protocols procedures for mechanical safety testing.<br>• How to perform mechanical safety tests. |
| 2 | Perform any appropriate calibration or set-up procedures, following manufacturer or locally agreed SOPs/protocols. | • Calibration/Quality assurance:<br>  ○ Calibration procedures.<br>  ○ Measurement principles:<br>  ▪ reliability, repeatability, validity, limitations.<br>  ○ Appropriate calibration equipment.<br>• SOP for performing calibration and set-up procedures.<br>• Calibration and set-up procedures. |
| 2 | Perform any appropriate functional tests where necessary, following manufacturer or locally agreed SOPs/protocols. | • The clinical use of a range of medical devices and the common faults or problems that may be experienced.<br>• Safety controls and systems associated with the device operation.<br>• Typical set-up procedures, including limits and alarms, and how |
| 2 | Record clear and unambiguous | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | information, including test results, and log them according to the local SOPs/protocols. | they may affect the practical operation of the equipment.<br>• Installation, maintenance, repair, testing, calibration and environmental issues encountered with equipment in a range of clinical environments, including knowledge of the electrical infrastructure, the requirement for uninterruptable power supplies and possible sources of interference and interaction between devices.<br>• Safety testing of portable medical devices, complex medical devices and systems.<br>• Safety testing fixed installations of complex medical devices and systems.<br>• Principles of wireless technologies applied to clinical engineering applications.<br>• Technical implications and challenges associated with equipment being brought into the clinical environment.<br>• SOPs for equipment storage and installation.<br>• How to perform function tests.<br>• Recording-keeping procedures.<br>• Health and safety procedures, including infection prevention control techniques to the testing procedures.<br>• Local systems to assess operator, technical, service, quality management.<br>• How to undertake a visual inspection of equipment.<br>• Why earth bonding points are or are not appropriate for the test being performed. |
| 2 | Store the equipment and consumables correctly to ensure the equipment remains fit for purpose and ready to use. | |
| 2 | Confirm the suitability of the installation site for the equipment. | |
| 2 | Install the equipment and perform a handover of the equipment into service following acceptance test. | |
| 3 | Select suitable test and simulation equipment. | |
| 3 | Select and apply the appropriate standards and limits for the equipment under test. | |
| 3 | Perform a full range of visual inspections on the equipment. | |
| 3 | Operate a range of test and simulation equipment. | |
| 3 | Operate a portable appliance tester (PAT). | |
| 3 | Operate a medical grade portable appliance tester. | |
| 3 | Make appropriate measurements on equipment with multiple patient connections, demonstrating the effect of multiple earth paths on | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | medical systems and selecting earth bonding points. | |
| 3 | Make safety measurements using discrete test equipment (e.g. voltmeter, ammeter and voltage source) and explain any differences that might occur compared with an automatic PAT tester. | |
| 3 | Where equipment has programmable features, adjust or confirm these with the agreed equipment set-up. | |
| 3 | Using test equipment or other means, check the calibration of the equipment by confirming that the input or output is within the specification. | |
| 3 | Perform any appropriate functional tests where necessary, following manufacturer or locally agreed SOPs/protocols | |
| 4 | Work within their own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary, complying with relevant guidance and laws, to include those relating to:<br>• your scope of practice<br>• probity | • Principles, guidance and law with respect to:<br>○ probity;<br>○ fitness to practise.<br>• The importance of maintaining your own health.<br>• *Good Scientific Practice*. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | • fitness to practise<br>• maintaining your own health. | |
| 4 | Maintain a professional and courteous attitude at all times. | • *Good Scientific P*ractice. |
| 4 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |
| 4 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 4 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 4 | Planned Preventative Maintenance (PPM), Equipment Repairs and Decommissioning of Medical Devices | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is for the student to apply knowledge and gain the work-based skills and experience in PPM and undertaking equipment repairs. Students will also be expected to be able to decommission and dispose of equipment safely. During this specialist work-based module students will be able to apply their learning from the generic, division-theme and specialist modules 'Science and Principles Supporting Medical Engineering' and 'Medical Engineering in the Clinical Environment'. | | |
| SCOPE | On completion of this module the student will be able to perform PPM on a range of medical devices and recognise and correct common artefacts and faults. They should also be able to decommission and dispose of equipment in accordance with local procedures. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Perform PPM procedures on a range of medical devices.*
2. Recognise and identify common artefacts, hazards, interference and faults that are associated with medical devices and suggest and/or perform corrective action.
3. Perform repair procedures on a range of medical devices.*
4. Decommission and dispose of equipment in a safe and appropriate manner, according to local procedures.
5. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

**The range of medical devices may include, but is not limited to, anaesthetic and ventilation equipment, blood pressure monitors, defibrillators, gas analysis and monitoring equipment, multiparameter monitors, single or multiparameter display equipment, electrocardiogram machines or other recording equipment, infusion devices, pulse oximeters and temperature measuring equipment.*

**CLINICAL EXPERIENTIAL LEARNING**

The clinical experiential learning for this module is:

- Participate in the PPM arrangements for a medical device on the medical device information system, e.g. in-house maintained, on external service contract, loan devices, etc., and select a range of devices to follow this process through.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Prepare and organise for PPM, estimating the time and resources needed and assessing the potential impact on clinical service delivery. | • Calibration/Quality assurance:<br>  ○ Calibration procedures.<br>  ○ Measurement principles:<br>  ▪ reliability, repeatability, validity, limitations.<br>  ○ Appropriate calibration equipment.<br>• The clinical use of a range of medical devices and the common faults or problems that may be experienced.<br>• Safety controls and systems associated with the device operation.<br>• Typical set-up procedures, including limits and alarms, and how they may affect the practical operation of the equipment.<br>• Installation, maintenance, repair, testing, calibration and environmental issues encountered with equipment in a range of clinical environments, including knowledge of the electrical infrastructure, the requirement of uninterruptable power supplies and possible sources of interference and interaction between devices.<br>• Safety testing of portable medical devices, complex medical devices and systems.<br>• Safety testing fixed installations of complex medical devices and systems.<br>• Principles of wireless technologies applied to clinical engineering applications.<br>• Technical implications and challenges associated with equipment being brought into the clinical environment.<br>• Working with third-party service providers.<br>• Practical risks associated with medical devices in clinical settings.<br>• Relevant SOPs.<br>• Relevant technical documentation required.<br>• The relevant and accurate information needed from other healthcare |
| 1 | Interpret and follow the technical documentation in order to perform PPM successfully. | |
| 1 | Review literature and service record to ensure there are no field service or central alerting system notices outstanding for the equipment. | |
| 1 | Identify, remove and refit or renew consumables as necessary when performing a PPM, adhering to infection prevention control techniques. | |
| 1 | Select correct tools and test equipment and perform PPM following the appropriate protocol for the equipment under test, where necessary dismantling and reassembling the equipment to module/component level. | |
| 1 | Identify the equipment component parts, indicating their purpose, and adjust the settings to those previously agreed necessary for use in the clinical setting. | |
| 1 | Perform any appropriate electrical | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | or mechanical safety testing procedures. | staff, carers and patients before undertaking PPM.<br>• Communication skills for obtaining necessary information.<br>• Working with third-party service providers, including contractual agreements, monitoring, auditing.<br>• How to locate field service or central alerting system notices.<br>• Infection control measures during PPM for each item of equipment.<br>• How to identify any anomalies, errors, or malfunctions, and the appropriate action to be taken to correct these, or how to put in place arrangements to have them corrected.<br>• How to identify the component parts of the equipment.<br>• The purpose of the component parts.<br>• How to determine the settings for each clinical use. |
| 1 | Perform any appropriate functional tests where necessary, following manufacturer or locally agreed SOPs. | |
| 1 | Record clear and unambiguous information relating to the PPM, using both written and electronic information processes and systems. | |
| 1 | Store equipment and consumables correctly to ensure the equipment and consumables remain fit for purpose and ready for use. | |
| 1 | Perform handover of equipment back into clinical service. | |
| 2 | Identify possible sources of interference on a range of equipment/situations and the methods used to prevent them, including:<br>• multiparameter monitors or writers (e.g. ECG monitor or recorder);<br>• the effect of poor electrode connections or application;<br>• effect of interference due to cable placement;<br>• poor transducer placement or | • Propagation of electrical signals in the human body.<br>• Effects of electrical current on the human body.<br>• Biomedical signals frequency and bandwidth.<br>• For a range of commonly measured physiological signals, understand the origin, nature, transmission and characteristics of the signal, including the magnitude and normal frequency range:<br>○ electrical origin (electrocardiogram [ECG], electromyogram [EMG], electroencephalogram [EEG], evoked responses, etc.);<br>○ non-electrical in origin (blood pressure, temperature, oxygen saturation, etc.).<br>• The clinical use of a range of medical devices and the common faults or problems that may be experienced.<br>• Basic principles and technology employed in a range of commonly used |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | interface (e.g. $SpO_2$ monitor, temperature sensors, automatic blood pressure devices);<br>• hazards associated with infusion devices (e.g. siphonage, free flow, occlusion, mechanical backlash, air in line, tampering, incorrect software set-up, incorrect consumables);<br>• poor user maintenance (e.g. battery (life, connections, installation), contamination (e.g. suction devices, tympanic sensors);<br>• patient movement. | transducers.<br>• Factors influencing the selection of appropriate transducers.<br>• Interactions between equipment in the clinical environment.<br>• Sources of interference on a range of clinical equipment.<br>• How to minimise and/or prevent interference in a range of clinical equipment/clinical situations. |
| 2 | Identify potential cable faults (including patient cables). | • Identification of common cable faults and how/when to repair/replace cables. |
| 3 | Prepare and organise prior to undertaking equipment repairs, identifying the fault and judging whether the fault can be found in situ or if the equipment needs to be moved. | • Relevant SOPs.<br>• Relevant technical documentation required.<br>• Use of troubleshooting guide to determine faults and error codes to determine equipment faults.<br>• The relevant and accurate information needed from other healthcare staff, carers and patients before undertaking PPM.<br>• Communication skills for obtaining necessary information.<br>• Time and resources needed to complete the task.<br>• Impact on the clinical service. |
| 3 | Identify potential risks to making a repair and estimate the time and | • How to risk assess equipment repairs.<br>• Factors to consider in assessing the potential impact of a repair on |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | resources needed to complete the repair. | clinical service delivery. |
| 3 | Identify and access relevant technical documentation, including the appropriate repair SOPs. | • Technical documentation, including the appropriate repair SOPs. |
| 3 | Identify access and interpret the appropriate literature and technical documentation and ensure there are not outstanding equipment notices in place. | • Technical documentation, including the appropriate repair SOPs, literature and previous service information.<br>• How to identify source of field service notices and central alerting system notices. |
| 3 | Select correct tools, test equipment and perform the repair, where necessary dismantling and reassembling the equipment to module/component level. | • The clinical use of a range of medical devices and the common faults or problems that may be experienced.<br>• Safety controls and systems associated with the device operation.<br>• Typical set-up procedures, including limits and alarms, and how they may affect the practical operation of the equipment.<br>• Installation, maintenance, repair, testing, calibration and environmental issues encountered with equipment in a range of clinical environments, including knowledge of the electrical infrastructure, the requirement of uninterruptable power supplies and possible sources of interference and interaction between devices.<br>• Safety testing of portable medical devices, complex medical devices and systems.<br>• Safety testing fixed installations of complex medical devices and systems.<br>• Principles of wireless technologies applied to clinical engineering applications<br>• Technical implications and challenges associated with equipment being brought into the clinical environment. |
| 3 | Identify/confirm equipment fault using fault-finding methodology. | |
| 3 | Identify, remove and refit or renew consumables as necessary when performing a repair. | |
| 3 | Identify the component parts of the equipment, indicating their purpose. | |
| 3 | Perform any appropriate electrical or mechanical safety testing procedures. | |
| 3 | Adjust the equipment settings to those previously agreed necessary for the clinical setting in which it is to be used. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 3 | Perform any appropriate functional tests. | • Working with third-party service providers<br>• Practical risks associated with medical devices in clinical settings.<br>• Infection control measures and the importance of adhering to infection prevention control techniques. |
| 3 | Record clear and unambiguous information relating to the repair using written and/or electronic information processes and systems, including initial fault description, actions taken, parts used, etc. | • Standards for record keeping for written and electronic systems. |
| 3 | Perform handover of equipment back into clinical service. | • SOPs. |
| 4 | Prepare and organise for decommissioning and disposal. | • Decommissioning and disposal:<br>  ○ decommissioning protocols;<br>  ○ legislation;<br>  ○ waste management:<br>  ▪ special waste, clinical waste, radioactive waste, waste electrical and electronic equipment, restriction of hazardous substances (RoHS).<br>• Disabling equipment.<br>• Removal/disposal of data and data storage.<br>• Importance of documentation.<br>• Relevant SOPs.<br>• Relevant technical documentation required.<br>• Time and resources needed to complete the task.<br>• Impact on the clinical service.<br>• The relevant and accurate information needed from other healthcare staff, carers and patients before undertaking PPM. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | • Communication skills for obtaining necessary information. |
| 4 | Perform an initial risk assessment to identify any potential risks and determine the type of disposal that needs to be followed and the regulations that apply. | • Theory of risk assessment using current statutory and professional guidance.<br>• How to perform an initial risk assessment.<br>• Potential risks from a range of clinical equipment and how to deal with each one. |
| 4 | Identify routes of disposal and obtain authorisation for disposal. | • Time and resources and cost implications associated with the disposal process.<br>• Correct tools and equipment required to perform the disposal. |
| 4 | Decontaminate equipment or if decontamination is not possible ensure correct local procedures/protocols are followed. | • When to remove equipment from clinical area.<br>• Decontamination techniques.<br>• Infection control procedures. |
| 4 | Remove/purge all data, especially confidential or identifiable data, from the equipment and disable equipment. | • Local procedures/protocols for removing data so that it cannot be recovered.<br>• Local procedures/protocols for disabling equipment. |
| 4 | Record clear and unambiguous information relating to the disposal and remove any unnecessary equipment documentation. | • How to use written and/or electronic information processes and systems for record keeping.<br>• Local procedures/protocols for removing equipment documentation. |
| 5 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 5 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 5 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 5 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 5 | Equipment Design and Safe Use in Medical Engineering | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| **AIM** | The aim of this module is for the student to build a simple electronic device and teach others how to use equipment safely and appropriately in a clinical environment. During this specialist work-based module students will be expected to apply their learning from the generic, division-theme and specialist academic modules, including 'Science and Principles Supporting Medical Engineering' and 'Medical Engineering in the Clinical Environment'. | | |
| **SCOPE** | On completion of this module the student will be able to specify, design and build a simple electronic device and teach other healthcare professionals how to operate a range of simple medical devices safely in a clinical environment. They should be able to perform a range of risk assessments and tasks within the equipment management life cycle. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Specify, design and build a simple electronic device using appropriate test and development equipment, with reference to the relevant standards.
2. Teaching/training healthcare staff how to operate equipment, use accessories and store a number of simple medical devices.
3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

## CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Specify, design and build a simple electronic device using appropriate test and development equipment, with reference to the relevant standards
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Produce a document outlining the specifications for a simple electronic device (including power requirements, inputs, outputs and physical requirements). | • Basic electronics and mechanics.<br>• Quality management systems relating to medical devices and systems design.<br>• Safety requirements for programmable medical electrical systems:<br>  ○ risk concepts relating to software-controlled devices.<br>• Specifications:<br>  ○ establishing a user specification;<br>  ○ establishing a technical and environmental specification.<br>• Determining applicable standards and legislation.<br>• Design evaluation:<br>  ○ analysing designs;<br>  ○ failure modes and effects analysis.<br>• Design, manufacture, testing and documentation:<br>  ○ design techniques, including for electromagnetic compatibility (EMC);<br>  ○ computer-aided design tools;<br>  ○ prototyping, simulating, experimentation, modelling;<br>  ○ use of advanced test equipment;<br>  ○ engineering drawings;<br>  ○ printed circuit manufacture;<br>  ○ constructional issues:<br>  ▪ materials, components ,wiring, physical layout;<br>  ○ EMC testing;<br>  ○ type testing;<br>  ○ functional calibration and safety testing;<br>  ○ design verification and validation testing.<br>• Appropriate mathematical methods that can be used to analyse design:<br>  ○ systematic methodology that can be applied to solve problems in design: |
| 1 | Use a computer-aided design package to design the electronic circuit and use software simulation or hardware development system to refine the design and confirm the circuit works as specified. | |
| 1 | Use a computer-aided design package to design the printed circuit board layout for the electronic circuit. | |
| 1 | Manufacture and populate the printed circuit board using appropriate tools, materials and local facilities. | |
| 1 | Produce a bill of materials and obtain parts required. | |
| 1 | Select appropriate test equipment and use suitable tests to confirm the device functions are as required and to the specification written. | |
| 1 | Design and manufacture a suitable enclosure with the use of drawing packages and mechanical workshop tools (assistance in the manufacture | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | may be required where specialist mechanical equipment is required). | ▪ application of basic principles and tools used in analysis of design;<br>▪ systematic analysis of design;<br>○ documentation:<br>▪ specification, operational manual, technical file, test documents.<br>• Circuit analysis:<br>○ appropriate mathematical methods that can be used to analyse circuit behaviour and describe electrical signals;<br>○ systematic methodology that can be applied to solve problems in circuit design;<br>○ application of electronic principles and tools used in analysis of circuits;<br>○ systematic analysis of analogue circuit design;<br>○ systematic analysis of digital circuit design.<br>• How to produce a specification for a simple electronic device.<br>• Health and safety issues that must be addressed when producing an electronic device.<br>• How to use a computer-aided design package to design electronic circuits.<br>• How to use software simulation or a hardware development system to refine designs and confirm the circuit works as specified.<br>• How to use a computer-aided design package to design a printed circuit board layout for the electronic circuit.<br>• How to manufacture and populate a printed circuit board and the health and safety issues that must be addressed.<br>• Requirements for a bill of materials.<br>• How to select appropriate test equipment.<br>• How to select the correct tests to confirm the device functions are as required and to the specification written. |
| 1 | Check the device conforms to the relevant standards previously identified. | |
| 1 | Produce a complete set of documentation (including specification, design, construction details, test documentation, bill of materials, etc.). | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | • How to design and manufacture a suitable enclosure using drawing packages and mechanical workshop tools.<br>• Health and safety considerations for design and manufacture.<br>• Standards to be adhered to.<br>• How to check the device conforms to the relevant standards.<br>• Requirements for compiling documentation.<br>• Record-keeping processes. |
| 2 | Teach a range of healthcare staff how to use, operate and store a number of simple medical devices. | • Planning a teaching session.<br>• Communication skills, including explaining, describing and instructing.<br>• The basic function and operation of the equipment, including the replacement of any consumables.<br>• User maintenance SOPs.<br>• How to present material effectively through reports or presentations.<br>• Safety controls and systems associated with the device operation.<br>• Typical set-up procedures, including limits and alarms, and how they may affect the practical operation of the equipment.<br>• How to evaluate a teaching session. |
| 2 | Review the suitability of user maintenance SOPs/protocols. | • User maintenance SOPs/protocols.<br>• How to critically review documents. |
| 2 | Reflect on learning from training programmes and summarise and report on key learning. | • Models of reflection.<br>• Critical reflection. |
| 3 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 3 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | restricted access. | |
| 3 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 3 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

## SECTION 13: WORK-BASED SYLLABUS: RADIATION ENGINEERING

This section describes the Learning Framework for the **Specialist Component** of work-based learning covering the Learning Outcomes, Clinical Experiential Learning, Competence, and Applied Knowledge and Understanding.

| | |
|---|---|
| **DIVISION** | Physical Sciences |
| **THEME** | Clinical Engineering |
| **SPECIALISM** | **Radiation Engineering** |

| Module 1 | Safe Working Practice in Radiation Engineering | COMPONENT | Specialist<br>Years 2 and 3 |
|---|---|---|---|
| **AIM** | The aim of this module is to ensure the student is able to work safely in the radiation engineering environment, with the emphasis on health and safety, risk management, risk assessment and responding to radiation equipment-related incidents. During this specialist work-based module students will be expected to apply their learning from the generic, division-theme and specialist academic modules, including the specialist modules 'Science and Principles supporting Radiation Engineering' and 'Radiation Engineering in the Clinical Environment'. | | |
| **SCOPE** | On completion of this module the student will be able to work safely in the radiation engineering environment. They should be able to perform a range of risk assessments and tasks within the equipment management life cycle. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Observe and assist radiation engineers in a range of environments, including diagnostic X-ray rooms and radiotherapy treatment rooms, adhering to safety restrictions and regulations.
2. Perform health and safety risk assessments in accordance with SOPs.
3. Produce and critically review a radiation equipment incident report applying the relevant processes and procedures.
4. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

## CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Observe the work undertaken in a range of clinical areas where radiation is used, for example X-ray, cardiac catheterisation and imaging, and discuss the role of radiation engineering as part of the team providing diagnostic procedures and treatment to patients.
- Participate in, or review the investigation of a radiation incident and discuss the causes and the learning from this that may help prevent a recurrence of the incident.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Observe and assist radiation engineers, adhering to the safety restrictions that apply to a range of radiation equipment and environments. | • Relevant health and safety legislation and local policy in all work environments, including:<br>  ○ local rules for work with ionising radiation within the X-ray department;<br>  ○ local rules for work with ionising radiation within the radiotherapy department;<br>  ○ Ionising Radiation Regulations;<br>  ○ Ionising Radiation (Medical Exposure) Regulations.<br>• The restrictions that apply in controlled areas and the importance of these restrictions.<br>• Roles and responsibilities of staff, including the radiation protection advisor (RPA) and radiation protection supervisor (RPS).<br>• Hospital organisation of radiological protection; radiation safety policies and local rules.<br>• The potential hazards and risks in diagnostic X-ray rooms.<br>• The relevant safety features in diagnostic X-ray rooms.<br>• The potential hazards and risks in radiotherapy treatment rooms.<br>• The relevant safety features in radiotherapy treatment rooms.<br>• Basic environmental requirements needed to support ionising radiation imaging and treatments, e.g. room design, shielding, interlocks. |
| 2 | Perform health and safety risk assessments in radiation safety in accordance with local procedures. | • Theory of risk assessment using current statutory and professional guidance. |
| 3 | Communicate effectively with equipment user and scientific staff in the event of radiation equipment-related incidents. | • Effective communication skills, including listening, describing, explaining.<br>• The local and national regulatory incident identification and escalation process. |
| 3 | Perform equipment risk | • Diagnostic radiology equipment and techniques. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | assessments in accordance with local procedures. | • Radiotherapy equipment and techniques.<br>• Theory of risk assessment using current statutory and professional guidance. |
| 3 | Complete an incident report in accordance with local procedures. | • Incident reporting process.<br>• The local and national regulatory incident identification and escalation process.<br>• The process of equipment related indent reporting to MHRA and equipment manufacturers.<br>• The process of equipment-related warning notice distribution.<br>• The role of a RPS with regard to a radiation-related incident.<br>• Roles and responsibilities of staff, including the RPA and RPS.<br>• Hospital organisation of radiological protection; radiation safety policies and local rules. |
| 3 | Critically review a full incident report. | |
| 3 | Maintain detailed, accurate and timely equipment records and documentation. | • Requirements for accurate record keeping. |
| 4 | Work within their own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary, complying with relevant guidance and laws, to include those relating to:<br>• your scope of practice<br>• probity<br>• fitness to practise<br>• maintaining your own health. | • Principles, guidance and law with respect to:<br>○ *Good Scientific Practice*<br>○ probity<br>○ fitness to practise.<br>• The importance of maintaining your own health. |
| 4 | Follow data protection policy and local procedures to maintain data | • Principles, guidance and law with respect to:<br>○ confidentiality |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | records and confidentiality. | ○ information governance<br>○ informed consent<br>○ probity<br>○ fitness to practise.<br>• The importance of maintaining your own health. |
| 4 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 4 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |
| 4 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 4 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 2 | Radiation Equipment Management, Calibration, Quality Systems and Processes | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is to introduce the student to equipment management and quality management systems and their use in the medical engineering environment to manage the range of equipment used within a healthcare setting. During this specialist work-based module students will be expected to apply their learning from the generic, division-theme and specialist academic modules, including 'Science and Principles supporting Radiation Engineering' and 'Radiation Engineering in the Clinical Environment'. | | |
| SCOPE | On completion of this module the student will be able to operate equipment management and quality management systems, including the management of rental and loan equipment. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Perform radiation equipment management procedures in accordance with SOPs.
2. Operate diagnostic X-ray equipment, CT scanners and radiotherapy treatment equipment, performing radiation equipment calibration and equipment quality assurance/control processes in accordance with SOPs.
3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

**CLINICAL EXPERIENTIAL LEARNING**

The clinical experiential learning for this module is:

- Participate in the quality assurance/control processes for diagnostic X-ray equipment, CT scanners and radiotherapy treatment equipment.
- Participate in the selection, calibration and quality assurance of test equipment used to perform radiation measurements in diagnostics X-ray and radiotherapy.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Communicate effectively with a range of service users, including:<br>• equipment user before, during and after maintenance operations;<br>• scientific staff in relation to maintenance operations;<br>• equipment manufacturers and their service engineers. | • Effective communication skills, including listening, describing, explaining.<br>• Working with third-party service providers:<br>○ contractual agreements;<br>○ monitoring;<br>○ auditing. |
| 1 | Assist in the monitoring and supervision of contractor activity in accordance with local management systems, complying with local instructions and procedures. | • How to locate relevant guidelines.<br>• Local management systems.<br>• Local instructions and procedures.<br>• Relevant national guidelines, standards and legislation.<br>• The relevance of the EU medical devices directive and CE marking. |
| 1 | Liaise with technical support organisations to resolve equipment-related issues. | • Effective communication skills, including listening, describing, explaining.<br>• Working with third-party service providers:<br>○ contractual agreements;<br>○ monitoring;<br>○ auditing.<br>• SOPs for equipment handover.<br>• Relevant national guidelines, standards and legislation. |
| 1 | Assist in the liaison process with external contractors to arrange visits and review work plans, and perform an external contractor induction. | |
| 1 | Undertake appropriate handover procedures. | |
| 1 | Participate in management system audit and corrective action activity. | • Quality systems:<br>○ general requirements, control of documentation, control of records, responsibility, authority and communication, planning of activities and resources, protocols and processes, identification and traceability, analysis and improvement, audit;<br>○ record keeping – applies to all aspects of the equipment life cycle |
| 1 | Complete detailed, accurate and timely equipment records and documentation in accordance with radiation equipment management | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | procedures. | (electronic or paper);<br>○ equipment information, including:<br>▪ warranty documents, manuals, certificates of conformity, protocols, safety test records, acceptance test records maintenance and repair records, decontamination records, risk assessments. |
| 2 | Communicate effectively with users of diagnostic and radiation equipment, including scientific staff before, during and after planned preventative maintenance operations. | • Effective communication skills, including listening, describing, explaining. |
| 2 | Operate diagnostic X-ray equipment and perform user checks. | • Diagnostic radiology techniques:<br>○ diagnostic radiography;<br>○ fluoroscopy: over-couch and under-couch system fluorography;<br>○ CT;<br>○ digital systems (radiography, subtraction and enhancement techniques);<br>○ mobile units, dental units, dental panoramic tomography, cephalometry;<br>○ mammography;<br>○ room layouts, control cubicles, shielding;<br>○ primary beam, scatter, leakage;<br>○ image processes;<br>○ factors affecting patient dose.<br>• SOPs, local management systems, local instructions and procedures.<br>• Relevant national guidelines, standards and legislation.<br>• Principles that underpin the operation of radiation imaging equipment.<br>• Operation of imaging equipment: |
| 2 | Operate CT scanners and perform user checks. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | ○ diagnostic X-ray equipment;<br>○ simulators;<br>○ CT.<br>• Machine procedures:<br>○ start, run-up and shut-down procedures;<br>○ maintenance and fault-finding protocols and procedures;<br>○ calibration;<br>○ safety testing. |
| 2 | Undertake quality assurance tasks, following specified procedures on a CT scanner. | • Quality assurance of CT scanners.<br>• Dosimetry:<br>○ instrument types, range of probes;<br>○ survey meters;<br>○ ionisation chambers, Geiger counters, scintillation counters, dose and dose rate meters;<br>○ diagnostic X-ray quality assurance (QA) instruments for tube output and kiloVoltage (kV).<br>• Practical use and applications of instruments:<br>○ primary standards and national system;<br>○ calibration of instruments against secondary standards;<br>○ checking instruments for consistency, comparison and accuracy;<br>○ storage;<br>○ SOPs, local management systems, local instructions and procedures;<br>○ relevant national guidelines, standards and legislation;<br>○ principles that underpin the operation of radiation imaging equipment. |
| 2 | Operate radiotherapy treatment equipment and perform equipment run-up and user checks. | • Radiotherapy treatment:<br>○ room design, shielding; |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 2 | Assist in the dosimetric calibration of radiation equipment. | ○ linear accelerators, technology applications to treatment:<br>▪ X-ray beam therapy, electron beam therapy, intensity modulated radiotherapy (IMRT), image guided radiotherapy (IGRT), proton therapy, arc therapy, tomotherapy hybrid systems (combined imaging and treatment machines);<br>○ superficial therapy;<br>○ beam generation, energy and delivery.<br>• Operation of linear accelerator technology:<br>○ beam generation:<br>▪ flatness, focusing, symmetry, energy, dose rate and dose accuracy, alignment;<br>○ waveguide;<br>○ radiofrequency (RF) system;<br>○ cooling systems;<br>○ high tension systems;<br>○ vacuum systems;<br>○ interlocks systems and how they affect the operation of the equipment;<br>○ control systems applied to the operation of radiation equipment.<br>• Operation and use of:<br>○ laser centering systems;<br>○ multi-leaf collimation (MLC);<br>○ wedges;<br>○ image generation equipment.<br>• Computer systems used in diagnostics and treatment:<br>○ principles of operation;<br>○ importance in the modern radiotherapy departments;<br>○ patient verification systems.<br>• Operation of superficial treatment. |
| 2 | Perform movement readout calibration procedures. | |
| 2 | Check the characteristics of the ionising radiation beam using appropriate beam measuring equipment. | |
| 2 | Check the optical and radiation alignment of the radiation beam. | |
| 2 | Undertake quality assurance tasks, following specified procedures on a linear accelerator. | |
| 2 | Carry out adjustments to beam parameters on linear accelerators. | |
| 2 | Following maintenance activity, confirm that equipment is operating within expected performance and safety parameters. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | • SOPs, local management systems, local instructions and procedures.<br>• Relevant national guidelines, standards and legislation.<br>• Radiotherapy treatment.<br>• Dosimetry:<br>  ○ instrument types, range of probes;<br>  ○ survey meters;<br>  ○ ionisation chambers, Geiger counters, scintillation counters, dose and dose rate meters;<br>  ○ radiotherapy QA instruments.<br>• Practical use and applications of instruments:<br>  ○ primary standards and national system;<br>  ○ calibration of instruments against secondary standards;<br>  ○ checking instruments for consistency, comparison and accuracy;<br>  ○ storage. |
| 2 | Carry out appropriate handover procedures before and after completing planned preventative maintenance. | • Working with third-party service providers:<br>  ○ contractual agreements;<br>  ○ monitoring;<br>  ○ auditing.<br>• SOPs for equipment handover.<br>• Relevant national guidelines, standards and legislation. |
| 2 | Maintain detailed, accurate and timely equipment records and documentation. | • Requirements for accurate record keeping. |
| 3 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 3 | Follow the dress and behaviour code, applying any additional requirements when | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | entering/working in controlled areas or areas of restricted access. | |
| 3 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 3 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 3 | Radiation Equipment Acquisition, Installation and Commissioning | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is to introduce the student to the radiation equipment procurement process from user specification through to safety checking and installation. The student will be able to perform a range of tasks to support the process and will apply the knowledge from the modules 'Science and Principles supporting Radiation Engineering' and 'Radiation Engineering in the Clinical Environment'. | | |
| SCOPE | On completion of this module the student will be able to undertake the procurement process from the initial definition of the user specification to the acceptance and installation procedures. They should also have the opportunity to assist senior staff in the installation, commissioning and introduction of radiation equipment into service. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Interpret a specification for radiation equipment and its associated accessories or parts and explain the procurement processes in accordance with SOPs.
2. Assist in the installation, commissioning and bringing into service radiation equipment in accordance with SOPs.
3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

## CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Review the specification for radiation equipment and its associated accessories or parts.
- Assist in the installation, commissioning and bringing into service of radiation equipment in accordance with SOPs.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Critically evaluate the specification of a diagnostic X-ray and radiotherapy installation to meet user and service requirements. | • **Medical equipment life cycle**<br>• Pre-purchase:<br>  ○ assessment of need;<br>  ○ defining or evaluation of specification;<br>  ○ relevant standards;<br>  ○ compliance with legislation;<br>  ○ identification of suitable equipment;<br>  ○ application of risk management to selection.<br>• Purchase:<br>  ○ purchasing processes;<br>  ○ purchasing authority.<br>• Acceptance and safety testing:<br>  ○ stages of acceptance, visual inspections, electrical safety testing, mechanical safety tests, appropriate test equipment, functional testing, purpose of measurements, performing measurements, assessing results.<br>• Room design and shielding for diagnostic X-ray and radiotherapy installation.<br>• Operation, parts and accessories for diagnostic X-ray and radiotherapy equipment.<br>• Local management systems, instructions and procedures.<br>• Relevant national guidelines, standards and legislation.<br>• Principles supporting the selection of radiation equipment and related accessories that ensure they are fit for purpose.<br>• Role of a RPA in relation to room design.<br>• Review the application of new and impending technology and techniques. |
| 1 | Critically review assessment of need and equipment evaluation documentation in relation to equipment or accessory procurement. | |
| 1 | Critically review radiation equipment room design documentation. | |
| 1 | Perform user maintenance on a | • Practical use and applications of instruments: |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | range of equipment used in the medical physics department. | ○ primary standards and national system;<br>○ calibration of instruments against secondary standards;<br>○ checking instruments for consistency, comparison and accuracy;<br>○ storage.<br>• The maintenance requirements of a range of equipment used in the department.<br>• The procedure to obtain local or manufacturer assistance in maintenance or repair. |
| 1 | Participate in the procurement of equipment parts. | • Local management systems, instructions and procedures.<br>• Relevant national guidelines, standards and legislation. |
| 2 | Participate in acceptance testing and commissioning of diagnostic X-ray and radiotherapy treatment equipment, selecting and using appropriate test and measurement equipment. | • Acceptance testing procedures for diagnostic X-ray and radiotherapy equipment.<br>• Local management systems, instructions and procedures.<br>• Relevant national guidelines, standards and legislation.<br>• Which information is required prior to equipment being brought into service, including accessories, ancillary devices, instruction manuals and service manuals.<br>• How to confirm equipment is operating within expected configuration, performance and safety parameters.<br>• Processes involved with delivering, installing and bringing equipment into clinical use.<br>• Selection of test equipment and phantoms.<br>• Calibration of test equipment.<br>• Reporting test results. |
| 2 | Assist in a radiation protection survey. | • Selection of survey meters.<br>• Calibration of survey meters.<br>• Acceptable levels of radiation dose in controlled, supervised and public areas. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | • Reporting survey results.<br>• Local management systems, instructions and procedures.<br>• Relevant national guidelines, standards and legislation. |
| 2 | Participate in the critical examination of a new device, including any associated accessories or systems, to ensure that it is safe and fit for purpose. | • Local management systems, instructions and procedures.<br>• Relevant national guidelines, standards and legislation. |
| 2 | Communicate effectively with equipment users and scientific staff. | • Effective communication skills including listening, describing, explaining. |
| 2 | Maintain detailed, accurate and timely equipment records and documentation. | • Requirements for accurate record keeping. |
| 2 | Register equipment assets in appropriate asset management system. | • How to use the equipment asset register.<br>• The importance of maintaining an equipment asset register to the department, trust and NHS. |
| 3 | Work within their own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary and complying with relevant guidance and laws, to include those relating to:<br>• your scope of practice<br>• probity<br>• fitness to practise<br>• maintaining your own health. | • Principles, guidance and law with respect to:<br>○ probity;<br>○ fitness to practise;<br>○ the importance of maintaining your own health.<br>• *Good Scientific Practice*. |
| 3 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 3 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |
| 3 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 3 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 4 | Planned Preventative Maintenance (PPM), Equipment Repairs and Decommissioning of Radiation Equipment | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is for the student to apply knowledge and gain work-based skills and experience in planned preventative maintenance and undertaking equipment repairs. Students will also be expected to be able to decommission and dispose of equipment safely. During this specialist work-based module students will be expected to apply their learning from the generic, division-theme and specialist academic modules, including the 'Science and Principles supporting Radiation Engineering' and 'Radiation Engineering in the Clinical Environment'. | | |
| SCOPE | On completion of this module the student will be able to perform PPM on radiation equipment and be able to rectify equipment breakdowns working to SOPs. They should also be able to assist in the decommissioning and disposal of equipment in accordance with local procedures. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Perform planned maintenance procedures, equipment modification activities and control checks and adjustments on radiation equipment in accordance with SOPs.
2. Investigate and rectify a radiation equipment breakdown in accordance with SOPs.
3. Assist in the decommissioning and disposal of equipment in accordance with relevant legislation, regulations and guidance.
4. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

*Note: Although the competencies for learning outcomes 1 and 2 appear similar, they should be dealt with separately. It is important to recognise that the approach to radiation equipment planned maintenance and planned equipment modification is usually different to that when carrying out unplanned equipment fault finding and repair in a breakdown scenario.*

**CLINICAL EXPERIENTIAL LEARNING**

The clinical experiential learning for this module is:

- Illustrate the PPM arrangements for an item of radiation equipment on the medical device information system, e.g. in-house maintained, on external service contract, loan devices, etc., and select one piece of equipment to follow this process through.
- Attend a multiprofessional meeting where clinical audit, research, or innovation is presented and consider how audit, research and innovation contribute to service improvements.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Communicate effectively with the equipment user and scientific staff before, during and after PPM operations. | • Effective communication skills, including listening, describing, explaining. |
| 1 | With respect to radiation equipment prepare appropriate work plans, organising time effectively for:<br>• planned maintenance procedures;<br>• equipment modification activities;<br>• control checks and adjustments. | • Local management systems, complying with local instructions and procedures.<br>• Relevant national guidelines, standards and legislation. |
| 1 | Assess health and safety risks associated with work activity and apply appropriate control. | • Local management systems, complying with local instructions and procedures.<br>• Relevant national guidelines, standards and legislation. |
| 1 | Perform planned maintenance procedures. | • Diagnostic radiology techniques:<br>○ diagnostic radiography;<br>○ fluoroscopy: over-couch and under-couch system, fluorography;<br>○ CT;<br>○ digital systems (radiography, subtraction and enhancement techniques);<br>○ mobile units, dental units, dental panoramic tomography, cephalometry;<br>○ mammography;<br>○ room layouts, control cubicles, shielding;<br>○ primary beam, scatter, leakage;<br>○ image processes;<br>○ factors affecting patient dose.<br>• SOPs, local management systems, local instructions and procedures.<br>• Relevant national guidelines, standards and legislation. |
| 1 | Perform equipment modification activities. | |
| 1 | Perform control checks and adjustments on radiation equipment. | |
| 1 | Interpret technical documentation and drawings. | |
| 1 | Dismantle and assemble systems safely, demonstrating appropriate standards of | |
| 1 | Work on high-voltage systems safely, demonstrating appropriate standards of workmanship. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Work with electromechanical systems safely, demonstrating appropriate standards of workmanship. | • Principles that underpin the operation of radiation imaging equipment.<br>• Operation of imaging equipment:<br>  ○ diagnostic X-ray equipment;<br>  ○ simulators;<br>  ○ CT.<br>• Machine procedures:<br>  ○ start, run-up and shut-down procedures;<br>  ○ maintenance and fault-finding protocols and procedures;<br>  ○ calibration;<br>  ○ safety testing.<br>• Radiotherapy treatment:<br>  ○ room design, shielding;<br>  ○ linear accelerators, technology applications to treatment:<br>  ▪ X-ray beam therapy, electron beam therapy, IMRT, IGRT, proton therapy, arc therapy, tomotherapy hybrid systems (combined imaging and treatment machines).<br>• Superficial therapy.<br>• Beam generation, energy and delivery.<br>• Operation of linear accelerator technology:<br>  ○ beam generation:<br>  ▪ flatness, focusing, symmetry, energy, dose rate and dose accuracy, alignment;<br>  ○ waveguide;<br>  ○ RF system;<br>  ○ cooling systems;<br>  ○ HT systems;<br>  ○ vacuum systems;<br>  ○ interlocks systems and how they affect the operation of the equipment; |
| 1 | Carry out appropriate handover procedures before and after completing PPM. | |
| 1 | Verify the correct functioning of safety and operational interlock systems. | |
| 1 | Identify issues that will affect the clinical performance of the equipment and follow procedures to ensure appropriate quality assurance occurs. | |
| 1 | Comply with local decontamination procedures. | |
| 1 | Maintain detailed, accurate and timely equipment records and documentation. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | ○ control systems applied to the operation of radiation equipment.<br>• Operation and use of:<br>○ laser-centering systems;<br>○ MLC;<br>○ wedges;<br>○ image generation equipment.<br>• Computer systems used in diagnostics and treatment:<br>○ principles of operation;<br>○ importance in the modern radiotherapy department;<br>○ patient verification systems.<br>• Operation of superficial treatment.<br>• SOPs, local management systems, local instructions and procedures.<br>• Relevant national guidelines, standards and legislation.<br>• Radiotherapy treatment.<br>• Dosimetry:<br>○ instrument types, range of probes;<br>○ survey meters;<br>○ ionisation chambers, Geiger counters, scintillation counters, dose and dose rate meters;<br>○ radiotherapy QA instruments.<br>• Practical use and applications of instruments:<br>○ primary standards and national system;<br>○ calibration of instruments against secondary standards;<br>○ checking instruments for consistency, comparison and accuracy;<br>○ storage.<br>• Local management systems, complying with local instructions and procedures.<br>• Relevant national guidelines, standards and legislation. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | • How to select and use appropriate tools and test equipment.<br>• How to interpret technical documentation and drawings.<br>• Required standards of workmanship. |
| 2 | Identify faults and select and use appropriate tools and test equipment and take remedial action to repair the radiation equipment. | • Local management systems, complying with local instructions and procedures.<br>• Relevant national guidelines, standards and legislation.<br>• How to select and use appropriate tools and test equipment.<br>• How to interpret technical documentation and drawings.<br>• Required standards of workmanship. |
| 2 | Dismantle and assemble systems safely, demonstrating appropriate standards of | |
| 2 | Work on high-voltage systems safely, demonstrating appropriate standards of workmanship. | |
| 2 | Work with electromechanical systems safely, demonstrating appropriate standards of workmanship. | |
| 2 | Verify the correct functioning of safety and operational interlock systems. | |
| 2 | Identify issues that will affect the clinical performance of the equipment and follow procedures to ensure appropriate quality assurance occurs, | |
| 2 | Communicate effectively with equipment user and scientific staff before, during and after PPM operations. | • Effective communication skills, including listening, describing, explaining. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 2 | Assess health and safety risks associated with work activity and apply appropriate controls. | • Local management systems, instructions and procedures.<br>• Relevant national guidelines, standards and legislation. |
| 2 | Comply with local decontamination procedures. | • Local decontamination procedures. |
| 2 | Maintain detailed, accurate and timely equipment records and documentation. | • Requirements for accurate record keeping. |
| 2 | Carry out appropriate handover procedures before and after completing PPM. | • SOPs. |
| 3 | Communicate effectively with equipment user and scientific staff when decommissioning and disposing of equipment. | • Effective communication skills, including listening, describing, explaining. |
| 3 | Establish the presence and category of hazardous materials and the risks associated with their disposal. | • Criteria for the withdrawal of equipment from service.<br>• SOPs.<br>• Local management systems, instructions and procedures.<br>• Relevant national guidelines, standards and legislation. |
| 3 | Determine the most effective option for safe and compliant disposal of equipment and associated hazardous substances, identifying specialists and seeking advice and assistance if necessary. | • SOPs.<br>• Local management systems, instructions and procedures.<br>• Relevant national guidelines, standards and legislation. |
| 3 | Decommission and dispose of equipment by methods appropriate to identified risks in accordance with local procedures. | • SOPs.<br>• Local management systems, instructions and procedures.<br>• Relevant national guidelines, standards and legislation. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 3 | Maintain detailed, accurate and timely equipment records and documentation. | • Requirements for accurate record keeping. |
| 4 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 4 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |
| 4 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 4 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

## SECTION 14: WORK-BASED SYLLABUS: RENAL TECHNOLOGY

This section describes the Learning Framework for the **Specialist Component** of work-based learning covering the Learning Outcomes, Clinical Experiential Learning, Competence, and Applied Knowledge and Understanding.

| | |
|---|---|
| **DIVISION** | Physical Sciences |
| **THEME** | Clinical Engineering |
| **SPECIALISM** | **Renal Technology** |

| Module 1 | Safe Working Practice in Renal Technology | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is to ensure the student is able to work safely in the renal technology environment, with the emphasis on health and safety, risk management, risk assessment and equipment management. During this specialist work-based module students will be expected to apply their learning from the generic, division-theme and specialist academic modules 'Science and Principles Supporting Renal Technology' and 'Renal Technology in Clinical Environment'. | | |
| SCOPE | On completion of this module the student will be able to work safely in the renal technology environment. They should be able to perform a range of risk assessments and tasks within the equipment management life cycle. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Apply health and safety and risk management principles to all aspects of the renal technologist's role.
2. Observe and perform a range of risk assessments appropriate to renal services.
3. Observe how the equipment life cycle applies to renal services and the role of the renal technologist.
4. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

*Note: When performing a risk assessment all risk elements must be considered.*

**CLINICAL EXPERIENTIAL LEARNING**

The clinical experiential learning for this module is:

- With permission, observe the treatment of a patient during renal dialysis and peritoneal dialysis and discuss the impact of renal replacement therapy (RRT) with the patient, reflecting on the role of the renal technologist in promoting high-quality care.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Complete all generic health and safety and mandatory training contextualised to the work placement and observe the range of activities undertaken by renal technologists. | • Local health and safety policy covering work-based activities.<br>• Risks associated with lone working, working on live equipment and the steps that are in place or need to be put in place to mitigate these risks.<br>• Fire escape routes, location of alarms and extinguishers, hand-washing facilities, etc.<br>• Practical risks associated with medical devices in clinical settings.<br>• Installation.<br>• Environment, including physical risks, services (e.g. electricity, gases).<br>• Safety testing.<br>• Functional testing.<br>• Interference.<br>• Sources of artefacts.<br>• Systems.<br>• Additional equipment.<br>• Location of and access to risk assessments in the department. |
| 2 | Review a local risk assessment and comment on how it applies in the workplace. | • Theory of risk assessment using current statutory and professional guidance.<br>• The kind of risk assessments that are performed, where they are kept and how to access them.<br>• The types of symbols, meaning and the implications these may have on any further action:<br>  ○ equipment classifications;<br>  ○ electrical symbols;<br>  ○ biological hazards;<br>  ○ chemical hazards.<br>• COSHH assessment and comment on application in the workplace.<br>• Hazards in the patient environment: |
| 2 | Perform **two** environmental risk assessments on areas where work activities are performed, one workshop based and one in a clinical setting. | |
| 2 | Perform a risk assessment of the acceptance testing procedure. | |
| 2 | Perform risk assessment on the PPM procedures for RRT equipment. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 2 | Perform risk assessment covering repair procedures for RRT equipment, one in a workshop-based setting and one in a clinical environment. | ○ Electrical hazards:<br>▪ electrical safety principles;<br>▪ effects of electricity on the human body;<br>▪ electrical safety limits;<br>▪ measurements and methods.<br>○ Mechanical and other physical hazards:<br>▪ loading;<br>▪ stability;<br>▪ surface measurements.<br>• The clinical use of a range of medical devices and the common faults or problems that may be experienced.<br>• Installation, maintenance, repair, testing, calibration and environmental issues encountered with equipment in a range of clinical environments, including knowledge of the electrical infrastructure, the requirement of uninterruptable power supplies, and possible sources of interference and interaction between devices.<br>• Technical implications and challenges associated with equipment being brought into the clinical environment.<br>• Interactions between equipment in the clinical environment:<br>○ acceptance and safety testing;<br>○ PPM and repair;<br>○ decontamination;<br>○ infection control;<br>○ decontamination techniques:<br>▪ disinfection, sterilisation and cleaning.<br>• Procedure for undertaking environmental risk assessments.<br>• Procedure for undertaking a risk assessment of acceptance testing.<br>• Procedure for undertaking a risk assessment of PPM procedure for RRT equipment. |
| 2 | Perform **two** risk assessments covering decontamination procedures, one in a workshop setting and one in a clinical environment. | |
| 2 | Review a local COSHH assessment and comment on how it applies in the workplace, and perform a COSHH assessment. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | • Procedure for undertaking a risk assessment of repair procedures for RRT equipment.<br>• Procedure for undertaking a risk assessment of decontamination procedures.<br>• COSHH regulations.<br>• How to assess and comment on the COSHH application in the workplace. |
| 3 | Observe the various equipment management processes through the department, identifying, recording and commenting on any appropriate documentation that may apply to each stage. | • Structure of the department, noting the main features, including any controlled, restricted, or storage areas.<br>• Key roles within the department and who performs them.<br>• Range of healthcare staff that renal technologists will liaise and work with while performing their duties.<br>• Organisational policies that apply to the renal technologist.<br>• Locations where equipment life-cycle duties are performed and any restrictions that may apply.<br>• Passage of central alerting system through the department and explain the processes that are followed.<br>• Actions that would be taken in the event of an untoward incident involving medical equipment. |
| 4 | Work within their own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary, complying with relevant guidance and laws, to include those relating to:<br>• your scope of practice;<br>• probity;<br>• fitness to practice; | • Principles, guidance and law with respect to:<br>○ *Good Scientific Practice*;<br>○ probity;<br>○ fitness to practise.<br>• The importance of maintaining your own health. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | • maintaining your own health. | |
| 4 | Follow data protection policy and local procedures to maintain data records and confidentiality. | • Principles, guidance and law with respect to:<br>  ○ confidentiality;<br>  ○ information governance;<br>  ○ informed consent;<br>  ○ probity;<br>  ○ fitness to practise.<br>• The importance of maintaining your own health. |
| 4 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 4 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |
| 4 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 4 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 2 | Equipment Management, Quality Management Systems and Processes | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is to introduce the student to equipment management and quality management systems and their use in renal technology to manage the range of equipment used within a healthcare setting. During this specialist work-based module students will be expected to apply their learning from the generic, division-theme and specialist academic modules, including 'Science and Principles Supporting Renal Technology' and 'Renal Technology in the Clinical Environment'. | | |
| SCOPE | On completion of this module the student will be able to operate equipment management and quality management systems, including the management of rental and loan equipment. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Operate equipment management and quality management systems, both electronic and manual, to support all aspects of equipment management activities that apply to renal services.
2. Apply equipment management processes to assist in the management of rental and loan equipment.
3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

