University of the West of Scotland
Module Descriptor

Session: 2022/23

Title of Module: Thin Film Characterisation			
Code: PHYS11014	**SCQF Level: 11** (Scottish Credit and Qualifications Framework)	**Credit Points: 20**	**ECTS: 10** (European Credit Transfer Scheme)
School:	School of Computing, Engineering and Physical Sciences		
Module Co-ordinator:	Shigeng Song		

Summary of Module

The module offers advanced study at Level 11 of the thin film physics that underpins the critical understanding of thin film properties and their analysis. It is suitable for all Level 10 students with an undergraduate science/materials related degree, and is a core module for students enrolled on the Masters in Thin Films programme at UWS. The module is intended to teach fundamental principles in the analysis and characterisation of optical, electrical, magnetic, structure, surface and mechanical properties related to thin films.
The module will also cover theoretical/experimental/analytical skills, and computational skills (particularly data analysis), providing students with a range of techniques (standard and specialised) to use in their studies and future work. The course material will primarily be delivered in lectures. The module also includes practical classes, which will enable students to practice applying the principles covered in the lectures. Part of the practical element is laboratory based (e.g. lab session to study optical analysis of thin films using spectrophotometer and ellipsometry, structure analysis using XRD, surface analysis using SEM and AFM, and elemental analysis using EDX), This module also involves programming for data fitting and thin film simulation, using computing skills to enhance study, and to allow improved critical evaluation of a wide range of numerical and graphical data. There is online support for this module on the Moodle internet resource (examples in Mathcad). This module is assessed by course work, mini-projects and written examination

- 1 Determination of structure, surface and morphology of thin film on a macroscopic & microscopic scale and atomic scale using techniques such as optical microscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), scanning probe & atomic force microscopies (STM & AFM), stylus profilometer, X-ray diffraction (XRD), low energy electron diffraction (LEED), and reflection high energy electron diffraction (RHEED);

- 2 Elemental, impurities, chemical states analysis using Auger Electron Spectroscopy (AES), Energy Dispersive Analysis of X-rays (EDAX), X-ray Photoelectron Spectroscopy (XPS), Secondary Ion Mass Spectrometry (SIMS), Rutherford Backscattering (RBS), and Raman analysis;

- 3 Optical properties of thin film such as dispersion of refractive index, absorption, dielectric properties using techniques of spectrophotometry (transmission, reflection), ellipsometry, light scattering, and interferometry. Surface roughness, uniformity, homogeneity can also be obtained using optical methods;

- 4 Electrical properties of thin film, particularly for electronic devices such as resistance / conductance, capacitance, also including carrier density and mobility

of semiconductor film using techniques of four point probe, impedance analysis, hall effect and TFT measurement.

- 5 Magnetic properties of thin film such as hysteresis loops, magneto-optical Kerr effect (MOKE), and ferromagnetic resonance (FMR)

- 6 The mechanical properties of the thin film: internal stress in films / substrates, friction, adhesion using stress curvature measurements, pin on disk friction test, adhesion tests; hardness and young modulus using Macro/nano indentation technique.

- The Graduate Attributes relevant to this module are given below. Academic: Critical thinker; analytical; inquiring; knowledgeable; digitally literate; problem solver; autonomous; incisive; innovative. Personal: Effective communicator; influential; motivated Professional: Collaborative; research-minded; enterprising; ambitious; driven

Module Delivery Method

Face-To-Face	Blended	Fully Online	HybridC	HybridO	Work-based Learning
	✓				

Face-To-Face
Term used to describe the traditional classroom environment where the students and the lecturer meet synchronously in the same room for the whole provision.
Blended
A mode of delivery of a module or a programme that involves online and face-to-face delivery of learning, teaching and assessment activities, student support and feedback. A programme may be considered "blended" if it includes a combination of face-to-face, online and blended modules. If an online programme has any compulsory face-to-face and campus elements it must be described as blended with clearly articulated delivery information to manage student expectations
Fully Online
Instruction that is solely delivered by web-based or internet-based technologies. This term is used to describe the previously used terms distance learning and e learning.
HybridC
Online with mandatory face-to-face learning on Campus
HybridO
Online with optional face-to-face learning on Campus
Work-based Learning
Learning activities where the main location for the learning experience is in the workplace.

