FACULTY OF SCIENCE & HUMANITIES

Approved Special Electives for
M.S. / Ph.D. Degree Programs
(upto 25th AC 02.05.2019)
## SPECIAL ELECTIVES FOR FACULTY OF SCIENCE AND HUMANITIES

<table>
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<tr>
<th>COURSE CODE</th>
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** PH code used by Ph.D. Students / CG code used by M. Phil. Students
PH 761 (Old Code: CG101)  CRYSTAL GROWTH THEORY

Aim: To introduce the fundamentals and theoretical concepts of crystal growth
To enhance the understanding of the phenomena of nucleation and crystal growth

Objectives:
- To provide the basic understanding of the crystal growth of technologically important crystals
- To understand the concepts of homogeneous and heterogeneous nucleation
- To formulate the modeling of crystal based on various theories of crystal growth.

UNIT I

UNIT II
Homogeneous nucleation of Binary system - Induction period. Heterogeneous nucleation - Equilibrium concentration of embryos for different sizes - Energy of formation of a critical nucleus - Free energy of formation of a critical heterogeneous - cap shaped - disc shaped nucleus - Heterogeneous nucleation of Binary vapour - Secondary nucleation.

UNIT III
Theories of crystal growth - Surface energy theory - Diffusion theory - Adsorption layer theory - Volmer theory - Bravais theory - Kossel theory - Stranski's treatment - Two dimensional nucleation theory - Thermodynamics of nucleation - Free energy of formation of a two dimensional nucleus - Possible shapes - Correction to the two-dimensional nucleation theory - Rate of nucleation - Mononuclear model - Polynuclear model - Birth and spread model - Modified Birth and spread model.

UNIT IV
Crystal growth by mass transfer processes - Bulk diffusion model - Surface diffusion growth theories - Mobility of adsorbed molecules on a crystal surface Physical modeling of BCF theory - BCF differential surface diffusion equation - single straight step - Multiple straight parallel steps - Surface supersaturation and concentration near the step - Growth rate of an F-face - Giant dislocation steps - Description, Derivation, and interpretation of Temkin's model of crystal growth - PBC theory of crystal growth - Computer simulation technique

UNIT V
Effect of impurities on growth processes - Thermodynamics and structure of solutions - adsorption - Dependence of growth and morphology on the concentration of impurities - Creation of defects – slip Plane and Twinning - Inclusions - Inclusions of the mother liquor - Inclusions of foreign particles - Dislocations from a seed - Creation of dislocations in surface processes - Orientation of Dislocations - Thermal stresses - Dislocations related to vacancies and impurities - Grain boundaries.

REFERENCES:
1. T. Nishinaga, Advances in the understanding of crystal growth mechanisms Elsevier, 1997
   K. Sangwal, Elementary Crystal Growth, Sahaan Publisher, UK, 1994

Faculty of Science and Humanities
(Approved in 3rd AC 22.11.2003) ITEM NO.3.4 (2(2))

PH 762 (Old Code: CG102) CRYSTAL GROWTH EXPERIMENTAL L T P C
TECHNIQUES 3 1 0 4

AIM: To introduce the basic concepts of various types of crystal growth methods and characterisation techniques

OBJECTIVES:
- To study the different types of crystal growth methods
- To provide the concepts of melt, vapor, solution and epitaxial growth technique
- To develop the knowledge on characterisation of grown crystal

UNIT I

UNIT II
Growth of crystals from vapour phase - Physical vapour deposition - Chemical vapour transport - Open and closed system - Thermodynamics of chemical vapour deposition process - Physical, thermo-chemical factors affecting growth process.

UNIT III

UNIT IV
Epitaxy - Vapour phase epitaxy (VPE) - Liquid phase epitaxy (LPE) - Molecular Beam Epitaxy (MBE) - Atomic layer Epitaxy (ALE) - Electroepitaxy - Metalorganic Vapour Phase Epitaxy - (MOVPE) Chemical Beam Epitaxy (CBE).

UNIT V

TOTAL PERIODS = 45
REFERENCES:
3. K. Sangwal, Elementary Crystal Growth - Saaan Publisher, UK, 1994
4. M.M. Faktor, I. Garret, Growth of Crystals from Vapor, Chapmann and Hall, 1988

Faculty of Science and Humanities  (Approved in 3rd AC 22.11.2003) ITEM NO.3.4 (2(3))

PH 763 (Old Code: CG001)  EPITAXIAL GROWTH  L  T  P  C  3  0  0  3

AIM:  To introduce the fundamentals of various types of epitaxy.
      To enhance the understanding of the phase diagrams, epitaxial growth processes and instrumentation of epitaxial techniques.

OBJECTIVES: On completion of the course the student would be in position
- To understand the concepts of homoepitaxy and heteroepitaxy
- To derive the expressions for the kinetically controlled and thermodynamically controlled growth regimes in epitaxy
- To design the various reactor models in LPE, VPE, MOCVD, MBE, CBE and ALE

UNIT I  (10)

UNIT II  (10)

UNIT III  (9)
Principle of method and apparatus - reactor design - growth of III-V compound Semiconductors - InP - GaAs - GaInAs - GaInAsP and other III-V compounds.

UNIT IV  (6)
Mechanism of MOCVD growth - Thermodynamic concepts - growth rate calculations - applications of III-V materials grown from MOCVD - Low pressure MOCVD (LPMOCVD)
UNIT V

REFERENCES:
1. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India, New Delhi, 1994

Faculty of Science and Humanities

PH 764 (Old Code: CG002) SEMICONDUCTOR PHYSICS L T P C
3 0 0 3

AIM: To prepare the student for the understanding of the optical and electrical properties of semiconductor

OBJECTIVES:
- Introduce the fundamental concepts of semiconductor physics
- Evaluate the significant advantages in semiconductors for the use in optical and electrical devices
- Create an awareness of the usefulness of advanced semiconductors

UNIT I
UNIT II

UNIT III

UNIT IV
Thermal effects in Semiconductors: Thermal conductivity - Thermo-electric power - Thermomagnetic effects - condition of degeneracy - strong magnetic fields - relative magnitudes of the magnetic effects. Optical and High frequency effects in Semiconductor: Optical constants of semiconductors - the fundamental absorption - exciton absorption photoconductivity - the photo-magnetic effect - high frequency effects in magnetic field - impurity absorption - lattice absorption - Infra-red emission from semiconductors - diffusion of electron and positive holes. Methods of determining of characteristic properties of Semiconductors: The minimum energy gap - mobility of electrons and holes - carrier concentration - effective mass - energy levels in the forbidden band due to impurities - thermal methods - optical methods - minority carrier lifetime - injection ratio.

UNIT V
Application of semiconductors: Use of Semiconductors in electrical technology - Rectifiers - Transistors - Photodiode - Photo-electric power generator - Photo cells - Infra-red detectors - Infra-Red and Microwave modulators - Thermopiles - Thermo-electric refrigerators - Thermistors,Varistors and Other non-linear resistors.

TOTAL PERIODS = 45

REFERENCES:
AIM: To introduce the relevant aspects of semiconductor crystals evaluation and identify the factors responsible for the performance of the devices.

OBJECTIVES:
- Detailed understanding of the structural characterisation techniques related to X-ray diffraction
- Evaluation of the optical techniques to characterize the semiconductor crystals
- Discussion of the relevant characterisation techniques to estimate the usefulness of the semiconductor crystals for application purpose.

UNIT I
X-ray diffraction - Powder method - rotating crystal method - specimen preparation - measurement of d-values - indexing procedure for cubic and tetragonal crystals - Single crystal diffractometer - double crystal diffractometer - triple crystal diffractometer - four crystal diffractometer - determination of unit cell and space group.

UNIT II
X-ray topography(XRT) - Berg-Barret-Lang geometry - Crystal perfection analysis- Hall effect - Evaluation of Carrier Concentration - Hall Mobility - resistivity -. Deep Level Transient Spectroscopy (DLTS) - analytical technique for impurity/defect.

UNIT III

UNIT IV
Optical, Scanning Electron Microscope (SEM) - morphological studies -- Transmission Electron Microscope (TEM) - structural analysis - Luminescence - Photoluminescence(PL) - Thermoluminescence (TL) - Electroluminescence (EL) - Bulk Analysis.

