STELLA MARIS COLLEGE (AUTONOMOUS), CHENNAI – 600 086
M.Sc. DEGREE – PHYSICS

SYLLABUS
(Effective from the academic year 2019–2020**)**

ASTROPHYSICS

CODE:19PH/PE/AP15 **CREDITS:5**
L T P:5 0 0
TOTAL TEACHING HOURS:65

OBJECTIVES OF THE COURSE

- To learn about stars and constellations
- To appreciate the universe.

COURSE LEARNING OUTCOMES

On successful completion of the course, students will be able to

- Understand the violent universe -white dwarf, neutron stars and black hole.
- Explain the origin of our universe
- Describe the structure and evolution of stars
- Describe the general observed properties of star and their formation with respect to HR diagram.
- Understand the basic concepts of modern astrophysics, such as: Stellar classification and spectroscopy, solar system and planetary motion, stellar evolution and nuclear fusion etc.

Unit 1

General Astronomy **(13 Hours)**

System of Coordinates - Altazimuth, Equatorial (local and Universal), Ecliptic and Galactic systems. Magnitude scale and magnitude systems - correction for observed magnitudes. The proper motion - stellar parallax - Trignometric, cluster and secular parallaxes. Method of Luminosity distance.

Unit 2

Stellar temperatures and sizes **(13 Hours)**

Colour and effective temperatures - defining stellar temperatures by matter laws - HR diagram - Spectral and luminosity classification of stars. Measurement of stellar radii - Relation of luminosity with mass, radii and surface temperature. Binary stars – visual, spectroscopic and eclipsing binaries.

Unit 3

Stellar structure **(13 Hours)**

Equations of stellar structure - Russel - Vogt theorem - Ideas of polytropic model - stellar opacity - Free - Free transitions, Bound - Free transitions and electron scattering. Eddington's standard model. Homologous model for main sequence stars - Schwarzchild's model for real stars.

Unit 4

Stellar evolution **(13 Hours)**

The virial theorem - application to an isothermal gas sphere - evolution of stars near the main sequence - effect of hydrogen depletion - Schoenberg - Chandrasekhar limit of an isothermal core - nuclear time scale - ages of clusters - Star formation - Jean's criterion.

Unit 5

Stellar energy sources **(13 Hours)**

Thermonuclear fusion - CN cycle - pp chain - simple formulae for the energy generation rates - abundances for the elements in the stars structure of the sun from helioseismology - problems of nucleosynthesis.

BOOKS FOR STUDY:

Abhyankar K D, *Astrophysics: Stars and Galaxies,* Tata Mc Graw Hill (1992)

V.B.Bhatia, *Text Book of Astronomy and Astrophysics with elements of Cosmology,* Narosa Publishing House.

Baidyanath Basu, *An Introduction to Astrophysics,* Prentice Hall India Learning Pvt. Ltd. (2003)

BOOKS FOR REFERENCES:

Simon F. Green, Mark H. Jones, S. Jocelyn Burnell, *An Introduction to the Sun and Stars,* Cambridge University Press(2004)

Günter Dietmar Roth, *Compendium of practical astronomy, Volume 1,* Springer (1994)

A. C. Phillips, *The physics of stars*, 2nd Edition, John Wiley (1999)

PATTERN OF ASSESSMENT:

Continuous Assessment Test: **Total Marks: 50** **Duration: 90 minutes**

Section A – 5 x 3 =15
Section B – 4x5 = 20 (4 out of 6 to be answered)
Section C – 1x15 = 15 (1 out of 2 to be answered)

Other Components:

Presentation/Assignments/Problem solving/Quiz

End-Semester Examination: **Total Marks: 100** **Duration: 3 hours**

Section A – 10 x 3 = 30 Marks (All questions to be answered)
Section B – 5 x 5 = 25 Marks (5 out of 7 to be answered)
Section C – 3 x 15 = 45 Marks (3 out of 5 to be answered)

STELLA MARIS COLLEGE (AUTONOMOUS), CHENAI-600 086
M. Sc. DEGREE – PHYSICS

SYLLABUS
(Effective from the academic year 2019–2020)

CRYSTAL PHYSICS

CODE:19PH/PE/CP15 **CREDITS:5**
L T P:5 0 0
TOTAL TEACHING HOURS:65

OBJECTIVES OF THE COURSE

- To know the different structures of crystals
- To understand types of characterization of crystals and its applications

COURSE LEARNING OUTCOMES

On successful completion of the course, students will be able to

- Recognize the applications of X-ray crystallography
- Understand the crystal structure and thermal properties of materials.
- Understand the influence of lattice vibrations on thermal behaviour.
- Relate crystalline structure to X-ray diffraction data and the reciprocal lattice.
- Understand the influence of crystal binding energy on crystalline structure.

