PHY504 – Vacuum Physics and Thin Films Technology

COURSE PARTICULARS

Course Code: PHY 504
Course Title: Vacuum Physics and Thin Film Technology
No. of Units: 3
Course Duration: Three hours of theory
Status: Compulsory
Course Email Address: phy504@futa.edu.ng.org
Course Webpage: http://www.phy.futa.edu.ng/courseschedule.php?coursecode=PHY%20204
Prerequisite: PHY210, PHY314

COURSE INSTRUCTORS

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COURSE DESCRIPTION

This course is a specialised, descriptive and exploratory course. It is designed to equip the students with the basic knowledge of vacuum systems/pumps and the use of such systems in the preparation/fabrication of alloys and semiconductor materials/thin films of various forms. The course is expected to run parallel with workshop laboratory where the students will need to carry out systematic operations and fabrication and characterisation of alloy/thin films in their different forms using vacuum systems. The course will also meet the need of students in materials science and engineering.

COURSE OBJECTIVES

The objectives of this course are to:

- acquit the students with the basic knowledge of the vacuum systems and the fabrication of alloy/thin films materials; and
- provide students with opportunities to develop basic skills with respect to safety precautions in the vacuum system workshop .

COURSE LEARNING OUTCOMES / COMPETENCIES

Upon successful completion of this course, the student will be able to:
(Knowledge based)

- identify, explain and handle different types of vacuum systems;
- identify different pressure gauges and their uses;
- identify various sources of contaminations/causes of faults in vacuum systems;
- discuss the different types of leak and leak techniques in vacuum systems;
- adopt necessary safety guides/measures in the vacuum workshop;
- discuss the applications of vacuum systems;
- know how to fabricate thin films materials using different fabrication techniques;
- characterise the properties of the fabricated devices
- identify various forms of heat treatment of thin films and
- discuss the industrial applications of thin films.

GRADING SYSTEM FOR THE COURSE

This course will be graded as follows:

Class Attendance	5%
Assignments	10%
Test(s)	25%
Final Examination	60%
TOTAL	**100%**

GENERAL INSTRUCTIONS

Attendance: It is expected that every student will be in class for lectures and also participate in all practical exercises. Attendance records will be kept and used to determine each person's qualification to sit for the final examination. In case of illness or other unavoidable cause of absence, the student must communicate as soon as possible with the course lecturer. This must be done before class or assignment/test is given otherwise, such excuse shall not be entertained.

Academic Integrity: Violations of academic integrity, including dishonesty in assignments, examinations, or other academic performances are prohibited. You are not allowed to make copies of another person's work and submit it as your own; that is plagiarism. All cases of

academic dishonesty will be reported to the University Management for appropriate sanctions in accordance with the guidelines for handling students' misconduct as spelt out in the Students' Handbook.

Assignments and Group Work: Students are expected to submit assignments as scheduled. Failure to submit an assignment as at when due will attract a score of zero for that assignment. Only under acceptable circumstances, for which a student has notified the lecturer in advance, will late submission of assignments be permitted.

Code of Conduct in Lecture Rooms and Laboratories: Students should turn off their cell phones during lectures. Students are prohibited from engaging in other activities (such as texting, watching videos, *etc*.) during lectures. Food and drinks are not permitted in the laboratories.

READING LIST

[1] Chambers, A, Fitch, R. K. and Halliday, B. S. (1998). *Basic Vacuum Technology*. Institute of Physics Publishing, London.

[1] John F. O'Hanlon (1982). *A User's Guide to Vacuum Technology*. JohnWiley and Sons, N/Y

[3, 4]Alexander Roth. *Vacuum Technology*. North-Holland.

[3, 4]Walter Umrath (Ed.) (2007). Fundamentals of Vacuum Technology, Oerlikon Leybold Vacuum, Cologne.

Legend
1- Available in the University Library
2- Available in Departmental/School Libraries
3- Available on the Internet.
4- Available as Personal Collection

COURSE OUTLINE

WEEK	SPECIFIC TOPIC	AREAS TO BE COVERED/REMARKS
WK 1	Design and characteristics of vacuum systems	- Definition of a vacuum and vacuum systems - Operational vacuum system .Typical examples of an operational vacuum systems. - Explanation of the various parts chamber, accessories, e.t.c
WK2	Vacuum systems and & pump	- Vacuum systems and vacuum pumps - Different types of pumps - Evaluation of vacuum systems - Determination of speed, throughput, Capacitance e.t.c in vacuum systems
WK3	Pressure Gauges and Valves	- Different types of pressure gauges - Valves and their uses in vacuum systems - Sources of contaminant in vacuum systems - Different ways of eliminating/minimizing contaminants
Wk4	Industrial heating systems	- Furnace and industrial heating systems (IHS) - Ultrahigh vacuum systems(UHS) and their uses - Difference between furnace, oven and other heating systems. - (**A one hour Periodic Test PT shall be taken at the end of this week**)
WK 5	Vacuum Evaporation	- Class discussion of the test conducted in the previous week. - Meaning of vacuum Evaporation - Sources of vacuum evaporation - Techniques of vacuum evaporation
WK6	Thin Films	- Definition of thin film - Preparation of thin film for various uses - Substrate and substrate design for thin film preparation - Basic categories of thin film preparation i.e Evaporation masking and substrate etching
WK7	Methods of thin film preparation	- Different methods of thin film preparation e.g Sputtering, Electrolytic deposition, vacuum evaporation, ion implantation e.t.c - Epitaxial growth and types e.g. Liquid phase, vapour phase e.t.c.
WK8	Heat Treatment	- Meaning of heat treatment

		- Reasons for heat treatment of films - Various means of heat treatment. - Compatibility of film and substrate. - (**A thirty minutes Periodic Test PT shall be taken at the end of this week**). The teacher will utilise the remaining thirty minutes of the class to discuss the questions given in the test with the students.
WK9	Mask and film removal	- Preparation and use of mask for thin film preparation - Photo resist and its characteristics. - Mask/Substrate cleaning (chronological steps for substrate/mask cleaning should be emphasized). - Characterisation and application of thin films
WK10	Further thin film deposition and characterization Technique.	- Deposition of thin insulating film by Rutherford sputtering technique - Rutherford back scattering and Recoil techniques (Quantitative treatment to include the calculation of the stopping power, Recoil angle e.t.c.) - Scanning Electron microscopy (SEM) and other methods such as TEM, NMR e.t.c.
WK11	Revision	- 1hour devoted for topics treated in wks 1 – 3 - 1 hour devoted for topics treated in wks 4 – 6 - 1 hour devoted for topics treated in wks 7 - 10
WK 12	Evaluation and Test	- Evaluation of the course is carried out in the week - Continuous assessment is equally conducted for the students.