UNIT V

REFERENCES:
AIM: Comprehensive understanding of imperfection in crystals

OBJECTIVES:
- Evaluation of the different types of imperfections
- Understanding the process of defect dynamics
- To study the limitations imposed by imperfections on materials

UNIT I
Crystal Symmetry: Point group and space group symmetry operations - Space group diagrams - international notations - special positions - asymmetric unit and its importance - molecular weight determination - reciprocal lattice concept - interpretation of Bragg's law - Laue condition

UNIT II

UNIT III
Line tension - polygonal dislocations - force on a dislocation - the Peach and Coheler formula - interaction between dislocations - interaction between two parallel dislocations - Inclusions - Inclusions of the mother liquor - Inclusions of foreign particles - dislocation from a seed - propagation of dislocations - creation of dislocations in surface processes - orientation of dislocations - Thermal stresses - Dislocations related to vacancies and impurities - Grain boundaries.

UNIT IV
Imperfect Dislocations - Stacking faults and twins - Schottky dislocations - Frenkel dislocations - origin of growth dislocations - creep - cleavage - interaction of dislocations with other defects - interaction energy - elastic interaction - electrostatic interaction - Screw dislocations - interaction of dislocations with electrical properties and thermal properties of metals and semiconductors.

UNIT V

TOTAL PERIODS = 45

REFERENCES:

Faculty of Science and Humanities (Approved in 3RD AC 22.11.2003) ITEM NO.3.4 (2(7))

PH 767 (Old Code: CG005) SEMICONDUCTOR DEVICES L T P C
3 0 0 3

AIM: To impart sound knowledge of working principles of various types of electron and optical semiconductor devices.

OBJECTIVES:
- To understand different types of heterostructures in devices.
- To develop the skills in electron devices using ion implantation
- To know the concepts of unipolar and bipolar electron devices
- To develop the knowledge in microwave and optical devices
- To gain the knowledge of integrated circuits and sensors

UNIT I (8)

UNIT II (3)

UNIT III (6)
UNIT IV

UNIT V

REFERENCES:

Faculty of Science and Humanities
(Approved in 3rd AC 22.11.2003) ITEM NO.3.4 (2(8))

PH 768 (Old Code: CG006) FABRICATION AND CHARACTERIZATION OF SOLAR CELLS L T P C 3 0 0 3

AIM: To expose the students on the fundamentals and experimental aspects of solar cell fabrication and evaluation

OBJECTIVES:
- Conceptual understanding of the fundamentals involved in the solar cell fabrication process.
- Evaluation methodologies in estimating the efficiency of solar cells
- Expose the researchers to the actual fabrication process and to the need specific design issues of solar cell fabrication

UNIT I
Sources of energy - Solar cell energy conversion - Materials and material problems - Spectral distribution of solar radiation - The Sun and Sun Earth relative motion - Measurements of solar insolations - Solar simulation.
UNIT II
Photon absorption in semiconductors - Carrier transport across p-n junction solar cells - Heterojunction solar cells - Schottky barrier and MIS solar cells - Contacts and surface properties: Contact structures - Antireflection coatings - Surface texturing - Gird design - Etching - Solar cell arrays - Radiation damage on solar cells.

UNIT III
The calculation of solar efficiency - The ideal cell under illumination - The effects of series and parallel resistance - Other treatments of the calculation of the solar efficiency - The effect of temperature and illumination on solar cell efficiency - Loss analysis - Some common and emerging solar cells - Fabrication process and photovoltaic performance of some standard solar cells like Silicon, Gallium arsenide (GaAs), Indium phosphide (InP), Copper indium selenide (CuInSe₂), Cadmium Telluride (CdTe), Cu₂S based solar cells and polycrystalline thin film silicon solar cells and amorphous silicon solar cells - photoelectrochemical cell.

UNIT IV
Novel concepts in design of high efficiency solar cells - High intensity effects - Unconventional non-concentrator cells: Metal insulator semiconductor cells (MIS) - Induced junction cell and front surface field cell - Multiple pass cell - Liquid junction cells - Unconventional concentrator cells: parallel multiple vertical junction cells - Series multiple perpendicular junction cell - V grooved multijunction solar cell - Integrated back contact (IBC) cell - High low junction emitter cell - Graded band gap solar cell - Multiple cell systems: Spectrum splitting and cascade cells - Thermophotovoltaic (TPV) system - photoelectrolytic cell.

UNIT V
Characterization techniques - Photovoltaic measurements I-V characteristics - Spectral response - Optical scanning - light beam induced current (LBIC) pictures and electron beam induced current (EBIC) micrograph for the direct determination of minority carrier diffusion length - junction analysis: I-V analysis - Capacitance measurements - DLTS Technique. Material characterization-X-ray diffraction – Reflection high energy electron diffraction (RHEED) - Scanning electron microscopy (SEM) - Scanning transmission electron microscopy (STEM) - Transmission electron microscopy (TEM) - Auger electron spectroscopy (AES) - Electron spectroscopy for chemical analysis (ESCA) - Secondary ion mass spectroscopy (SIMS).

TOTAL PERIODS = 45

REFERENCES:
4. Willard, Merrit, Dean and Settle, Instrumental methods of analysis, CBS publishers and distributors, India, 1986
PH 769 (Old Code: CG007) CHARACTERIZATION TECHNIQUES

AIM: To enable the students to understand the importance of materials characterization
To expose the students on Advanced Characterization Techniques

OBJECTIVE:
- Through this course, the students would be exposed to Advanced
- Materials Characterization Techniques to understand the structural, optical, mechanical and
defect characteristics of the materials.

UNIT I
Absorption & Emission spectroscopy - Nature of electromagnetic radiation - Atomic energy levels
Molecular electronic energy levels - vibrational energy levels - Raman effect - X-ray energy levels.

UNIT II
Infrared spectroscopy - Near IR - Mid IR - Far IR Region - Correlation of infrared spectra with
molecular structure - structural Analysis - Radiation sources - Detectors - Thermal Detectors -
Photon Detectors - Spectrophotometers - Fourier Transforms Interferometer - Sample handling.

UNIT III
Raman spectroscopy - Theory - Resonance Raman Spectroscopy - Comparison of Raman with
Infrared Spectroscopy - Diagnostic - Structural Analysis - Polarization measurements -
Instrumentation - Quantitative analysis.

UNIT IV
X-ray methods - Production of X-rays and X-ray Spectroscopy - Instrumental units - Detectors for the
measurements of radiation - Semiconductor detectors - Direct X-ray methods - Nuclear magnetic
Resonance Spectroscopy - Basic principles - Quantitative analyses - Scanning Electron Microscopy -

UNIT V
Thermal analysis - Differential Thermal Analysis - Instrumentation – Differential Scanning
calorimetry - Thermogravimetry - Instrumentation - Methodology of Differential Scanning
Calorimetry & Thermo Gravimetric Analysis - Conductance method - Electrical conductivity -
Measurement of electrical conductance - Measurement of dielectric constant. Microhardness -
Etching studies.

REFERENCES:
1. X.F. Zong, Y.Y. Wang, J. Chen, Material and Process Characterization for VLSI, World Scientific,
   New Jersey, 1988
2. S.M. Sze, Semiconductor Devices, Physics and technology, John Wiley Publishers, New York,
   2000
   New York , 1990

TOTAL PERIODS = 45
AIM: To introduce the subject of biomineralisation.  
To introduce Crystallization of biological macromolecules and their application to Structural Biology.

OBJECTIVE:
- To expose the students to the basic science of crystallisation of biological molecules like proteins, enzymes etc., and their application to structural biology & drug designing.
- To understand the importance of the study of Biominerals to Materials Technology.
- To study the synthesis of Hydroxyapatite which is a bone and dental replacement material.

UNIT I
Crystal Growth from solution - Driving force for crystallization - solubility in biological fluids - growth kinetics - Nucleation - Diffusion effects - Dissolution - Morphology in vivo & In vitro studies - Crystals responsible for the crystal deposition diseases - Mono sodium urate monohydrate - Calcium pyrophosphate dihydrate - Cholesterol - Steroids - Dicalcium phosphate dehydrate - hydroxyapatite - Calcium oxalate - Calcium hydrogen phosphate dihydrate crystals.

UNIT II

UNIT III

UNIT IV

UNIT V

TOTAL PERIODS = 45

REFERENCES:

Faculty of Science and Humanities

(Approved in 3rd AC 22.11.2003) ITEM NO.3.4 (2(11))

PH 771 (Old Code: CG009) CRYSTAL GROWTH-GEL MEDIUM

L T P C
3 0 0 3

AIM: To expose the students to the gel method of crystallization and its application to biomacromolecular crystallization and microgravity experiments

OBJECTIVE:
- To study about different types of gels and their suitability to grow organic and inorganic crystals

UNIT I

UNIT II
Gel structure & properties - Gel preparation and properties - Cooling of a sol - Chemical reaction – Precipitating agents - incompatible solvents - Gelling mechanism & Structure of silica gels - Gels as diffusion media.