**CLINICAL EXPERIENTIAL LEARNING**

The clinical experiential learning for this module is:

- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Log on to an electronic inventory system (or obtain paper record) and locate:<br>• an individual item of equipment;<br>• particular types/groups of equipment;<br>• appropriate manuals, maintenance, calibration and repair SOPs or SOPs/protocols. | • The specialist roles and individuals associated with them with respect to the equipment management and quality management systems and processes.<br>• Manuals, maintenance, calibration and repair SOPs or SOPs/protocols within an electronic inventory.<br>• Manuals, maintenance, calibration and repair SOPs or SOPs/protocols within a paper-based inventory system.<br>• Document version control system in use and how to work within this system.<br>• Quality systems:<br>  ○ General requirements, control of documentation, control of records, responsibility, authority and communication, planning of activities and resources, protocols and processes, identification and traceability, analysis and improvement, audit.<br>  ○ Record keeping – applies to all aspects of the equipment life cycle (electronic or paper).<br>  ○ Equipment information, including:<br>  ▪ warranty documents, manuals, certificates of conformity, protocols, safety test records, acceptance test records maintenance and repair records, decontamination records, risk assessments.<br>• Data storage and retrieval.<br>• Electronic systems in renal technology.<br>• How to access any work schedules on the electronic records system. |
| 2 | Complete electronic records for new entries on to the inventory system after PPM, repair, calibration, decontamination, decommissioning, etc., updating records as necessary. | |
| 2 | Operate stock control systems that are in place, participating in the management of spares and consumables, including the maintenance of stock levels. | • How to maintain adequate stock levels.<br>• Electronic stock control systems:<br>  ○ purchase of spares and consumables;<br>  ○ purchasing processes. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | • Purchasing authority. |
| 2 | Identify loan/rental equipment through electronic and/or paper record systems and list the major types of equipment obtained on loan/rental basis. | • The specialist roles and individuals associated with them with respect to the equipment management and quality management systems and processes.<br>• NHS standards for loan equipment and indemnity. |
| 2 | Operate stock control systems that are in place, participating in the management of spares and consumables, including the maintenance of stock levels. | • How to maintain adequate stock levels. |
| 2 | Access indemnity forms and NHS delivery forms and select the appropriate indemnity form to be completed for given circumstances. | • Major types of equipment obtained on loan/rental basis.<br>• NHS standards for loan equipment and indemnity. |
| 2 | Access the register of suppliers through the Department of Health (DH) website and interpret and use the information appropriately. | • How to access the register of suppliers through the DH website. |
| 2 | Use record systems to determine:<br>• equipment on rental or loan and rental/loan period that applies;<br>• the responsibilities of the organisation with regard to rental/loan equipment. | • Level of maintenance/repair activity, consumable replacements, decontamination, etc., in equipment in relation to rental/loan equipment. |
| 3 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 3 | Follow the dress and behaviour code, applying any additional | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | requirements when entering/working in controlled areas or areas of restricted access. | placement. |
| 3 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 3 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 3 | Medical Device Acquisition, Acceptance Testing and Installation | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is to introduce the student to the medical equipment procurement process from user specification through to safety checking and installation. The student will be able to perform a range of tasks to support the process and will apply the knowledge from the modules 'Renal Technology in the Clinical Environment' and 'Science and Principles Supporting Renal Technology'. | | |
| SCOPE | On completion of this module the student will be able to undertake the procurement process from the initial definition of the user specification to the acceptance and installation procedures. They should also be able to perform a range of electrical safety tests and calibration checks. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Observe and undertake the procurement process from working with the user to define the user specification through to the procurement process adhering to trust processes.
2. Complete equipment acceptance procedures and, where appropriate, additional installation procedures for a range of medical devices managed by renal technologists.
3. Perform a range of electrical safety tests and calibration checks and adjustments on medical devices with and without patient-applied parts used within renal services.
4. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

## CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Attend a multiprofessional meeting where clinical audit, research, or innovation is presented and consider how audit, research and innovation contribute to improvements in patient care.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Draw up a basic specification detailing the main features required from the equipment. | • **Medical equipment life cycle**<br>• Quality systems:<br>○ General requirements, control of documentation, control of records, responsibility, authority and communication, planning of activities and resources, protocols and processes, identification and traceability, analysis and improvement, audit.<br>○ Record keeping - applies to all aspects of the equipment life cycle (electronic or paper).<br>○ Equipment information, including:<br>▪ warranty documents, manuals, certificates of conformity, protocols, safety test records, acceptance test records maintenance and repair records, decontamination records, risk assessments.<br>○ Pre-purchase.<br>○ Information required to establish the need for the equipment, including the necessary equipment functions.<br>○ Key legislation or standards applying to the equipment.<br>○ Technical implications and challenges associated with equipment being brought into the clinical environment.<br>○ Identification of suitable equipment.<br>○ Application of risk management to selection.<br>○ Purchase.<br>○ Purchasing processes.<br>○ Purchasing authority.<br>○ Acceptance and safety testing.<br>○ Stages of acceptance, visual inspections, electrical safety testing, mechanical safety tests, appropriate test equipment, functional testing, purpose of measurements, performing measurements, assessing results. |
| 1 | Use the available record systems to determine if there is any suitable equipment within the organisation that is available to meet the identified requirement. | |
| 1 | Obtain manufacturer and/or other literature or data to select suitable equipment options for further consideration. | |
| 1 | Interpret, compare and contrast commercial specifications of a medical device to meet the user requirements, explaining why they are or are not appropriate devices to meet the user requirements. | |
| 1 | Review a pre-purchase questionnaire (PPQ) form and make a judgement on the suitability of the information presented. | |
| 1 | Assess any installation requirements. | |
| 1 | Participate in the procurement of equipment, accessories or consumables following the procurement procedures, including:<br>• completion of documentation, | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | e.g. requisitions with order codes;<br>• authorisation process;<br>• submission of the order. | • Installation, maintenance, repair, testing, calibration and environmental issues encountered with equipment in a range of clinical environments, including knowledge of the electrical infrastructure, the requirement of uninterruptable power supplies and possible sources of interference and interaction between devices.<br>• Use of record systems.<br>• Manufacturer literature/data relevant to the specific procurement process.<br>• Evidence-based evaluations.<br>• How to critically review data and select equipment options from available data.<br>• Manufacturer and/or other literature or data (including evidence-based evaluations) to select suitable equipment options for further consideration.<br>• Other sources of expert advice<br>• Reasons why a PPQ form may or may not be required for a particular purchase.<br>• Differing requirements for devices that have a direct electrical patient connection and those that do not.<br>• Major ongoing costs, e.g. consumables, maintenance, repair, parts (including batteries, probes, etc.).<br>• Manufacturer and/or other literature or data (including evidence-based evaluations) to select suitable equipment options for further consideration.<br>• Other sources of expert advice.<br>• Structure and purpose of a PPQ.<br>• Procurement procedures and regulations.<br>• How to complete documentation, including requisitions and the relevant |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | order codes.<br>• Authorisation procedures.<br>• Procedure for processing equipment orders. |
| 2 | Prepare and organise acceptance test procedures. | • Application of organisation skills to acceptance testing. |
| 2 | Make a risk assessment of the acceptance task. | • Theory of risk assessment using current statutory and professional guidance.<br>• The importance of risk assessing the acceptance task.<br>• How to risk assess the acceptance task for a range of common items of medical equipment. |
| 2 | Examine packaging for damage and identify, collect and record appropriate information from packaging and delivery notes comparing it against the initial order. | • The actions to be taken in the event of a package being damaged.<br>• The importance of comparing the delivery note with the initial order. |
| 2 | Unpack equipment in a safe manner and check and confirm all items are as per the delivery note and the original order. | • Relevant health and safety regulations.<br>• The importance of comparing the delivery note with the contents of the package.<br>• Actions to be taken in the event of missing or damaged items. |
| 2 | Examine equipment, cables, accessories and consumables for damage, ensuring the equipment has appropriate markings, e.g. model, serial number, CE mark, electrical type and classification, etc. | • Relevant health and safety regulations.<br>• Type and purpose of markings on new equipment, including CE mark.<br>• Actions to be taken in the event of damaged items, inappropriate CE mark, etc. |
| 2 | Complete acceptance documentation collecting all relevant information for inventory system. | • The importance of completing acceptance documentation in an accurate and timely manner. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 2 | Where necessary assemble equipment and fit any consumables according to instructions. | • Tests or checks necessary for new equipment.<br>• How to select appropriate test equipment. |
| 2 | Select test equipment and perform any appropriate electrical safety test procedures, following manufacturer or locally agreed SOPs/protocols. | • Relevant protocols, procedures, and SOPs for electrical safety testing.<br>• Safety testing of portable medical devices, complex medical devices and systems.<br>• Safety testing fixed installations of complex medical devices and systems. |
| 2 | Perform any appropriate mechanical safety tests procedures, following manufacturer or locally agreed SOPs/protocols. | • Relevant protocols, procedures, and SOPS for mechanical safety testing.<br>• How to perform mechanical safety tests. |
| 2 | Perform any appropriate calibration or set-up procedures, following manufacturer or locally agreed SOPs/protocols. | • SOP for performing calibration and set-up procedures.<br>• How to perform calibration and set up procedures. |
| 2 | Perform any appropriate functional tests where necessary, following manufacturer or locally agreed SOPs/protocols. | • Haemofiltration (HF) equipment.<br>• Haemodiafiltration (HDF) equipment.<br>• Haemoperfusion equipment:<br>○ principles, scope of use, differences in sorbent materials, efficacy, anticoagulation, combined haemodialysis/haemoperfusion.<br>• Plasma exchange equipment.<br>• Peritoneal dialysis (PD) equipment.<br>• Online therapies and associated technologies.<br>• Safety controls and systems associated with the device operation.<br>• Typical set-up procedures, including limits and alarms, and how they may affect the practical operation of the equipment.<br>• Installation, maintenance, repair, testing, calibration and |
| 2 | Record clear and unambiguous information, including test results, and log them according to the local SOPs/protocols. | |
| 2 | Store the equipment and consumables correctly to ensure the equipment remains fit for purpose and ready to use. | |
| 2 | Confirm the suitability of the | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | installation site for the equipment. | environmental issues encountered with equipment in a range of clinical environments, including knowledge of the electrical infrastructure, the requirement of uninterruptable power supplies, and possible sources of interference and interaction between devices.<br>• Safety testing of portable medical devices, complex medical devices and systems.<br>• Safety testing fixed installations of complex medical devices and systems.<br>• Principles of wireless technologies applied to clinical engineering applications.<br>• Technical implications and challenges associated with equipment being brought into the clinical environment.<br>• SOPs for equipment storage and installation.<br>• How to perform function tests.<br>• Record-keeping procedures.<br>• Health and safety procedures, including infection prevention control techniques to the testing procedures.<br>• Local systems to assess operator, technical, service, quality management.<br>• How to undertake a visual inspection of equipment.<br>• Why earth bonding points are or are not appropriate for the test being performed. |
| 2 | Install the equipment and perform a handover of the equipment into service following acceptance test. | |
| 3 | Select suitable test and simulation equipment. | |
| 3 | Select and apply the appropriate standards and limits for the equipment under test. | |
| 3 | Perform a full range of visual inspections on the equipment. | |
| 3 | Operate a range of test and simulation equipment. | |
| 3 | Operate a PAT. | |
| 3 | Operate a medical grade portable appliance tester. | |
| 3 | Make appropriate measurements on equipment with multiple patient connections, demonstrating the effect of multiple earth paths on medical systems and selecting earth bonding points. | |
| 3 | Make safety measurements using discrete test equipment (e.g. voltmeter, ammeter and voltage source) and explain any differences that might occur compared with an automatic PAT tester. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 3 | Where equipment has programmable features, adjust or confirm these with the agreed equipment set up. | |
| 3 | Use test equipment or other means to check the calibration of the equipment by confirming that the input or output is within the specification. | |
| 3 | Perform any appropriate functional tests where necessary, following manufacturer or locally agreed SOPs/protocols. | |
| 4 | Work within their own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary, complying with relevant guidance and laws, to include those relating to:<br>• your scope of practice;<br>• probity;<br>• fitness to practice;<br>• maintaining your own health. | • Principles, guidance and law with respect to:<br>  ○ Probity;<br>  ○ fitness to practise.<br>• The importance of maintaining your own health.<br>• *Good Scientific Practice*. |
| 4 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 4 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | restricted access. | |
| 4 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 4 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 4 | Planned Preventative Maintenance (PPM), Equipment Repairs and Decommissioning of Medical Devices in Renal Service | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is for the student to apply knowledge and gain work-based skills and experience in PPM and undertaking equipment repairs. Students will also be expected to be able to decommission and dispose of equipment safely. During this specialist work-based module students will be expected to apply their learning from the generic, division-theme and specialist academic modules, including 'Science and Principles Supporting Renal Technology' and 'Renal Technology in the Clinical Environment'. | | |
| SCOPE | On completion of this module the student will be able to perform PPM on a range of medical devices and recognise and correct common artefacts and faults. They should also be able to decommission and dispose of equipment in accordance with local procedures. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Perform PPM procedures on a range of dialysis equipment and associated devices.*
2. Recognise and identify common artefacts, hazards, interference and faults that are associated with medical devices and suggest and/or perform corrective action.
3. Perform repair procedures on dialysis equipment and associated devices.*
4. Decommission and dispose of equipment in a safe and appropriate manner according to local procedures.
5. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice.*

**Including infusion devices, temperature measuring devices and blood pressure monitoring devices.*

**CLINICAL EXPERIENTIAL LEARNING**

The clinical experiential learning for this module is:

- Illustrate the PPM arrangements for a device used in renal dialysis on the medical device information system, e.g. in-house maintained, on external service contract, loan devices, etc., and select one device to follow this process through.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Use effective communication skills to obtain as much relevant and accurate information as possible from other healthcare staff, carers and patients. | • Impact of PPM on patients with renal disease.<br>• Calibration/Quality assurance:<br>  ○ calibration procedures;<br>  ○ measurement principles:<br>  ▪ reliability, repeatability, validity, limitations;<br>  ○ appropriate calibration equipment.<br>• The clinical use of a range of medical devices and the common faults or problems that may be experienced.<br>• Safety controls and systems associated with the device operation.<br>• Typical set-up procedures, including limits and alarms, and how they may affect the practical operation of the equipment.<br>• Installation, maintenance, repair, testing, calibration and environmental issues encountered with renal dialysis equipment in a range of environments (including the home), including knowledge of the electrical infrastructure, requirements for water supply, the requirement of uninterruptable power supplies and possible sources of interference and interaction between devices.<br>• Safety testing of renal dialysis equipment and supporting devices.<br>• Safety testing fixed installations of renal dialysis systems.<br>• The effect of different equipment settings on the performance of the equipment and the effect they will have on patient treatment.<br>• The component parts of various haemodialysis machines, indicating what they do and how they work.<br>• How to programme the full range of machine parameters.<br>• How to access current settings and change them as necessary to meet a new set of requirements for the equipment.<br>• How to reset the equipment to the default/factory pre-settings.<br>• How to use the programming computer and associated programming |
| 1 | Prepare and organise for PPM, estimating the time and resources needed and assessing the potential impact on clinical service delivery. | |
| 1 | Interpret and follow the technical documentation to ensure appropriate action is taken while carrying out a repair. | |
| 1 | Operate dialysis or other monitoring equipment to produce a series of outcomes that can be measured and checked to test and assess the functionality and safe operation of the equipment against the operational specification. | |
| 1 | Check and re-calibrate various machine parameters following the programme changes, then test the equipment to ensure the machine performs to the technical specification. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Identify, remove, refit, or renew haemodialysis consumables as necessary when performing a PPM, adhering to infection prevention control techniques. | software.<br>• Technical implications and challenges associated with equipment being brought into the clinical environment.<br>• Working with third-party service providers.<br>• Practical risks associated with medical devices in clinical settings.<br>• Relevant SOPs.<br>• Relevant technical documentation required.<br>• The relevant and accurate information needed from other healthcare staff, carers and patients before undertaking PPM.<br>• Communication skills for obtaining necessary information.<br>• Working with third-party service providers, including contractual agreements, monitoring and auditing.<br>• How to locate field service or central alerting system notices.<br>• Infection control measures during PPM for each item of equipment.<br>• How to identify any anomalies, errors, or malfunctions and the appropriate action to be taken correct these or how to put in place arrangements to have them corrected.<br>• Clinical impact of errors when maintaining or repairing haemodialysis machines.<br>• How to identify the component parts of the equipment.<br>• The purpose of the component parts.<br>• How to determine the settings for each clinical use.<br>• SOP for equipment handover back into clinical service. |
| 1 | Select correct tools and test equipment and perform PPM following the appropriate protocol for the equipment under test, where necessary dismantling and reassembling the haemodialysis equipment to module/component level. | |
| 1 | Adjust and calibrate the equipment settings. | |
| 1 | Identify the equipment component parts, indicating their purpose, and adjust the settings to those previously agreed necessary for use in the clinical setting. | |
| 1 | Perform any appropriate electrical or mechanical safety testing procedures. | |
| 1 | Perform any appropriate functional tests where necessary, following manufacturer or locally agreed SOPs. | |
| 1 | Record clear and unambiguous information relating to the PPM | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | using both written and electronic information processes and systems. | |
| 1 | Store equipment and consumables correctly to ensure the equipment and consumables remain fit for purpose and ready for use and provide information regarding the levels of stock. | |
| 1 | Perform handover of equipment back into clinical service. | |
| 2 | Identify potential cable faults (including patient cables). | • Identification of common cable faults and how/when to repair/replace cables. |
| 3 | Prepare and organise prior to undertaking equipment repairs on dialysis equipment and associated devices, identifying the fault and judging whether the fault can be found in situ or if the equipment needs to be moved. | • Relevant SOPs.<br>• Relevant technical documentation required.<br>• Use of troubleshooting guide to determine faults and error codes to determine equipment faults.<br>• The relevant and accurate information needed from other healthcare staff, carers and patients before undertaking PPM.<br>• Communication skills for obtaining necessary information.<br>• Time and resources needed to complete the task.<br>• Impact on the clinical service. |
| 3 | Identify potential risks to making a repair and estimate the time and resources needed to complete the repair. | • How to risk assess equipment repairs.<br>• Factors to consider in assessing the potential impact of a repair on clinical service delivery and the patient. |
| 3 | Identify and access relevant technical documentation, including the appropriate repair SOPs. | • Technical documentation, including the appropriate repair SOPs. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 3 | Identify, access and interpret the appropriate literature and technical documentation and ensure there are no outstanding equipment notices in place. | • Technical documentation, including the appropriate repair SOPs, literature and previous service information.<br>• How to identify source of field service notices and central alerting system notices. |
| 3 | Select correct tools, test equipment and perform the repair, where necessary dismantling and reassembling the equipment to module/component level. | • The effect of different equipment settings on the performance of the equipment and the effect they will have on patient treatment.<br>• The component parts of various haemodialysis machines, indicating what they do and how they work.<br>• How to programme the full range of machine parameters.<br>• How to access current settings and change them as necessary to meet a new set of requirements for the equipment.<br>• How to reset the equipment to the default/factory pre-settings.<br>• How to use the programming computer and associated programming software.<br>• Installation, maintenance, repair, testing, calibration and environmental issues encountered with renal dialysis equipment in a range of environments (including the home), including knowledge of the electrical infrastructure, water supply, the requirement of uninterruptable power supplies and possible sources of interference and interaction between devices.<br>• Safety testing of renal dialysis equipment and supporting devices.<br>• Safety testing fixed installations of renal dialysis systems.<br>• Technical implications and challenges associated with equipment being brought into the clinical environment.<br>• Working with third-party service providers.<br>• Practical risks associated with medical devices in clinical settings.<br>• Infection control measures and the importance of adhering to infection |
| 3 | Identify/confirm equipment fault using fault-finding methodology. | |
| 3 | Identify, remove and refit or renew consumables as necessary when performing a repair. | |
| 3 | Identify the component parts of the equipment, indicating their purpose. | |
| 3 | Perform any appropriate electrical or mechanical safety testing procedures. | |
| 3 | Adjust the equipment settings to those previously agreed necessary for the clinical setting in which it is to be used. | |
| 3 | Perform any appropriate functional tests. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | prevention control techniques. |
| 3 | Record clear and unambiguous information relating to the repair using written and/or electronic information processes and systems, including initial fault description, actions taken, parts used, etc. | • Standards for record keeping for written and electronic systems. |
| 3 | Perform handover of equipment back into clinical service. | • SOPs. |
| 4 | Prepare and organise for decommissioning and disposal. | • Decommissioning and disposal:<br>  ○ decommissioning protocols;<br>  ○ legislation;<br>  ○ waste management:<br>  ▪ special waste, clinical waste, radioactive waste, waste electrical and electronic equipment (WEEE), restriction of hazardous substances (RoHS).<br>• Disabling equipment.<br>• Removal/disposal of data and data storage.<br>• Importance of documentation.<br>• Relevant SOPs.<br>• Relevant technical documentation required.<br>• Time and resources needed to complete the task.<br>• Access to equipment.<br>• Impact on the clinical service.<br>• The relevant and accurate information needed from other healthcare staff, carers and patients before undertaking PPM.<br>• Communication skills for obtaining necessary information. |
| 4 | Perform an initial risk assessment to | • Theory of risk assessment using current statutory and professional |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | identify any potential risks and determine the type of disposal that needs to be followed and the regulations that apply. | guidance.<br>• How to perform an initial risk assessment.<br>• Potential risks from a range of clinical equipment and how to deal with each one. |
| 4 | Identify routes of disposal and obtain authorisation for disposal. | • Time and resources and cost implications associated with the disposal process.<br>• Correct tools and equipment required to perform the disposal. |
| 4 | Decontaminate equipment, or if decontamination is not possible ensure correct local procedures/protocols are followed. | • When to remove equipment from clinical area. |
| 4 | Remove/purge all data, especially confidential or identifiable data, from the equipment and disable equipment. | • Local procedures/protocols for removing data so that it cannot be recovered.<br>• Local procedures/protocols for disabling equipment. |
| 4 | Record clear and unambiguous information relating to the disposal and remove any unnecessary equipment documentation. | • How to use written and/or electronic information processes and systems for record keeping.<br>• Local procedures/protocols for removing equipment documentation. |
| 5 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 5 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |
| 5 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 5 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 5 | Maintenance, Repair and Quality Control of Water Treatment Plants for Renal Dialysis | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| **AIM** | The aim of this module is for the student to perform maintenance and repair procedures on water treatment plants which are essential to dialysis centres and ensure the quality control of the water used. During this specialist work-based module students will be expected to apply their learning from the generic, division-theme and specialist academic modules, including 'Science and Principles Supporting Renal Technology' and 'Renal Technology the Clinical Environment'. | | |
| **SCOPE** | On completion of this module the student will be able to perform maintenance and repair procedures on water treatment plants and perform a range of quality control procedures and be able to interpret the results in the context of quality control parameters. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Perform PPM and repair procedures on water treatment plants.
2. Take water samples from water treatment plants for quality control purposes and review and interpret quality control results.
3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

## CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Attend a renal clinic where patients with renal disease are reviewed and discuss with your training supervisor how the role of a clinical engineering practitioner can impact positively on patient care.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Prepare and organise prior to PPM or service process on water treatment equipment to be carried out with maximum efficiency and the minimum of equipment down time. | • Relevant SOPs.<br>• Relevant technical documentation required.<br>• Use of troubleshooting guide to determine faults and error codes to determine equipment faults.<br>• The relevant and accurate information needed from other healthcare staff, carers and patients before undertaking PPM.<br>• Communication skills for obtaining necessary information.<br>• Time and resources needed to complete the task.<br>• Impact on the clinical service.<br>• The dangers of contamination of water treatment equipment and the importance this has on the impact on patient treatment(s).<br>• The action to be taken if a manufacturer issues a Safety Information Bulletin or a Hazard Notice is reported during the PPM or service process.<br>• The management of equipment spare parts and the information that needs to be provided regarding the levels of stock.<br>• How to store equipment, accessories and consumables to ensure equipment/consumables remain fit for purpose and ready for use. |
| 1 | Dismantle and re-assemble each component in a water treatment system. | • Water treatment and quality, biochemistry, microbiology and virology at the point of dialysis:<br>o hospital dialysis unit, satellite unit, home.<br>• Water sources and treatment – municipal systems:<br>o municipal water supplies;<br>o municipal water supply treatments;<br>o municipal water supply standards;<br>o sampling and testing.<br>• The importance of water quality.<br>• Legislation, standards and guidance. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | • The effect on the haemodialysis equipment of using untreated or poorly treated water for haemodialysis.<br>• The various 'Standards' for water for dialysis and ability to access these 'Standards'.<br>• How to interpret the 'Standards' for water for dialysis and incorporate the information when repairing existing water treatment systems.<br>• The 'Drinking Water Standards' and the responsibility of the water treatment companies to maintain the supply of water for drinking.<br>• The processes involved by the water treatment companies to produce water for drinking.<br>• The function of each component in a water treatment system. |
| 1 | Apply 'good practice' maintenance methodology to the water treatment equipment PPM process. | • The impact (technical, clinical and financial) of performing a PPM, including any resulting action that may be required, and contextualise this into patient and service impact. |
| 1 | Perform individual water treatment component testing to confirm that each item is working correctly. | • Components of a water treatment plant.<br>• The requirement to clean and sanitise the water treatment system, including the individual components and the distribution system.<br>• How to apply fault-finding methodology to water treatment equipment if a repair is required.<br>• How to identify and access relevant technical documentation.<br>• How to interpret technical documentation in order to ensure appropriate action is taken while carrying out a repair. |
| 1 | Perform cleaning, disinfection and sanitisation of the water treatment components and distribution system. | |
| 1 | Perform the repairs to water treatment equipment. | |
| 1 | Test the individual water treatment components to ensure they are performing to specification. | |
| 1 | Record clear and unambiguous information relating to the disposal and remove any unnecessary | • How to use written and/or electronic information processes and systems for record keeping.<br>• Local procedures/protocols for removing equipment documentation. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | equipment documentation. | |
| 1 | Perform handover of equipment back into clinical service. | • SOPs for handover. |
| 2 | Take water samples and analyse water samples using sterile techniques and ensuring all relevant details are recorded. | • Water treatment and quality, biochemistry, microbiology and virology at the point of dialysis:<br>o hospital dialysis unit, satellite unit, home.<br>• Water sources and treatment – municipal systems:<br>o municipal water supplies;<br>o municipal water supply treatments;<br>o municipal water supply standards;<br>o sampling and testing.<br>• The importance of water quality.<br>• 'Standards' for water for dialysis and ability to access these 'Standards'.<br>• Appropriate technical documentation, local policies, rules and protocols relating to water sampling.<br>• 'Standards' for water for dialysis and ability to incorporate the information when working on or checking existing water treatment systems.<br>• Requirement for microbiological and chemical standards.<br>• Clinical impact on haemodialysis patients of using water that does not meet the microbiological and chemical standards.<br>• The local testing procedure to test water samples for specific chemicals and microbiological contamination.<br>• How to select correct test equipment when checking the quality of the water at various locations in the systems. |
| 2 | Record water sample results, interpret the information and make recommendations for actions based on the results. | |
| 3 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 3 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |
| 3 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 3 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 6 | Equipment Design and Safe Use in Renal Services | COMPONENT | Specialist<br>Years 2 and 3 |
|---|---|---|---|
| **AIM** | The aim of this module is for the student to build a simple electronic device and teach others how to use equipment safely and appropriately in the clinical environment. During this specialist work-based module students will be expected to apply their learning from the generic, division-theme and specialist academic modules, including 'Science and Principles Supporting Renal Technology' and 'Renal Technology the Clinical Environment'. | | |
| **SCOPE** | On completion of this module the student will be able to specify, design and build a simple electronic device and teach other healthcare professionals how to operate a range of simple medical devices safely in a clinical environment. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Specify, design and build a simple electronic device using appropriate test and development equipment with reference to the relevant standards.
2. Teach/train healthcare staff on the use, operation, accessories and storage of RRT equipment and consumables.
3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Pr*actice.

## CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Specify, design and build a simple electronic device using appropriate test and development equipment with reference to the relevant standards.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Produce a document outlining the specifications for a simple electronic device (including power requirements, inputs, outputs and physical requirements). | • Basic electronics and mechanics.<br>• Quality management systems relating to medical devices and systems design.<br>• Safety requirements for programmable medical electrical systems:<br>  ○ risk concepts relating to software-controlled devices.<br>• Specifications:<br>  ○ establishing a user specification;<br>  ○ establishing a technical and environmental specification.<br>• Determining applicable standards and legislation.<br>• Design evaluation:<br>  ○ analysing designs;<br>  ○ failure modes and effects analysis.<br>• Design, manufacture, testing and documentation:<br>  ○ design techniques, including for EMC;<br>  ○ computer-aided design tools;<br>  ○ prototyping, simulating, experimentation, modelling;<br>  ○ use of advanced test equipment;<br>  ○ engineering drawings;<br>  ○ printed circuit manufacture;<br>  ○ constructional issues:<br>  ▪ materials, components ,wiring, physical layout;<br>  ○ EMC testing;<br>  ○ type testing;<br>  ○ functional calibration and safety testing;<br>  ○ design verification and validation testing.<br>• Appropriate mathematical methods that can be used to analyse design:<br>  ○ Systematic methodology that can be applied to solve problems in design: |
| 1 | Use a computer-aided design package to design the electronic circuit and use software simulation or a hardware development system to refine the design and confirm the circuit works as specified. | |
| 1 | Use a computer-aided design package to design the printed circuit board layout for the electronic circuit. | |
| 1 | Manufacture and populate the printed circuit board using appropriate tools, materials and local facilities. | |
| 1 | Produce a bill of materials and obtain parts required. | |
| 1 | Select appropriate test equipment and use suitable tests to confirm the device functions are as required and to the specification written. | |
| 1 | Design and manufacture a suitable enclosure with the use of drawing packages and mechanical workshop tools (assistance in the manufacture | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | may be required where specialist mechanical equipment is required). | ▪ application of basic principles and tools used in analysis of design;<br>▪ systematic analysis of design.<br>○ Documentation:<br>▪ specification, operational manual, technical file, test documents.<br>• Circuit analysis:<br>○ appropriate mathematical methods that can be used to analyse circuit behaviour and describe electrical signals;<br>○ systematic methodology that can be applied to solve problems in circuit design;<br>○ application of electronic principles and tools used in analysis of circuits;<br>○ systematic analysis of analogue circuit design;<br>○ systematic analysis of digital circuit design.<br>• How to produce a specification for a simple electronic device.<br>• Health and safety issues that must be addressed when producing an electronic device.<br>• How to use a computer-aided design package to design electronic circuits.<br>• How to use software simulation or a hardware development system to refine designs and confirm the circuit works as specified.<br>• How to use a computer-aided design package to design a printed circuit board layout for the electronic circuit.<br>• How to manufacture and populate a printed circuit board and the health and safety issues that must be addressed.<br>• Requirements for a bill of materials.<br>• How to select appropriate test equipment.<br>• How to select the correct tests to confirm the device functions are as required and to the specification written. |
| 1 | Check the device conforms with the relevant standards previously identified. | |
| 1 | Produce a complete set of documentation (including specification, design, construction details, test documentation, bill of materials etc.). | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | • How to design and manufacture a suitable enclosure using drawing packages and mechanical workshop tools.<br>• Health and safety considerations for design and manufacture.<br>• Standards to be adhered to.<br>• How to check the device conforms to the relevant standards.<br>• Requirements for compiling documentation.<br>• Record-keeping processes. |
| 2 | Teach a range of healthcare staff how to use, operate and store a number of simple medical devices. | • Planning a teaching session.<br>• Communication skills, including explaining, describing and instructing.<br>• The basic function and operation of the equipment, including the replacement of any consumables.<br>• User maintenance SOPs.<br>• How to present material effectively through reports or presentations.<br>• Safety controls and systems associated with the device operation.<br>• Typical set-up procedures, including limits and alarms, and how they may affect the practical operation of the equipment.<br>• How to evaluate a teaching session. |
| 2 | Review the suitability of user maintenance SOPs/protocols. | • User maintenance SOPs/protocols.<br>• How to critically review documents. |
| 2 | Reflect on learning from training programmes and summarise and report on key learning. | • Models of reflection.<br>• Critical reflection. |
| 3 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 3 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | restricted access. | |
| 3 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 3 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

## SECTION 14: WORK-BASED SYLLABUS: REHABILITATION ENGINEERING

This section describes the Learning Framework for the **Specialist Component** of work-based learning covering the Learning Outcomes, Clinical Experiential Learning, Competence, and Applied Knowledge and Understanding.

