Course Code ESE-815	Credit Hours (Th-Pr) 3.0-0	**Thin Films (Elective)**	Contact Hrs/Week (Th-Pr) 3.0-0	Total Contact Hrs (Th-Pr) 45-0

Course Outline:

Thin film science and technology have gone through a thorough development which results in numerous new devices (e.g., Light Emitting Diodes (LED), fuel cell and solar cell) and new materials with fundamentally new properties. Topics include, but are not limited to, fundamentals on crystal structures and defects in thin films, the basic nucleation and growth mechanisms of thin films (growth models, lattice matching epitaxy and domain matching epitaxy), thin film processing techniques (CVD, MOCVD, MBE, PLD, Laser-MBE, sputtering, and evaporation etc.), thin film growth instrumentation aspect (energy source, chamber configurations, vacuum systems and growth controllers), and several advanced topics related to electrical and optical devices. Clean room technology.

Eligibility Criteria: B.E (Chemical, Mechanical, Electrical, Environmental and Materials)

Recommended Books:

S. No.	Title	Author(s)	Assigned Code	Remarks
1.	Electronic Thin Film Science for Electrical Engineers and Materials Scientists	K-N Tu, J. W. Mayer and L. C.	KNJ	Text
2.	Materials Science of Thin Films: Deposition and Structure	M. Ohring	MO	Reference
3.	Elements of X-ray Diffraction, 2nd Edition,	B. D. Cullity	BDC	Reference
4	Introduction to	D. Hull and D. J. Bacon	DHD	Reference

	Dislocations			

Course Objectives:

The primary objectives of this course are to familiarize students with practical applications of the principles of thermodynamics to various areas of engineering and operational aspects of deposition techniques to grow thin films to make devices.

Learning outcome:

In conjunction with the solar PV core module, this course will enable the students to differentiate between competing technologies i.e. monocrystalline solar cells & their thin film counterparts. The attendees will become conversant with the critical film fabrication technologies and the various means of characterization of the fabricated product.

Topics Covered:

No.	Topics	Text Book	Contact Hours
1.	Thin film and nanomaterial characterization methods: scanning probe microscopy (AFM, STM, etc.), and electronic and optical spectroscopy (ellipsometry, Raman, XPS, EELS, etc.) Silicon thin film technology: plasma synthesis of nanomaterials, the design and manufacturing of amorphous silicon cells •Copper indium gallium selenide (CIGS) technology: deposition methods, materials and cells • Cadmium telluride (CdTe) technology: materials and cells • Dye-sensitized solar cells • High-efficiency solar cells	KNJ	4
2.	Overview of thin film technology for various industrial Applications; Clean room technology	KNJ	2
3.	Crystal structures of thin films	KNJ	4

	Defects in thin films (vacancies and interstitials, dislocations, grain boundaries etc.) Nanocrystalline, polycrystalline and epitaxial thin films)	+MO	
4.	Interface and surface of thin films	MO+BDC	4
5.	Thin film nucleation and growth models (2D, 3D, and 2D-3D combination)	KNJ	4
6.	Epitaxial growth of thin films Homoepitaxy and heteroepitaxy; Lattice matching epitaxy and domain matching epitaxy; Superlattice structures and quantum wells	MO+BDC	3
7.	Diffusions: inter-diffusion, grain boundary diffusions, reaction, and phase transformation,	KNJ	4
8.	Thin film growth techniques (Physical Vapor Deposition- Thermal evaporation and e-beam evaporation Sputtering, MBE, Laser MBE PLD)	KNJ	4
9.	Thin film growth techniques (Chemical Vapor Deposition-CVD, PECVD, MOCVD)	KNJ	4
10.	Solution based deposition techniques-Sol-Gel, PAD. Liquid phase epitaxy-LPE and other deposition techniques	KNJ	4
11.	Special topics on various thin film devices and fabrications	KNJ+MO	4
12.	General overview of thin film characterization techniques (structural, chemical, and electrical characterizations)	KNJ + MO	4