THE STANDARD FIREWORKS RAJARATNAM

COLLEGE FOR WOMEN (AUTONOMOUS)

(Reaccredited with **'A'** Grade by **NAAC and**
College with Potential for Excellence by UGC)

SIVAKASI – 626 123.

Affiliated to Madurai Kamaraj University, Madurai.

Programme Scheme, Scheme of Examination and Syllabi

(With effect from June 2016)

DEPARTMENT OF PHYSICS

M.Phil. PROGRAMME

Curriculum Design & Development Cell

Chairman of the Board	Deans of CDDC	Deans of Academic Affairs	COE

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THE STANDARD FIREWORKS RAJARATNAM COLLEGE FOR WOMEN (AUTONOMOUS),

(Reaccredited with 'A' Grade by NAAC and College with Potential for Excellence by UGC)

SIVAKASI-626 123.

Affiliated to Madurai Kamaraj University, Madurai

DEPARTMENT OF PHYSICS

M. Phil. DEGREE PROGRAMME IN PHYSICS

RULES AND REGULATIONS, PROGRAMME SCHEME AND SCHEME OF EVALUATION GOVERNING THE M.Phil. DEGREE PROGRAMME IN PHYSICS

(For those admitted in June 2016 and later)

I PROGRMME OBJECTIVES:

1. To develop research culture among the physics students.
2. To assist the students in job opportunities.
3. To direct them in publishing research papers in various journals.
4. To guide them in participating in Research Seminars.
5. To promote the department as a Research Centre.
6. To pursue Ph.D.

II Curriculum:

1. To follow Madurai Kamaraj University Syllabus.
2. To adopt Choice Based Credit System.
3. Class handling and Dissertation guidance by Ph.D. holders.

III Eligibility condition for admission:

The minimum qualification for admission to this programme will be a Post-Graduate Degree in Physics with 60% of marks.

IV Duration of the Programme:

The duration of the programme is one academic year. Each academic year consists of two semesters. The duration of a semester is 90 working days.

V Attendance:

The rules regarding the attendance for regular classes for the candidates to appear for the summative examinations are framed as given below.

a) Each student must put in a minimum attendance of 68 days (75% of 90 days per semester) so as to become eligible to appear for the summative examinations.

Shortage of Attendance:

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b) Those students with attendance of 68 days and less but 59 days and above (65%) can be permitted to appear for the summative examinations provided they should submit the condonation certificate to the principal stating the proper reasons for their absence, within five days after the last working days of the concerned class. The certificate may be obtained from the office on payment of as per Madurai Kamaraj University.

c) In case of attendance with 58 days and less but 45 days and (50%) above, the students cannot appear for the final examinations of that semester but can appear for the next examinations by obtaining special permission from the principal providing necessary documents supporting the reasons for the absence on payment of Rs.250/-.

d) Students with attendance of 44 days and less should repeat the whole semester.

VI Evaluation procedure:

Evaluation of each Theory Course will be 25% Continuous Internal Assessment (CIA) and 75% External Examinations. Evaluation of Project will be 100% External Examinations. A mark statement will be issued to every student at the end of every semester.

VII Passing minimum:

For a pass in each course, a student should secure a minimum of 45% marks in the External Examinations and a minimum of 50% marks in aggregate (i.e., internal and external marks put together). The same rule is applicable for dissertation / project report and viva voce.

VIII Eligibility condition for getting the degree:

A candidate undergoing the M.Phil.degree programme will be eligible for the award of M.Phil. degree in physics if she completes the entire programme and passes all the courses prescribed for the programme.

IX Classification of successful candidates:

The successful candidates will be classified as per the details given in the table below.

CGPA	GRADE	Classification of Final Result
9.500 – 10.000	O+	First Class
9.000 – 9.499	O	
8.500 – 8.999	D++	
8.000 – 8.499	D+	
7.500 – 7.999	D	
7.000 – 7.499	A++	
6.500 – 6.999	A+	
6.000 – 6.499	A	
5.500 – 5.999	B+	Second Class

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5.000 – 5.499	B	
0.000 – 4.999	U	Re - appear

X Awards of Ranks:

CUMULATIVE GRADE POINT AVERAGE (CGPA) = $\frac{\Sigma_i C_i G_i}{\Sigma_i C_i}$

CGPA = Sum of the multiplication of grade points by the respective credits of the course cleared in the entire programme

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Sum of the credits of all the courses cleared in the programme

C_i – Credits earned for course i in any semester.
G_i – Grade point obtained for course i in any semester.
Σ_i – Summation of all courses cleared in a semester.