Campus(es) for Module Delivery

The module will **normally** be offered on the following campuses / or by Distance/Online Learning: (Provided viable student numbers permit)

Paisley:	Ayr:	Dumfries:	Lanarkshire:	London:	Distance/Online Learning:	Other:
✓						

Term(s) for Module Delivery					
(Provided viable student numbers permit).					
Term 1		Term 2	✓	Term 3	

Learning Outcomes: (maximum of 5 statements)
On successful completion of this module the student will be able to: L1. L1. Gain critical understanding in the methods of thin film characterization for the aspects defined in the brief outline of the syllabus. L2. L2. Have a deeper understanding of the physics, chemistry and other science background for thin film characterization for the aspects defined in the brief outline of the syllabus, thus allowing better understanding and integration of these related fields. L3. L3. Gain a range of practical skills for performing data analysis using maths and program skills for thin film characterization, undertaking critical evaluations of various relevant data. L4. L4. Be able to critically evaluate analysis and extract thin film properties with understanding of limitation and accuracy of analytical methods; therefore be able to apply the obtained answers to carry out relevant thin film device design correctly.

Employability Skills and Personal Development Planning (PDP) Skills	
SCQF Headings	During completion of this module, there will be an opportunity to achieve core skills in:
Knowledge and Understanding (K and U)	SCQF Level 11. 1. Critical understanding of physics and chemical as applied to thin film characterization principles and concepts 2. Critical understanding of required theoretical basis of thin film characterisation 3. Extensive, detailed and critical knowledge and understanding implementation of the methods for thin film characterisation 4. Critical awareness of operational/ production issues associated with physical thin film deposition processes 5. Ability to define required thin film characterisation methodologies in relation to end applications.
Practice: Applied Knowledge and Understanding	SCQF Level 11. 1. Understanding of core thin film characterisation principles, methodologies and techniques as applied in different application/ product-based industries 2. Understand and adopt/apply best practice in thin film characterisation methods for effective ultimate use 3. Execute standard and specialised physical thin film characterisation methods to deliver maximum value for end user cost effective research, development and/ or production 4. Develop and implement a mind-set of continuous improvement in relation to thin film characterisation methods, to facilitate application of learnt skills in varied professional contexts.
Generic Cognitive skills	SCQF Level 11. 1. Apply critical analysis, evaluation and synthesis to issues which are at the forefront of, or informed by, developments at the forefront of thin

	film characterisation methods, processes and hardware and control. 2. Identify, conceptualise and define new and abstract problems and issues related to the inherent difficulty of the process of extracting mathematical modelling, simulations and evaluation of real thin film analysis. 3. Critically review, consolidate and extend knowledge, skills practices and thinking in thin film characterisation 4. Understand the complex multi-parametric nature of thin film characterisation processes and hardware and professionally implement best practice research and/ or design of experiments for cost effective implementation.	
Communication, ICT and Numeracy Skills	SCQF Level 11. 1. Communicate effectively with peers, senior colleagues and specialists. 2. Use a range of thin film characterisation software and programming for the characterisation of thin film properties. 3. Undertake critical evaluations of the limitations and accuracies of thin film characterisation methods.	
Autonomy, Accountability and Working with others	SCQF Level 11. 1. Exercise substantial autonomy and initiative in professional and equivalent activities. 2. Take responsibility for own work (i.e. independent learner). 3. Take responsibility for a significant range of resources beyond minimum requirements. 4. Demonstrate leadership and/or initiative and make an identifiable contribution to change and development (i.e. flipped classroom environment). 5. Practise in ways which draw on critical reflection on own roles.	
Pre-requisites:	Before undertaking this module the student should have undertaken the following:	
	Module Code:	**Module Title:**
	Other:	
Co-requisites	**Module Code:**	**Module Title:**

* Indicates that module descriptor is not published.