Unit 1

Crystal Physics **(13 Hours)**

Crystal Structure - Lattice representation - Simple symmetry operations - Bravais Lattices, Unit cell, Wigner -Seitz cell - Miller planes and spacing - Characteristics of cubic cells - Structural features of NaCl, CsCl, Diamond, ZnS – Close packing. Diffraction: Bragg's law - Reciprocal representation - Diffraction conditions and Laue equations - Brillouin zones for cubic lattices - Rotation, Laue and Powder methods of X-ray diffraction (an overview only) - Concepts of Scattering , Structure and Temperature factors. Crystal Binding: Interactions in inert gas crystals and cohesive energy - Interactions in ionic crystals and Madelung energy - Overview of Covalent, metal and hydrogen bonded interactions.

Unit 2

LATTICE DYNAMICS **(13 Hours)**

Theory of elastic vibrations in mono and diatomic lattices -Phonons – Dispersion relations - Phonon momentum. Heat Capacity Vibrational modes - Einstein model - Density of modes in one and three dimensions - Debye Model of heat capacity. Anharmonic effects: Explanation for Thermal expansion, Conductivity and resistivity – Umklapp process.

Unit 3

Low Temperature Growth Techniques (13 Hours)

Low temperature solution growth - slow cooling and slow evaporation methods - temperature gradient method - criteria for optimizing solution growth parameters - basic apparatus for solution growth. Gel growth - structure of silica gel and gelling mechanism -nucleation control - merits of gel method - experimental methods - chemical reaction method - chemical reduction method - complex de - complex method - solubility reduction method - sol gel method.

Unit 4

Crystal Characterization (13 Hours)

X Ray diffraction(XRD) - Thermal analysis - methods of thermal analysis - thermogravimetric analysis (TGA) - Differential thermal analysis (DTA) - Differential Scanning Calorimetry (DSC) - Mechanical studies - methods of hardness testing (qualitative) - Vickers hardness testing - correlation of microhardness with other properties - estimation of hardness number and work hardening coefficient (n) – dielectric

UNIT 5

Liquid Crystals (13 Hours)

Liquid Crystals: Classification-isotropic-nematic, smectic-cholestic phases, Phase transition of liquid phases, Properties:- optical, electric and magnetic fields, Application of liquid crystals

BOOKS FOR STUDY:

James Coble Brice, *Crystal growth processes*, John Wiley and Sons, New York.(1986)

John Chadwick Brice, *The growth of crystals from liquids*, North - Holland Pub. Co., (1973)

BOOKS FOR REFERENCE:

Harold Eugene Buckley, *Crystal growth*, John Wiley and Sons, New York(1951)

Brian R. Pamplin, *Crystal growth*, 2nd Edition, Pergamon,(1980)

Heinz K. Henisch, *Crystals in Gels and Liesegang Rings,* Cambridge University Press(2005)

PATTERN OF ASSESSMENT:

Continuous Assessment Test: Total Marks: 50 Duration: 90 minutes

Section A – 5 x 3 =15
Section B – 4x5 = 20 (4 out of 6 to be answered)
Section C – 1x15 = 15 (1 out of 2 to be answered)

Other Components:

Presentation/Assignments/Problem solving/Quiz

End-Semester Examination: Total Marks: 100 Duration: 3 hours

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STELLA MARIS COLLEGE (AUTONOMOUS), CHENNAI – 600 086
M.Sc. DEGREE – PHYSICS

SYLLABUS
(Effective from the academic year 2019–2020**)**

GEOPHYSICS

CODE:19PH/PE/GP15 **CREDITS:5**
L T P:5 0 0
TOTAL TEACHING HOURS:65

OBJECTIVE OF THE COURSE

- To provide brief introduction to seismology and to have a look at the experimental data supporting electric and magnetic properties of earth.

COURSE LEARNING OUTCOMES

On successful completion of the course, students will be able to

- Understand the structure and evolution of the Earth
- Apply Physics to the study of the Earth
- Different techniques used to map and analyze the physical properties of the Earth.
- Understand the physical principles of reflection seismology
- Appreciate the application of geophysics for understanding the physical conditions of the Earth's multi-layered interior.