XI Other provisions:

1. Those who are absent for the exam should be marked AA on the Mark sheet.
2. If there is a charge of malpractice by a student she should be sent out from the Exam. Hall and given chance only during the following semester.
3. The Courses she has already appeared during that semester will not be considered.
4. A student can appear for any number of arrear courses.
5. Repeat examinations will be conducted for the final semester paper within a month after the publication of final semester result.
6. Revaluation is permitted.

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DEPARTMENT OF PHYSICS

M. Phil. DEGREE PROGRAMME IN PHYSICS

(For those admitted in June 2016 and later)

Details of the courses under the M.Phil. Programme

Sem.	Course code	Title	Teaching hours per week	Duration of summative exam. hours	Marks allotted			No. of Credits
					Int.	Ext.	Tot.	
I	16MPH11	Research Methodology	6	3	25	75	100	9
	16MPH12	Eigen Physics	6	3	25	75	100	9
	16MPH1V	Subject Viva-Voce	-	-			100	3
II	16MPH2A	Optional Paper I- Introduction to Fuels cells and Hydrogen storage	6	3	25	75	100	9
	16MPH2B	Optional Paper II- Nanomaterials and Characterization Techniques						
	16MPH2C	Optional Paper III- Properties of Thin Films						
	16MPH2D	Dissertation	6	-	-	100	100	10
	16MPH2V	Viva – voce	-	-	-	100	100	5
Total							**600**	**45**

Allotment of hours (Per week) for M.Phil. Degree Programme

Core	Semester		
	I	II	Total
Theory	12	6	18
Dissertation	-	6	6
Total	12	12	24

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QUESTION PATTERN FOR SUMMATIVE EXAMINATIONS

Max. Marks: 75 **Time : 3 hrs**

SECTION A (5 x 6 = 30 marks)

Five questions, one from each unit with internal choice. Each question should be answered not exceeding three pages.

SECTION B (3 x 15 = 45 marks)

Three out of five questions, open choice, one from each unit. Each question should be answered not exceeding six pages.

Section	Questions	Marks	Total
A	5	6	30
B	3	15	45
		Total	75

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THE STANDARD FIREWORKS RAJARATNAM COLLEGE FOR WOMEN, SIVAKASI
DEPARTMENT OF PHYSICS
M.Phil. PHYSICS
SEMESTER – I

16MPH11 - RESEARCH METHODOLOGY

(For those admitted in June 2016 and later)

Contact hours per week : 06
Contact hours per semester : 90
Total number of credits : 09

Objectives:
To enable the students to

1. know the basics of Raman spectroscopy.
2. understand the concepts of symmetry operations.
3. gain insights into the basics of X-ray crystallography.
4. learn various synthesis techniques of thin film technology.

UNIT – I:

Infrared & Raman spectroscopy:

Experimental spectroscopy- classical theory of Raman effect & selection rule for Raman scattering - quantum theory of Raman effect - pure rotational Raman spectra of diatomic molecules - vibrational Raman spectra of polyatomic molecules - Raman vibrational studies of diatomic molecules - vibrational Raman spectra of polyatomic molecules - rotation-vibration Raman studies & application of Raman spectroscopy.

UNIT – II:

Molecular Symmetry:

Symmetry operations - symmetry elements-multiplication table - Molecular point groups - Matrix representation of symmetry operations - reducible & irreducible representations - The great orthogonality theorem - character table for C2v and C3v point groups - symmetry species of point groups - complete character table for point group - Distribution of fundamentals among symmetry species - IR activity-Raman activity.

UNIT – III:

X-Ray Crystallography:

Diffraction of X-rays by crystal lattice - Laue's formulation of X-ray diffraction - Diffraction methods - Laue diffraction-rotating crystal method-oscillation method - powder method - X-ray diffractometer - Data collection.

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UNIT – IV:

Structure Determination:

Scattering factor-structure factor - phase problem - structure determination - structure refinement - structure analysis

Thin Film Technology:

Thermal evaporation - General consideration - Evaporation methods - Chemical methods - Electrodeposition - Chemical vapour deposition - Miscellaneous methods.

