RKUNIVERSITY	SYLLABUS
Course Title	**NUCLEAR & PARTICLE PHYSICS**
Course Code	MPH311
Course Credit	Lecture : 04
	Tutorial : 00
	Practical : 00
	Total : 04

Detailed Syllabus:

Sr. No	Name of chapter & Details	Session Allotted
	SECTION-I	
1	**Nuclear Energy** Nuclear fission: Introduction, spontaneous fission and potential barrier, emission of neutron in fission, self-sustaining chain reaction: nuclear reactor, neutron balance in reactor, Uncontrolled chain reaction bomb. Nuclear fusion: Introduction controlled fusion, Source of stellar energy, Thermonuclear reactions, Pressurized Water Reactor, Boiling Water Reactor	**10**
2	**Nuclear models** Liquid drop model, semi empirical mass formula, mass parabola, liquid drop model of fission, experimental evidence for shell effect, Shell model, spin orbit coupling model, magic numbers, angular momenta and parities of nuclear ground state	**8**
3	**Two nuclear problems at low energies** Deuteron low energy np and pp scattering, spin dependence of nuclear forces, noncentral forces, charge independence and isospin, meason and Yukawa theory of nuclear forces.	**10**
	SECTION-II	
4	**Decay theories** Properties of α - particles, β- particles and γ - rays. Beta decay : introduction, modes of beta decay, conditions for spontaneous emission of beta decay, neutrino hypothesis, decay constant for beta decay, Fermi's theory of beta decay, shape of beta spectrum, life time and classification of beta decay, detection and properties of neutrino Gamma decay: energetics of gamma decay , interaction of gamma rays with matter, internal conversion	**09**
5	**Nuclear measurement techniques** Detectors: GM counters, scintillation, semiconductor detectors,BF_3 counter accelerators: Van de Graaff accelerator, tandem principle, linear accelerators, cyclotron phase stability principle, synchrotron.	**09**

6	**Elementary particle physics** Baryon spectrum, meson spectrum, conservation of isospin, strangeness, charm, baryon numbers, quarks. hadron spectroscopy, necessity of color, mesons as Quark-antiquark pairs, elementary ideas of QCD, quark and gluon jets, elementary ideas about electroweak theory	**10**

Instructional Method and Pedagogy:

1. Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
2. Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.
3. Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
4. The course includes a laboratory, where students have an opportunity to buildan appreciation for the concepts being taught in lectures.

Students Learning Outcomes:

After Successful completion of the above course, students will be able to:

Recall basic nuclear physics & various types of nuclear decay.

Review nuclear models& nuclear radiation detection methods.

Interpret nuclear forces.

Distinguish elementary particles.

Text book:

1. Nuclear Physics: Kaplan, Narosa Publishing House
2. Nuclear Physics by R.R. Roy & B P Nigam, Wiely-Eastern Ltd.,
3. Concepts of Particle Physics by Gottfried and Weisskoff
4. Nuclear Detectors and Measurement by G. K. Knoll

Reference Books:

1. Introduction to Nuclear Physics, Somaiyajulu
2. Elements of Nuclear Physics, L E Mayerhof, Tata McGraw Hill. 1959
3. Concept of Modern Physics, Arthur Beiser, McGraw Hill Inter. 1987

RK UNIVERSITY	**SYLLABUS**
Course Title	**SPACE AND COMPUTATIONAL PHYSICS**
Course Code	MPH312
Course Credit	Lecture : 04
	Tutorial : 00
	Practical : 00
	Total : 04

Detailed Syllabus:

Sr. No	Name of chapter & Details	Session Allotted
	SECTION-I	
1	**Basic Concepts of Earth's Atmosphere** Atmospheric nomenclature, Hydrostatic equation scale height, Geopotential height, Exosphere and gaseous escape, Chemical concepts of atmosphere, Thermodynamic considerations, elementary chemical kinetics composition and chemistry of middle atmosphere and thermosphere. Thermal balance in the atmosphere, models of neutral atmosphere.	**08**
2	**Structure and variability of Earth's Ionosphere** Introduction to ionosphere, photochemical processes, Chapman's theory of photo ionization, production of ionospheric layers, loss mechanisms and chemistry of ionospheric regions, morphology of the ionosphere.	**06**
3	**Radio waves propagation measurement in Ionosphere** Radio waves in an ionized medium and radio propagation techniques Ionosonde, Ionogram and its interpretation, Absorption measurement techniques Basic principle of RADAR, radar range equation: powers and frequencies used in radar, basic pulsed radar system, Tracking radar systems.	**08**
4	**Elements of sun & effects of solar radiation on atmosphere** Structure and composition of the sun, sun as a source of radiation, sunspots an solar cycles, solar flares, coronal mass ejection, solar radiation at the top of the atmosphere, Attenuation of solar radiation in the atmosphere, radiative transfer, thermal effect of radiation, photochemical effects of radiation, Airglow.	**06**
	SECTION-II	
5	**Introduction to Computer System & Programming** Basic Terminologies: Program, Software, Operating System, I/O Devices, Process. Brief about computer systems: Block diagram, Basics of Number System. Basic structure of simple program (Input, Process & Output).	**06**

6	**Basics of Algorithm and Flowchart** Introduction to Algorithm, Characteristic of Algorithm, Algorithm Notation, Merits & Demerits of Algorithms. Introduction to Flowchart, Symbols, Rules of Flowchart, Merits & Demerits of flowchart.	**08**
7	**Computer programming** Review of principles of programming, Problem solving techniques – Algorithms, Flowcharts, Programming logic, Sequential, Conditional and Repetitive flows, Programming introduction to C language, Program testing. Data types, Assignment and Arithmetic/Logical expressions, Hierarchy of operations. Various functions available in the programming language Conditional and Looping instructions I/O Methods. Programme of straight line fitting, Programme for numerical integration techniques.	**10**
8	**Numerical analysis of data and plotting** Types of data series, time series, plotting and presentation of data, chart types, X-Y scatter, bar, line and pie charts, contours plotting. Curve fitting, the least square method, linear fits, linear fit with both variables having errors, nonlinear fits, and spectral analysis of time series data.	**04**

Instructional Method and Pedagogy:

1. Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
2. Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.
3. Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
4. The course includes a laboratory, where students have an opportunity to buildan appreciation for the concepts being taught in lectures.

Students Learning Outcomes:

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

Recall the basic concept of earth's atmosphere.
Differentiate ionospheric layers of the earth.
Review elements of sun and solar radiation.
Classify computer systems.
Analyze numerical data.
Develop computer program.

Text book:

1. Physics of the Space Environment by T.I. Gombosi (Cambridge Atmospheric and Space Science Series).
2. Fundamental of Computer by E. Balagurusamy, Tata McGraw-Hill Education.
3. Programming In Ansi C by E. Balagurusamy, Tata McGraw-Hill Education.

Reference Books:

1. The Solar-Terrestrial Environment by J. K. Hargreaves (Cambridge Atmospheric and Space Science Series).
2. Remote Sensing and Image Interpretation: T.M. Lillesand and R.L. Kiefer, (John Wiley & Sons, 4th Edition).

RK UNIVERSITY

SYLLABUS

Course Title	**SYNTHESIS OF MATERIALS**
Course Code	MPM301
Course Credit	Lecture : 04
	Tutorial : 00
	Practical : 00
	Total : 04

Detailed Syllabus:

Sr. No	Name of chapter & Details	Session Allotted
	SECTION-I	
1	**Preparation Methods of Materials** Introduction, Solid State reaction to prepare materials, High Energy Ball milling process, Importance of these methods	**06**
2	**Growth of Single Crystal** Introduction of crystal growth, Czochralski method, Bridgman and Stockbarger method, SR method, Zone melting method, Flux method.	**08**
3	**Microwave synthesis** Introduction of method, Preparation of Oxide material through microwave synthesis. Synthesis of Nano Materials: Introduction, Surface effect on nanomaterials, Sol – gel method, Wet chemical method, Application of Nano materials.	**08**
4	**Synthesis of polycrystalline materials** Structure of polycrystalline e.g. spinel, perovskite, CMR, GMR, etc. Fine particle oxide materials. Structural, magnetic, electrical and transport properties of respective materials.	**06**
	SECTION-II	
5	**Preparation methods of thin film** Vacuum Evaporation method, Sputtering method, Spin Coating method, Pulse Laser Deposition method, Chemical Vapor Deposition method.	**08**
6	**Smart Materials** Shape Memory Alloys: Introduction, Preparation method, pseudoelasticity, Shape memory effect, Applications. Metallic Glasses: Introduction, Synthesis, Properties, Applications. Bio – materials: Introduction, biocompatibility and bio medical applications.	**06**
7	**Ferrohydrodynamics** Scope of ferrohydrodynamics, Ferromagnetic solid, Magnetic fluids, Ferromagnetic concept and units, Concept of fluid mechanics.	**08**

8	**Magnetic fluids** Stability requirements, Preparation of magnetic colloids by size reduction, Preparation of ferrofluid by chemical precipitation, Paramagnetic salt solution, Physical properties and applications.	**06**

Instructional Method and Pedagogy:

1. Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
2. Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.
3. Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
4. The course includes a laboratory, where students have an opportunity to buildan appreciation for the concepts being taught in lectures.

Students Learning Outcomes:

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

Recall types of materials.
Review the different synthesis methods of materials.
Choose the appropriate synthesis methods for materials.
Apply the methods to prepare materials.

Text book:

1. Solid State chemistry and its applications by Anthony R. West (John Wiley & Sons)
2. Crystal Growth Processes & Methods by P. Santhana Raghavan, P. Ramasamy (KRU Publications)
3. Ferrohydrodynamics by R. E. Rosensweig (Dover Publication INC. New York)
4. Thin film fundamentals by A.Goswami (New Age International)

Reference Books:

1. Solid State Chemistry – Introduction by Lesley Smart and Elaine Moor (Viva books Private LTD)
2. Crystal Growth – A Tutorial Approach by Eds. W. Bradsley, D.T.J. Hurle & J. B. Mullin (North Land)
3. Hand book of thin film technology by K. L. Chopra (MacGrow Hill)

RK UNIVERSITY	**SYLLABUS**
Course Title	**MATERIALS CHARACTERIZATION**
Course Code	MPM302
Course Credit	Lecture : 04
	Tutorial : 00
	Practical : 00
	Total : 04

Detailed Syllabus:

Sr. No	Name of chapter & Details	Session Allotted
	SECTION-I	
1	**X- Ray Diffraction Techniques** Introduction, basic principle, powder diffractometer, intensities of powder pattern lines, Examples of intensity calculations, Measurement of x-ray intensity on powder pattern, Effect of crystal size on powder pattern, particle size measurement, Effect of stress on powder pattern, Refinement of unit cell parameters and indexing of powder pattern, calculate crystal structure from powder pattern, influence of crystal symmetry, multiplicity Structure-factor calculations, Multiplicity factor, Lorentz factor, Absorption factor, Temperature factor.	**10**
2	**Ultraviolet – Visible Spectroscopy** Introduction, absorbing species, containing π, σ *and* η electrons, change transfer absorption, Typical instrumentation, applications. **Fourier Transform Infrared Spectroscopy** Theory of infrared absorption, vibrational modes, infrared ranges, Fourier transform infrared, instrumentation, use of FT-IR, Typical spectral analysis.	**08**
3	**Electron Microscopy** **Energy Dispersive Analysis of X-Ray spectroscopy:** EDAX measurements, wavelength dispersive, energy dispersive, Fluorescence Spectroscopy, Design of the Spectrometer, Chemical analysis. **Scanning Electron Microscopy:** Physical Basis and primary mode of operation, Instrumentation, Sample requirement, application. **Transmission Electron Microcopy:** Basic Principle, resolution, sensitivity, TEM operation, Image mode, Specimen preparation. **Scanning Tunneling Microscopy and Atomic Force Microscopy:** Introduction, Instrumentation, topography, profilometry, sample requirements.	**10**
	SECTION-II	
4	**Resistivity** Two point-four point probes, Derivation of four point probe expression, Correction factors, Measurement errors and precautions, factors:- sample size,	**10**