Unit 1
Seismology: **(13 Hours)**
Introduction - Seismology - P - waves - S waves, their velocities - Time distance curves and the location of epicenters - Effect of Boundaries - Major discontinuities - Properties of rocks and minerals and factors that control them - Seismic energy sources – Detectors -Reflection and refraction field surveys and interpretation of time and distance curves.

Unit 2
Internal structure of earth **(13 Hours)**
Introduction - Seismic waves - Rayleigh waves and love waves - Study of earth by seismic waves - Earthquake seismology - Horizontal and vertical seismograph - Seismograph equation - Internal structure of earth.

Unit 3
Earth's age and electrical properties: **(13 Hours)**
Geochronology - Radioactivity of the earth - Radioactive dating of rocks and minerals - Geological time scale - Geoelectricity - AC and DC type resistivity meters - Factors affecting resistivity - Field data collection and interpretation - Application of resistivity method and engineering.

Unit 4
Geomagnetism **(13 Hours)**

Geomagnetism - Definitions, magnetic field, main field, external field and local anomalies, rock susceptibility - Method of Gauss - Saturation induction magnetometers - Proton precession magnetometer - Dynamo theory of earth magnetism – Magnetic surveying - application.

Unit 5

Geodynamics **(13 Hours)**

Plate dynamics - Earth's size and shape - Earth's rotation – absolute and relative methods of Measurement of gravity – Gravity measurements - reduction of gravity data - separation of regional and residual. Interpretation of gravity data obtained over spherical and cylindrical objects - Application of gravity methods.

BOOKS FOR STUDY:

M. B. Ramachandra Rao, *Outlines of geophysical prospecting: a manual for geologists,* University of Mysore(1975)

William Murray Telford, W. M. Telford, L. P. Geldart, Robert E. Sheriff, R. E. Sheriff, *Applied Geophysics 2nd Edition*, Cambridge University Press (1990)

B. S. Rama Rao, I V R Murthy, *Gravity and magnetic methods of prospecting,* 4th Edition, Arnold - Heinemann, (1978)

V. L. S. Bhimasankaram, Vinod Kumar Gaur, Association of Exploration Geophysicists, *Lectures on exploration geophysics for geologists and engineers,* Association of Exploration Geophysicists, (1977)

BOOKS FOR REFERENCE:

George David Garland, *Introduction to geophysics: mantle, core, and crust*,2nd Edition, Saunders, (1979)

Alan H. Cook, *Physics of the earth and planets*, Macmillan,(1973)

William Lowrie, *Fundamentals of Geophysics,* 2nd Edition, Cambridge University Press, (2007)

PATTERN OF ASSESSMENT:

Continuous Assessment Test: **Total Marks: 50** **Duration: 90 minutes**

Section A – 5 x 3 =15
Section B – 4x5 = 20 (4 out of 6 to be answered)
Section C – 1x15 = 15 (1 out of 2 to be answered)

Other Components:

Presentation/Assignments/Problem solving/Quiz

End-Semester Examination: **Total Marks: 100** **Duration: 3 hours**

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STELLA MARIS COLLEGE (AUTONOMOUS), CHENNAI – 600 086
M.Sc. DEGREE– PHYSICS

SYLLABUS
(Effective from the academic year 2019–2020**)**

MATERIAL PHYSICS AND NANOSCIENCE

CODE:19PH/PE/MN15 **CREDITS:5**
L T P:5 0 0
TOTAL TEACHING HOURS:65

OBJECTIVES OF THE COURSE

- To introduce the rapidly developing field of nanoscience and technology with special focus on the methods of synthesis, characterization techniques and applications of nanomaterials
- To understand the necessary concepts in nanotechnology
- To develop skills to perform their project works related to the synthesis and characterization of nanomaterials by direct experience.

COURSE LEARNING OUTCOMES

On successful completion of the course, students will be able to

- Explain the basic concepts of Nanoscience and Nanotechnology
- Give an account of the various synthesis procedures for nanofabrication
- Describe the state-of-the-art characterization methods for nanomaterials
- describe the size effects induced changes on material properties
- Exhibit a broad and coherent knowledge of nanoscale phenomena and describe how and why materials and systems at the nanoscale differ from those at macro- and micro-scales.