UNIT – V:

Cathode sputtering - Sputtering process-Glow discharge methods - sputtering variants -Low pressure sputtering - Reactive sputtering - sputtering of multicomponent materials -Vacuum deposition apparatus - Vacuum systems - Substrate deposition Technology -Thickness measurement - Microbalance monitors - Optical Interference methods - Analytical methods - Chemical methods - Structural analysis - Surface structure - Volume structure - Growth process - General description - Liquid like Coalescence.

Text Books:

Unit-1

Spectroscopy [Vol. II] – By B.P.Straughan and S.Walker - John Wiley & Sons, New York Chapter-4 (Sec:11 to 19).

Unit-2

Molecular Structure and Spectroscopy- By S.Aruldhas - Prentice-Hall of India (2001), Chapter-5.

Unit-3 & 4

Elementary Crystallography- by D.Velmurugan- MJP Publishers (2008).

Chapter-4 (pg: 123-237).

Reference: X-ray Structure determination, A practical guide - GH.Stout and LH.Jensen Wiley Publications (1989) 2nd Edition.

Thin Film Phenomena - Kasturi Chopra published by Mc Graw Hill Book Company

Part II Sec.2 and Part II Sec.4.

Unit-5

Thin Film Phenomena - Kasturi Chopra published by Mc Graw Hill Book Company

Part II Sec.3 and Part II Sec.5

Part III Sec.1.2 and 1.5, Part III Sec.2

Part IV Sec.2.1

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THE STANDARD FIREWORKS RAJARATNAM COLLEGE FOR WOMEN, SIVAKASI
DEPARTMENT OF PHYSICS
M.Phil. PHYSICS
SEMESTER – I
16MPH12– EIGEN PHYSICS
(For those admitted in June 2016 and later)

Contact hours per week : 06
Contact hours per semester : 90
Total number of credits : 09

Objectives:
To enable the students to

1. Learn the applications of field equations
2. know the basic concepts and applications of Schrodinger's wave equation
3. apply cylindrical solutions to diffraction and diffusion problems
4. apply spherical solutions to vibrational and scattering systems.
5. Have an exposure on approximate methods and their applications to quantum molecular physics.

UNIT- I:
The field equations : Introduction –Poisson & Laplace's equation –The diffusion equation – The Wave equation –Boundary conditions & uniqueness of solution- orthogonality & the sturm-liouville equation. Rectangular Cartesian coordinate systems: Introduction –Wave equation for a uniform stretched string-Hybridization of the normal nodes of vibration-The freely hanging chain –Lattice vibrations.

UNIT- II:
Wave equation for a two dimensional membrane –The schrodinger wave equation: solutions for which the potential is a constant –The linear harmonic oscillator-The periodic potential-The diffusion equation.

UNIT- III:
Orthogonal curvilinear coordinate systems: Cylindrical solutions:Introduction –Wave equation for a uniform stretched circular membrane-correlation between square, circular & elliptical modes – Franhofer diffraction at a circular aperture – Diffusion in an infinitely long cylinder –Propogation at an electromagnetic wave in a cylindrical conductor.

UNIT –IV:
Orthogonal curvilinear coordinate systems: Spherical solutions :Introduction-Uniformly moving sphere in an ideal fluid-Vibrational modes of a spherical droplet –Electrostatic multipolar fields-Normal interior modes of vibration of a rotation gaseous star-Partial wave analysis & elastic scattering-The hydrogen atom-Hydrogenic systems-Spherical harmonic oscillator.

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UNIT-V:
Approximate methods and Applications:

Introduction- Perturbation theory for non degenerate states - Perturbation theory for degenerate states – The WKBJ approximation – The variational approximation – Quantum molecular physics: molecular orbital theory – Quantum molecular physics: valence bond theory - Hybridization.

