GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3173907
Semester – VII
Subject Name: LITHOGRAPHY

Type of course: Thin Film Technology

Prerequisite: Physics of Nanomaterials, Characterization of Nanomaterials, Coating Technology, Thin Film Technology

Rationale: To make the students understand the newly developed fabrication, physics and chemistry of multilayered devices.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	0	4	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	PHOTORESISTS Positive and Negative Resists Adhesion Promotion Resist Spin Coating Resist Soft Bake and Hard bake Photochemistry of Resists Acid- Catalyzed DUV Resists	8
2	NANOIMPRINT LITHOGRAPHY Introduction printing to NanoImprint The fabrication of the mold Separating the mold and the resist after imprint: de-embossing The problem Adhesion Adhesion and physico-chemical surface properties Surface treatment of the mold Treatment of the resist Characterization of the demolding process The residual layer problem in NanoImprint The residual layer: a NanoImprint specific issue Is the thickness of the residual layer predictable?	9

	How can the process impact the thickness of the residual layer? Residual layer thickness measurement Macro-scale approach: coherence between film color and thickness	
3	X-RAY LITHOGRAPHY (XRL) Irradiation system for XRL High Resolution and Deep XRL Examples of X-ray lithography beam lines Physics of X-ray lithography How phase and intensity of X-rays are altered by interaction with matter X-ray lithography as a shadow printing technique X-ray absorption in a resist and physical mechanisms involved in its exposure	**8**
4	MATROLOGY FOR LITHOGRAPHY-1 The concept of CD in metrology CD measurement after a lithography stage: definitions What are the metrological needs during a lithography step? Scanning electron microscopy (SEM) SEM principle Matter–electron interaction From signal to quantified measurement Provisional conclusion on scanning electron microscopy	**8**
5	MATROLOGY FOR LITHOGRAPHY-2 3D atomic force microscopy (AFM3D) AFM principle Three-dimensionnal AFM (AFM3D) special features Provisional conclusion on AFM 3D Grating optical diffractometry (or scatterometry) Principle Example: ellipsometry characterization of post development lithography Pros and cons Optical measurements analysis Specificities of scatterometry for CD metrology Scatterometry implementation: R&D versus production New fields for scatterometry	**9**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	**30**	**30**	**10**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. NANOLITHOGRAPHY M Feldman (Editor), ISBN: 9780081014042, Elsevier, Imprint: Woodhead Publishing, 13th November 2013.
2. MICROFABRICATION AND NANOMANUFACTURING Mark J. Jackson, Taylor & Francis, 2006.
3. SPRINGER HANDBOOK OF NANOTECHNOLOGY Bharat Bhushan (Editors), DOI:10.1007/978-3-642-02525-9, Springer-Verlag Berlin Heidelberg, 2010
4. NANOLITHOGRAPHY Stefan Landis (Editor), ISBN: 978-1-84821-211-4, Wiley-ISTE, 20

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the aspect associate with lithographic technique.	25%
CO-2	Determine the basic parameter associated with nanoimprint lithography	25%
CO-3	Determine advanced technical aspects of XRL lithography	25%
CO-4	Analyze the metrology aspects associated with nanostructure	25%