Unit 1 **(13 Hours)**

Fundamentals of Material Physics and Nanoscience

1.1. Smart Materials – Introduction - Classification of Smart Materials - Different Types of Smart Materials - Their Applications

1.2. Introduction - nano and nature - background to nanotechnology - scientific revolutions opportunities at the nanoscale - time and length scale in structures - surfaces and dimensional space - evolution of band structures and Fermi surfaces - electronic structure of nanocrystals - bulk to nano transition - size and shapes - dimensionality and size dependent phenomena

Unit 2 **(13 Hours)**

Classification of nanoparticles and its properties

2.1 Metal Nanoparticles: Size control of metal nanoparticles, Structural, Surface, electronic and optical properties. **Semiconductor Nanoparticles:** solid state phase transformation,Excitons, Quantum confinement effect, Semiconductor

quantum dots (SQDs), Correlation of properties with size, Quantum Well, Quantum Wires, Super lattices band and Band offsets, Quantum dot lasers.
Magnetic nanomaterials: Fundamentals of magnetic materials, Dia, Para, Ferro, Ferric, and Superpara magnetic materials, Nanostructured Magnetism.

2.2 Semiconductor Nanocomposites: Types of Nanocomposites (Metal oxides, ceramic an.d .Glass), Core - Shell nanoparticles – Types of systems - properties of nanocomposites. **Carbon Nanostructures:** Introduction, Fullerenes, C60, CNT, mechanical, optical and properties.

Unit 3 **(13 Hours)**

Synthesis of Nanomaterials

3.1 Physical methods: Thermal evaporation, Spray pyrolysis, Molecular beam epitaxy (MBE), Physical vapour deposition (PVD), Microwave heating, Electric arc deposition, Ion implantation.

3.2 Chemical methods: Chemical and co - precipitation, Sol fundamentals - sol – gel synthesis of metal oxides, Micro emulsions or reverse micelles, Solvothermal, Sonochemical synthesis, Electrochemical synthesis, Photochemical synthesis, Langmuir - blodgett (LB) technique, Chemical vapour deposition (CVD)

3.3. Biological methods: Green Synthesis

Unit 4 **(13 Hours)**

Characterization Techniques

4.1 Powder X - Ray Diffraction, Scanning electron microscope (SEM), Transmission electron microscope (TEM), Scanning tunnelling microscope (STM), Atomic force microscope (AFM), Scanning probe microscopy (SPM), UV - Visible absorption, Impedance measurement, V - I characteristics, Vibrating sample magnetometer (VSM).

4.2 Brunauer - Emmett - Teller (BET) Surface Area Analysis, Energy dispersive X – ray (EDX), X - ray photoelectron spectroscopy (XPS) and Photoluminescence.

Unit 5 **(13 Hours)**

Applications of Nanomaterials and Nanocomposites

5.1 Nanophotonics and Devices: ID, 2D, 3D Photonic crystals, Couplers, Waveguides,
Photonic crystal fibres, Optical data storage systems and Quantum computing
Medical applications: Imaging of cancer cells, Biological tags and Targeted nano drug delivery system.

5.2 Nanosensors: Sensors based on physical properties - Electrochemical sensors, Sensors for aerospace, defence and Biosensors. **Energy:** Solar cells, LEDs and Photovoltaic device applications. **Photocatalytic applications:** Air purification, Water purifications and Volatile organic pollution degradation -waste management.
Carbon nanotubes: Field emission, Fuel cells and Display devices.

BOOKS FOR STUDY

B. Viswanathan, *Structure and properties of solid state materials*, 2nd Edition, Alpha Science International, (2006).

T.Pradeep, Nano - The essentials, Tata McGraw – Hill publishing company limited (2007).

BOOKS FOR REFERENCE

Pulickel M. Ajayan, Linda S. Schadler, Paul V. Braun, *Nanocomposite Science and Technology*, John Wiley & Sons, (2006)

Günter Schmid, *Nanoparticles: From Theory to Application*, 2nd Edition, John Wiley & Sons, (2011)

Sulabha K.Kulkarni, *Nanotechnology: Principles And Practices*, Capital publishing company (2007).

B. Viswanathan, *Nanomaterials*, Narosa PublishingHouse Pvt. Ltd., New Delhi, (2009)

A. K. Bandyopadhyay, *Nano Materials*, 2nd Edition, New Age International Publishers Ltd., New Delhi, (2007).

C. R. Brundle, Charles A. Evans, Shaun Wilson, Butterworth, *Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films*, Heinemann publishers (1992).