	Carrier injection, probe spacing, current temperature, surface preparation, high sheet resistance material, Van der Pauw method-measurement of arbitrary shape samples. **Dielectric Study:** Dielectric materials, types of polarizabilities, dielectric behavior with frequency, introduction to Cole – Cole plot, Ferro– electricity, P – E loop characterization.	
5	**Magnetometry** Basic principle, vibrating sample magnetometer (VSM), SQUID magnetometer. **Thermogravimetry:** Principle, Apparatus, application, Differential thermal analysis and Differential Scanning Calorimetry, Principles, Apparatus and applications	**10**
6	**Magnetic Fluid** Structure, Size and size distribution, Magnetization, Importance of this method, Application of this method.	**08**

Instructional Method and Pedagogy:

1. Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
2. Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.
3. Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
4. The course includes a laboratory, where students have an opportunity to buildan appreciation for the concepts being taught in lectures.

Students Learning Outcomes:

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

List different characterization techniques of materials.
Identify proper characterization technique for materials
Apply proper characterization technique for materials.
Analyze the result of prepared materials.
Calculate the physical parameters using obtained result.

Text book:

1. Principles of Instrumental Analysis by D. A. Skoog and P. M. West.
2. Solid State Chemistry and its applications by Anthony R. West (John Wiley & Sons).
3. Characterization of Materials by E. N. Kaufmann, Wiley – Inter science.

RKUNIVERSITY

SYLLABUS

Course Title	Material Science Experiments
Course Code	MPM303
Course Credit	Lecture : 00
	Tutorial : 00
	Practical : 09
	Total : 09

Detailed Syllabus

Sr. No	List of Experiments	Hours Allotted
1	To study the characteristics of a GM tube and determination of its operating voltage, plateau length/slope.	
2	To verify the Inverse Square Law for γ - rays using GM counter.	
3	To study a nuclear counting statistics using GM counter.	
4	To write a computer program to find out the radius of nucleus.	
5	To write a computer program to find the amount of energy release during nuclear fission.	
6	To fit resistivity data in Microsoft excel and Origin software.	
7	To calculate Solubility constant (K_{sp}) of different materials.	
8	To synthesis nano material by wet-chemical method.	
9	To synthesis bio-nano material.	
10	To prepare Alumina using aluminum foil.	
11	To prepare single crystal of Ammonium Dihydrogen Phosphate (ADP).	
12	To identify band of given IR spectra and calculate force constants.	
13	To calculate bulk and X-ray density of a given oxide material.	
14	To determine crystal structure of given X-ray diffraction pattern using PowderX software.	
15	To study the surface microstructure (AFM) of the film using WSxM software.	
16	To calculate the grain size of given material by analyzing scanning ekectron micrograph.	
17	To find Fermi energy of given material.	
18	To find curie constant of material by phase transition in barium titanate.	
19	To find viscosity, density and % of Si of a given sample.	
20	To find susceptibility of magnetic materials.	
21	To estimate quantity of metals (i.e. Ni, Ba, etc) from given samples by gravimetric analysis.	
22	To synthesis oxide nano materials by sol-gel method.	
23	To design and implement regulated power supply using etching method on special purpose PCB.	

24	To find temperature dependent electrical conductivity of different materials (i.e. soda lime glass, zirconium oxide, steel)	
25	To measure DC resistivity of cylindrical oxide material with temperature variation using computer interface resistance measurement device.	

Students Outcome :

After Successful completion of the above course, students will be able to:

- **Test** the radioactive materials.
- **Develop** computer program to solve physics problems.
- **Compare** different synthesis methods of materials.
- **Estimate** structural properties of materials.
- **Make** single crystal from raw materials.

Text book:

1. Principle of Electronics by V. K. Mehta
2. Lab Experiment manuals.
3. Demonstrations for the Materials Science Classroom by Dr. Jud Ready, Georgia Institute of Technology.