| | |
|---|---|
| **DIVISION** | Physical Sciences |
| **THEME** | Clinical Engineering |
| **SPECIALISM** | **Rehabilitation Engineering** |

| Module 1 | Safe Working Practice in Rehabilitation Engineering | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is to ensure the student is able to work safely in the rehabilitation engineering environment with the emphasis on health and safety, equipment repair and PPM. During this specialist work-based module students will be expected to apply their learning from the generic, division-theme and specialist academic modules, including 'Science and Principles Supporting Rehabilitation Engineering' and 'Rehabilitation in the Clinical Environment'. | | |
| SCOPE | On completion of this module the student will be able to work safely in the rehabilitation engineering environment. They should be able to test equipment, diagnose faults and repair equipment in accordance with SOPs and teach patients and service users. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Select and use appropriate test equipment and service tools.
2. Perform and monitor PPM across a range of equipment used in rehabilitation engineering.
3. Diagnose equipment faults, determine appropriate action and repair equipment.
4. Plan for and teach users, carers and other healthcare staff within the rehabilitation engineering environment.
5. Produce appropriate technical and user documentation for use within the rehabilitation engineering environment.
6. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

**CLINICAL EXPERIENTIAL LEARNING**

The clinical experiential learning for this module is:

- With permission, observe patient consultations (initial visit and follow-up) and discuss the impact of assistive technology with the patient, reflecting on the role of the rehabilitation engineer in promoting high-quality care.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Complete all generic health and safety and mandatory training contextualised to the work placement and observe the range of activities undertaken by rehabilitation engineers, including assistive technology devices and quality assurance. | • Local health and safety policy covering work-based activities.<br>• Risks associated with lone working, working on live equipment and the steps that are in place or need to be put in place to mitigate these risks.<br>• Fire escape routes, location of alarms and extinguishers, hand-washing facilities, etc.<br>• Practical risks associated with medical devices in clinical settings.<br>• Installation.<br>• Environment, including physical risks, services (e.g. electricity, gases).<br>• Safety testing.<br>• Functional testing.<br>• Interference.<br>• Sources of artefacts.<br>• Systems.<br>• Additional equipment.<br>• Location of and access to risk assessments in the department. |
| 1 | For a range of mobility, postural, environmental and communication equipment found within rehabilitation engineering, diagnose faults and determine appropriate action. | • Planned preventative maintenance (PPM) and repair:<br>○ basic maintenance techniques;<br>○ repair process and post-repair quality control requirements;<br>○ range of planned technical support activities relevant to the equipment;<br>○ relevant engineering principles and concepts;<br>○ basic engineering principles on which the medical device operation is based;<br>○ basic engineering terminology;<br>○ factors affecting decisions on maintenance activity, including urgency, time, impact on services and the availability of other equipment.<br>• Range of devices encountered by rehabilitation engineers, including |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | assistive technology devices.<br>• Correct protocol for type and range of equipment. |
| 2 | Perform and monitor PPM to specified schedule. | • Technology (design and manufacture, materials and equipment):<br>o rehabilitation technology design;<br>o mobility, wheelchairs and special seating systems;<br>o prosthetics and orthotics;<br>o electronic assistive technology (Environmental Control systems, functional electrical stimulation [FES], augmentative and alternative communication systems [AAC], switches, integrated systems, etc.);<br>o architectural barriers and design;<br>o aids to daily living;<br>o information technology (IT) in rehabilitation engineering;<br>o materials and manufacturing.<br>• How to use the detailed technical information provided by the manufacturers' service manuals.<br>• How to confirm test equipment is correctly calibrated for maintenance and repair activities.<br>• Impact of PPM and repairs on patients. |
| 3 | Repair a range of mobility, postural, environmental and communication equipment found with rehabilitation engineering in accordance with best practice guidelines. | • SOPs.<br>• Range of devices encountered by rehabilitation engineers, including assistive technology devices.<br>• How to use the detailed technical information provided by the manufacturers' service manuals.<br>• How to confirm test equipment is correctly calibrated for maintenance and repair activities.<br>• Impact of PPM and repairs on patients. |
| 3 | Complete all records accurately and store in correct location for future | • Requirements for accurate record keeping.<br>• SOPs. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | use. | |
| 3 | Inform users of the progress of repairs and advise on contingency arrangements, reasons for fault, action taken and how to avoid re-occurrence. | • Impact of PPM and repairs on patients.<br>• Verbal communication skills. |
| 4 | Teach users, carers and other healthcare staff as necessary within the rehabilitation engineering environment. | • Planning a teaching session.<br>• Communication skills, including explaining, describing and instructing.<br>• The basic function and operation of the equipment, including the replacement of any consumables.<br>• User maintenance SOPs.<br>• How to present material effectively through reports or presentations.<br>• Safety controls and systems associated with the device operation.<br>• Typical set-up procedures, including limits and alarms, and how they may affect the practical operation of the equipment.<br>• How to evaluate a teaching session. |
| 5 | Produce appropriate technical documentation. | • Guidelines for writing technical documentation.<br>• Guidelines for writing user documentation.<br>• Governance and approval process. |
| 5 | Produce appropriate user documentation. | |
| 6 | Work within own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary, complying with relevant guidance and laws, to include those relating to:<br>• your scope of practice;<br>• probity; | • Principles, guidance and law with respect to:<br>◦ *Good Scientific Practice*;<br>◦ probity;<br>◦ fitness to practise.<br>• The importance of maintaining your own health. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | • fitness to practice;<br>• maintaining your own health. | |
| 6 | Follow data protection policy and local procedures to maintain data records and confidentiality. | • Principles, guidance and law with respect to:<br>◦ confidentiality;<br>◦ information governance;<br>◦ informed consent;<br>◦ probity;<br>◦ fitness to practise.<br>• The importance of maintaining your own health. |
| 6 | Use verbal communication skills that are appropriate to:<br>• users;<br>• carers;<br>• colleagues;<br>• other clinical staff in the MDT. | • Principles of effective communication, including language, listening, summarising. |
| 6 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 6 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |
| 6 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 6 | Reflect on your practice and generate a reflective diary that demonstrates how you take | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 2 | Assistive Technology in Rehabilitation Engineering | COMPONENT | Specialist Year 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is to ensure the student is able to work with range of patients to use assistive technology to support the rehabilitation and enhance the quality of life of patient. During this specialist work-based module students will develop their patient-facing skills and will apply their learning from the generic, division-theme and specialist academic modules including 'Science and Principles Supporting Rehabilitation Engineering' and 'Rehabilitation in the Clinical Environment'. | | |
| SCOPE | On completion of this module the student will be able to work with patients referred to the rehabilitation engineering environment. They should be able to perform a range of tasks to identify, recommend and adjust assistive technology and perform a range of patient assessments adhering to health and safety guidelines, including infection control. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Identify a wide range of assistive technology equipment and make the appropriate choice of equipment/procedure for a range of mobility, posture, environmental and communication equipment and a range of patient assessment procedures.
2. Perform and document appropriate risk analysis to the patient's needs, assistive technology and the environment.
3. Set up and adjust equipment to ensure it meets the needs of the individual, including mobility, posture, environmental and communication equipment.
4. Use the controls of the equipment to produce the highest-quality patient outcome across a range of mobility, posture, environmental and communication equipment.
5. Perform patient assessments, interventions and equipment handovers in a safe manner while undertaking appropriate infection control techniques and other health and safety best practice.
6. Assess equipment to ensure it meets or continues to meet individual needs and the equipment remains fit for purpose.
7. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

**CLINICAL EXPERIENTIAL LEARNING**

The clinical experiential learning for this module is:

- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | For a range of mobility, postural, environmental and communication equipment found within rehabilitation engineering, assemble assistive technology equipment and fit any consumables according to instructions. | • The purpose of the equipment.<br>• Clinical use of the equipment, including any limitations of use.<br>• When functional tests are required. |
| 1 | Select appropriate test equipment and perform any appropriate electrical safety test procedures undertaking functional tests or checks as required. | • Manufacturer or locally agreed SOPs.<br>• When to perform functions tests. |
| 1 | Choose the appropriate equipment and/or procedure across a range of mobility, posture, environmental and communication equipment and a range of patient assessment procedures, identifying or modifying as necessary. | • How to confirm the reason for referral, clinical need, objectives of assessment or prescription.<br>• How to confirm the nature, type and extent of measurements that will be required to complete the assessment or the equipment required to meet the prescription.<br>• Criteria for justifying the choice of assessment procedure or equipment.<br>• How to identify any modifications to procedures or equipment that may be required. |
| 1 | Perform a critical review of procedures against literature evidence and best practice and write procedures in accordance with the evidence. | • Criteria for critical reviews.<br>• How to establish the evidence base and best practice.<br>• Process for developing procedures.<br>• National and international standards. |
| 2 | Perform risk analysis, accounting for the patient's needs, the assistive technology available and | • Process to confirm the reason for referral, clinical need, objectives of assessment or prescription.<br>• Process to confirm the nature, type and extent of measurements that |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | the environment and document as appropriate, including:<br>• clinical assessment procedures;<br>• a range of rehabilitation and assistive technology equipment;<br>• user's environment prior to the implementation of a new technology. | will be required to complete the assessment or the equipment required to meet the prescription.<br>• Local risk assessment methodology<br>• SOPs. |
| 3 | Select appropriate environment for commissioning devices. | • Process to confirm suitability of operation and/or fit of the device within expected performance parameters and prescription. |
| 3 | Evaluate the effective operation of the device within the user environment (actual or simulated). | • How to confirm effective operation of the device within the user environment (actual or simulated).<br>• Clinical practice:<br>o rehabilitation engineering in the health service;<br>o the rehabilitation engineer in the professional healthcare team;<br>o psychosocial aspects and classification of disabilities (including the International Classification of Functioning);<br>o assessment methods;<br>o other professional roles (occupational therapist, physiotherapist, speech therapist, consultant in rehabilitation medicine);<br>o communication with client and carer;<br>o postural management;<br>o development and prevention of deformity.<br>• Assessment:<br>o disabling pathologies and prognosis;<br>o psychological state; |
| 3 | Document maintenance periods and requirements for device management, and establish and agree responsibility for equipment issued. | |
| 4 | Confirm the reason for the clinical referral and, where required, restrict device functions for initial or trial periods to enable familiarity and ensure safety. | |
| 4 | Agree relevant trial and review periods to co-ordinate with user treatment plan and develop full capabilities in use of the device. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 4 | Where adjustments are required, obtain relevant measurements and other data, make minor adjustments to achieve required performance and if necessary arrange for modification to be undertaken. | ○ communication abilities/limitations;<br>○ physical abilities/limitations;<br>○ musculoskeletal abilities/limitations;<br>○ neuromuscular abilities/limitations;<br>○ social goals/limitations;<br>○ mobility goals/limitations;<br>○ postural management/needs;<br>○ carer needs/abilities.<br>• Measurements:<br>○ types and range of measurements;<br>○ measurement limitations;<br>○ anatomical measurements;<br>○ specialist measuring equipment;<br>○ use of photography.<br>• Measurement technology:<br>○ gait measurement;<br>○ tissue interface measurement;<br>○ outcome measurement;<br>○ digital photography;<br>○ physiological measurement;<br>○ transducers.<br>• Disabling pathologies<br>○ International Classification of Functioning, Disability and Health (ICF);<br>○ sensation and sensory loss;<br>○ congenital pathologies;<br>○ diabetes;<br>○ pressure sores;<br>○ spinal pathologies; |
| 4 | Instruct user and carers in the safe use, transport and general maintenance of the device, and confirm understanding. | |
| 4 | Identify, document and report fully the device(s) issued in order to facilitate traceability, the process and outcomes of commissioning, including user training, ensuring that arrangements for further action are implemented. | |
| 5 | Correctly interpret data from individual user assessment and confirm objectives. | |
| 5 | Confirm the reason for referral, clinical need, objectives of assessment goals of individual and carers, e.g. patient assessment and the nature, type and extent of measurements that will be required to complete the assessment. | |
| 5 | Perform appropriate clinical | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | assessment either autonomously or as part of a MDT with adherence to good infection control techniques and other health and safety best practices. | ○ continence and control;<br>○ joint and muscle pathologies;<br>○ neurological disorders;<br>○ ageing;<br>○ cardiovascular disease.<br>• Planning for detecting and reporting device failure and the importance of user involvement in the plan.<br>• How to establish mechanisms for ongoing device management and embed them in the user plan.<br>• The rationale behind the device prescription.<br>• When to restrict device functions.<br>• How to establish usage, including frequency and duration based on clinical considerations.<br>• The importance of and how to confirm that user and carers have relevant documentation, are confident and comfortable with use of the device and understand what further action may be taken.<br>• The role of the rehabilitation engineer as it relates to the patient/clinical team.<br>• The role of other relevant healthcare professionals working in the clinical pathway.<br>• How to manage the non-attendance of other members of relevant MDT.<br>• Infection control measures.<br>• Health and safety.<br>• The scope and limitations of the individual's function, capacity and social interaction that will influence the type, nature, design, or use of intended solution.<br>• How to exchange relevant information sensitively with users and |
| 5 | Select appropriate measuring devices to complete assessment, taking accurate, relevant and sufficient measurements to assist with specification or decision on alternative solutions. | |
| 5 | Undertake a risk assessment of the intended solution, the patient's needs and the environment in which the solution will be used. | |
| 5 | Produce complete and accurate records of the assessment process and results. | |
| 5 | Report on the assessment, relating results directly to the agreed objectives and referral questions raised, and propose suitable action where the original referral or information proves to be inappropriate or where information collected raises additional issues. | |
| 5 | Perform environment assessments. | |
| 6 | Where adjustments to equipment are required, obtain relevant | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | measurements and other data, and make adjustments to achieve required performance. | carers (to include limitations) and using terminology that aids communication.<br>• When to seek advice and support from relevant people (rehabilitation networks) to inform judgements and decisions.<br>• Guidelines underpinning the confidential exchange of relevant clinical information with other healthcare professionals and using terminology that aids communication.<br>• The clinical use of the equipment and understanding the reason for the re-assessment of the equipment use. |
| 6 | Arrange for modification to be undertaken if necessary. | |
| 6 | Instruct user and carers of any changes made to the device and confirm understanding. | |
| 6 | Confirm that user and carers have relevant documentation, are confident and comfortable with use of the device and understand what further action may be taken. | |
| 6 | Identify and document fully the device(s) issued in order to facilitate traceability. | |
| 6 | Document and report the process and outcomes of commissioning, including user training, ensuring that arrangements for further action are implemented and agreeing and documenting a timescale for any further review. | |
| 7 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 7 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | restricted access. | |
| 7 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 7 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 3 | Design Assistive Technology in Rehabilitation Engineering | COMPONENT | Specialist Year 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is to ensure the student is able to work with range of patients to use assistive technology to support the rehabilitation and enhance the quality of life of patient. During this module students will develop their patient-facing skills and will apply their learning from the generic, division-theme and the specialist modules 'Science and Principles Supporting Rehabilitation Engineering' and 'Rehabilitation in the Clinical Environment'. | | |
| SCOPE | On completion of this module the student will be able to work with patients referred to the rehabilitation engineering environment. They should be able to perform a range of tasks to identify, recommend and adjust assistive technology and perform a range of patient assessments adhering to health and safety guidelines, including infection control. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the work place and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Perform measurements, checks and tests required in order to prescribe or design assistive technology solutions.
2. Specify, design and facilitate the manufacture of new devices or modification to an existing device.
3. Assess the solution identified against outcome requirement, financial viability, time constraints and resource implications.
4. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

## CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Attend an occupational therapy clinical assessment of patient needs for an aid for daily living and reflect on how the occupational therapy can positively influence quality of life of patients.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Assess and interpret information correctly to assist with informed decision on a clinically acceptable solution, liaising with other stakeholders to ensure that all current influencing factors have been taken into consideration. | • Measurement technology:<br>o gait measurement;<br>o tissue interface measurement;<br>o outcome measurement;<br>o digital photography;<br>o physiological measurement;<br>o transducers.<br>• Biomechanics:<br>o biomechanical analysis;<br>o biomechanical models;<br>o biomechanics of major musculoskeletal structures;<br>o tissue biomechanics;<br>o wheelchair biomechanics;<br>o biomechanics of seating;<br>o biomechanics of gait;<br>o prosthetic and orthotic biomechanics.<br>• Disabling pathologies:<br>o ICF;<br>o sensation and sensory loss;<br>o congenital pathologies;<br>o diabetes;<br>o pressure sores;<br>o spinal pathologies;<br>o continence and control;<br>o joint and muscle pathologies;<br>o neurological disorders;<br>o ageing;<br>o cardiovascular disease.<br>• How to review options generated with key stakeholders and reach |
| 1 | Undertake further patient assessment as necessary. | |
| 1 | Undertake an evaluation of equipment available to meet the technical solution, making performance measurements as appropriate. | |
| 1 | Produce a design specification that meets prescription and accommodates manufacturing constraints by those who will manufacture or implement. | |
| 1 | Recommend appropriate manufacturing process and produce engineering drawings. | |
| 2 | Establish/review the specification for manufacturing viability correctly and interpret the specification for the assistive device. | |
| 2 | Identify existing components for suitability and determine those aspects of specification that relate to | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | modification or adaptation of existing devices. | agreement on optimum solution.<br>• Process to ensure specification has taken full account of clinical, personal and environmental factors and risks affecting use and effectiveness.<br>• Clinical practice:<br>○ rehabilitation engineering in the health service;<br>○ the rehabilitation engineer in the professional healthcare team;<br>○ psychosocial aspects and classification of disabilities (including the ICF);<br>○ assessment methods;<br>○ other professional roles (occupational therapist, physiotherapist, speech therapist, consultant in rehabilitation medicine);<br>○ communication with client and carer;<br>○ postural management;<br>○ development and prevention of deformity.<br>• Assessment:<br>○ disabling pathologies and prognosis;<br>○ psychological state;<br>○ communication abilities/limitations;<br>○ physical abilities/limitations;<br>○ musculoskeletal abilities/limitations;<br>○ neuromuscular abilities/limitations;<br>○ social goals/limitations;<br>○ mobility goals/limitations;<br>○ postural management/needs;<br>○ carer needs/abilities.<br>• Measurements:<br>○ types and range of measurements;<br>○ measurement limitations; |
| 2 | Monitor and liaise with all individuals or agencies involved in the production process. | |
| 2 | Document and record manufacture in accordance with relevant procedures. | |
| 2 | Produce and assemble components to meet specification. | |
| 3 | Review the time, cost and resource implications of supplying the product, comparing the results with any commercially available alternatives that might be suitable. | |
| 3 | Test product against specification prior to fitting with individual patient and confirm performance within expected parameters, identify any modifications required in the final product, and implement and document changes. | |
| 3 | Develop training material appropriate to the user and deliver user training appropriate to the needs of the user/carer. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | | ○ anatomical measurements;<br>○ specialist measuring equipment;<br>○ use of photography.<br>• Prescribing**.**<br>• Notation of special requirements that may relate to personal or environmental factors influencing use of the assistive technology by the patient.<br>• Integration of the specified solution with the user's overall treatment plan, including agreement of trial periods and reviews, which may be required.<br>• Incorporation of relevant testing, inspection and risk management throughout the manufacturing and commissioning process.<br>• Process to confirm that final product meets design specification and required performance parameters. |
| 4 | Work within own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary, complying with relevant guidance and laws, to include those relating to:<br>• your scope of practice;<br>• probity;<br>• fitness to practice;<br>• maintaining your own health. | • Principles, guidance and law with respect to:<br>○ probity;<br>○ fitness to practise.<br>• The importance of maintaining your own health.<br>• *Good Scientific Practice*. |
| 4 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 4 | Follow the dress and behaviour code, applying any additional | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | requirements when entering/working in controlled areas or areas of restricted access. | placement. |
| 4 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 4 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

| Module 4 | Equipment Management and Repair in Rehabilitation Engineering | COMPONENT | Specialist Years 2 and 3 |
|---|---|---|---|
| AIM | The aim of this module is to ensure the student is able to undertake tasks associated with equipment management, equipment repair and the auditing of repair work to quality standards. During this module students will apply their learning from the generic, division-theme and the specialist modules 'Science and Principles Supporting Rehabilitation Engineering' and 'Rehabilitation in the Clinical Environment'. | | |
| SCOPE | On completion of this module the student will be able to identify and repair equipment and perform safety tests. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote continuous professional development. | | |

**LEARNING OUTCOMES**

**On successful completion of this module the student will:**

1. Operate equipment management and quality management systems (QMS) both electronic and manual to support all aspects of equipment management activities.
2. Apply equipment management processes to assist in the management of rental and loan equipment.
3. Perform any appropriate electrical or mechanical safety testing procedures for a range of mobility, posture, environmental and communication equipment.
4. Perform audit and checks on the work of third-party service providers.
5. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

## CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Observe the equipment management process through the department, identifying, recording and commenting on any appropriate documentation that may apply to each stage, including the passage of central alerting system through the department and explaining the processes that are followed.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 1 | Log on to electronic inventory or obtain paper record) system and locate:<br>• an individual item of equipment;<br>• particular types/groups of equipment;<br>• appropriate manuals, maintenance, calibration and repair SOPs or SOPs/protocols. | • The specialist roles and individuals associated with them with respect to the equipment management and quality management systems and processes.<br>• Manuals, maintenance, calibration and repair SOPs or SOPs/protocols within an electronic inventory.<br>• Manuals, maintenance, calibration and repair SOPs or SOPs/protocols within a paper-based inventory system.<br>• Document version control system in use and how to work within this system.<br>• Quality systems:<br>○ general requirements, control of documentation, control of records, responsibility, authority and communication, planning of activities and resources, protocols and processes, identification and traceability, analysis and improvement, audit;<br>○ record keeping – applies to all aspects of the equipment life cycle (electronic or paper);<br>○ equipment information, including:<br>▪ warranty documents, manuals, certificates of conformity, protocols, safety test records, acceptance test records maintenance and repair records, decontamination records, risk assessments.<br>• Data storage and retrieval.<br>• Electronic systems in clinical engineering.<br>• How to access any work schedules on the electronic records system. |
| 1 | Complete electronic records for new entries on to the inventory system after PPM, repair, calibration, decontamination, decommissioning, etc., updating records as necessary. | |
| 1 | Operate stock control systems that are in place, participating in the management of spares and consumables, including the | • How to maintain adequate stock levels.<br>• Electronic stock control systems:<br>○ purchase of spares and consumables;<br>○ purchasing processes; |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | maintenance of stock levels. | ○ purchasing authority. |
| 2 | Access indemnity forms and NHS delivery forms and select the appropriate indemnity form to be completed for given circumstances. | • Major types of equipment obtained on loan/rental basis.<br>• NHS standards for loan equipment and indemnity. |
| 2 | Access the register of suppliers through the DH website and interpret and use the information appropriately. | • How to access the register of suppliers through the DH website. |
| 2 | Use record systems to determine:<br>• equipment on rental or loan and rental/loan period that applies;<br>• the responsibilities of the organisation with regard to rental/loan equipment. | • Level of maintenance/repair activity, consumable replacements, decontamination, etc., in equipment in relation to rental/loan equipment. |
| 3 | Unpack equipment in a safe manner and check and confirm all items are as per the delivery note and the original order. | • Relevant health and safety regulations.<br>• The importance of comparing the delivery note with the contents of the package.<br>• Actions to be taken in the event of missing or damaged items. |
| 3 | Examine equipment, cables, accessories and consumables for damage, ensuring the equipment has appropriate markings, e.g. model, serial number, CE mark, electrical type and classification, etc. | • Relevant health and safety regulations.<br>• Type and purpose of markings on new equipment, including CE mark.<br>• Actions to be taken in the event of damaged items, inappropriate CE mark, etc. |
| 3 | Complete acceptance documentation, collecting all relevant information for inventory system. | • The importance of completing acceptance documentation in an accurate and timely manner. |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 3 | Where necessary assemble equipment and fit any consumables according to instructions. | • Tests or checks necessary for new equipment.<br>• How to select appropriate test equipment. |
| 3 | Select test equipment and perform any appropriate electrical safety test procedures, following manufacturer or locally agreed SOPs/protocols. | • Relevant SOPs for electrical safety testing.<br>• Relevant protocols procedures for electrical safety testing.<br>• Safety testing of portable medical devices, complex medical devices and systems.<br>• Safety testing fixed installations of complex medical devices and systems. |
| 3 | Perform any appropriate mechanical safety tests procedures, following manufacturer or locally agreed SOPs/protocols. | • Relevant SOPs for mechanical safety testing.<br>• Relevant protocols procedures for mechanical safety testing.<br>• How to perform mechanical safety tests. |
| 3 | Perform any appropriate calibration or set-up procedures, following manufacturer or locally agreed SOPs/protocols. | • Calibration/Quality assurance:<br>  ○ calibration procedures;<br>  ○ measurement principles:<br>  ▪ reliability, repeatability, validity, limitations;<br>  ○ appropriate calibration equipment.<br>• SOP for performing calibration and set-up procedures.<br>• How to perform calibration and set up procedures. |
| 3 | Perform any appropriate functional tests where necessary, following manufacturer or locally agreed SOPs/protocols. | • The range of mobility, posture, environmental and communication equipment in use.<br>• Safety controls and systems associated with the device operation.<br>• Typical set-up procedures, including, limits and alarms, and how they may affect the practical operation of the equipment.<br>• Installation, maintenance, repair, testing, calibration and environmental issues encountered with equipment in a range of clinical environments, |
| 3 | Record clear and unambiguous information, including test results and log them according to the local SOPs/protocols. | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| 3 | Store the equipment and consumables correctly to ensure the equipment remains fit for purpose and ready to use. | including knowledge of the electrical infrastructure, the requirement of uninterruptable power supplies and possible sources of interference and interaction between devices.<br>• Safety testing of the range of mobility, posture, environmental and communication equipment in use.<br>• Technical implications and challenges associated with equipment being brought into the clinical environment.<br>• SOPs for equipment storage and installation.<br>• How to perform function tests.<br>• Record-keeping procedures.<br>• Health and safety procedures, including infection prevention control techniques to the testing procedures.<br>• Local systems to assess operator, technical, service, quality management.<br>• How to undertake a visual inspection of equipment.<br>• Why earth bonding points are or are not appropriate for the test being performed. |
| 3 | Confirm the suitability of the installation site for the equipment. | |
| 3 | Install the equipment and perform a handover of the equipment into service following acceptance test. | |
| 3 | Select suitable test and simulation equipment. | |
| 3 | Select and apply the appropriate standards and limits for the equipment under test. | |
| 3 | Perform a full range of visual inspections on the equipment. | |
| 3 | Operate a PAT. | |
| 3 | Where equipment has programmable features, adjust or confirm these with the agreed equipment set-up. | |
| 3 | Use test equipment or other means to check the calibration of the equipment by confirming that the input or output is within the specification. | |
| 3 | Perform any appropriate functional tests where necessary, following manufacturer or locally agreed | |

| KEY LEARNING OUTCOMES | COMPETENCES | KNOWLEDGE AND UNDERSTANDING |
|---|---|---|
| | SOPs/protocols. | |
| 4 | Perform audits and checks on the work of third-party service providers for a range of services within the rehabilitation engineering environment. | • Manufacturer or locally agreed SOPs. |
| 4 | Document the performance of the service provider against agreed measures to enable a decision on compliance with the contract to be made. | • Requirement for clear and unambiguous records. |
| 5 | Maintain a professional and courteous attitude at all times. | • *Good Scientific Practice*. |
| 5 | Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access. | • *Good Scientific Practice*.<br>• Local requirements for dress and behaviour in specific areas of work placement. |
| 5 | Work constructively and effectively as a member of a MDT. | • The underpinning principles of effective teamwork and working within and across professional boundaries. |
| 5 | Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD. | • Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.<br>• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes.<br>• How continuous personal development can improve personal performance. |

# SECTION 15: APPENDICES

# Appendix 1: Contributor List

**Contributors to BSc (Hons) curriculum in Clinical Engineering**
The BSc curriculum for Clinical Engineering has been co-ordinated by the Modernising Scientific Careers (MSC) team working with professional colleagues in Clinical Engineering in each of the four specialisms of Clinical Engineering within this programme.

**The Clinical Engineering curriculum working group since first publication:**

**To 2015**

| | |
|---|---|
| Shaun Atherton | Christie Hospital NHS Trust, Manchester |
| Paul Blackett | Lancashire Teaching Hospitals NHS Foundation Trust |
| Gerry Boyle | St James's Hospital, Dublin |
| Douglas Cartwright | Coventry University |
| Andy Fielder | Royal Devon and Exeter Hospital |
| David Gandy | Guy's and St Thomas' NHS Foundation Trust, London |
| David Harrison | West Midlands Rehabilitation Centre, Birmingham |
| Phil Harrison | Newcastle Hospitals NHS Fondation Trust |
| Andy Iles | Bristol Haematology and Oncology Centre |
| Andy Mosson | Churchill Hospital Renal Unit, Oxford |
| Paul Robbins | Papworth Hospital NHS Foundation Trust, Cambridge |
| Stuart Slade-Carter | Churchill Hospital, Oxford |
| Dimitar Stefanov | Coventry University |
| Bob Wheller | Leeds Teaching Hospital NHS Trust |

The BSc curriculum for Clinical Engineering has also been circulated to the following professional bodies and societies for their comments and contributions:

AIME – The Association of Institutions concerned with Medical Engineering
ART – Association of Renal Technologists
IET – Institute of Engineering and Technology
IHEEM – Institute of Healthcare Engineering and Estate Management

IPEM – Institute of Physics and Engineering in Medicine
RESMaG – Rehabilitation Engineering Service Managers Group
VRCT – Voluntary Register of Clinical Technologists

**2015 revision**

**Lead Editor**

| | |
|---|---|
| **Richard Scott** | **Sherwood Forest Hospitals NHS FT and National School of Healthcare Science** |
| David Calder | Calder Sherwood Forest Hospitals NHS Foundation Trust |
| Doug Cartwright | Coventry University |
| Mike Heelis | Birmingham Community Healthcare NHS Trust |
| Antony Hill | University of the West of England |
| Max McClements | Addenbrookes Hospital, Cambridge University Hospitals NHS Foundation Trust |
| Roger Moore | New Cross Hospital, Royal Wolverhampton NHS Trust |
| Ian Threlkeld | Bradford Teaching Hospitals NHS Foundation Trust |
| Bob Wheller | Leeds Teaching Hospitals NHS Trust |

In addition to the professionals detailed above 23 patient groups, 54 professional bodies/groups and 26 PTP accredited Higher Education Institutions were alerted to the opportunity to feedback on the proposed revisions to the scientific content between December 2015 and February 2016.

# Appendix 2: Programme Amendments
**March 2016**

### Generic Changes
The BSc (Hons) curriculum has been amended and is now presented in a single document which includes both the BSc syllabus and the work-based Learning Guide.

The Introduction (Section 1) has been updated and amended to reflect the totality of the curriculum and apprenticeships. A background to the Modernising Scientific Career (MSC) programme has been added and the importance of *Good Scientific Practice* (GSP) in setting the standards of practice in healthcare science has been emphasised. There has been additional information and emphasis in areas such as: entry routes, progression, patient and public involvement, accreditation through the National School of Healthcare Science, programme delivery and monitoring, student support and mentoring and clarity about a number of issues around programme delivery.

Key professional practice learning outcomes have been added through the GSP syllabus (Section 3), which embeds the standards of professionalism set out in GSP in all aspects of the delivery and assessment of the programme. The GSP syllabus is a common component of all PTP curricula and must be followed throughout the whole training period, with engagement at the appropriate level, depending on the stage of training.

The Professional, Scientific and Technical modules (Section 4) have been revised.

### Clinical Engineering
- The essential content of the specialisms was felt to be appropriate as it provided a basic foundation on which to build by experience in the workplace, hence no major omissions were identified.
- Basic electrical, electronic and mechanical engineering skills are a core set of skills that have been strengthened in the curriculum (but advanced electronics knowledge is not required).
- Newly qualified practitioners will not be doing device design and development – this was felt to be an advanced practice so the module on design and development was reviewed. They would however become involved in device modification so the need to understand the underpinning legislation and best practice has been recognised.
- The level of mathematic content should be such that it provides practical working knowledge applicable to the workplace rather than coverage of more abstract concepts. This module is now shared with the Medical Physics curriculum.

- Computing in the curriculum has been reviewed to ensure it was consistent with expectations in practice.
- While the requirement to gain a workplace introduction into all areas of Clinical Engineering in the first year remains, greater flexibility has been introduced so that there do not to be equal periods of time in each specialism.

**April 2017**

The recommended number of assessments per year on p.20 was clarified and a table added to illustrate this. The new version of the curriculum is PTP Clinical Engineering Version 1.01 2016.