UNIT III
Growth mechanism - Diffusion patterns & single crystal growth rates - Functions of the gel - Advantages of the gel growth - Habit modifications - Concentration of feed solution - Crystallization temperature - Gel structure - Addition of various impurities - Various types of gels - Spacial distribution.

UNIT IV
Nucleation - Evidence for homogenous nucleation - Nucleation control - Suitable reactants - Gels prepared with various acids - changing the gel structure - Intermediate neutral gel - effect of concentration variation.

UNIT V
Liesegang rings - Qualitative features - Spiral formation - Radiation effects - Effects of gravity - Effect of electric field - Sol coagulation models - Conditions of quasi stability - Effect of growth rate - Chemical reaction method - Complex dilution method - Solubility reduction method.

TOTAL PERIODS = 45
REFERENCES:

Faculty of Science and Humanities

(Approved in 3rd AC 22.11.2003) ITEM NO.3.4 (2(12))

PH 772 (Old Code: CG010) LIQUID PHASE EPITAXY L T P C

3 0 0 3

AIM: To enhance in-depth knowledge in the fundamentals and applications of Liquid Phase epitaxy.

OBJECTIVES:
- To make the students to understand the concepts of liquid phase epitaxy and should be in a position to fabricate Liquid Phase Epitaxial system for the growth of heterostructures of elemental and compound semiconductors.

UNIT I
Introduction to Epitaxy - Phase equilibria - Basic concept of LPE growth process - Impurity segregation - Substrate surface preparation - Operational consideration - Physical principles of the LPE process - Equilibrium cooling - Step cooling - Super cooling - Two phase solution cooling - Electroepitaxy - Advantages and disadvantages of LPE as a growth technique for device materials

UNIT II
Properties and Phase diagrams - Properties and phase diagrams of Binary, ternary and quaternary compounds semiconductors - Gallium arsenide - Gallium phosphide - Gallium antimonide - Indium phosphide - Indium antimonide - Indium arsenide - Gallium aluminium arsenide - Indium gallium arsenide - Indium arsenide phosphide - Gallium arsenide antimonide - Gallium arsenide phosphide - Indium arsenide antimonide - Aluminium gallium phosphide - Indium gallium arsenide phosphide

UNIT III
Apparatus and Methodology - Boat designs: Tip system - Dip system - Horizontal sliding boat system - Rotary slider - Wipingless growth system - Multi slice boat designs - Furnace design – Theory - Diffusion limited growth theory - Solid liquid phase diagram - Impurity incorporation model - Phase diagram - Homoepitaxy - Heteroepitaxy - Device application of LPE growth

UNIT IV
Properties and Characterization - Band gap - Electrical properties - Optical properties - Crystal perfection - Layers thickness control - Abrupt junctions - Selective area and structured substrate growth - Composition control
UNIT V

REFERENCES:

Faculty of Science and Humanities (Approved in 3rd AC 22.11.2003) ITEM NO.3.4 (2(13))

PH 773 (Old Code: CG011)  OXIDE CRYSTALS – GROWTH PROPERTIES AND APPLICATIONS

AIM:  To enable the students to study the fundamental properties of oxide materials and the crystal growth of oxide materials

OBJECTIVE:
- The explore the fundamental issues with regard to the growth of oxide single crystal and the associate difficulties, various crystal growth techniques for the growth of oxide crystals and the technological applications of oxide crystals.

UNIT I
Growth of oxide single crystals - Experimental set up - Czochralski technique - Verneuil technique - Flux technique.

UNIT II

UNIT III

UNIT IV
Characterization of grown crystals - X-ray Laue, powder diffraction and oscillation photographs - IR spectra analysis - ESCA - SEM and EPMA studies - TGA and DTA to analyse thermal properties - Study of lasing action in crystals - Phase conjugation studies - Holographic materials.
UNIT V
Single Crystals for Radiation Detectors - Introduction - Scintillation characteristics in general - Survey of typical scintillation crystals - Crystal growth of scintillation detectors - Scintillation characteristics - Radiation damage of scintillation crystals - Applications of high-Z scintillators.

REFERENCES:

Faculty of Science and Humanities

PH 774 (Old Code: CG012) FERROELECTRICS L T P C

AIM: To enhance the understanding of the Ferroelectric materials, which are the special class of electronic materials.

OBJECTIVE:
- To explore the importance and applications of Ferroelectric materials
- Study of domain structure and domain kinetics of Ferroelectrics, electrical and switching characteristics of Ferroelectric materials.

UNIT I

UNIT II
Optical and related properties - Refractive index and Birefringence - Optical dispersion - Thermooptic behaviour - Elastooptic behaviour - Electrooptic characteristics - Non-Linear optical effects - photo refractive effect - Light scattering effect - Absorption - Photoluminescence - Electroluminescence and Luminescence.

UNIT III

UNIT IV
Non-linear optics - wave propagation in Non-linear dielectrics - Electrooptic and Non-linear optic coefficients - The nonlinear susceptibility - Optical second Harmonic generation.

UNIT V
Order-Disorder Ferroelectrics - Triglycine Sulphate - Sodium nitrate - Displacive Ferroelectrics - oxygen Octahedran - Applications of Ferroelectrics - Pyroelectric detection - Memories and display.

TOTAL PERIODS = 45
REFERENCES:
4. Amnon Yariv, Quantum mechanics, John Wiley and Sons Inc, New York, 1975

Faculty of Science and Humanities  (Approved in 3rd AC 22.11.2003) ITEM NO.3.4 (2(15))

PH 775 (Old Code: CG013) SUPERCONDUCTING MATERIAL L T P C
PREPARATION AND CHARACTERIZATION 3 0 0 3

AIM: To enhance theoretical and modern technological aspects of Superconductivity and Superconducting materials.

OBJECTIVE:
- To explore the fascinating field of superconductivity, to study the mechanism of superconductivity, growth of superconducting single crystals, magnetic and electrical properties, to explore the applications of these materials.

UNIT I

UNIT II

UNIT III
Structure of LSCO - YBCO - BSCCO - TIBCCO - Domain structure - superstructure formation - structure modulation in superconducting materials (9)

UNIT IV

UNIT V
Fullerenes - Making of fullerenes - deposition of graphitic soot - Isolation of Buckminster fullerenes C60 and higher fullerenes - Superconductivity in fullerenes - effects of different dopants - enhancement of Tc values - resistivity and susceptibility measurements - Growth of C60 single crystals. (10)

TOTAL PERIODS = 45
REFERENCES:

Faculty of Science and Humanities

(Approved in 3rd AC 22.11.2003) ITEM NO.3.4 (2(16))

PH 776 (Old Code: CG014) NUMERICAL METHODS AND COMPUTER PROGRAMMING

AIM: To introduce the fundamentals of various types of numerical simulation techniques
To enhance the understanding of the numerical simulation in crystal growth by using computation methods

OBJECTIVES: On completion of the course the student would be in position
- To understand the basic concepts of numerical simulation
- To solve the heat and mass transfer related problems in crystal growth

UNIT I

UNIT II
Interpolation, curve fitting and statistics: Finite difference operator - Newton’s forward and backward interpolation formula - Lagrange’s Interpolation – Lagrange’s inverse interpolation – curve fitting principle of least squares – Linear correlation and regression analysis – sampling distributions - small and large samples – tests of hypothesis – students distribution – F-distribution - chi square distribution

UNIT III

UNIT IV
C programming: Introduction, operator, expressions, variables, input, output statements, control statements, functions, arrays, pointers, structures, unions – simple applications.

UNIT V

TOTAL PERIODS = 45
REFERENCES:

Faculty of Science and Humanities

PH 777 (Old Code: CG015) X-RAY CRYSTALLOGRAPHY  L T P C
3 0 0 3

AIM: To enhance the theoretical and experimental understanding of X-ray crystallography and structural characterization of materials

OBJECTIVE:
- Through this course the students would be exposed to the X-ray diffraction analysis of material properties including structural analysis, determination of lattice parameters, symmetry properties and Texturing aspects of crystalline materials.

UNIT I

UNIT II

UNIT III

UNIT IV
UNIT V

TOTAL PERIODS = 45

REFERENCES:

Faculty of Science and Humanities

PH 778 (Old Code: CG016)  GROWTH OF CRYSTALS FROM VAPOUR PHASE  L T P C

AIM: To study the fundamentals of various types of nucleation processes during vapour growth process
To learn the optimum conditions for the growth of technologically important materials from vapor phase and the methods of epitaxial growth techniques.