Charles P.Poole, Frank J. Owens, *Introduction to nanotechnology*, John Wiley & Sons publication (2003).

Ulrich Schubert, Nicola Housing, *Synthesis of inorganic materials*, 3rd Edition, John Wiley & Sons, (2012)

Paolo Milani, Salvatore Iannotta, *Cluster beam synthesis of nanostructured materials* Springer, (1999)

PATTERN OF ASSESSMENT:

Continuous Assessment Test: Total Marks: 50 Duration: 90 minutes

Section A – 5 x 3 =15
Section B – 4x5 = 20 (4 out of 6 to be answered)
Section C – 1x15 = 15 (1 out of 2 to be answered)

Other Components:

Presentation/Assignments/Problem solving/Quiz

End-Semester Examination: Total Marks: 100 Duration: 3 hours

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STELLA MARIS COLLEGE (AUTONOMOUS), CHENNAI – 600 086
M.Sc. DEGREE – PHYSICS

SYLLABUS
(Effective from the academic year 2019–2020**)**

MEDICAL PHYSICS AND ULTRASONICS

CODE:19PH/PE/MU15 **CREDITS:5**
L T P:5 0 0
TOTAL TEACHING HOURS:65

OBJECTIVES OF THE COURSE

- To learn the fundamentals of health Physics.
- To acquire knowledge about diagnostic and therapeutic devices.

COURSE LEARNING OUTCOMES

On successful completion of the course, students will be able to

- Acquire a better understanding of the importance of physics for medical diagnosis and treatment.
- Explain and describe the physical concepts for different modalities used in medical diagnosis and treatment.
- Learn how different external physical factors including ionizing radiation, electrical and magnetic fields and thermal effects influence biological systems.
- Understand the Physics of medical imaging
- Describe the application of physics principles such as ultrasound and Nuclear Magnetic Resonance

Unit 1

Diagnostic Devices **(13 Hours)**

Blood Pressure and its Measurement - High Pressure Measurement – Electrical Signals from Heart : Electrocardiography(ECG) – Electrical Signals from brain : Electroencephalogram(EEG) – Electrical signal from muscles : Electromyogram(EMG) – Magnetic Resonance Imaging(MRI)

Unit 2

Therapeutic Devices **(13 Hours)**

Microprocessor based Ventilators – AC and DC Defibrillator – Pacemaker – Versatile Electro Therapeutic Stimulator – Anasthesia Machine – Ventilator – Dialysis process – Comparision between Haemodialysis and Peritoneal Dialysis – Peritoneal Dialysis Unit.

Unit 3

Medical Applications Of Lasers **(13 Hours)**

Laser based Blood Cell Counter – Laser Doppler Blood Flow Meter – Laser in

Angioplasty – Principle And Theory of Fluorescence – Reflectance and Light Scattering Spectroscopy – Laser Spectroscopy Cancer Detection.

Unit 4

Ultrasonic Study Of Liquid Mixtures And Solutions **(13 Hours)**

Preparation of multi component liquid mixtures : Mole fraction – Weight fraction – Volume fraction. Measurement techniques : Ultrasonic Interferometer – Continuous Wave Method – Density – Viscosity Pure liquids and binary mixtures : Free length theory – Collision factor theory – Nomoto's Relation Acoustical Parameters – Adiabatic compressibility – Acoustic Impedence – Intermolecular Free Length – Molar Volume – Free Volume – Internal Pressure.

Unit 5

Applications Of Ultra Sound **(13 Hours)**

Low Frequency – High Intensity Applications : Ultrasonic Welding – Ultrasonic Cleaning – Applications – Food Industry – Length Meters.

High Frequency - Low Intensity Applications : Level Meters – Thickness Measurements – Ultrasonic Microscopy – Acoustic Holography(Transmission Acoustic Holography).

BOOKS FOR STUDY:

Dr.M.Arumugam , 2005, *Biomedical Instrumentation*, Anuradha Publications, Chennai.

S.Svanberg, 2010, *Atomic and Molecular Spectroscopy(Basic Aspects and Practical Applications),* fourth edition, WILY Publications.

Baldevraj, V.Rajendran and P.Palinichamy, 2009, *Science and Techology of Ultrasonics,* fourth edition, Narosa Publications, New Delhi.