TEXT BOOK FOR STUDY: Introductory to Eigen Physics – C.A.Croxton

Unit - I (Chapter 1)
Unit - II (Chapter 2.1 to 2.6)
Unit – III (Chapter 3)
Unit – IV (Chapter 4)
Unit – V (Chapter 5)

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THE STANDARD FIREWORKS RAJARATNAM COLLEGE FOR WOMEN, SIVAKASI
DEPARTMENT OF PHYSICS
M.Phil. PHYSICS
SEMESTER – II
16MPH2A - OPTIONALPAPER I

Introduction to Fuel cells and Hydrogen storage

(For those admitted in June 2016 and later)

Contact hours per week : 06
Contact hours per semester : 90
Total number of credits : 09

Objectives:

To enable the students to

1. gain knowledge on Polymer Physics
2. understand the Crystal Structures
3. become familiar with the working of Fuel cells .
4. learn various experimental techniques.
5. gain knowledge on hydrogen as engine fuel.

Unit-1 Crystal Structure

Introduction to crystals - lattice translation vectors - fundamentals of lattices-characteristics of lattices - simple crystal structures - diffraction of waves by crystals; bragg law - reciprocal lattice vectors - laue equations - brillouin zones-structure factor of the bcc & fcc lattice - quasi crystals.

Unit-2 Polymer Physics

Introduction to polymers - classification of polymers - intermolecular forces in polymers - determination of molecular weight of polymers - nomenclature of polymers - specialty polymers; polyelectrolytes, ion conducting polymers (ionomers),conducting polymers, solid polymer electrolytes-thermo plastic elastomers – polybends - liquid crystalline polymes - telechelic polymers & polymer micro gels.

Unit-3 Fuel Cells

Fuel cells; relevance & importance – fuel cells: how do they differ from batteries? – classification of electrochemistry basis; thermodynamic aspects of electrochemical energy conversion – efficiency of electrochemical energy conversion – factors affecting the efficiency of electrochemical energy conversion – electrode kinetics of electrochemical energy conversion – type of fuel cells – fuel cell processing.

Unit-4 Proton exchange membrane (Ch- 9&17)

Introduction to proton exchange membrane (PEM) – preparation techniques for PEM's; compression molding, injection molding, blow molding, transfer molding, solution casting – chemical analysis of polymers; infrared spectroscopy, nmr spectroscopy, x-ray diffraction analysis, SEM & impedance analyzer – application of PEM; proton exchange membrane fuel cell.

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Unit-5 Hydrogen storage

Introduction to hydrogen storage – hydrogen production – hydrogen as an engine fuel – methods of hydrogen storage; storing hydrogen as a gas, high pressure gas cylinders, liquid hydrogen storage, storage via chemical reactions – hydrogen storage materials; hydrogen in metals, prediction of hydrogen uptake in carbon materials, storage via physisorption & chemisorption – hydrogen storage measurements; gravimetric method, thermal deposition spectroscopy.

Text Books

1. Introduction to Solid State Physics – 7^{th} edition – Charles Kittel
   (Unit 1 – Ch: 1 & 2).

2. Principles of Polymer science – 2^{nd} edition – P.Bahadur & N.V. Sastry
   (Unit 2 – Ch:1 & 8).

3. Fuel cells – Principles & applications – B.Viswanathan & M.Aulice Scibioh
   (Unit 3 – Ch:1-9),(Unit 4 – P.No.272 – 277) & (Unit 5 – P.No. 372-434)

4. Text Book of polymer science – Fred W.Billmeyar, JR
   (Unit 4 –P.No.457-467).

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THE STANDARD FIREWORKS RAJARATNAM COLLEGE FOR WOMEN, SIVAKASI
DEPARTMENT OF PHYSICS
M.Phil. PHYSICS
SEMESTER – I
16MPH2B - OPTIONAL PAPER II- NANOMATERIALS AND CHARACTERIZATION TECHNIQUES
(For those admitted in June 2016 and later)

Contact hours per week : 06
Contact hours per semester : 90
Total number of credits : 09

Objectives:
To enable the students to

1. learn the synthesis, characterization and uses of quantum dots.
2. investigate and manipulate materials in the nanoscale.
3. learn about UV-Vis and Infrared Spectrophotometers.
4. understand the principle and the measurement of fluorescence and phosphorescence
5. know about photo acoustic spectrometers and thermo-analytical instruments

Unit I:
Semiconductor Quantum Dots:

Introduction-Synthesis of quantum dots: General strategies - Synthesis in confined media - Molecular precursors - Chemical synthesis using clusters - Modification of the surface of nano crystals - InP nanoparticles - Electronic structure of nano crystals - Study of quantum dots: Absorption and emission spectroscopy -Lifetime and dynamics of the excited states - X-ray diffraction - Transmission electron microscopy - Ancillary techniques - Correlation of properties with size - Uses: Chemical properties – single electronic devices.