OBJECTIVES: On completion of the course the student would be in position
- To do independent work on the growth of crystals from vapour phase
- To design the various reactors for the growth of crystals using CVT, PVT, CVD, PVD techniques

UNIT I
Methods of vapour phase growth – Physical Vapor Transport (PVT) – Physical Vapor Deposition (PVD) – Chemical Vapor Deposition (CVD) – Chemical Vapour Transport (CVT) – reaction types - thermodynamics, kinetics - transport processes - Thermodynamics of Chemical vapor deposition process – physical, thermo – chemical factors affecting growth process.

UNIT II

UNIT III

UNIT IV
Advantages and Limitations of Chemical Vapor Transport (CVT) – stationary temperature profile (STP) – linearly time varying temperature profile (LTVTP) – oscillating temperature profile (OTP) – the role of chemical and geometrical parameters on CVT – determination of thermodynamic values – LPCVD – VPE – MOVPE.
UNIT V
The transport of solid substances and its special applications – metal transport with vapor, hydrogen halides and volatile halides – oxides transport with water vapor, hydrogen halides, oxygen and volatile halides – introduction of impurities by transport-Growth of II-VI and I-III-VI$_2$ compounds from vapour phase.

TOTAL PERIODS = 45

REFERENCES:
2. A.C. Zettlmoyer, Nucleation, Manced, Dekker, New York, 1972

Faculty of Science and Humanities
PH 779 (Old Code: CG017) SEMICONDUCTOR DEVICE
FABRICATION

AIM: To disseminate the knowledge of semiconductor device processing and to deliver the functional devices.

OBJECTIVES:
At the end of the course the student should be in a position to meet the following objectives.
- Preparation of semiconductor structures for processing
- Deposition of oxides, masking and etching
- Applications and limitations of optical lithography and electron lithography
- Metallization, lift off and annealing
- Dicing, bonding and packing of devices.

UNIT I
Wafer Preparation: Bulk Crystal Growth - Cutting and Polishing - Surface Cleaning - Etching for oxide layer removal - Controlled dissolution of surfaces - Identification for batch processing.

UNIT II
Deposition: Deposition processes - Silicon dioxide - Silicon nitride - Other materials - Plasma assisted deposition - Plasma Enhanced Chemical Vapour Deposition (PECVD) - Oxidation: Growth mechanism and kinetics - Oxidation techniques and systems - Oxide properties - Redistribution at interface - Oxidation induced defects.

UNIT III
UNIT IV
Metallization: Methods of physical vapour deposition - Selected metals for metal-semiconductor contacts - Problems encountered in metallization - Metallization failure - Silicides for gates and interconnections - Corrosion and bonding.

UNIT V
Assembly Techniques and packaging: Wafer separation and sorting - Die interconnections - Package types and fabrication technology - Special package considerations.

TOTAL PERIODS = 45

REFERENCES:
UNIT IV
Optical Microscopy - Use of polarized light microscopy, phase contrast microscopy and interference microscopy – hot stage microscopy – surface morphology – Etch pit density – Hardness Measurements

UNIT V

REFERENCES:

Faculty of Science and Humanities
(Approved in 8th AC 18.03.2006) ITEM NO.8.2.3(1)

FS1911 (Old Code CY 081) ORGANIC SYNTHESIS L T P C 3003

UNIT I PRINCIPLES OF ORGANIC SYNTHESIS 9
Basic principles - Convergent and linear synthesis - Concept of retrosynthetic analysis - Synthons and synthetic equivalents - Stereoselectivity, Stereospecificity, Regio selectivity and Chemoselectivity.

UNIT II FUNCTIONAL GROUP PROTECTION 9
Functional group interconversions – Protection and deprotection – Latent functionality – Reverse polarity (Umpolung) - One group C-X disconnection.

UNIT III FUNCTIONAL GROUP DISCONNECTION 9
Two group disconnection -1,2-Difunctional compounds, 1,3-Difunctional compounds and 1,4 - Difunctional compounds.

UNIT IV PERICYCLIC REACTIONS 9

UNIT V PHOTOCHEMICAL REACTIONS 9
Olefin metathesis - Heterocyclic ring synthesis - Photochemical reactions in organic synthesis.

TOTAL: 45 PERIODS

REFERENCES:

Faculty of Science and Humanities
(Approved in 8th AC 18.03.2006) ITEM NO.8.2.3 (2)

FS1912 (Old Code CY 082) ASYMMETRIC SYNTHESIS L T P C

UNIT I STEREOCHEMISTRY 9
Stereoselectivity, enantioselectivity and diastereoselectivity- Cram’s rule and Felkin-Anh model
Addition to carbonyl compounds - Organo magnesium, Organo copper, Organo cadmium, Organo zinc, Organo tin and Organo indium compounds.

UNIT II CHIRAL SYNTHESIS 9
Alpha substitution using chiral enolates – chiral auxiliary approach – chiral Auxiliaries derived from amino acids and simple carbohydrates - Asymmetric aldol reactions.

UNIT III ADDITION REACTIONS 9
Addition to C-C double bonds – asymmetric Diels - Alder reactions – asymmetric 2,3 cycloaddition reactions - Chirality transfer and pericyclic reactions.

UNIT IV ASYMMETRIC SYNTHESIS REACTIONS 9
Asymmetric cyclopropanations- asymmetric Michael additions – Asymmetric reduction of ketones by chiral Binap and chiral boranes- Chiral transfer hydrogenations –enzymatic reduction of ketones.

UNIT V ASYMMETRIC OXIDATION 9
Asymmetric oxidations asymmetric hydroxylation of enolates Asymmetric dihydroxylation of C-C double bonds – asymmetric epoxidation of allylic alcohols and olefins.

TOTAL: 45 PERIODS

REFERENCES:
FS1913  BIOSENSORS AND INSTRUMENTATION  L T P M  3 0 0 100

UNIT I  INTRODUCTION
Concepts and components of a biosensor - principles of operation, integration of biosensor in instrumentation.

UNIT II  PREPARATION OF BIOSENSOR
Biomolecules used in biosensors and their properties, general Immobilization techniques for (Optical-detection biosensor, thermal-detection biosensor, electrochemical biosensor etc..) behaviour of different types of biosensors.

UNIT III  TYPES OF BIOSENSOR
Enzyme based biosensor; (glucose biosensor, cholesterol biosensor), microbial immunobiosensor and their characteristics.

UNIT IV  APPLICATIONS OF BIOSENSORS
Validation (Specificity, Speed, Simplicity, Capability), application of biosensor in environment, Microbiology: bacterial and viral analysis, Food and beverage production and analysis, Clinical Diagnosis.

UNIT V  INSTRUMENTATION OF BIOSENSOR
Transducers: OpticalTransducers, Fluorescence transducers, Acoustic transducer. Polarizable and non-polarizable electrodes acoustic, plasmon resonance, holographic and microengineered sensors for monitoring low molecular weight anlaytes, proteins, DNA and whole cells.

REFERENCES:

FS1914  DOMINATION IN GRAPHS  L T P M  3 0 0 100

UNIT I  DOMINATING SETS
Dominating sets in graphs – Minimal dominating sets – Hereditary and superhereditary properties – Minimal and Maximal P-sets – Independent sets – Every maximal independent set is a minimal dominating set – Irredundant sets– Domination chain – Bounds involving domination, independence and irredundance numbers.

UNIT II  CHANGING AND UNCHANGING DOMINATION
UNIT III  CONDITION ON DOMINATING SET  9
Condition on the dominating set – Independent dominating sets – Total dominating sets – Connected dominating sets – Bounds for connected domination number – External graphs attaining the bounds.

UNIT IV  DOMINATING CLIQUES  9
Dominating cliques – Sufficient condition for existence of a dominating clique – Bounds for the clique domination number – Paired dominating sets – Paired domination number – Bounds for paired domination number – Inequalities connecting paired domination number and other domination parameters

UNIT V  VARIETIES OF DOMINATION  9
Varieties of domination – Multiple domination – Bounds for the multiple domination number – k–dependence number – Inequality connected k–domination number and k–dependence number – Locating domination – Locating domination number – Bounds – Strong and weak domination – Strong and weak domination number – Bounds.