BOOK FOR REFERENCE:

John R.Cameron and James G.Skofronick, 2009, *Medical Physics*, John Wiley Interscience Publication, Canada, Second edition.

PATTERN OF ASSESSMENT:

Continuous Assessment Test: **Total Marks: 50** **Duration: 90 minutes**

Section A – 5 x 3 =15

Section B – 4x5 = 20 (4 out of 6 to be answered)

Section C – 1x15 = 15 (1 out of 2 to be answered)

Other Components:

Presentation/Assignments/Problem solving/Quiz

End-Semester Examination: **Total Marks: 100** **Duration: 3 hours**

Section A – 10 x 3 = 30 Marks (All questions to be answered)

Section B – 5 x 5 = 25 Marks (5 out of 7 to be answered)

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STELLA MARIS COLLEGE (AUTONOMOUS), CHENAI-600 086

M. Sc. DEGREE: BRANCH III – PHYSICS

SYLLABUS
(Effective from the academic year 2019–2020)

REACTOR PHYSICS

CODE:19PH/PE/RP15 **CREDITS:5**
L T P:5 0 0
TOTAL TEACHING HOURS:65

OBJECTIVES OF THE COURSE

- To expose the students to the physics of neutrons and fuel inside a reactor.
- To understand the construction of a nuclear reactor and precautions to be taken in its operation

COURSE LEARNING OUTCOMES

On successful completion of the course, students will be able to

- Discuss the various aspects of reactor physics.
- demonstrate a knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter;
- Explain processes of nuclear collisions and nuclear reactions.
- describe the physical processes as well as the different components of a nuclear power plant
- Understand important reactor parameters including performance and safety
- Acquire a clear understanding of the applications of nuclear physics

Unit 1

Nuclear energy **(13 Hours)**

Nuclear mass - Binding energy-Radioactivity - Nuclear reactions -Nuclear fission - Mechanism of fission - Fuels - Products of fission - Energy release from fission - Reactor power and calculations - Fuel burn up - Consumption.

Unit 2

Neutron diffusion **(13 Hours)**

Multiplication factor - neutron balance and conditions for criticality - Conversion and breeding - Classification of reactors.Diffusion of neutrons: Flux and current density - Equation of continuity - Fick's law - Diffusion equation - Boundary conditions and solutions - Diffusion length - Reciprocity theorem.

Unit 3

Neutron moderation **(13 Hours)**

Energy loss in elastic collision - moderation of neutrons in Hydrogen - lethargy - Space dependent slowing down - Fermi's age theory - Moderation with absorption. Fermi theory of Bare thermal reactor: Criticality of an infinite reactor - One region finite thermal reactor - Critical equation – Optimum reactor shape.

Unit 4

Reactor kinetics **(13 Hours)**

Infinite reactor with and without delayed neutrons - Stable period - Prompt jump - Prompt criticality - Negative reactivity - Changes in reactivity - Temperature coefficient - Burn up and conversion.

Unit 5

Control and shielding **(13 Hours)**

Reactor control: Rod worth - One control rod - modified one group,two group theory - ring of rods.Radiation shielding : Reactor safeguards - Reactor properties over life-core life estimation.

BOOKS FOR STUDY:

John R. Lamarsh, *Introduction to Nuclear Reactor Theory*, American Nuclear Society (2002)

Samuel Glasstone, Milton C. Edlund, *The Elements of Nuclear Reactor Theory*, Van Nostrand, (1965)

BOOKS FOR REFERENCE:

H.S. Isbin, *Introductory Nuclear Reactor Theory*, Reinhold, New York (1963)

WEB RESOURCES

www.ans.org/PowerPlants
npcil.nic.in/main/AllProjectOperationDisplay.aspx

PATTERN OF ASSESSMENT:

Continuous Assessment Test: **Total Marks: 50** **Duration: 90 minutes**

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STELLA MARIS COLLEGE (AUTONOMOUS), CHENNAI – 600 086

M.Sc. DEGREE – PHYSICS

SYLLABUS

(Effective from the academic year 2019 – 2020**)**

SPECTROSCOPY

CODE:19PH/PE/SP15 **CREDITS:5**

L T P:5 0 0

TOTAL TEACHING HOURS:65

OBJECTIVES OF THE COURSE

- To have in depth understanding of various techniques of spectroscopy
- to study its applications to modern science.