Learning and Teaching	
Learning Activities During completion of this module, the learning activities undertaken to achieve the module learning outcomes are stated below:	**Student Learning Hours** (Normally totalling 200 hours): (Note: Learning hours include both contact hours and hours spent on other learning activities)
Lecture/Core Content Delivery	20

Tutorial/Synchronous Support Activity	10
Laboratory/Practical Demonstration/Workshop	6
Independent Study	164
	200 Hours Total

****Indicative Resources: (eg. Core text, journals, internet access)**

The following materials form essential underpinning for the module content and ultimately for the learning outcomes:
Essential reading
Ludmila Eckertova, “Physics of Thin Films”, Springer; 2nd edition (1986)

Recommended reading
Brian N. Chapman (Ed), J. C. Anderson (Ed) "Science and Technology of Surface Coating", Academic Press Inc, (1974)
E. D. Palik, “Handbook of Optical Constants of Solids”
H. Mayer, “Physics of thin films Parts”, I and II. (1972)

Supplementary reading
Harald Ibach, "Physics of Surfaces and Interfaces", Springer; (2006)
J. M. Walls, ed. "Methods of Surface Analysis", Cambridge Univ. Press, (1989)

(**N.B. Although reading lists should include current publications, students are advised (particularly for material marked with an asterisk*) to wait until the start of session for confirmation of the most up-to-date material)

Engagement Requirements

Students are academically engaged if they are regularly engaged with timetabled on-campus and online teaching sessions, asynchronous online learning activities, course-related learning resources, and complete assessments and submit these on time. Please refer to the Academic Engagement and Attendance Procedure at the following link: Academic Engagement and Attendance Procedure

Supplemental Information

Programme Board	Physical Sciences
Assessment Results (Pass/Fail)	No
Subject Panel	Physical Sciences
Moderator	Carlos Garcia
External Examiner	D Faux
Accreditation Details	IoP and IET

Changes/Version Number	2.04

Assessment: (also refer to Assessment Outcomes Grids below)
Summative Assessments: Course work: marks from course work with feedback will contribute 30% of the marks; Mini Projects: will contribute 20%; Final Written Examination: will contribute 50%; The course work marks and Mini Project marks will be the average of respective test marks. Failure to attend a test/exam will result in a mark of 0 (zero) in that respective test/exam.
Formative assessments: (1) peer-assessed teamwork and (2) short essays on specific topics The formative assessments must each receive “pass” to achieve final degree.
(N.B. (i) **Assessment Outcomes Grids** for the module (one for each component) can be found below which clearly demonstrate how the learning outcomes of the module will be assessed. (ii) An **indicative schedule** listing approximate times within the academic calendar when assessment is likely to feature will be provided within the Student Handbook.)

Assessment Outcome Grids (Footnote A.)

Component 1

Assessment Type (Footnote B.)	Learning Outcome (1)	Learning Outcome (2)	Learning Outcome (3)	Learning Outcome (4)	Weighting (%) of Assessment Element	Timetabled Contact Hours
Dissertation/ Project report/ Thesis			✓	✓	20	20
Essay	✓	✓			30	0

Component 2

Assessment Type (Footnote B.)	Learning Outcome (1)	Learning Outcome (2)	Learning Outcome (3)	Learning Outcome (4)	Weighting (%) of Assessment Element	Timetabled Contact Hours
Unseen closed book (standard)	✓	✓	✓	✓	50	2
Combined Total For All Components					100%	22 hours

Footnotes
A. Referred to within Assessment Section above
B. Identified in the Learning Outcome Section above

Note(s):

1. More than one assessment method can be used to assess individual learning outcomes.
2. Schools are responsible for determining student contact hours. Please refer to University Policy on contact hours (extract contained within section 10 of the Module Descriptor guidance note).
   This will normally be variable across Schools, dependent on Programmes &/or Professional requirements.

Equality and Diversity
The programme team have considered how the programme meets the requirements of potential students irrespective of age, disability, political belief, race, religion or belief, sex, sexual orientation, social background or any other protected characteristic. Students/participants with special needs (including additional learning needs) will be assessed/accommodated and any identified barriers to particular groups of students/participants discussed with the Enabling Support Unit (for further details, please refer to the UWS Equality, Diversity and Human Rights policy). Further guidance is available from CAPLED, Student Services, School Disability Co-ordinators or the University's Equality and Diversity Co-ordinator. UWS Equality and Diversity Policy
(N.B. Every effort will be made by the University to accommodate any equality and diversity issues brought to the attention of the School)