TEXT BOOK:
   (Sections 1.2, 3.1, 3.2, 3.3, 3.4, 5.1, 5.2, 5.3, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 7.1, 7.3, 7.5)
REFERENCES:
1. T. W. Haynes, S. T. Hedetniemi and P. J. Slater, Domination in Graphs – Advanced Topics, Marcel Dekker, Inc., New York, 1998. (Sections 3.1, 3.2.1, 3.2.2, 3.3.1)

Faculty of Science and Humanities

FS1916 CRYSTAL GROWTH AND SPECTROSCOPY L T P M
3 0 0 100

UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V

REFERENCES:
Faculty of Science and Humanities

**ITEM NO. FS 13.01(1)**

**FS 1917**  
**RESERVOIR SEDIMENTATION**  
**L T P C**  
3 0 0 3

**UNIT I**  
**CATCHMENT PROCESSES**  
8


**UNIT II**  
**RESERVOIR EUTROPHICATION**  
10


**UNIT III**  
**SEDIMENTS**  
12


**UNIT IV**  
**SEDIMENT SAMPLING AND ANALYSIS**  
8


**UNIT V**  
**SEDIMENT CONTROL AND MANAGEMENT**  
7

Control of reservoir sedimentation– sediment removal and disposal – environmental, social and economical impacts.

**TOTAL:** 45 PERIODS

**REFERENCES:**


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**ITEM NO. FS 13.01(2)**

**FS 1918**  
**GENETIC ENGINEERING**  
**L T P C**  
3 0 0 3

**UNIT I**  
**SALIENT FEATURES OF CLONING VECTORS**  
9

Types of cloning vectors viz. Plasmids, Cosmids, ssDNA Phages, Yeast cloning vectors, Animal viruses, Ti Plasmids and cauliflower Mosaic Virus.

**UNIT II**  
**PLASMID BIOLOGY**  
8

Structural and Functional Organization of Plasmids, Plasmid Replication, Stringent and Relaxed Plasmids, Incompatibility of Plasmid Maintenance.
UNIT III  ENZYMES IN GENETIC ENGINEERING  8
DNA polymerase, Polynucleotide kinase, T4 DNA ligase, Nick translation System, Terminal
deoxynucleotide transferase, Reverse transcriptase Restriction Endonucleases Type I & II.

UNIT IV  ISOLATION OF GENOMIC AND NUCLEAR DNA  9
DNA digestion and restriction fragment analysis and sequencing by chemical, Enzymatic and big-by
terminator methods.

UNIT V  GENE MODIFICATION & APPLICATION OF RECOMBINANT DNA TECHNOLOGY  11
Mutagenesis-Deletion mutagenesis, Oligonucleotide derived mutagenesis, Site directed mutagenesis-
Its applications; Applications of rDNA technology in Diagnostics; Pathogenesis; Genetic diversity;
Therapeutic proteins-Vaccines. Molecular probes (production, labeling and uses), P.C.R.

TEXT BOOKS:
   Publication 1985.
2. “Genes VI” by B. Lewin
3. “From Genes to Clones” by E.L. Winnecker.

Faculty of Science and Humanities  
(Approved in 13th AC 20.12.2008) ITEM NO. FS 13.01(3)

FS 1919  ANALYTICAL TECHNIQUE IN BIOTECHNOLOGY  L T P C
                                             3 0 0 3
UNIT I  CHROMATOGRAPHY - TECHNIQUES  8
Chromatography – adsorption, affinity, partition (GLC, GC, HPLC, TLC, RPC etc.) Immobilized cells.

UNIT II  MICROSCOPY - TECHNIQUES  8
Microscopic identification of various microorganisms: phase contrast and confocal microscopy: SEM-
TEM microscopy.

UNIT III  SPECTROSCOPIC TECHNIQUES  9
Introduction to principles and applications of Spectroscopic methods UV, Vis, IR, Fluorescence, ORD,
CD, PAS, NMR, ESR and mass spectrometry.

UNIT IV  NUCLEOTIDE AND DNA ANALYSIS  8
DNA purification, PCR – based analysis; DNA fingerprinting; DNA sequencing.

UNIT V  IMMUNO-TECHNIQUES  12
Antiserum production, immunofluorescence, immuno histocompatibility ELISA; Isolation of cells in tissues
immunoblotting; monoclonal antibodies. Theory of Lyophilization and its applications to biological
systems. Cell sorter and their applications. Theory of centrifugation and application to biological
systems. Rotors angle / vertical, zonal / continuous flow buoyant density centrifugation. Ultracentrifuge
– principle and application.

TEXT BOOK:
FS 1920 KEY COMPONENTS FOR ALL-OPTICAL NETWORKS L T P C 3 0 0 3

UNIT I DWDM & ALL OPTICAL NETWORKS 9
ITU grid frequencies – Basic network elements of a point to point DWDM system – Issues in DWDM networks- wavelength stabilization, chirping, non-linearities –self phase modulation, FWM, dispersion management, DWDM link design (case study ), Evolution of all – optical networks (optical internet)

UNIT II NETWORK ELEMENTS 9

UNIT III WAVELENGTH ROUTING ELEMENTS 9
ROADM architectures, OXC’s, Wavelength converters, Adaptation of these components to optical MEMs based systems for dynamic configurability.

UNIT IV PHOTONIC COMPONENTS & MATERIALS 9
SEED based devices for optical programming logic, photonic bandgap structures, metamaterials, photonic crystal fibers, programmable optical delays

UNIT V OPTICAL PACKET SWITCHING 9
GMPLS, Key elements of All- optical packet switching nodes, KEOPS test-bed

REFERENCES:
4. Rajiv Ramaswamy and Kumar Sivarajan, "Optical Networks-A Practical perspective”, Morgan-Kaufman

FS 1921 BIOMIMETIC OXIDATION CHEMISTRY L T P C 3 0 0 3

UNIT I BIOCATALYST OXIDATIONS 9

UNIT II BIOMIMETIC OXIDATIONS OF CYTOCHROME P450MIMIES 9
Biocatalytic conversion – oxygenases – oxidases – peroxidases – Biomimetic oxidations – cytochrome P450mimies – MMO mimies
UNIT III  BIOMIMETIC CHEMISTRY OF MOLYBDENUM
Biomimetic chemistry of Molybdenum – Overview of Biomimetic systems – Oxygen atom transfer reaction – Coupled electron - Proton transfer reaction

UNIT IV  DISTINGUISHING BIOMIMETIC OXIDATIONS FROM OXIDATIONS MEDIATED BY FREELY DIFFUSING RADICALS-FREE RADICALS
Distinguishing Biomimetic oxidations from oxidations mediated by freely diffusing radicals - free radicals – Clock-choice of activation source – Effect of additives – competitive Kinetics – Oxygenated Penton chemistry.

UNIT V  METAL – OXO AND METAL – PEROXO INTERMEDIATES
Biometric oxygenation related to Cytochrome P450 Metal- Oxo and Metal – Peroxo intermediates – Mechanism of hydroxylation by Cytochrome P450–Decomposition catalysis for Peroxy nitrite by impartan biological oxidants.

REFERENCES:
5. Biomimetic Oxidations Catalyzed by Transition Metal Complex by Bernard Meunier, Imperial College Press.

Faculty of Science and Humanities (Approved in 14th AC 29.08.2009) ITEM NO. VC14.08(1)

FS1922  BOSE EINSTEIN CONDENSATION  L T P C  3 0 0 3
UNIT I  INTRODUCTION & THE NON-INTERACTING BOSE GAS
Bose-Einstein condensation in atomic clouds - Superfluid helium - Other Condensates -The Bose Distribution - Transition temperature and condensate fraction – Density profile and Velocity distribution - Thermodynamic quantities (Condensed phase, Normal phase and specific heat close to TC) – Effect of finite particle number – Lower dimensional systems.

UNIT II  TRAPPING AND COOLING OF ATOMS

UNIT III  THEORY OF CONDENSED STATE & ITS DYNAMICS

UNIT IV  SUPER FLUIDITY
The Landau criterion – The two component picture (Momentum carried by excitations and Normal fluid density) – Dynamical processes – First and second sound – Interactions between excitations (Landau damping)
UNIT V  MIXTURES AND SPINOR CONDENSATES
Mixtures – Equilibrium properties and collective modes, Spinor Condensates – Mean field description and Beyond the mean field approximation.

REFERENCES:

Faculty of Science and Humanities  (Approved in 14th AC 29.08.2009) ITEM NO.VC 14.08(2)

FS1923  ICT FOR DEVELOPMENT  L T P C
3 0 0 3

AIM
To introduce the students to principles and tools of information and communication technology (ICT), and its applications for development.

OBJECTIVES
- To understand the information and communication technology developments in India and their role in creating social change.
- To know the different tools of ICT.
- To know the benefits of the tools of ICT for development.