Unit II:
Investigating and manipulating materials in the nanoscale:

Electron microscopes: Scanning electron microscopy - Transmission electron microscopy - Image collection in electron microscopes - Environmental transmission electron microscopy - Scanning probe microscopies: Scanning tunneling microscopy - Atomic force microscopy - X-ray diffraction: Intensities in X-ray scattering - particle size effects.

Unit III:
Absorption Instruments:

Radiation Sources - Optical Filters - Monochromators - Optical Components - photosensitive Detectors - Slit width - Sample holders. Ultraviolet and Visible Absorption Spectroscopy (UV-Vis). Infrared Spectrophotometers: Infrared Spectroscopy - Sample Handling

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Techniques: Gas cells - Liquid cells - Variable path length cells - Sampling of solids - Micro-sampling. Fourier Transform infrared spectroscopy - FTIR spectrophotometers.

Unit IV:
Fluorimeters and phosphormeters:

Fluorescence spectroscopy - principle of fluorescence - Relationship between Concentration and Fluorescence Intensity - Factors Affecting fluorescent Yield - Measurement of fluorescence - Single - beam filter fluorimeter - Double-beam filter fluorimeter - Ratio fluorimeters, Measurement of phosphorescence - phosphorescence spectrometer. Raman spectrometer: The Raman Effect – Resonance - enhanced Raman Scattering - Surface-enhanced Raman Scattering - Raman spectrometer: The source-sample Chamber - The spectrometer - The Detector - Computer - PC based Raman spectrometer - Infrared and Raman micro spectrometry.

Unit V:
Photoacoustic spectrometers:

Photo acoustic spectroscopy - System components - Typical photo acoustic spectrometers. Thermo-analytical instruments: thermo-analytical methods - thermogravimetric analysis - Instrumentation - Differential Thermal Analysis - Instrumentation - Differential Scanning Calorimetry - Simultaneous Thermal Analysis/Mass spectrometer.

Text Books:

1. **Unit-I:** Sections 7.1-7.6 of Nano: The essentials by T.Pradeep, Published by Tata Mc-Graw-Hill (2007).
2. **Unit-II:** Sections 2.2-2.3 and 2.6-2.7 of Nano: The essentials by T.Pradeep, Published by Tata Mc-Graw-Hill (2007).
3. **Unit-III:** Sections 2.3-2.4, 3.1, 3.4, and3.5 of Handbook of Analytical Instruments by R.S. Khandpur, Second Edition, Published by Tata Mc-Graw-Hill (2006).
4. **Unit-IV:** Sections 6.1-6.3, 6.6 and7.1-7.4 of Handbook of Analytical Instruments by R.S. Khandpur, Second Edition , published by Tata Mc-Graw-Hill (2006).
5. **Unit-V:** Sections 8.1 and 18.1-18.5 of Handbook of Analytical Instruments by R.S. Khandpur , Second Edition, published by Tata Mc-Graw-Hill (2006).

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THE STANDARD FIREWORKS RAJARATNAM COLLEGE FOR WOMEN, SIVAKASI
DEPARTMENT OF PHYSICS
M.Phil. PHYSICS
SEMESTER – I
16MPH2C - OPTIONALPAPER III- PROPERTIES OF THIN FILMS
(For those admitted in June 2016 and later)

Contact hours per week : 06
Contact hours per semester : 90
Total number of credits : 09

Objectives:
To enable the students to

1. promote knowledge on electrical properties of metallic films
2. develop an understanding on transport properties of semiconducting and insulating films.
3. become familiar with dielectric properties of thin films.
4. appreciate the optical properties of thin films.
5. characterize thin films using various spectroscopic techniques.

UNIT-I:
Electrical conduction in solids:

Classical theory of electrical conduction in metal – Summerfield's modification – Block theory and periodic potential – energy band structure of a solid – effective electron mass – Atomistic view of band structure – insulator, semiconductor, semimetal – concept of hole – Thermal effect.