**For any queries regarding this change please email:** nshcs@wm.hee.nhs.uk

# Appendix 3: Abbreviations

### Generic abbreviations

| | |
|---|---|
| AHCS | Academy for Healthcare Science |
| AO | Assessment Organisation |
| APL | Accreditation of Prior Learning |
| BSc | Bachelor of Science |
| CAS | Central Alerting System |
| CBD | Case Based Discussion |
| CEL | Clinical Experiential Learning |
| COSHH | Control of Substances Hazardous to Health |
| CPD | Continuing Professional Development |
| CPPD | Continuing Personal and Professional Development |
| CSO | Chief Scientific Officer |
| CT | Computer Tomography |
| DH | Department of Health |
| DICOM | Digital Image and Communications in Medicine |
| DfE | Department for Education |
| DOPs | Direct Observation of Practical skills |
| EPA | End-point Assessment |
| ETSG | Education and Training Scrutiny Group |
| ETWG | Education and Training Working Group |
| EU | European Union |
| FHEQ | Framework for Higher Education Qualifications |
| FtP | Fitness to Practise (FtP) |
| GCP | Good Clinical Practice |
| GM | Generic Module (Professional, Scientific and Technical) |
| GSP | Good Scientific Practice |
| HCPC | Health and Care Professions Council |

| | |
|---|---|
| HCS | Healthcare Science |
| HCSP | Healthcare Science Practitioner |
| HEE | Health Education England |
| HEI | Higher Education Institutions |
| HL7 | Health Level 7 |
| IBMS | Institute of Biomedical Science |
| ICT | Information and Communication Technologies |
| IOE | Institute of Education |
| IT | Information Technology |
| LETB | Local Education and Training Board |
| MDA | Medical Device Alerts |
| MDT | Multidisciplinary Team |
| MHRA | Medicines and Healthcare products Regulatory Agency |
| MRI | Magnetic Resonance Imaging |
| MSC | Modernising Scientific Careers |
| NES | NHS Education for Scotland |
| NICE | National Institute for Health and Care Excellence |
| NIHR | National Institute for Health Research |
| NHS | National Health Service |
| NSHCS | National School of Healthcare Science |
| OCE | Observed Clinical Event |
| OLAT | Online Assessment Tool |
| PACS | Picture Archiving and Communications Systems |
| PSA | Professional Standards Authority |
| PTP | Practitioner Training Programme |
| QA | Quality Assurance |
| QAA | Quality Assurance Agency |
| QC | Quality Control |
| QMS | Quality Management System |
| RoAAO | Register of Apprenticeship Assessment Organisations |

| | |
|---|---|
| RoATP | Register of Apprenticeship Training Providers |
| SCQF | Scottish Credit and Qualifications Framework |
| SFA | Skill Funding Agency |
| SJT | Situational Judgement Test |
| SPECT | Single Photon Emission Computed Tomography |
| UCAS | The Universities and Colleges Admissions Service |
| UK | United Kingdom |

**Programme Specific Abbreviations (Clinical Engineering)**

| | |
|---|---|
| AAC | Augmentative and Alternative Communication systems |
| ALARA | As Low as Reasonable Achievable |
| BS | British Standards |
| CAPD | Continuous Ambulatory Peritoneal Dialysis |
| CE | Clinical Engineering |
| CEME | Clinical Engineering: Medical Engineering |
| CERE | Clinical Engineering: Radiation Engineering |
| CERhE | Clinical Engineering: Rehabilitation Engineering |
| CERT | Clinical Engineering: Renal Technology |
| COSHH | Control of Substance Hazardous to Health |
| ECG | Electrocardiogram |
| EEG | Electroencephalogram |
| EMC | Electromagnetic Compatibility |
| EMG | Electromyography |
| EMI | Electromagnetic interference |
| EN | European Normal |
| FES | Functional Electrical Stimulation |
| GP | General Practice |
| HDF | Haemodiafiltration |
| HF | Haemofiltration |

| | |
|---|---|
| IEC | International Electrotechnical Commission |
| ICF | International Classification of Functioning, Disability and Health |
| IGRT | Image Guided Radiotherapy |
| IMRT | Intensity Modulated Radiotherapy |
| IPD | Intermittent Peritoneal Dialysis |
| ISO | International Standards Organisation |
| MLC | Multi-leaf Collimation |
| NPD | Nightly Peritoneal Dialysis |
| PFD | Paired Filtration Dialysis |
| RF | Radio Frequency |
| RoHS | Restriction of Hazardous Substances |
| RPA | Radiation Protection Adviser |
| RPS | Radiation Protection Supervisor |
| RRT | Renal replacement therapy |
| TPD | Tidal Peritoneal Dialysis |
| WEEE | Waste Electrical and Electronic Equipment |

# Appendix 4: Glossary

| Term | Definition |
|---|---|
| **Clinical experiential learning** | The cyclical process linking concrete experience with abstract conceptualisation through reflection and planning. |
| **Clinical experiential learning outcomes** | The activities that the student will undertake to enable and facilitate their learning in the workplace. |
| **Competence** | The ability of an individual to perform a role consistently to required standards, combining knowledge, understanding, skills, attitudes, behaviour and values. |
| **Competence statements** | Active and outcome-based statements that provide a further breakdown of the work-based Learning Outcomes – reflecting what the student will be able to do in the workplace at the end of the programme. Each competence should be linked back to the numbered Learning Outcomes. |
| **Component** | An indication of the type of module within the curriculum, i.e. Generic, Theme or Specialist. |
| **Curricula** | An outline of the expected educational outcomes across a subject area. The learning that is expected to take place during the Practitioner Training Programme described in terms of knowledge, skills, attitudes, behaviours and values. |
| **Division** | A high-level description of an area of practice within healthcare science. There are four divisions: Life Sciences, Physical Sciences, Physiological Sciences and Clinical Bioinformatics. |
| **Domains of learning** | Cognitive (knowledge and intellectual skills), affective (feelings and attitudes), interpersonal (behaviour and relationships with others) and psychomotor (physical skills). |
| **Feedback** | Specific information about the comparison between a student's observed performance and a standard, given with the intent of improving the student's performance (van de Ridder JMM, Stokking KM, McGaghie WC and ten Cate OT. What is feedback in clinical education? *Medical Education* 2008: 42: 189–197). |
| **Good Scientific Practice** | Non-statutory guidance on the minimum requirements for good practice for the healthcare science workforce. |
| **Job** | A specific definition of the work activities, requirements and skills required to undertake work activities within a local context. This differs from a role – see below. |
| **Key learning** | A defined learning outcome linked to relevant competence(s) within the work-based Learning |

| Term | Definition |
|---|---|
| **outcome** | Framework. |
| **Learning framework** | The specification for work-based learning contained within the work-based syllabus. |
| **Learning outcome** | A high-level, outcome-based statement that describes what a student will be able to do at the end of the module. |
| **Mentoring** | Mentoring is *a process in which a trainer (mentor) is responsible for overseeing the career and development of the student.* The emphasis is therefore on the relationship (rather than the activity). |
| **Module aim** | The overall objective of a module – defining the intended learning achievements of the student. The aim works together with the 'Scope' statement to define the overall objectives and scope of the module. |
| **Module scope** | A statement within a module that defines the range/limits of the learning undertaken by the student in a module – patients/investigations/equipment/modalities, etc. |
| **National Occupational Standards** | Nationally recognised standards of expected workplace performance and level of competence for a role. The standards are outcome based, defining what the role holder should to be able to do, as well as what they must know and understand to demonstrate competent work performance. National Occupational Standards are supported by nationally agreed frameworks of expected attitudes, behaviours and skills. |
| **Practical skill** | A cognitive, psychomotor, physical, or communicative ability that supports performance of the required role. |
| **Programme** | The package of learning, teaching assessment and quality assurance leading to an award. |
| **Provider** | An organisation that delivers required training and learning activities to specified quality assurance requirements. |
| **Role** | A collection of functions undertaken in the workplace that represent the main broad areas of work for all similar workers at national level. A role differs from a job, the latter being defined specifically for a local context. |
| **Specialism** | A focused area of practice within a division of healthcare science. |
| **Trainer** | A qualified individual who provides learning and development support for students. |
| **Theme** | A group of related specialisms usually within a division of healthcare science. |
| **Work-based learning** | Learning that takes place in a real work setting and involves the application of academic learning to real work activities. |
| **Work performance** | The requirements of satisfactory and consistent demonstration of competence in specified functions for a |

| Term | Definition |
|---|---|
| | work role. |
| **Workplace** | A real work setting in which the student can apply learning. |

# Appendix 5: Assessment Proformas

## A5.1: Direct Observation of Practical/Procedural Skills Template

| Student identification data | | | |
|---|---|---|---|
| **Procedure** | | | |
| **Clinical context** | **Insert module title** | **Insert module title** | **Insert module title** |

| **Assessor's name** | | | | | |
|---|---|---|---|---|---|
| **Assessor's position** | | | | **Insert** | **Insert** |

| **Difficulty of the procedure** | | **Low** | **Average** | **High** |
|---|---|---|---|---|
| **Number of times procedure performed by student** | | **1–4** | **5–9** | **>10** |
| | | | | |

| **Please grade the following areas using the scale below** | **Below expectations** | **Borderline** | **Meets expectations** | **Above expectations** | **Unable to comment[1]** |
|---|---|---|---|---|---|
| **1. Understands scientific principles of procedure, including basic science underpinning it** | | | | | |

| Please grade the following areas using the scale below | Below expectations | Borderline | Meets expectations | Above expectations | Unable to comment[1] |
|---|---|---|---|---|---|
| **2. Has read, understands and follows the appropriate standard operating procedures, risk and COSHH assessments, and any other relevant health and safety documentation** | | | | | |
| **3. Understands and applies the appropriate internal and external quality control associated with the procedure** | | | | | |
| **4. Understands the risks associated with items of equipment and uses them appropriately** | | | | | |
| **5. Completes associated documentation accurately** | | | | | |
| **6. Output meets accepted laboratory/professional standards** | | | | | |
| **7. Carries out the procedure within the appropriate time frame** | | | | | |

| Please grade the following areas using the scale below | Below expectations | Borderline | Meets expectations | Above expectations | Unable to comment[1] |
|---|---|---|---|---|---|
| 8. Is aware of the limitations of the test | | | | | |
| 9. Demonstrates awareness of the limits of responsibility and when to seek advice | | | | | |
| 10. Professionalism | | | | | |

**[1]Please mark this if you have not observed the behaviour.**

| FEEDBACK AND DOCUMENTATION OF LEARNING NEEDS | AGREED ACTION |
|---|---|
| | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Outcome** | **Satisfactory**<br>**Unsatisfactory** | | **Date of assessment** | | **Time taken for assessment** | |
| **Signature of assessor** | | **Signature of student** | | | **Time taken for feedback** | |

**A5.2: Case-based Discussion Template**

| Student identification data | | | |
|---|---|---|---|
| **Brief description of output and focus of scenario discussed** | | | |
| **Module** | **Insert title** | **Insert title** | **Insert title** |
| **Complexity of the scenario** | **Low** | **Average** | **High** |

| | |
|---|---|
| **Assessor's name** | |
| **Assessor's position** | |

| **Please grade the following areas using the scale below** | **Below expectations** | **Borderline** | **Meets expectations** | **Above expectations** | **Unable to comment**[1] |
|---|---|---|---|---|---|
| **1. Understands clinical and/or scientific principles relevant to scenario** | | | | | |
| **2. Can discuss relevant health and safety issues** | | | | | |

| Please grade the following areas using the scale below | Below expectations | Borderline | Meets expectations | Above expectations | Unable to comment[1] |
|---|---|---|---|---|---|
| **3. Can discuss the procedures used to obtain the results** | | | | | |
| **4. Can discuss the quality control procedures to ensure the result is accurate** | | | | | |
| **5. Demonstrates a knowledge of relevant 'Best Practice' guidelines and other policies relevant to the scenario** | | | | | |
| **6. Can discuss the significance of routine patient results with reference to the reason for referral** | | | | | |
| **7. Is aware of, and can use as required, appropriate resources to aid in the interpretation of results** | | | | | |
| **8. Is aware of the importance of the audit trail and can complete the audit trail accurately** | | | | | |

| Please grade the following areas using the scale below | Below expectations | Borderline | Meets expectations | Above expectations | Unable to comment[1] |
|---|---|---|---|---|---|
| **9. Demonstrates awareness of the limits of responsibility and when to seek advice** | | | | | |
| **10. Professionalism** | | | | | |

[1]Please mark this if you have not observed the behaviour.

| FEEDBACK AND DOCUMENTATION OF LEARNING NEEDS | AGREED ACTION |
|---|---|
| | |

| Outcome | Satisfactory Unsatisfactory | | Date of assessment | | Time taken for assessment | |
|---|---|---|---|---|---|---|
| Signature of | | Signature | | | Time taken for feedback | |

| | | | | | |
|---|---|---|---|---|---|
| **assessor** | | **of student** | | | |

**A5.3: Observed Clinical Event Template**

| Student identification data | | | |
|---|---|---|---|
| **Brief description of output and focus of scenario discussed** | | | |
| **Module** | **Insert title** | **Insert title** | **Insert title** |
| **Complexity of the scenario** | **Low** | **Average** | **High** |

| | |
|---|---|
| **Assessor's name** | |
| **Assessor's position** | |

| **Please grade the following areas using the scale below** | **Below expectations** | **Borderline** | **Meets expectations** | **Above expectations** | **Unable to comment[1]** |
|---|---|---|---|---|---|
| **1. History taking**<br>*Does the student obtain the information required prior to undertaking a procedure from the patient or a clinical colleague?* | | | | | |
| **2. Communication skills**<br>*e.g. Does the student use language appropriate to the situation (verbal and/or body language) when explaining or discussing an aspect of clinical care (test results, diagnostic procedure, equipment repair at the bedside), do they check the understanding of the patient or their* | | | | | |

| **Please grade the following areas using the scale below** | **Below expectations** | **Borderline** | **Meets expectations** | **Above expectations** | **Unable to comment[1]** |
|---|---|---|---|---|---|
| *colleague?* | | | | | |
| **3. Clinical examination skills**<br>*e.g. Does the student undertake a clinical skill, such as locating a vein for phlebotomy, performing a diagnostic test appropriately and accurately?* | | | | | |
| **4. Clinical judgement**<br>*e.g. Is the procedure correct for the required outcome?* | | | | | |
| **5. Scientific judgement**<br>*e.g. Was the choice of equipment appropriate for the required outcome, has it been correctly calibrated and any necessary settings correctly applied?* | | | | | |
| **6. Professionalism**<br>*e.g. Did the student introduce themselves and their role or did they discuss the procedure/result with a colleague using appropriate language, considering any patient confidentiality or ethical issues?* | | | | | |
| **7. Organisation and efficiency**<br>*e.g. Was the student well organised and efficient, ensuring all record keeping was appropriate and accurate; did they keep to time and ensure accurate recording of results; did they process the results in a timely fashion?* | | | | | |

| **Please grade the following areas using the scale below** | **Below expectations** | **Borderline** | **Meets expectations** | **Above expectations** | **Unable to comment[1]** |
|---|---|---|---|---|---|
| **8. Overall clinical care**<br>*e.g. Did the student show respect, empathy and compassion for the patient and/or recognise the importance of the procedure/test within the care pathway for the patient or colleagues where the test contributes to a diagnosis, treatment or management?* | | | | | |

For specific examples of opportunities where an OCE may be appropriate please visit the National School of Healthcare Science website (www.nshcs.org.uk/).

# Appendix 6: Further Information

## NHS Networks

An open network to share curricula produced for the Modernising Scientific Careers (MSC) programme.
www.networks.nhs.uk/nhs-networks/msc-framework-curricula/

Details of the Practitioner Training Programme including curricula from 2010/11 to 2015/16 can be found at:
www.networks.nhs.uk/nhs-networks/msc-framework-curricula/ptp

Details of the Practitioner Training Programme including curricula from 2016 onwards can be found at:
https://www.nshcs.hee.nhs.uk/

## National School of Healthcare Science (NSHCS)

As part of the Modernising Scientific Careers (MSC) programme, the National School of Healthcare Science (the School) was established in October 2011 to support the implementation and delivery of the new healthcare science education and training programmes and to comply with the structures within 'Liberating the NHS: Developing Healthcare Workforce - Policy 16977 (January 2012)' acting on behalf of the Chief Scientific Officer (CSO) for England. It also provides some elements of support for the three other UK health departments.

On 1st April 2013, the School became part of Health Education England (HEE) and is hosted within the West Midlands.
The role of the NSHCS includes:

- Curricula management including assessment (new developments; review; fitness for purpose; version control etc);
- Coordination and monitoring of MSC Education and Training implementation;
- Quality management including accreditation of academic and work-based training environments;
- Monitoring and supporting the progress of trainees through the NSHCS themed boards (STP/HSST).

www.nshcs.org.uk

## Chief Scientific Officer (CSO)

Source of information and news, including the CSO Bulletin, latest press releases, publications and consultations can be found at:
https://www.england.nhs.uk/tag/chief-scientific-officer/

## Academy for Healthcare Science (AHCS)

The Academy for Healthcare Science (AHCS) brings together the UK's diverse and specialised scientific community who work across the health and care system including; NHS Trusts, NHS Blood and Transplant, Public Health England, independent healthcare organisations, and the academic sector across the UK.

The AHCS runs a Professional Standards Authority accredited Register for Healthcare Science Practitioners not covered by statutory regulation.
www.academyforhealthcarescience.co.uk/

## Council of Healthcare Science in Higher Education (CHSHE)

The Council of Healthcare Science in Higher Education builds a unified identity of academic healthcare science by representing the interests of the sector. Working to improve and maintain quality in healthcare science education and training, the Council itself is made up of senior members of the academic healthcare science team. The work of the Council is also informed by two special interest groups made up of staff involved in the delivery and implementation of MSC programmes the PTP SIG and STP SIG.
www.councilofhealthcarescience.ac.uk/

## Health and Care Professions Council (HCPC)

The Health and Care Professions Council is a regulator set up to protect the public. It keeps a register of health professionals who meet the HPC standards for their training, professional skills, behaviour and health.
www.hpc-uk.org/

*Last Accessed 16th November 2016*