UNIT I  INTRODUCTION

UNIT II  ICT IN HEALTH

UNIT III  ICT IN AGRICULTURE

UNIT IV  ICT IN HOLISTIC DEVELOPMENT
UNIT V ICT IN SUSTAINABLE DEVELOPMENT

Sustainable Development Definition – economic, environmental, social and human sustainability – Brundtland report – Improving public awareness – Monitoring – Response systems – Facilitating environmental activism – Enabling more efficient resource use through ICT.

TEXT BOOKS:
2. Akhtar Badshah, Sarbuland Khan and Maria Garrido, Connected for Development, UN ICT Task Forces.

REFERENCES:
3. Subhash Bhatnagar and Robert Schware, Information and Communication Technology in Development Cases from India, Sage Publication, New Delhi, 2000

Faculty of Science and Humanities

(Approved in 15th AC 13.02.2010) ITEM NO. FS 15.02(1)

FS9001 FINITE VOLUME METHOD L T P C 3 0 0 3

UNIT I CONSERVATION LAWS AND BOUNDARY CONDITIONS
Governing equation of fluid flow: Mass, Momentum and Energy equations, Equation of state; Navier-Stokes equations for a Newtonian fluid, Conservative form of equations of fluid flow, Differential and integral forms of the transport equation, classification of PDE’s and fluid flow equations, viscous fluid flow equations, transonic and supersonic compressible flows.

UNIT II FINITE VOLUME METHOD FOR DIFFUSION & CONVECTION-DIFFUSION PROBLEMS
FVM for Diffusion Problems: one-dimensional steady state diffusion, two-dimensional diffusion and three-dimensional diffusion problems; FVM for Convection-Diffusion problems one-dimensional steady state convection-diffusion, central differencing schemes for one-dimensional convection-diffusion, upwind differencing scheme, hybrid differencing scheme, Higher-order differencing scheme for convection-diffusion problems, TVD schemes

UNIT III SOLUTION ALGORITHMS FOR PRESSURE-VELOCITY LINKED EQUATIONS
Staggered grid, momentum equations, SIMPLE, SIMPLER, SIMPLEXC algorithms, PISO algorithms, solution of discretised equation: Multigrid techniques.

UNIT IV FINITE VOLUME METHOD FOR UNSTEADY FLOWS
One-dimensional unsteady heat conduction: Explicit, Crank-Nicolson, fully implicit schemes, implicit method for two- and three- dimensional problems, transient convection – diffusion equation and QUICK differencing scheme, solution procedures for unsteady flow calculations and implementation of boundary conditions.
UNIT V  METHOD WITH COMPLEX GEOMETRIES  9
Body-fitted co-ordinate grids for complex geometries, Cartesian Vs. Curvilinear grids, difficulties in Curvilinear grids, Block-structured grids, Unstructured grids and discretisation in unstructured grids, Discretisation of the diffusion term, Discretisation of convective term, treatment of source terms, Assembly of discretised equations, Pressure-velocity coupling in unstructured meshes, staggered Vs. co-located grid arrangements, face velocity interpolation method to unstructured meshes.

TOTAL : 45 PERIODS

TEXTBOOK:

REFERENCES:
UNIT V  GENETIC ALGORITHMS

TOTAL: 45 PERIODS

TEXTBOOKS:

REFERENCES:
REFERENCES:

Faculty of Science and Humanities

FS9004 QUANTUM MECHANICAL COMPUTATION OF MOLECULAR MODELS

UNIT I COMPUTATIONAL THEORY, MODELING AND MOLECULAR MECHANICS

UNIT II SIMULATIONS OF MOLECULAR ENSEMBLES

UNIT III MOLECULAR ORBITAL THEORY

UNIT IV SEMIEMPIRICAL IMPLEMENTATIONS OF MOLECULAR ORBITAL THEORY

UNIT V DENSITY FUNCTIONAL THEORY

REFERENCES:
FS9005

DIFFERENTIAL SUBORDINATION

UNIT I
PRELIMINARIES AND THEORY OF SECOND ORDER DIFFERENTIAL SUBORDINATIONS

Basic definitions and results – Subordinations – Hyper geometric functions – Classes of functions – Integral operators.
Introduction – Fundamental lemmas – admissible functions and examples – Open door lemma and integral existence theorem

UNIT II
APPLICATIONS OF FIRST ORDER DIFFERENTIAL SUBORDINATION

First order linear differential subordinations – Briot – Bouquet differential subordination - Analytic integral operators – Subordination preserving integral operators.

UNIT III
APPLICATIONS OF SECOND ORDER DIFFERENTIAL SUBORDINATION

Second order linear differential subordination – integral operators preserving functions with positive real parts – Integral operators preserving bounded functions – Averaging integral operators – Hyper geometric functions – Schwarzian and Starlikeness

UNIT IV
SPECIAL DIFFERENTIAL SUBORDINATION

Conditions for special sub classes of star like functions – Simple Conditions for star likeness and convexity – On a theorem of Robertson – subordination by convex functions – Function with bounded turning and star like functions – star like with respect to symmetric points.

UNIT V
DIFFERENTIAL SUBORDINATION OF SEVERAL COMPLEX VARIABLES AND APPLICATIONS

Preliminary lemmas – extensions of the fundamental lemma – Dominant and admissible functions in \( C^n \) - Differential subordination in \( C^n \).

TOTAL: 45 PERIODS

TEXT BOOK:

REFERENCES:
UNIT II  Drug Delivery  

UNIT III  Controlled, Sustained and Advances in drug delivery system  

UNIT IV  Introduction to tissue engineering and regenerative medicine  
Basic definition – current scope of development – regenerative medicine, stem cell concepts and its role in tissue and organ developments – use in therapeutics and in vitro testing.

UNIT V  Scaffolds  
Scaffolds – importance of scaffolds – fabrication of scaffolds – tissue culture methods, types of cells – cytotoxicity – bioreactors and its types – Advantages of Composites and Composite scaffolds.

TEXT BOOK:

REFERENCES:

AIM: To introduce the fundamentals of various types of epitaxy. To enhance the understanding of the phase diagrams, epitaxial growth processes and instrumentation of epitaxial techniques.

OBJECTIVES: On completion of the course the student would be in position
- To understand the concepts of homoepitaxy and heteroepitaxy
- To derive the expressions for the kinetically controlled and thermodynamically controlled growth regimes in epitaxy
- To design the various reactor models in LPE, VPE, MOCVD, MBE, CBE and ALE

UNIT I
UNIT II

UNIT III
Principle of method and apparatus - reactor design - growth of III-V compound Semiconductors - InP - GaAs - GaInAs - GaInAsP and other III-V compounds.

UNIT IV
Mechanism of MOCVD growth - Thermodynamic concepts - growth rate calculations - applications of III-V materials grown from MOCVD - Low pressure MOCVD (LPMOCVD)

UNIT V

TOTAL: 45 PERIODS

REFERENCES:
1. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Pretice Hall of India, New Delhi,1994
UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V

REFERENCES:
6. Peter Gise & Richard Blanchard, Modern Semiconductor fabrication technology
   Prentice-Hall, New Jersey, 1986

Faculty of Science and Humanities

FS9009 FLUID DYNAMICS L T P C
UNIT I KINEMATICS OF FLUIDS IN MOTION 9
Real and ideal fluids – Velocity of a fluid at a point – Acceleration of a fluid – Streamlines – Pathlines

UNIT II EQUATIONS OF MOTION 9
Pressure at a point in a fluid at rest and in a moving fluid – Boundary conditions of two inviscid
immiscible fluids - Euler’s equations of motion – Bernoulli’s equation – Some potential flows - Flows
involving axial symmetry.

UNIT III TWO DIMENSIONAL FLOWS 9
Two-dimensional flows – Use of cylindrical polar co-ordinates – Stream function – Complex potential
for two-dimensional flows – Two dimensional image systems – Milne-Thomson circle theorem –
Theorem of Blasius.

UNIT IV EXACT SOLUTIONS OF THE NAVIER-STOKES EQUATIONS 9
Parallel flows – Couette flow – Hagen-Poiseuille flow – Flow between two concentric rotating cylinders
– Stokes’ first and second problems – Stagnation in plane flow – Flow in convergent and divergent
channels.

UNIT V VERY SLOW MOTION AND LAMINAR BOUNDARY LAYER 9
Very slow motion - Parallel flow past a sphere – Hydrodynamic theory of lubrication – Boundary layer
equations for two-dimensional flow – Boundary layer on a plate – Similar solutions – Momentum and
energy integral equations for the boundary layer – Flow past a cylinder - symmetrical case – the
Blasius series.