Conduction in metallic film:

Continuous and discontinuous film – conduction in continuous metal films – scattering of electrons – effects of post deposition treatment of films – temperature coefficient of resistance – thermoelectric effect – Hall effect – magneto resistance – mean free path of electrons – specularity factor and asperities – conduction in discontinuous metal film – Thermionic Schottky emission – activated charge carriers and tunneling process – tunneling through allowed states – tunneling via trap in a substrate – conductivity and activation energy – semi continuous and cermet films.

UNIT-II:
Semiconducting films:

Intrinsic semiconductor – impurity semiconductor – impurity energy level – doping – impurity, trap, recombination centre etc – surface states – impurity sub band – degeneracy – Grain boundary effect – semiconductor surface and space charge effect, metal semiconductor and semimetals.

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Insulator films:

Metal-insulator contact – Ohmic or Mott Gurney contact – Neutral contact – Blocking or Schottky barrier contact – two electrode systems – conduction in insulator film – intrinsic conduction – Poole-frankel emission – thermally activated hopping – space charge limited current – ionic conduction – current limiting process – photo conduction – photovoltaic effect – voltage controlled negative resistance (VCNR), memory effect and current controlled negative resistance (CCNR).

UNIT-III:
Dielectric properties:

Basic concepts in dielectrics – permittivity – capacitance and polarization in static fields – time varying fields – complex permittivity and loss factor – A.C. Conductivity – temperature dependence of dielectric constant – Relaxation and Debye equations – equivalent circuit – dispersion of electromagnetic waves – resonance absorption – thin films – breakdown voltage and field strength – experimental techniques for dielectric film – capacitor preparation and set-up measuring instruments and techniques – Wheatstone bridge method – Resonance method – heterodyne boat method – dielectric constant – breakdown voltage – annealing effect – effect of film thickness – effect of frequency and temperature – theoretical models – frequency effect and loss minimum – temperature effect, electrode and load resistance effect – non-stochiometric and high defect – density dielectric film – thermal and dipolar activation energy – breakdown voltage etc – applications of thin film dielectrics.

UNIT-IV:
Optical properties:

Electromagnetic theory of wave propagation – Dispersion of electromagnetic waves – dispersion in metal and semiconductor – reflection, transmission, absorption, energy band gap, transition etc.,- relation of reflections, transmission with n and k-reflections and transmission by a single film – reflection from multi layers – absorbing films – thin film optical constant – methods for determining optical constant – reflection method – graphical method – experimental technique for determination of optical parameters – measurements of reflectance, transmittance, absorption etc.,- optical constants from R_s and R_p components of polarized light – optical constants from R and T etc.,-with polarized light – thickness and temperature effect on optical constant energy band gap and electronic transition – applications of optical films – antireflection coating – high reflecting coating – interference filter – total reflection filter.

UNIT-V:
Material characterization:

Introduction – photoluminescence – Excitation energy: penetration depth and Stoke's shift – Excitation intensity : interface state density and distribution – Photoluminescence spectrum: photoluminescence peak positions, energy levels, photoluminescence line width and splitting – Alloy disorder and interface roughness – photoluminescence intensity: dependence on

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applied bias: surface potential, spatial dependence, interface uniformity and carrier diffusion ,time dependence – recombination rates, temperature dependence – thermal population – photoluminescence polarization – conclusion – reflection high energy electron diffraction (RHEED) – Ellipsometry.

Characterization of surface:

Fourier transform infra red spectroscopy (FTIR) – secondary ion mass spectroscopy (SIMS) – Auger electron spectroscopy (AES) – Photo electron spectroscopy (XPS).

Text books:

1. Thin film fundamentals by A.Goswami (New Age International Pvt. Ltd.)
2. Photoluminescence in Analysis of Surfaces and Interfaces, Timothy H.Gfroerer in Encyclopedia of Analytical Chemistry,

   R.A.Meyers (Ed) PP.9209-9231, John Wiley & Sons Ltd, Chichester, 2000.
3. Principles of physical vapour deposition of thin films by K.Harsha (Elsevier, 2006).

   Unit I-Chapter 6&7

   Unit II-Chapter 8&9

   Unit III-Chapter 10

   Unit IV – Chapter II (Thin film fundamentals by A.Goswami)

   Unit V – (Photoluminescence in Analysis of Surfaces and Interfaces (page 1-25), Principles of physical vapour deposition of thin films by K.Harsha (Elsevier, 2006) (page 895-905 & 937-953).