COURSE LEARNING OUTCOMES

On successful completion of the course, students will be able to

- Acquire an advanced knowledge about the interactions of electromagnetic radiation and matter and their applications in spectroscopy
- Explain the basic principles of IR, Electronic, Vibrational and Nuclear spectroscopy
- Discuss the basic components common to most spectroscopic instruments
- Understand the use of these spectroscopic methods for organic structure elucidation
- Choose an appropriate spectroscopic technique in their research.

Unit 1

Microwave Spectroscopy **(13 Hours)**

Rotation of molecules-Rotational spectroscopy-Rigid and non-rigid diatomic Rotator - Intensity of spectral lines-Isotopic substitution-Poly atomic molecules (Linear and symmetric top)-Hyperfine structure and quadrupole effects-Inversion spectrum of ammonia-Chemical analysis by microwave spectroscopy-Techniques and instrumentation microwave oven

Unit 2

Vibrational Spectroscopy **(13 Hours)**

Infrared spectroscopy-Vibration of molecules-Diatomic vibrating rotator-Vibrational rotational spectrum-Interactions of rotations and vibrations-Influence of rotation on the Vibrational spectrum of linear and symmetric top and poly atomic molecules-Analysis by infrared techniques-Instrumentation-FTIR spectroscopy. **Raman spectroscopy:** Classical and quantum mechanical picture of Raman effect-Polarizability –Pure rotational Raman spectrum- Vibrational Raman Spectrum-Raman activity of vibrations of CO_2 and H_2O-Rule of mutual exclusion-Overtones and combination- Rotational fine structure - Depolarization ratio-Vibrations of spherical top molecule-structural determination from IR and Raman spectroscopy-techniques and instrumentation-FT Raman spectroscopy.

Unit 3

Electronic Spectrosccopy (13 Hours)

Electronic spectra-Frank-Condon principle-Dissociation energy and dissociation products-Fortrat diagram-predissociation-shapes of some molecular orbits-Chemical analysis by electronic spectroscopy-Techniques and instrumentation-Mass spectroscopy-ESR spectroscopy- Introduction techniques and instrumentation-Electronic angular momentum in diatomic molecules.

Unit 4

Nuclear Spectrosopy (13 Hours)

Introduction- Nuclear magnetic resonance spectroscopy-x-Interaction of spin and magnetic field-population of energy levels-Larmor precession-Relaxation times-Double resonance- Chemical shift and its measurement-Coupling constant-Coupling between several nuclei- -C13 NMR spectroscopy- Interpretation of simple spectrum-Quadrupole effects- NQR Mossbauer spectroscopy: Principle-instrumentation- Isomer shift-Effect of electric and magnetic fields- Magnetic hyperfine interaction

Unit 5

Surface Spectrocopy And Devices (13 Hours)

Electron energy loss spectroscopy (EELS)-Reflection absorption spectroscopy(RAIRS) -Photoelectron spectroscopy (PES) – Instrumentation – interpretation of spectrum; XPES, UPES-Auger electron spectroscopy (AES) - X-ray Flourescence spectroscopy (XRF)- SIMS – Surfaces for SERS study-SERS Microbes-Surface selection rules- SEM- TEM- AFM.

BOOKS FOR STUDY:

G. Aruldhas, *Molecular and Structure and Spectroscopy*, PHI Learning Private Limited 2 edition, 2007

Colin Banwell and Mc Cash, *Fundamentals of molecular spectroscopy:,* TMH publishers-5th edition, 2004

Raymond Chang, *Basic Principles of Spectroscopy*, R.E. Krieger Publishing Company, 1980

BOOKS FOR REFERENCE:

Rajat K. Chaudhuri, M.V. Mekkaden, A. V. Raveendran, A.Satya Narayanan, *Recent Advances in Spectroscopy:Theoretical, Astrophysical and Experimental Perspectives.*

Berman Paul R., Malinovski Vladimir S. *Principles of Laser Spectroscopy and Quantum Optics,* Princeton University Press 2011

Tuniz C., Kutschera W., Fink D., Herzog G.F, *Accelerator Mass Spectrometry,* CRC press 2011

Thomas Engel, *Quantum Chemistry and Spectroscopy* International Edition 3rd Edition Pearson Publications 2012

Wozniak Bogdian, Dera Jerzy, *Light Absorption in Sea Water* Springer Publications 2011

WEB RESOURCES:
www.ups.edu/faculty/hanson/chemwebsites/organicwebsites.htm
www.rsc.org/.../InterestGroups/ESRSpectroscopy/index.asp

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