TOTAL : 45 PERIODS

BOOKS FOR STUDY:
2.10, 3.1 – 3.9, 5.1 – 5.9 )
1968. (Chapters V, VI a,b,c, VII, VIII a,b,c,e, IX c)

REFERENCE BOOKS:
Fa

Faculty of Science and Humanities

( Approved in 17th AC [Ad hoc] 27.04.2012) ITEM NO. FS 17.01(3)

FS9010 FUEL CELLS FOR ENERGY SOURCES L T P C
3 0 0 3

UNIT I INTRODUCTION TO FUEL CELLS
Relevance and Importance of fuel cells; Fuel cell basics - Fuel cell definition - Difference between
batteries and fuel cells – Principle and working of fuel cells - Types of fuel cells – Electrolyte
membranes.

UNIT II CLASSIFICATION OF FUEL CELLS
Proton exchange membrane fuel cell (PEMFC) - Direct methanol fuel cell (DMFC) - Alkaline fuel cell
(AFC) - Phosphoric acid fuel cell (PAFC) - Solid oxide fuel cells (SOFC) - Molten carbonate fuel cell
(MCFC) – Borohydride fuel cell (BHFC) – Bio fuel cell (BFC).

UNIT III ELECTROCHEMISTRY IN FUEL CELLS
Basics of electrochemistry – Cyclic Voltammetry – Chronoamperometry – Chronocoulometry - Fuel
cell thermodynamics - second law - Analysis of fuel cells - efficiency of fuel cells -fuel cell
electrochemistry - Nernst equation, Electrochemical Kinetics - Butler-Volmer equation – Conductive
measurement by impedance spectroscopy.

UNIT IV CONSTRUCTION AND WORKING OF FUEL CELLS
Fuel cell design and components - Cell components, stack components, system components –
Membrane electrode assembly (MEA) preparation - - Fuel Cell Performance - Activation, Ohmic and
Concentration over potential

UNIT V NANOTECHNOLOGY IN FUEL CELLS
Hydrogen energy – Hydrogen: Its merit as a fuel; Applications – Hydrogen production methods –
Hydrogen storage – carbon nano tubes (CNTs) – Nano catalysts and Nano composite membranes –
preparation methods – methods of fabricating CNT and CNF (Carbon nano fibers) – Electrospinning,
Chemical vapor deposition, Pyrolysis – Hydrogen sensors.

TOTAL: 45 PERIODS

TEXTBOOKS/REFERENCE BOOKS
6. B. Viswanathan and M. Aulice Scibioh, Fuel cells principles and applications, Universities
(2007)
FS9011  CHARACTERIZATION TECHNIQUES                L  T  P  C

AIM:  To enable the students to understand the importance of materials characterization
      To expose the students on Advanced Characterization Techniques

OBJECTIVE: 
- Through this course, the students would be exposed to Advanced
  Materials Characterization Techniques to understand the structural, optical, mechanical and
  defect characteristics of the materials.

UNIT I
Absorption & Emission spectroscopy - Nature of electromagnetic radiation - Atomic energy levels -
Molecular electronic energy levels - vibrational energy levels - Raman effect - X-ray energy levels.

UNIT II
Infrared spectroscopy - Near IR - Mid IR - Far IR Region - Correlation of infrared spectra with
molecular structure - structural Analysis - Radiation sources - Detectors - Thermal Detectors -
Photon Detectors - Spectrophotometers - Fourier Transforms Interferometer - Sample handling.

UNIT III
Raman spectroscopy - Theory - Resonance Raman Spectroscopy - Comparison of Raman with
Infrared Spectroscopy - Diagnostic - Structural Analysis - Polarization measurements -
Instrumentation - Quantitative analysis.

UNIT IV
X-ray methods - Production of X-rays and X-ray Spectroscopy - Instrumental units - Detectors for the
measurements of radiation - Semiconductor detectors - Direct X-ray methods - Nuclear magnetic
Resonance Spectroscopy - Basic principles - Quantitative analyses - Scanning Electron Microscopy -

UNIT V
Thermal analysis - Differential Thermal Analysis - Instrumentation – Differential Scanning
calorimetry - Thermogravimetry - Instrumentation - Methodology of Differential Scanning
Calorimetry & Thermo Gravimetric Analysis - Conductance method - Electrical conductivity -
Measurement of electrical conductance - Measurement of dielectric constant. Microhardness -
Etching studies.

REFERENCES:
1. X.F. Zong, Y.Y. Wang, J. Chen, Material and Process Characterization for VLSI, World Scientific,
   New Jersey, 1988
2. S.M. Sze, Semiconductor Devices, Physics and technology, John Wiley Publishers, New York,
   2000
   1982
   Sons Inc., New York , 1990

TOTAL: 45 PERIODS
AIM:
To make the students understand the principles of optical phase conjugation.

OBJECTIVE:
To teach the students the basic theory of Degenerate four-wave mixing, Optical phase conjugation and their applications.

UNIT I OPTICAL PHASE CONJUGATION 9

UNIT II DEGENERATE FOUR-WAVE MIXING 9

UNIT III MATERIALS ON OPTICAL PHASE CONJUGATION 9

UNIT IV WAVE-FRONT REVERSAL (WFR) 9

UNIT V APPLICATIONS OF NONLINEAR OPTICAL PHASE CONJUGATION 9

REFERENCES:
SSH001 SUPRAMOLECULAR CHEMISTRY

Aim: To introduce the fundamentals and synthetic concepts of supramolecular chemistry.

UNIT I SYNTHESIS AND STRUCTURE OF SUPRAMOLECULES
Definition of supramolecular chemistry, synthesis, structural properties and applications of crown ethers, lariat ethers, podands, cryptands, spherands, cyclam, cucurbit[n]uril, cyclodextrins, cyclophanes, cryptophanes, cyclotriveratrylene, Host-Guest interactions, pre-organization techniques for assembly of supramolecules, Binding of cationic, anionic, ion pair and neutral guest molecules.

UNIT II NATURE OF BINDING INTERACTIONS IN SUPRAMOLECULAR STRUCTURES
Structure and functions of non-cova lent interactions like ion-ion-, ion-dipole, dipole-dipole, H-bonding, cation-π, anion-π, π-π, and Vander Waals interactions.

UNIT III SELF-ASSEMBLY MOLECULES
Design, synthesis and properties of the self-assembly molecules, self assembling by H-bonding, metal-ligand interactions and other weak interactions, synthesis, properties and applications of metallomacrocycles-aromatic, aliphatic and chiral macrocycles, catenanes- types, synthesis, properties and applications of catenane molecules, rotaxanes- clipping, threading, slipping methods to assembly of rotaxanes and their properties and applications.

UNIT IV MOLECULAR DEVICES
Synthesis, working principles and their applications of Molecular electronic devices, molecular wires-
highly conjugated aromatic and aliphatic organic molecular wires, nanowires in molecular electronics, molecular rectifiers-unimolecular rectifiers, rectifiers based on donor/acceptor assemblies, molecular switches-photochromic, host-guest, mechanically interlocked molecular switches, molecular logic gates- YES, NOR, OR, AND logic gates.

UNIT V RELEVANCE OF SUPRAMOLECULAR CHEMISTRY TO MIMIC BIOLOGICAL SYSTEMS
Synthesis of simple, reactive site modified cyclodextrin and their enzyme mimics, ion channels- synthesis and ion transporting properties, supramolecular catalysis- synthesis of organometallic and enzyme catalyst and their catalytic properties and mechanism.

TOTAL: 45 PERIODS

TEXT BOOKS:
P. D. Beer, P. A. Gale, D. K. Smith; Supramolecular Chemistry (Oxford University Press, 1999).
J. W. Steed and J. L. Atwood; Supramolecular Chemistry (Wiley, 2000).
UNIT II  MODIFICATION OF EXISTING STRUCTURES BY ION EXCHANGE AND INTERCALATION REACTIONS

Ion exchange reactions – synthesis of new meta stable phases by ‘chimie Douce’ – intercalation reactions – graphite intercalation compounds – transition metal dichalcogenides and other intercalation compounds – tungsten bronzes.

UNIT III  HIGH PRESSURE METHODS


UNIT IV  SOL-GEL METHOD


UNIT V  VAPOR PHASE TRANSPORT METHODS

The process – use of transporting agents – importance of gas phase transporting agents – synthesis of binary and ternary compounds – synthesis of Ca$_2$SnO$_4$, NiCr$_2$O$_4$, Al$_2$S$_3$, Nb$_5$Si$_3$, synthesis of chalcogenides, preparation of zinc tungstate and oxides – crystal growth

TOTAL: 45 PERIODS

REFERENCES

Faculty of Science and Humanities

(Approved in 22nd AC 26.07.2017) ITEM NO. FS 22.02(1))

FS9013  MASS COMMUNICATION STRATEGIES FOR GREEN BUILDINGS  L T P C 3 0 0 3

OBJECTIVES
- To expose to classical and contemporary theories of communication and to examine the validity of theories.
- To explore the elements of a strategic communication using principles and strategies of public relations, corporate communication, advertising, branding, and agency management in a multinational environment.
- To examine the current green building trend, and to understand the impact and applications of green building as a practice.

UNIT I  MASS COMMUNICATION THEORIES

UNIT II  STRATEGIC COMMUNICATION

UNIT III  SUSTAINABLE DEVELOPMENT
Concept of Sustainability and Sustainable Development - Sustenance and Development - Aspects of sustainability and development - social, economic and environmental - Physical sustainability - living within the laws of nature - Energy, Entropy and Materials - Global and Local Views - Sources of energy - Quality of energy - Sources of high-quality energy - historical perspective - current picture and possible future - Material resources - Real World Applications - Green buildings - Sustainable agriculture and forestry - Ecological footprint - Life Cycle Assessment - Water resources management - Mass communication strategies for Sustainable Development

UNIT IV  GREEN BUILDINGS

UNIT V  MEDIA AND ENVIRONMENT
About Ecology and Environment their Scope and importance - Different eco-systems – Interdisciplinary nature of environmental studies - Need for public awareness - Role of Media - Science, technology and environment - Major environmental production bodies and institutions in India and abroad - Development and environment - Designing environmental media programs - Use of media for environmental messages - Media in environmental management.

TOTAL: 45 PERIODS

OUTCOMES
• Understanding the communication theories and strategies for effective communication methodologies through mass media
• Understanding the uses of Sustainable living and green buildings which enhances the quality of living.

TEXT BOOKS
3. EBN article, “Durability: A Key Component of Green Building”
FS9014 ADVANCED CHEMISTRY AND TECHNOLOGY OF VEGETABLE AND ORGANIC TANNAGES

UNIT I VEGETABLE TANNING
Vegetable tannins - definition and classification, Occurrence, Biosynthesis; Chemistry of hydrolysable tannins - gallotannins, ellagi tannins – their structural aspects including tannin dimers, trimers, etc., Chemistry of condensed (flavanoid) tannins proanthocyanidins, dimers, trimers and other oligomers – Isolation and characterization of vegetable tannins.

UNIT II CONSTITUENTS OF VEGETABLE TANNING MATERIALS
Tannins as well as non tannins, polyphenolic constituents present in popular tanning materials like avaram, konnam, wattle, cutch, babul, myrobalan, etc., and their physicochemical properties and their effect on the physical properties of leathers.

UNIT III MECHANISM AND PRACTICE OF VEGETABLE TANNING

UNIT IV OTHER ORGANIC TANNAGES
Mechanism of tanning with aldehyde, dialdehydes, oil, sulphonyl chloride, quinone, oxazolidine, phosphonium and other organic tanning agents; wet white leathers; Synthetic tannins – Classification –properties, uses in leather industry – Mechanism of reaction with collagen.

UNIT V PREPARATION OF VEGETABLE TANNIN EXTRACTS AND SYNTHETIC TANNING AGENTS
Methods of preparation of vegetable tannin extracts, spray dried vegetable tannins, synthetic and other organic tannages.

TOTAL: 45 PERIODS

TEXTBOOKS
2. Rodd, “Chemistry of carbon compounds”, Vol. III-D, Chapter on “Hydrolysable tannins”.
OBJECTIVES

- To familiarize researchers with the origin of English language teaching-learning theories with the specific reference to current trends at various levels.
- To enable researchers to prepare lesson plans to impart skills and approaches.
- To make research scholars conversant with the theoretical foundations of teaching of English language.

UNIT I ORIGIN OF ENGLISH LANGUAGE

Origin of English Language teaching – Various approaches to English language teaching over the years – Palmer, Sweet, Hornby, I.A.Richards – Modern methods in teaching of English language learning - First language and second language Acquisition-Enhancing behaviourism – Cognitivism – Communicative Competence.

UNIT II THEORIES OF SECOND LANGUAGE LEARNING


UNIT III CURRICULUM DEVELOPMENT


UNIT IV PRODUCTION OF LEARNING TOOLS

Preparation of learning tools – Insight into material production – Relative merits of tasks and activities – Enhancing fluency through activities – Enriching four language skills (LSRW) through specific lesson plans – Scheming grammar and vocabulary through computer graphics and cartoons – Generating material for error free use of language – Borrowing materials from literature.

UNIT V TESTING AND EVALUATION


Teaching Methods: Lectures, invited lectures, presentations, discussions, classroom observations, teaching practice.

REFERENCES


Faculty of Science and Humanities

(Approved in 23rd AC 03.05.2018) **ITEM NO. FS 23.01(2)**

**SSH004** ENGLISH LANGUAGE TEACHING TECHNOLOGY

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**OBJECTIVES**

- To make research scholars familiar with the fundamentals and implementation of ICT tools in the second language classroom with the aid of various learning equipments.
- To help researchers use computer and internet for effective learning and teaching of English.

**UNIT I USE OF TECHNOLOGY**

9


**UNIT II LEARNING EQUIPMENTS**

9

Learning instruments and equipments – Twitter, Facebook, Quora Digest, Linked in, Video Conferencing – Webquest, Cyberspace developing skills - System and methodologies.

**UNIT III MATERIAL PRODUCTION FOR LEARNING AND TEACHING**

9


**UNIT IV TESTING ABILITY OF LEARNERS**

9

Traditional testing methods – Computer based testing – Online testing advantages – Self assessment.

**UNIT V PROBLEMS IN IMPLEMENTING TECHNOLOGY**

9

New dimensions in teaching technology – Problems and solutions – New challenges in using technology in second language teaching – Relevance of technology in language testing – Use of CALL in language classes.

Teaching Methods: Lectures, invited lectures, presentation, discussions, classroom observations, teaching practice.

**REFERENCES**

### FS9015 TELEVISION ON DEMAND

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**OBJECTIVES**
- To make the students understand about the various television transmission systems.
- To learn the Global content production.

**UNIT I**

**UNIT II**
Player types - Video on demand (VOD) – Advertising based video on demand – Transaction based video on demand - Changing the fundamentals of content creation and consumption – Space shifting - place shifting – Time shifting.

**UNIT III**
Evolution of Global and domestic content production – Impact of OTT on domestic production Eco systems – Language and local content creation.

**UNIT IV**
The challenges of building end-to-end OTT video workflows - explosive OTT growth, abundant viewer choices - changing viewing habits, increased complexity, and more.

**UNIT V**
The four pillars of an economical and profitable OTT video plan – flexibility, agility, intelligence, and global scale – and why they are non-negotiable - The best-tested ways to support OTT video workflows + real-world customer use case.

**TOTAL: 45 PERIODS**

**OUTCOMES**
- The students will be able to distinguish different platforms of video on demand.
- The students will gain knowledge on economical and profitable OTT Video plan.
- The students will be able to understand the need for second screen.

**TEXT BOOKS**

**REFERENCES**
SSH005    HISTORY AND USE OF MYTHS IN INDIAN WRITING IN ENGLISH   

UNIT I    
Origin and development of Indian English Novel, Indian English writers who used myths. 

UNIT II   
Use of myths in Indian English Poetry with special reference to Toru Dutt, Sarojini Naidu and Kamala Das. 

UNIT III   
Indian myths in Indian English Drama with special reference to Sri Aurobindo, Girish Karnad and T.P.Kailasam. 

UNIT IV    
Mythical elements in Indian English novel with special reference to Raja Rao, Chitra Banerjee Divakaruni and Amish Tripathi. 

UNIT V    
Tagore’s short stories dealing with myths. 

TOTAL: 45 PERIODS 

REFERENCES: 

SSH006    CRITICAL APPROACHES TO THE STUDY OF MYTHS IN INDIAN WRITING IN ENGLISH 

UNIT I    
History of Indian myths and their usage in Indian English novels. 

UNIT II    
Various approaches to literary criticism-Psychological, Sociological, Moralistic and Formalistic approaches. 

UNIT III   
Archetypal approach to literary criticism 

UNIT IV    
Historical overview of Feminism and Feminist criticism.
UNIT V
An introduction to Kavita Kane and her works - Themes, Mythical and feministic elements in Kane’s works.

REFERENCES: