ACHARYA NAGARJUNA UNIVERSITY

A State Government University, Accredited with "A" Grade by NAAC

Nagarjuna Nagar - 522 510, Guntur, Andhra Pradesh, India.

M.Sc. NANOTECHNOLOGY

SYLLABUS

2022 - 2023 onwards

UNIVERSITY COLLEGE OF SCIENCES

PROGRAM CODE:

ANUCS15


ACHARYA NAGARJUNA UNIVERSITY
సత్యం సర్వం ప్రతిష్ఠితమ్

ABOUT UNIVERSITY

ACHARYA NAGARJUNA UNIVERSITY (ANU)

- A Brief Profile

Acharya Nagarjuna University, a State University established in 1976, has been constantly striving towards achieving progress and expansion during its existence for over four decades, in terms of introducing new courses in the University Colleges, affiliated colleges and professional colleges. Spread over 300 acres of land on the National High Way (NH-16) between Vijayawada and Guntur of Andhra Pradesh, the University is one of the front ranking and fastest expanding Universities in the state of Andhra Pradesh. The University was inaugurated on 11th September, 1976 by the then President of India, Sri Fakruddin Ali Ahmed and celebrated its Silver Jubilee in 2001. The National Assessment and Accreditation Council (NAAC) awarded "A" grade to Acharya Nagarjuna University and also has achieved 108 International ranks, 39 National ranks UI Green Metrics rankings and many more It is named after Acharya Nagarjuna – one of the most brilliant preceptors and philosophers, whose depth of thought, clarity of perception and spiritual insight were such that even after centuries, he is a source of inspiration to a vast number of people in many countries. The University is fortunate to be situated on the very soil where he was born and lived, a soil made more sacred by the aspiration for light and a state of whole someness by generations of students. With campus student strength of over 5000, the University offers instruction for higher learning in 68 UG & PG programs and guidance for the award of M.Phil. and Ph.D. in 48 disciplines spread over six campus colleges and one PG campus at Ongole. It also offers 160 UG programs in 440 affiliated colleges in the regions of Guntur and Prakasam Districts. It has a Centre for Distance Education offering 87 UG & PG programs. Characterized by its heterogeneous students and faculty hailing from different parts of the state and the country, the University provides most hospitable environment for pursuing Higher Learning and Research. Its aim is to remain connected academically at the forefront of all higher educational institutions. The University provides an excellent infrastructure and on- Campus facilities such as University Library with over one lakh books & 350 journals; Computer Centre; University Scientific Instrumentation Centre; Central Research Laboratory with Ultra-modern Equipment; Well-equipped Departmental Laboratories; Career Guidance and Placement Cell; Health Centre; Sports Facilities with Indoor & Outdoor Stadiums and Multipurpose Gym; Sports Hostel; Separate hostels for Boys, Girls, Research Scholars and International Students; Pariksha Bhavan (Examinations Building); Computers to all faculty members; Wi-Fi connectivity to all Departments and Hostels; Canteen, Student Centre & Fast-food Centre; Faculty Club; Dr. H.H. Deichmann & Dr. S.John David Auditorium cum Seminar Hall; Post office; Telecom Centre; State Bank of India; Andhra Bank; Energy Park; Silver Jubilee Park; Fish ponds; internet center; xerox center; cooperative stores; Water harvesting structures.

VISION, MISSION & OBJECTIVES OF THE UNIVERSITY

ACHARYA NAGARJUNA UNIVERSITY

VISION

To generate sources of knowledge that dispels ignorance and establish truth through teaching, learning and research.

MISSION

To promote a bank of human talent in diversified faculties – Commerce & Management Studies, Education, Engineering & Technology, Humanities, Law, Natural Sciences, Pharmacy, Physical Education & Sports Sciences, Physical Sciences and Social Sciences that would become an investment for a prosperous society.

OBJECTIVES

- To inspire and encourage all who would seek knowledge through higher education and research.
- To provide quality instruction and research for the advancement of science and technology.
- To promote teaching and research studies in disciplines of societal relevance.
- To bridge the gap between theory and practice of the principles of higher education.
- To develop human talent necessary for the industry.
- To open up avenues of higher education and research through non-formal means.
- To invite and implement collaborations with other institutes of higher learning on a continuous basis for mutual academic progress.
- To motivate and orient each academic department/centre to strive for and to sustain advanced levels of teaching and research so that the university emerges as an ideal institute of higher learning.
- To focus specially on the studies involving rural economy, justifying its existence in the rural setting.

VISION

&

MISSION OF THE COLLEGE

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

VISION OF THE COLLEGE:

University College of Sciences envisages to be a good team of people with scientific temperament, research bent and a flair for Teaching & Learning for the betterment of the Community, Society, State and the Country at large.

MISSION OF THE COLLEGE:

The College intends to incubate and nurture the Leaders, Mentors, Educators and researchers who can transform the country and contribute to advances in science while addressing the challenges faced by the society for the betterment of human life.

VISION & MISSION OF THE DEPARTMENT

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF NANOTECHNOLOGY

VISION OF THE DEPARTMENT:

The Department of Nanotechnology envisions a world where the transformative potential of nanotechnology is harnessed to create unprecedented opportunities for progress and well-being, thereby shaping a future where nanotechnology plays a pivotal role in advancing society, promoting sustainability, and improving the overall human experience.

MISSION OF THE DEPARTMENT:

The Department of Nanotechnology is committed to pioneering cutting-edge research, strive to advance the fundamental understanding of nanoscale phenomena and application of nanoscale science and technology to address global challenges and improve the quality of life for all.

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF NANOTECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES(PEO's):

The Integrated M.Sc. Nanotechnology programme will enable the student to

PROGRAM EDUCATIONAL OBJECTIVES (PEO's)	
PEO-1	Post Graduates will understand the core and advanced concepts thoroughly
PEO-2	Post Graduates will function in their profession with social awareness and responsibility
PEO-3	Post Graduates will acquire critical thinking supported by advanced analytical skills to address Nanotechnology related problems
PEO-4	Post Graduates will be successful in pursuing research in their chosen field
PEO-5	Enhance skills for employability through activities, such as, seminar, communication skills, industrial visit, internship, and research project dissertation.

PO's	PROGRAM EDUCATIONAL OBJECTIVES (PEO's)				
	PEO-1	**PEO-2**	**PEO-3**	**PEO-4**	**PEO-5**
PO-1	3	2	3	3	2
PO-2	2	3	3	3	2
PO-3	3	3	3	2	2
PO-4	2	2	3	3	3
PO-5	2	2	2	3	3

PROGRAMME OUTCOMES (PO's):

On successful completion of Integrated M.Sc. Nanotechnology programme, the student will be able to

PROGRAM OUTCOMES (PO's)	
PO-1	Having a clear understanding of the basic subject related concepts of Communication, Computers, Mathematics, Physics, Chemistry and Nanotechnology
PO-2	Think critically to gain problem solving ability to address conceptual problems in these subjects
PO-3	Prepare and present scientific and technical information resulting from various laboratory outputs.
PO-4	Design methodologies of research in synthesis, analysis and writing articles along with research ethics
PO-5	Work independently as well as in a team to pursue the career as an employee/researcher/entrepreneur

PROGRAMME SPECIFIC OUTCOMES (PSO's):

Upon successful completion of Integrated M.Sc. Nanotechnology programme, the student will be able to

PROGRAM SPECIFIC OUTCOMES (PSO's)	
PSO-1	Acquire the knowledge recent advancements in the scientific field
PSO-2	Understand the features of compounds and devices in Nanotechnology domain
PSO-3	Develop computational and experimental skills to explore molecular level Phenomena for fabricating nano devices
PSO-4	Apply technical skills in a sophisticated laboratory environment & secure challenging position in Industry & Academics.
PSO-5	Enhance employability through laboratory activities, solving problems and cocurricular activities

STRUCTURE

ACHARYA NAGARJUNA UNIVERSITY :: UNIVERSITY COLLEGE OF SCIENCES
DEPARTMENT OF NANOTECHNOLOGY
COURSE STRUCTURE
SEMESTER-I

I YEAR I SEMESTER/I SEMESTER								
S.No.	**PAPER CODE**	**PAPER**	**HR/WEEK**	**INTERNAL MARKS**	**THEORY MARKS**	**TOTAL**	**CREDITS**	
1	**R22NT101**	COMMUNICATIVE ENGLISH -1 (A COURSE IN COMMUNICATION AND GRAMMAR)	4	30	70	100	3	
2	**R22NT102**	INTRODUCTION TO COMPUTERS	4	30	70	100	4	
3	**R22NT103**	MATHEMATICS - I (DIFFERENTIAL EQUATIONS)	4	30	70	100	4	
4	**R22NT104**	PHYSICS - I (MECHANICS, WAVES AND OSCILLATIONS)	4	30	70	100	4	
5	**R22NT105**	CHEMISTRY - I (INORGANIC & PHYSICAL CHEMISTRY)	4	30	70	100	4	
6	**R22NT106**	LIFE SKILLS (BASIC COMPUTER APPLICATIONS) **		-	50	50	2	
7	**R22NT107**	SKILL DEVELOPMENT (ELECTRICAL APPLIANCES)**		-	50	50	2	
8	**R22NT108**	PHYSICS LAB-I (WAVES & OSCILLATIONS)	6	15	35	50	1	
9	**R22NT109**	CHEMISTRY LAB-I (ANALYSIS OF SALT MIXTURES)	6	15	35	50	1	
SUB TOTAL			**32**			**700**	**25**	

**** IS THE SKILL DEVELOPMENT AND LIFE SKILLS COURSES AND THE CREDITS TO THE COURSES FROM ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION (APSCHE).**

SEMESTER-II

I YEAR II SEMESTER/II SEMESTER								
S.No.	**PAPER CODE**	**PAPER**	**HR/WEEK**	**INTERNAL MARKS**	**THEORY MARKS**	**TOTAL**	**CREDITS**	
10	**R22NT201**	COMMUNICATIVE ENGLISH-II (A COURSE IN READING & WRITING SKILLS)	4	30	70	100	3	
11	**R22NT202**	PROGRAMMING WITH C	4	30	70	100	3	
12	**R22NT203**	MATHEMATICS - II (THREE DIMENSIONAL ANALYTICAL SOLID GEOMETRY)	4	30	70	100	4	
13	**R22NT204**	PHYSICS - II (WAVE OPTICS)	4	30	70	100	4	
14	**R22NT205**	CHEMISTRY - II (ORGANIC & GENERAL CHEMISTRY)	4	30	70	100	4	
15	**R22NT206**	LIFE SKILLS (ELEMENTARY STATISTICS)**		-	50	50	2	
16	**R22NT207**	SKILL DEVELOPMENT(SOLAR ENERGY)**		-	50	50	2	
17	**R22NT208**	SKILL DEVELOPMENT(FOOD ADULTERATION)**		-	50	50	2	
18	**R22NT209**	COMPUTER LAB - I (PROGRAMMING WITH C)	4	15	35	50	1	
19	**R22NT210**	PHYSICS LAB - II (WAVE OPTICS)	6	15	35	50	1	
20	**R22NT211**	CHEMISTRY LAB - II (VOLUMETRIC ANALYSIS)	6	15	35	50	1	
SUB TOTAL			**36**			**800**	**27**	
**** IS THE SKILL DEVELOPMENT AND LIFE SKILLS COURSES AND THE CREDITS TO THE COURSES FROM ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION (APSCHE).**								

SEMESTER-III

II YEAR I SEMESTER/III SEMESTER								
S. No	**PAPER CODE**	**PAPER**	**HR/WEEK**	**INTERNAL MARKS**	**THEORY MARKS**	**TOTAL**	**CREDITS**	
21	**R22NT301**	A COURSE IN CONVERSATIONAL SKILLS	4	30	70	100	3	
22	**R22NT302**	INTRODUCTION TO PYTHON	4	30	70	100	3	
23	**R22NT303**	MATHEMATICS-III (ABSTRACT ALGEBRA)	4	30	70	100	4	
24	**R22NT304**	PHYSICS - III (THERMODYNAMICS)	4	30	70	100	4	
25	**R22NT305**	CHEMISTRY - III (ORGANIC & INORGANIC CHEMISTRY)	4	30	70	100	4	
26	**R22NT306**	LIFE SKILLS (ANALYTICAL SKILLS)**		-	50	50	2	
27	**R22NT307**	LIFE SKILLS (ENVIRONMENTAL EDUCATION)**		-	50	50	2	
28	**R22NT308**	SKILL DEVELOPMENT (ENVIRONMENTAL AUDIT)**		-	50	50	2	
29	**R22NT309**	COMPUTER LAB - II (INTRODUCTION TO PYTHON)	4	15	35	50	1	
30	**R22NT310**	PHYSICS LAB - III (THERMODYNAMICS)	6	15	35	50	1	
31	**R22NT311**	CHEMISTRY LAB - III (ORGANIC QUALITATIVE ANALYSIS AND CHROMATOGRAPHY)	6	15	35	50	1	
32	**R22NT312**	**YOGA##**	-	-	-	-	-	
SUB TOTAL			**36**	-	-	800	27	

**** IS THE SKILL DEVELOPMENT AND LIFE SKILLS COURSES AND THE CREDITS TO THE COURSES FROM ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION (APSCHE).**

IS THE EXTRA CURRICULUM ACTIVITY IT HAS NO MARKS AND ZERO CREDITS

SEMESTER-IV

II YEAR II SEMESTER/IV SEMESTER							
S.No	**PAPER CODE**	**PAPER**	**HR/WEEK**	**INTERNAL MARKS**	**THEORY MARKS**	**TOTAL**	**CREDITS**
33	**R22NT401**	MATHEMATICS - IV (REAL ANALYSIS)	4	30	70	100	4
34	**R22NT402**	MATHEMATICS - V (LINEAR ALGEBRA)	4	30	70	100	4
35	**R22NT403**	PHYSICS - IV (ELECTRICITY, MAGNETISM AND ELECTRONICS)	4	30	70	100	4
36	**R22NT404**	PHYSICS - V (MODERN PHYSICS)	4	30	70	100	4
37	**R22NT405**	CHEMISTRY - IV (INORGANIC & PHYSICAL CHEMISTRY)	4	30	70	100	4
38	**R22NT406**	CHEMISTRY - V (MOLECULAR SPECTROSCOPY)	4	30	70	100	4
39	**R22NT407**	MATHEMATICS LAB - I	4	15	35	50	2
40	**R22NT408**	PHYSICS LAB - IV (ELECTRONICS)	4	15	35	50	2
41	**R22NT409**	CHEMISTRY LAB - IV (CONDUCTOMETRIC AND POTENTIOMETRIC TITRIMETRY)	4	15	35	50	2
42	**R22NT410**	**YOGA##**	-	-	-		
43	**R22NT411**	**NSS/SPORTS/NCC##**	-	-	-	-	-
TOTAL			36			750	30
## IS THE EXTRA CURRICULUM ACTIVITY IT HAS NO MARKS AND ZERO CREDITS							

SEMESTER – V

III Year I Semester/V Semester								
S.No	**PAPER CODE**	**PAPER**	**HR/WEEK**	**INTERNAL MARKS**	**THEORY MARKS**	**TOTAL**	**CREDITS**	
44	**R22NT501**	MATHEMATICS-VI(NUMERICAL METHODS)	4	30	70	100	4	
45	**R22NT502**	MATHEMATICS-VII (MULTIPLE INTEGRALS AND APPLICATIONS OF VECTOR CALCULUS)	4	30	70	100	4	
46	**R22NT503**	PHYSICS-VI (LASERS)	4	30	70	100	4	
47	**R22NT504**	PHYSICS-VII (FIBER OPTICS)	4	30	70	100	4	
48	**R22NT505**	CHEMISTRY - VI (ORGANIC & PHYSICAL CHEMISTRY)	4	30	70	100	4	
49	**R22NT506**	CHEMISTRY - VII (ORGANIC SPECTROSCOPY)	4	30	70	100	4	
50	**R22NT507**	MATHEMATICS LAB - II	4	15	35	50	2	
51	**R22NT508**	PHYSICS LAB - V (FIBER OPTICS)	4	15	35	50	2	
52	**R22NT509**	CHEMISTRY LAB-V (ORGANIC PREPARATIONS & IR ANALYSIS)	4	15	35	50	2	
TOTAL			**36**			750	30	

SEMESTER – VI

III Year II Semester/VI Semester							
S. NO	**PAPER CODE**	**PAPER**	**INTERNAL MARKS**	**THEORY MARKS**	**CREDITS**	**TOTAL CREDITS**	**SEMESTER (MARKS)**
53	**R22NT601**	**PROJECT WORK-I**	100 (Viva-Voce)	200 (Dissertation)	12	12	**(300 M)**
TOTAL 3 YEARS						151	**4100 M**

SEMESTER – VII

IV Year I Semester /VII Semester/ I Semester (Lateral Entry)									
S.No		**PAPER CODE**	**PAPER**	**HR/WEEK**	**INTERNAL MARKS**	**THEORY MARKS**	**TOTAL**	**CREDITS**	
54	Mandatory Core	**R22NT701**	CLASSICAL AND STATISTICAL MECHANICS	4	30	70	100	4	
55		**R22NT702**	SOLID STATE PHYSICS	4	30	70	100	4	
56	Compulsory Foundation	**R22NT703**	NANOTECHNOLOGY-SMALL MOLECULES CHEMISTRY	4	30	70	100	4	
57	Elective Foundation (Opt*1)	**R22NT704A**	ATOMIC PHYSICS	4	30	70	100	4	
		R22NT704B	MAGNETIC MATERIALS						
		R22NT704C	MATHEMATICS-VIII (INTEGRAL TRANSFORMS WITH APPLICATIONS)						
58	Core Practical-I	**R22NT705**	SOLID STATE PHYSICS LAB	6	30	70	100	4	
59	Core Practical-II	**R22NT706**	NANOMATERIALS LAB-I (SYNTHESIS OF NANOMATERIALS)	6	30	70	100	4	
60	Audit course	**R22NT707**	HUMAN VALUES AND PROFESSIONAL ETHICS	2	100				
TOTAL				**30**			**600**	**24**	

SEMESTER – VIII

IV YEAR II SEMESTER /VIII SEMESTER/ II SEMESTER (LATERAL ENTRY)									
S.No		**PAPER CODE**	**PAPER**	**HR/WEEK**	**INTERNAL MARKS**	**THEORY MARKS**	**TOTAL**	**CREDITS**	
61	Mandatory Core	**R22NT801**	QUANTUM MECHANICS	4	30	70	100	4	
62		**R22NT802**	SYNTHESIS OF NANOMATERIALS	4	30	70	100	4	
63	Compulsory Foundation	**R22NT803**	BASIC CHARACTERIZATION OF NANOMATERIALS	4	30	70	100	4	
64	Elective Foundation (Opt*1)	**R22NT804A**	PHYSICS AND CHEMISTRY OF MATERIALS	4	30	70	100	4	
		R22NT804B	ADVANCED QUANTUM MECHANICS						
		R22NT804C	MATHEMATICS-IX (MATHEMATICAL SPECIAL FUNCTIONS)						
65	Core Practical-I	**R22NT805**	MATERIALS PHYSICS LAB	6	30	70	100	4	
66	Core Practical-II	**R22 NT806**	NANOMATERIALS LAB - II (SYNTHESIS AND CHARACTERIZATION)	6	30	70	100	4	
67	Core Practical-III	**R22 NT807**	COMPREHENSIVE VIVA-VOCE (VII & VIII SEMESTERS)	2	-	50	50	2	
68	Audit course/Skill development	**R22NT808**	RESEARCH AND PUBLICATION ETHICS	4	100				
TOTAL				**32**			**650**	**26**	

SEMESTER – IX

V YEAR I SEMESTER /IX SEMESTER/ III SEMESTER (LATERAL ENTRY)								
S.No		**PAPER CODE**	**PAPER**	**HR/WEEK**	**INTERNAL MARKS**	**THEORY MARKS**	**TOTAL**	**CREDITS**
69	Mandatory Core	**R22NT901**	CONDENSED MATTER PHYSICS	4	30	70	100	4
70		**R22NT902**	ELECTROMAGNETIC THEORY	4	30	70	100	4
71	GENERIC ELECTIVE-I (OPT* 1)	**R22NT903A**	CHEMICAL AND BIOSENSORS	4	30	70	100	4
		R22NT903B	ADVANCED CHARACTERIZATION OF NANOMATERIALS					
		R22NT903C	SUPERCONDUCTIVITY					
72	Open Elective -I (Opt* 1)	**R22NT904A**	CARBON NANOSCIENCE AND IT'S APPLICATIONS	4	30	70	100	4
		R22NT904B	ENVIRONMENTAL NANOTECHNOLOGY AND BIOSAFETY					
		R22NT904C	BASICS OF NANOTECHNOLOGY					
73	Core Practical-I	**R22NT905**	CONDENSED MATTER PHYSICS LAB	6	30	70	100	4
74	Core Practical-II	**R22NT906**	NANOMATERIALS LAB - III (KNOWLEDGE ON LATEST RESEARCH TOPICS)	6	30	70	100	4
75	Skill Enhancement		MOOCS/ SWAYAM COURSE	2	50	-	-	-
TOTAL				**30**			**600**	**24**

SEMESTER – X

V YEAR II SEMESTER /X SEMESTER/ IV SEMESTER (LATERAL ENTRY)									
S.No		**PAPER CODE**	**PAPER**	**HR/WEEK**	**INTERNAL MARKS**	**THEORY MARKS**	**TOTAL**	**CREDITS**	
76	Mandatory Core	**R22 NT1001**	NUCLEAR AND PARTICLE PHYSICS	4	30	70	100	4	
77		**R22 NT1002**	ADVANCED PHYSICS	4	30	70	100	4	
78	Core Elective-I (OPT* 1)	**R22 NT1003A**	NANOMATERIALS FOR SUSTAINABLE ENERGY	4	30	70	100	4	
		R22 NT1003B	ADVNCED NANOBIOTECHNOLOGY						
		R22 NT1003C	NANOSTRUCTURE FABRICATION AND METROLOGY						
79	Open Elective -II (Opt* 1)	**R22 NT1004A**	INDUSTRIAL NANOTECHNOLOGY	4	30	70	100	4	
		R22 NT1004B	NANOMATERIALS IN MEDICINE						
		R22 NT1004C	LIQUID CRYSTALS						
80	Core Practical-I	**R22 NT1005**	NANOMATERIALS LAB - IV (MINI PROJECT)	6	30	70	100	4	
81	Core Practical-II	**R22 NT1006**	NANOMATERIALS LAB - V (MANUSCRIPT PREPARATION AND COMMUNICATION)	6	30	70	100	4	
82	Core Practical-III	**R22 NT1007**	COMPREHENSIVE VIVA-VOCE (IX & X SEMESTERS)	2	-	50	50	2	
	SUB TOTAL			30			650	26	
						TOTAL CREDITS		**Total(Marks)**	
B.SC NANOTECHNOLOGY(3 YEARS)				**TOTAL 1-3 YEARS**		**151**		**4100 M**	
M.Sc. NANOTECHNOLOGY (LATERAL ENTRY)				**TOTAL 4-5 YEARS**		**100**		**2500 M**	
INTEGRATED M.Sc. NANOTECHNOLOGY (5 YEARS)				**TOTAL 1-5 YEARS**		**151+100=251**		**4100+2500=6600 M**	

FIRST SEMESTER

ACHARYA NAGARJUNA UNIVERSITY
UNIVERSITY COLLEGE OF SCIENCES
DEPARTMENT OF NANOTECHNOLOGY
M.Sc. NANOTECHNOLOGY
SEMESTER-I

I Year I Semester/I Semester

R22NT101/NT 1.1.1(21): COMMUNICATIVE ENGLISH- I
(A COURSE IN COMMUNICATION AND GRAMMAR)

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students were able to interpret different types of texts	2
CO-2	Students were positioned to improve the written and spoken English without grammatical mistakes.	2
CO-3	Students were able to speak and different platforms.	3
CO-4	Students can able to improve pronunciation and improve LSRW skills	3
CO-5	Students were capable to write short stories, dialogues etc.,	2

UNIT- 1 **12Hrs**

Prose : 1. The Bond of Love -- Kenneth Anderson

Poetry : 2. Song 36 from Gitanjali -- Rabindranath Tagore

Skills : 3. Reading Comprehension

UNIT – 2 **12Hrs**

Prose : 1. Knowledge Society -- APJ.Kalam

Poetry : 2. Ode to Autumn -- John keats

Non-Detail : 3. How Far is the River -- Ruskin Bond

UNIT – 3 **12Hrs**

Prose : 1. I Have a Dream -- Martin Luther King Jr.

Poetry : 2. The Road Not Taken -- Robert Frost

UNIT – 4 **12Hrs**

Non-Detail : 1. The Merchant of Venice (Casket Scene) -- William Shakespeare

Skills : 2.Punctuation

3. Role – play

UNIT – 5 **12Hrs**

Grammar:

1) Tenses
2) Correction of Sentences
3) Articles
4) Prepositions

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	3	2
CO-2	2	3	3	3	2
CO-3	3	3	3	2	2
CO-4	2	2	3	3	3
CO-5	2	2	2	3	3

SEMESTER-I

I Year I Semester/I Semester

R22NT102 / NT 1.1.2(21): INTRODUCTION TO COMPUTERS

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students can get an in-depth understanding on - why computers are essential components in business, education and society.	1
CO-2	Students can understand the fundamentals of computing devices and reinforce computer vocabulary, particularly with respect to personal use of computer hardware and software and operating systems.	2
CO-3	Students may learn hands-on use of Microsoft Office 2007 applications Word, Excel and PowerPoint.	3
CO-4	Students can able to apply and understand how computers are essential components in business and society	2
CO-5	Students might able to practice various computer program applications	3

Unit- 1: Exploring Computers 12 h

Exploring computers and their uses: Overview: Computers in our world, the computer defined, Computers for individual users, Computers for organizations, Computers in society, Why are computers so important.

Looking inside the computer system: Overview Detecting the ultimate machine, the parts of a computer system, the information processing cycle, Essential computer hardware: Processing devices, memory devices, input and output devices, storage devices, system software, application software, Computer Data, Computer users.

Using the keyboard and mouse: Overview: The keyboard and mouse, the keyboard, how the computer accepts input from the keyboard, the mouse, variants of the mouse, ergonomics and input devices.

Unit 2: Storage Devices and Operating System Basics 12 h

Types of storage devices: Overview: An ever-growing need, categorizing storage devices, magnetic storage devices How data is stored on a disk, how data is organized on a magnetic disk, how the operating system finds data on a disk, Diskettes, hard disks, removable high-capacity magnetic disks, tape drives, optical storage devices, solid-state storage devices, smart cards, solid-state disks.

Operating system basics: Overview: The purpose of operating systems, types of operating systems, providing a user interface, running programs, managing hardware, enhancing OS utility software.

Unit-3: MS-Word 12 h

Word Basics: Starting word, creating a new document, opening preexisting document, the parts of a word window, typing text, selecting text, deleting text, undo, redo, repeat, inserting text, replacing text, formatting text, cut, copy, paste - Formatting text and Documents: Auto format, Line spacing margins, Boarders and Shading.

Headers and Footers: Definition of headers and footers, creating basic headers and footers, creating different headers and footers for odd even pages.

Tables: Creating a simple table, creating a table using the table menu, Entering and editing text in table, selecting in table, adding rows, changing row heights, deleting rows, inserting columns, deleting columns, changing column width.

Macros: Macro, Record in macros, editing macros, running a macro.

Mail Merge: Mail Merge concept, main document, data sources, merging data source and main document, overview of word menu options word basic tool bar.

Unit-4 MS- Excel 12 h

Excel Basics: Overview of Excel features, Getting started, creating a new worksheet, selecting cells, Entering and editing text, Entering and Editing Numbers, entering and Editing formulas, referencing cells, moving cells, copying cells, sorting cell data, inserting rows, inserting columns, inserting cells, Deleting parts of a worksheet, clearing parts of a worksheet.

Formatting: Page Setup, changing column widths and Row heights, auto format, changing font sizes and attributes, centering text across columns, using border buttons and commands, changing colors and shading, hiding rows and columns.

Introduction to functions: parts of function, Functions requiring add-ins, the function wizard, examples functions by category: Date and Time functions, Engineering functions, Math and Trig functions, Statistical functions, Text functions.

Excel Charts: Chart parts and terminology, instant charts with the chart wizard, creation of different types of charts, printing charts, deleting charts- linking in Excel.

Unit-5 MS – PowerPoint 12 h

Power Point Basics: Basics, Terminology, Getting started, and Views

Creating Presentations: Using auto content wizard, using blank presentation option, Using design template option

Working with Slides: Adding slides, deleting a slide, Importing Images from the outside world, drawing in power point.

Presentations: Transition and build effects, deleting a slide, numbering a slide saving presentation, closing presentation, printing presentation elements.

REFERENCE BOOKS:

1) Peter Norton, Introduction to Computers, sixth Edition, Tata McGraw Hill (2007)
2) Ran Mansfield, working in Microsoft office, Tata McGraw Hill (2008).

REFERENCE BOOKS:

1) Michael Miller, Absolute Beginner's guide to computer Basics, Fourth Edition, Pearson Education (2007).
2) Deborah Morley, Charles S. Parker, understanding computers today and tomorrow, edition, Thomson (2007).
3) Ed Bot, woody Leonhard, using Microsoft Office 2007, Pearson Education (2007).

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	2	2	3
CO-2	2	2	3	2	3
CO-3	3	2	2	2	3
CO-4	3	2	2	2	3
CO-5	2	2	2	2	3

SEMESTER-I

I Year I Semester/I Semester

R22NT 103/ NT 1.1.3 (21): MATHEMATICS-I (DIFFERENTIAL EQUATIONS)

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students can develop a solid understanding of the fundamental concepts of differential equations, including the definitions of differential equations, order, linearity, and solutions.	3
CO-2	Students can be able to convert non exact homogeneous equations to exact differential equations by using integrating factors.	2
CO-3	Students were capable to analyze the methods of finding solutions of differential equations of the first order but not of the first degree.	3
CO-4	Students can solve higher-order linear differential equations, both homogeneous and non-homogeneous, with constant coefficients.	2
CO-5	Students can understanding on the concepts and apply appropriate methods for solving differential equations.	3

UNIT – I **12 h**

Differential Equations of first order and first degree: Linear Differential Equations; Differential equations reducible to linear form; Exact differential equations; Integrating factors; Change of variables.

UNIT – II **12 h**

Orthogonal Trajectories

Differential Equations of first order but not of the first degree: Equations solvable for *p*; Equations solvable for *y*; Equations solvable for *x*; Equations that do not contain x (or y); Equations homogeneous in x and y; Equations of the first degree in *x* and *y* – Clairaut's Equation.

UNIT – III **12 h**

Higher order linear differential equations-I:

Solution of homogeneous linear differential equations of order n with constant coefficients; Solution of the non-homogeneous linear differential equations with constant coefficients by means of polynomial operators. General Solution of f(D)y=0.

General Solution of f(D)y=Q when Q is a function of x, is expressed as partial fractions $x, \frac{1}{f(D)}$ P.I. of f(D)y = Q when $Q = be^{ax}$.

P.I. of f(D)y = Q when $Q = b\,Sinax\ or\ b\,Cosax$.

UNIT – IV **12 h**

Higher order linear differential equations-II:

Solution of the non-homogeneous linear differential equations with constant coefficients.

P.I. of f(D)y = Q when $Q = bx^k$.

P.I. of f(D)y = Q when $Q = V(x)e^{ax}$, where V(x) is a function of x.

P.I. of f(D)y = Q when $Q = xV(x)$, where V(x) is a function of x.

P.I. of f(D)y = Q when $Q = x^m V(x)$, where V(x) is a function of x.

UNIT –V **12 h**

Higher order linear differential equations-III:

Method of variation of parameters; Linear differential Equations with non-constant coefficients; The Cauchy-Euler Equation, Legendre's linear equations, miscellaneous differential equations.

CO-CURRICULAR ACTIVITIES

Seminar/ Quiz/ Assignments/ Applications of Differential Equations to Real life Problem / Problem Solving.

TEXT BOOKS:

1) Differential Equations and Their Applications by Zafar Ahsan, published by Prentice-Hall of India Pvt. Ltd, New Delhi-Second edition.

REFERENCE BOOKS:

1) A text book of Mathematics for B.A/B. Sc, Vol 1, by N. Krishna Murthy & others, published by S. Chand & Company, New Delhi.
2) Ordinary and Partial Differential Equations by Dr. M. D, Raisinghania, published by S. Chand & Company, New Delhi.
3) Differential Equations with applications and programs – S. Balachandra Rao & HR Anuradha- Universities Press.
4) Differential Equations -Srinivas Vangala & Madhu Rajesh, published by Spectrum University Press.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

Cos	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	2	2	2
CO-2	2	2	3	3	3
CO-3	3	2	2	2	3
CO-4	2	2	2	3	2
CO-5	3	3	2	2	3

SEMESTER-I

I Year I Semester/I Semester

R22NT 104 / NT 1.1.4(21):

PHYSICS – I (MECHANICS, WAVES AND OSCILLATIONS)

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students can understand Newton's laws of motion and motion of variable mass system and its application to rocket motion and the concepts of impact parameter, scattering cross section.	1
CO-2	Students may able to apply the rotational kinematic relations, the principle and working of gyroscope and its applications and the precessional motion of a freely rotating symmetric top.	2
CO-3	Students can learn and Comprehend the general characteristics of central forces and the application of Kepler's laws to describe the motion of planets and satellite in circular orbit through the study of law of Gravitation.	3
CO-4	Students can understand postulates of Special theory of relativity and its consequences such as length contraction, time dilation, relativistic mass and mass-energy equivalence.	2
CO-5	Students can examine phenomena of simple harmonic motion and the distinction between undamped, damped and forced oscillations and the concepts of resonance and quality factor regarding damped harmonic oscillator.	3

UNIT-I:

1. Mechanics of Particles **5 h**

Review of Newton's Laws of Motion, Motion of variable mass system, Motion of a rocket, Multistage rocket, Concept of impact parameter, scattering cross-section, Rutherford scattering-Derivation.

2. Mechanics of Rigid bodies **7 h**

Rigid body, rotational kinematic relations, Equation of motion for a rotating body, Angular momentum and Moment of inertia tensor, Euler equations, Precession of a spinning top, Gyroscope, Precession of atom and nucleus in magnetic field, Precession of the equinoxes

UNIT-II:

3. Motion in a Central Force Field **12 h**

Central forces, definition and examples, characteristics of central forces, conservative nature of central forces, Equation of motion under a central force, Kepler's laws of planetary motion- Proofs, Motion of satellites, Basic idea of Global Positioning System (GPS), weightlessness, Physiological effects of astronauts

UNIT-III:

4. Relativistic Mechanics **12 h**

Introduction to relativity, Frames of reference, Galilean transformations, absolute frames, Michelson-Morley experiment, negative result, Postulates of Special theory of relativity, Lorentz transformation, time dilation, length contraction, variation of mass with velocity, Einstein's mass-energy relation

UNIT-IV:

5. Undamped, Damped and Forced oscillations: **7 h**

Simple harmonic oscillator and solution of the differential equation, Damped harmonic oscillator, Forced harmonic oscillator – Their differential equations and solutions, Resonance, Logarithmic decrement, Relaxation time and Quality factor.

6. Coupled oscillations: **5 h**

Coupled oscillators-Introduction, Two coupled oscillators, Normal coordinates and Normal modes- N-coupled oscillators and wave equation

UNIT-V:

7. Vibrating Strings: **7 h**

Transverse wave propagation along a stretched string, General solution of wave equation and its significance, Modes of vibration of stretched string clamped at ends, Overtones and Harmonics, Melde's strings.

8. Ultrasonics: **5 h**

Ultrasonics, General Properties of ultrasonic waves, Production of ultrasonics by piezoelectric and magnetostriction methods, Detection of ultrasonics, Applications of ultrasonic waves, SONAR

REFERENCE BOOKS:

1) B. Sc. Physics, Vol.1, Telugu Academy, Hyderabad
2) Fundamentals of Physics Vol. I - Resnick, Halliday, Krane, Wiley India 2007
3) College Physics-I. T. Bhimasankaram and G. Prasad. Himalaya Publishing House.
4) University Physics-FW Sears, MW Zemansky& HD Young, Narosa Publications, Delhi
5) Mechanics, S.G. Venkatachalapathy, Margham Publication, 2003.
6) Waves and Oscillations. N. Subramanyam and Brijlal, VikasPulications.
7) Unified Physics - Waves and Oscillations, Jai Prakash Nath & Co. Ltd.
8) Waves & Oscillations. S. Badami, V. Balasubramanian and K.R. Reddy, Orient Longman.
9) The Physics of Waves and Oscillations, N.K. Bajaj, Tata McGraw Hill
10) Science and Technology of Ultrasonics- Baldevraj, Narosa, New Delhi,2004

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	2	2
CO-2	2	2	3	2	3
CO-3	2	2	3	2	3
CO-4	3	3	2	2	3
CO-5	3	3	3	3	3

SEMESTER-I

I Year I Semester/I Semester

R22NT105 / NT 1.1.5(21): CHEMISTRY-I

(INORGANIC & PHYSICAL CHEMISTRY)

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students can developed understanding on the preparation, properties and apply the knowledge in day-to-day applications of compounds from p, d and f-block elements	1
CO-2	Students can analyze and grasp the knowledge on principles and applications of d- & f-block elements	2
CO-3	Students may analyze the concepts in solid state chemistry, its applications and the concept of X-ray diffraction on crystals	3
CO-4	Students can develop a solid understanding on the basics of gaseous state, gas equations	3
CO-5	Students can gain knowledge in solutions, their purification methods and liquid crystals	2

Unit – I: Inorganic Chemistry – I **24 h**

1. Chemistry of p-block elements: **8 h**

Group – 13: Synthesis and structure of diborane and higher boranes (B_4H_{10} and B_5H_9), boron-nitrogen compounds ($B_3N_3H_6$ and BN)

Group – 14: Preparation and applications of silanes and silicones.

Group – 15: Preparation and reactions of hydrazine, hydroxylamine, phosphazenes.

Group – 16: Oxides and Oxoacids of Sulphur.

Group – 17: Pseudohalogens, Structures of Interhalogen compounds.

UNIT-II

1. Chemistry of d-block elements: **6 h**

Characteristics of d-block elements with special reference to electronic configuration, variable valence, magnetic properties, catalytic properties and ability to form complexes. Stability of various oxidation states.

2. Chemistry of f-block elements: **6 h**

Chemistry of lanthanides - electronic structure, oxidation states, lanthanide contraction, consequences of lanthanide contraction, magnetic properties. Chemistry of actinides - electronic configuration, oxidation states, actinide contraction, comparison of lanthanides and actinides.

3. Theories of bonding in metals: **4 h**

Valence bond theory and Free electron theory, explanation of thermal and electrical conductivity of metals based on these theories, Band theory- formation of bands, explanation of conductors, semiconductors and insulators.

UNIT-III Physical Chemistry-1 **36 h**

Solid state Chemistry **10 h**

Symmetry in crystals. Law of constancy of interfacial angles. The law of rationality of indices. The law of symmetry. Miller indices, Definition of lattice point, space lattice, unit cell. Bravais lattices and crystal systems. X-ray diffraction and crystal structure. Bragg's law. Powder method. Defects in crystals. Stoichiometric and non-stoichiometric defects.

UNIT-IV

1. Gaseous state **6 h**

van der Waal's equation of state. Andrew's isotherms of carbon dioxide, continuity of state. Critical phenomena. Relationship between critical constants and vander Waal's constants. Law of corresponding states. Joule- Thomson effect. Inversion temperature.

2. Liquid state **4 h**

Intermolecular forces, Liquid crystals, mesomorphic state. Differences between liquid crystal and solid/liquid. Classification of liquid crystals into Smectic and Nematic. Application of liquid crystals as LCD devices.

UNIT-V

Solutions, Ionic equilibrium & dilute solutions

1. Solutions **6 h**

Azeotropes-HCl-H_2O system and ethanol-water system. Partially miscible liquids-phenol-water system. Critical solution temperature (CST), Effect of impurity on consulate temperature. Immiscible liquids and steam distillation. Nernst distribution law. Calculation of the partition coefficient. Applications of distribution law.

2. Ionic equilibrium **5 h**

Ionic product, common ion effect, solubility and solubility product. Calculations based on solubility product.

3. Dilute solutions **5 h**

Colligative properties- RLVP, Osmotic pressure, Elevation in boing point and depression in freezing point, Reverse osmosis (basics).

REFERENCE BOOKS:

1) Principles of physical chemistry by Puri, Sharma and Pathania
2) Text book of physical chemistry by K L Kapoor, Volumes 1-5
3) Advanced physical chemistry by Bahl and Tuli
4) Concise Inorganic Chemistry by J. D. Lee

5) Inorganic Chemistry by J. E. Huheey
6) Basic Inorganic Chemistry by Cotton and Wilkinson
7) Atkins, P.W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 10th Ed (2014).

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	3	3
CO-2	2	2	3	2	2
CO-3	2	2	3	2	3
CO-4	3	3	2	2	3
CO-5	3	3	3	4	3

SEMESTER-I

I Year I Semester OR I Semester

PRACTICAL-I:

R22NT108/ NTP1.1.1(21): PHYSICS LAB-I

(WAVES AND OSCILLATIONS)

University Exam: 3 hours **Internal Marks: 15** **University Examination Marks: 35**

COURSE OUTCOMES (PRACTICALS):

On successful completion of this practical course, the student will be able to;

- Perform experiments on Properties of matter such as the determination of moduli of elasticity *viz.*, Young's modulus, Rigidity modulus of certain materials; Surface tension of water , Coefficient of viscosity of a liquid , Moment of inertia of some regular bodies by different methods and compare the experimental values with the standard values.
- Know how to determine the acceleration due to gravity at a place using Compound pendulum and Simple pendulum.
- Notice the difference between flat resonance and sharp resonance in case of volume resonator and sonometer experiments respectively.
- Verify the laws of transverse vibrations in a stretched string using sonometer and comment on the relation between frequency, length and tension of a stretched string under vibration.
- Demonstrate the formation of stationary waves on a string in Melde's string experiment.
- Observe the motion of coupled oscillators and normal modes.

MINIMUM OF 6 EXPERIMENTS TO BE DONE AND RECORDED:

1) Young's modulus of the material of a bar (scale) by uniform bending
2) Young's modulus of the material a bar (scale) by non- uniform bending
3) Surface tension of a liquid by capillary rise method
4) Viscosity of liquid by the flow method (Poiseuille's method)
5) Bifilar suspension –Moment of inertia of a regular rectangular body.
6) Fly-wheel -Determination of moment of inertia
7) Rigidity modulus of material of a wire-Dynamic method (Torsional pendulum)
8) Volume resonator experiment
9) Determination of 'g' by compound/bar pendulum
10) Simple pendulum- normal distribution of errors-estimation of time period and the error of the mean by statistical analysis
11) Determination of the force constant of a spring by static and dynamic method.
12) Coupled oscillators
13) Verification of laws of vibrations of stretched string –Sonometer
14) Determination of frequency of a bar –Melde's experiment.
15) Study of a damped oscillation using the torsional pendulum immersed in liquid-decay constant and damping correction of the amplitude.

RECOMMENDED CO-CURRICULAR ACTIVITIES:

MEASURABLE

1) Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
2) Student seminars (on topics of the syllabus and related aspects (individual activity)
3) Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams)
4) Field studies (individual observations and recordings as per syllabus content and related areas (Individual or team activity)
5) Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity)

GENERAL

1) Group Discussion
2) Visit to Research Stations, Science Museum Centres to understand the basic principles of mechanics with live examples and related industries
3) Visit to Satellite launching station at Sri Harikota.

RECOMMENDED ASSESSMENT METHODS:

Some of the following suggested assessment methodologies could be adopted;

- The oral and written examinations (Scheduled and surprise tests)
- Problem-solving exercises
- Practical assignments and Observation of practical skills
- Individual and group project reports
- Efficient delivery using seminar presentations
- Viva voce interviews.

SEMESTER-I

I Year I Semester OR I Semester

PRACTICAL-II:

R22NT109/NTP1.1.2(21): CHEMISTRY LAB-I

(ANALYSIS OF SALT MIXTURE)

University Exam: 3 hours **Internal Marks: 15** **University Examination Marks: 35**

QUALITATIVE INORGANIC ANALYSIS (MINIMUM OF SIX MIXTURES SHOULD BE ANALYSED) 50 M

COURSE OUTCOMES:

At the end of the course, the student will be able to;

- Understand the basic concepts of qualitative analysis of inorganic mixture
- Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
- Apply the concepts of common ion effect, solubility product and concepts related to qualitative analysis

ANALYSIS OF SALT MIXTURE 50 M

Analysis of mixture salt containing two anions and two cations (From two different groups) from the following:

Anions: Carbonate, Sulphate, Chloride, Bromide, Acetate, Nitrate, Borate, Phosphate. **Cations:** Lead, Copper, Iron, Aluminium, Zinc, Nickel, Manganese, Calcium, Strontium, Barium, Potassium and Ammonium.

RECOMMENDED CO-CURRICULAR ACTIVITIES:

MEASURABLE

1) Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
2) Student seminars (on topics of the syllabus and related aspects (individual activity)
3) Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams)
4) Field studies (individual observations and recordings as per syllabus content and related areas (Individual or team activity)
5) Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity)

GENERAL

1) Group Discussion
2) Visit to Research Stations, Science Museum Centres to understand the basic principles of mechanics with live examples and related industries
3) Visit to Satellite launching station at Sri Harikota.

RECOMMENDED ASSESSMENT METHODS:

Some of the following suggested assessment methodologies could be adopted;

1) The oral and written examinations (Scheduled and surprise tests)
2) Problem-solving exercises
3) Practical assignments and Observation of practical skills
4) Individual and group project reports
5) Efficient delivery using seminar presentations
6) Viva voce interviews.

SECOND SEMESTER

M.Sc. NANOTECHNOLOGY

SEMESTER-II

I Year II Semester / II Semester

R22NT201/NT1.2.1(21): COMMUNICATIVE ENGLISH - II

(A COURSE IN READING & WRITING SKILLS)

Syllabus (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students can able to Comprehend different texts	1
CO-2	Students can able to Comprehend different texts	2
CO-3	Students can able to Analyze what is being read	3
CO-4	Students can able to communicate confidently	2
CO-5	Students can able to Use good writing strategies, Write well for any purpose	3

UNIT - 1 **12 h**

Prose : 1. The Conjurer's Revenge -- Stephen Leacock

Poetry : 2. Don't Quit -- Edgar A. Guest

Skills : 3. One-word Substitutes

UNIT – 2 **12 h**

Prose : 1.The Necklace -- Guy De Maupassant

Poetry : 2. The Gift of India -- Sarojini Naidu

Skills : 3. Agenda and Notice Writing

UNIT – 3 **12 h**

Non-Detail : 1.The Happy Prince -- Oscar Wilde

Poetry : 2. All the World's a Stage -- William Shakespeare

Skills : 3. Letter Writing

UNIT – 4 **12 h**

Non-Detail : 1. Subha -- Rabindranath Tagore

Skills : 2. Collocations

UNIT - 5 **12 h**

Prose 1. The Lost Child -- Mulk Raj Anand

Skills : 2. Resume / C.V

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	2	3
CO-2	2	2	3	2	3
CO-3	2	2	3	2	3
CO-4	2	3	2	3	3
CO-5	3	2	3	2	3

SEMESTER-II

I Year II Semester /II Semester

R22NT202 / NT 1.2.2(21): PROGRAMMING WITH C

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can gain logical thinking, Implement the algorithms and analyze their complexity, Identify the correct and efficient ways of solving problems	1
CO-2	Students can Improved ability to develop function-oriented programs.	3
CO-3	Students may Write C programs using decision making, branching, looping constructs.	3
CO-4	Students can understand a functional hierarchical code organization.	3
CO-5	Students can have Ability to develop logics which will help them create programs in C, Ability to work with textual information, characters and strings.	2

Unit-I **12 h**

Introductory Concepts: Types of Programming Languages, Introduction to C, Desirable Program Characteristics

Introduction to C Programming: The C Character Set, Writing First Program of C, Identifiers and Keywords, Data types, Constants, Variables and Arrays, Declarations, Expressions Statements, Symbolic Constants

Unit II **12 h**

Operators and Expressions: Arithmetic Operators, Unary Operators, Relational and Logical Operators, Assignment Operators, the Conditional Operator, Library Functions.

Data Input and Output: Preliminaries, Single Character Input-The Getchar Function, Single Character Output – The Putchar Function, Enter Input Data – The Scanf Function, More About the Scanf Function, Writing Output Data – The Printf Function, More About the Printf Function, The Gets and Puts Functions-Preparing and Running a Complete C Program: Planning a C Program, Writing a C Program,

Unit-III **12 h**

Control Statements: Preliminaries, Branching: The IF-ELSE Statement, Looping: The while Statement, More Looping: The do-while Statement, Still More Looping: The for Statement, Nested Control Structures, The Switch Statement, The break Statement, The continue Statement, The comma Statement, The goto Statement.

Unit IV **12 h**

Functions: A Brief Overview, Defining a Function, Accessing a Function, Function Prototypes, Passing Arguments to a Function, Recursion

Arrays: Defining an Array, Processing an Array, Passing Arrays to Functions, Multidimensional Arrays, Arrays and Strings

Unit V: **12 h**

Pointers: Fundamentals, Pointer Declarations, Passing Pointers to a Function, Pointers and One-dimensional Arrays, Dynamic Memory Allocation, Operations on Pointers, Pointers and Multidimensional Arrays, Arrays of Pointers, Passing Functions to Other Functions

Structures and Unions: Defining a Structure, Processing a Structure, User-defined Data Types (Typedef), Structure and Pointers, Passing Structures to Functions, Self-referential Structures, Unions

REFERENCE BOOKS:

1) Byron S Gottfriend, "Programming with C", Second Edition, Schaum Out Lines, TATA Mc Graw Hill (2007)
2) Behrouy A. Foreuyan & Richard F. Gilberg, "Computer Science A structured programming Approach using C", Third Edition, Cengage Learning (2008).
3) Herbert Schildt, "The Complete Reference C", Fourth Edition, TMH (2008)
4) Ashok N. Kamthane, "Programming with ANSI and Turbo C", Pearson Education (2008)
5) Mullish Cooper, "The Spirit of C – An Introduction to Moderen Programming", Jaico Books (2006)

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

Cos	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	2	3	3
CO-2	2	2	3	2	3
CO-3	3	2	3	2	3
CO-4	2	3	2	3	3
CO-5	3	2	3	3	2

SEMESTER-II

I Year II Semester /II Semester

R22NT 203 / NT1.2.3 (21): MATHEMATICS-II
(THREE-DIMENSIONAL ANALYTICAL SOLID GEOMETRY)

Syllabus (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can be able to understand and analyze the concepts on planes.	2
CO-2	Students may be able to understand and analyze the concepts on lines.	2
CO-3	Students may be able to understand and analyze the concepts on sphere and cone	2
CO-4	Students can be able to understand and analyze the properties of planes, lines, spheres and cones.	3
CO-5	Students can be able to analyze the concepts and express the problems geometrically and then to get the solution	3

1) Gain a more profound understanding of measurement and of geometry.
2) Experience mathematics as a constructivist interaction among students, the instructor, and the course content.
3) Relate and integrate geometry into real life contexts as well as into other disciplines.

UNIT – I **12 h**

The Plane:

Equation of plane in terms of its intercepts on the axis, Equations of the plane through the given points, Length of the perpendicular from a given point to a given plane, Bisectors of angles between two planes, Combined equation of two planes, Orthogonal projection on a plane.

UNIT – II **12 h**

The Line:

Equation of a line; Angle between a line and a plane; The condition that a given line may lie in a given plane; The condition that two given lines are coplanar; Number of arbitrary constants in the equations of straight line; Sets of conditions which determine a line; The shortest distance between two lines; The length and equations of the line of shortest distance between two straight lines; Length of the perpendicular from a given point to a given line.

UNIT – III **12 h**

The Sphere:

Definition and equation of the sphere; Equation of the sphere through four given points; Plane sections of a sphere; Intersection of two spheres; Equation of a circle; Sphere through a given circle; Intersection of a sphere and a line; Power of a point; Tangent plane; Plane of contact; Polar plane; Pole of a Plane; Conjugate points; Conjugate planes;

UNIT – IV **12 h**

The Sphere and Cones:

Angle of intersection of two spheres; Conditions for two spheres to be orthogonal; Radical plane; Coaxial system of spheres; Simplified from of the equation of two spheres.

Cones:

Definitions of a cone; vertex; guiding curve; generators; Equation of the cone with a given vertex and guiding curve; equations of cones with vertex at origin are homogenous; Condition that the general equation of the second degree should represent a cone;

UNIT – V **12 h**

Cones:

Enveloping cone of a sphere; right circular cone: equation of the right circular cone with a given vertex, axis and semi vertical angle: Condition that a cone may have three mutually perpendicular generators; intersection of a line and a quadric cone; Tangent lines and tangent plane at a point; Condition that a plane may touch a cone; Reciprocal cones; Intersection of two cones with a common vertex.

CO-CURRICULAR ACTIVITIES:

Seminar/ Quiz/ Assignments/Three dimensional analytical Solid geometry and its applications/ Problem Solving.

TEXT BOOK:

Analytical Solid Geometry by Shanti Narayan and P.K. Mittal, published by S. Chand & Company Ltd. 7th Edition.

REFERENCE BOOKS:

1) A text book of Mathematics for BA/B.Sc Vol 1, by V Krishna Murthy & Others, published by S. Chand & Company, New Delhi.
2) A text Book of Analytical Geometry of Three Dimensions, by P.K. Jain and Khaleel Ahmed, published by Wiley Eastern Ltd., 1999.
3) Co-ordinate Geometry of two and three dimensions by P. Balasubrahmanyam, K.Y. Subrahmanyam, G.R. Venkataraman published by Tata-MC Gran-Hill Publishers Company Ltd., New Delhi.
4) Solid Geometry by B. Rama Bhupal Reddy, published by Spectrum University Press.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	2	2
CO-2	2	2	3	2	3
CO-3	2	2	3	2	3
CO-4	2	3	2	3	3
CO-5	3	2	3	3	3

SEMESTER-II

I Year II Semester /II Semester

R22NT204 / NT 1.2.4 (21): PHYSICS – II (WAVE OPTICS)

Syllabus (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can able to Understand the phenomenon of interference of light and its formation in (i) Lloyd's single mirror due to division of wave front and (ii) Thin films, Newton's rings and Michelson interferometer due to division of amplitude.	1
CO-2	Students can able to Distinguish between Fresnel's diffraction and Fraunhofer diffraction and observe the diffraction patterns in the case of single slit and the diffraction grating. Describe the construction and working of zone plate and make the comparison of zone plate with convex lens.	2
CO-3	Students can able to analyze the various methods of production of plane, circularly and polarized light and their detection and the concept of optical activity.	1
CO-4	Students can able to Comprehend the basic principle of laser, the working of He-Ne laser and Ruby lasers and their applications in different fields	2
CO-5	Students can able to understand the different aberrations in lenses and discuss the methods of minimizing them. Understand the basic principles of fibre optic communication and explore the field of Holography and Nonlinear optics and their applications.	3

UNIT-I: Interference of light: 12 h

Introduction, Conditions for interference of light, Interference of light by division of wave front and amplitude, Phase change on reflection- Stokes' treatment, Lloyd's single mirror, Interference in thin films: Plane parallel and wedge- shaped films, colours in thin films, Newton's rings in reflected light-Theory and experiment, Determination of wavelength of monochromatic light, Michelson interferometer and determination of wavelength.

UNIT-II: Diffraction of light: 12 h

Introduction, Types of diffraction: Fresnel and Fraunhoffer diffractions, Distinction between Fresnel and Fraunhoffer diffraction, Fraunhoffer diffraction at a single slit, Plane diffraction grating, Determination of wavelength of light using diffraction grating, Resolving power of grating, Fresnel's half period zones, Explanation of rectilinear propagation of light, Zone plate, comparison of zone plate with convex lens.

UNIT-III: Polarization of light: **12 h**

Polarized light: Methods of production of plane polarized light, Double refraction, Brewster's law, Malus law, Nicol prism, Nicol prism as polarizer and analyzer, Quarter wave plate, Half wave plate, Plane, Circularly and Elliptically polarized light-Production and detection, Optical activity, Laurent's half shade polarimeter: determination of specific rotation, Basic principle of LCDs

UNIT-IV: Aberrations and Fibre Optics: **12 h**

Monochromatic aberrations, Spherical aberration, Methods of minimizing spherical aberration, Coma, Astigmatism and Curvature of field, Distortion; Chromatic aberration-the achromatic doublet; Achromatism for two lenses (i) in contact and (ii) separated by a distance.

Fibre optics: Introduction to Fibers, different types of fibers, rays and modes in an optical fiber, Principles of fiber communication (qualitative treatment only), Advantages of fiber optic communication.

UNIT-V: Lasers and Holography: **12 h**

Lasers: Introduction, Spontaneous emission, stimulated emission, Population Inversion, Laser principle, Einstein coefficients, Types of lasers-He-Ne laser, Ruby laser, Applications of lasers; Holography: Basic principle of holography, Applications of holography

REFERENCE BOOKS:

1) BSc Physics, Vol.2, Telugu Akademy, Hyderabad
2) A Text Book of Optics-N Subramanyam, L Brijlal, S.Chand& Co.
3) Optics-Murugeshan, S.Chand& Co.
4) Unified Physics Vol.IIOptics, Jai PrakashNath&Co.Ltd., Meerut
5) Optics,F.A. Jenkins and H.G.White, McGraw-Hill
6) Optics, AjoyGhatak,TataMcGraw-Hill.
7) Introduction of Lasers – Avadhanulu, S.Chand& Co.
8) Principles of Optics- BK Mathur, Gopala Printing Press, 1995.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	3	3
CO-2	2	2	3	2	3
CO-3	2	2	3	2	3
CO-4	2	3	2	3	3
CO-5	2	3	3	2	3

SEMESTER-II

I Year II Semester /II Semester

R22NT205/ NT 1.2.5 (21): CHEMISTRY-II

(ORGANIC & GENERAL CHEMISTRY)

Syllabus (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can be able to understand and explain the differential behavior of organic compounds based on fundamental concepts learnt.	2
CO-2	Students may be able to formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved	2
CO-3	Students can learn and identify many organic reaction mechanisms including Free Radical Substitution, Electrophilic Addition and Electrophilic Aromatic Substitution	3
CO-4	Students may be able to understand and analyze the concepts that led to the atomic structure, quantum mechanics and the chemical bonding	2
CO-5	Students can be able to correlate and apply the stereochemical properties of organic compounds and reactions	3

UNIT-I: Organic Chemistry-I 36 h

Structural theory in Organic Chemistry 12 h

Types of bond fission and organic reagents (Electrophilic, Nucleophilic, and free radical reagents including neutral molecules like H_2O, NH_3 & $AlCl_3$).

Bond polarization: Factors influencing the polarization of covalent bonds, electro negativity – inductive effect. Application of inductive effect (a) Basicity of amines (b) Acidity of carboxylic acids (c) Stability of carbonium ions. Resonance or Mesomeric effect, application to (a) acidity of phenol, and (b) acidity of carboxylic acids. Hyper conjugation and its application to stability of carbonium ions, Free radicals and alkenes, carbanions, carbenes and nitrenes.

UNIT-II 12 h

Carbon-Carbon π-Bonds (Alkenes and Alkynes) General methods of preparation, physical and chemical properties. Mechanism of E1, E2, E1cb reactions, Saytzeff and Hoffmann eliminations, Electrophilic Additions, mechanism (Markownikoff/Antimarkownikoff addition) with suitable examples, *syn* and *anti*-addition; addition of H_2, X_2, HX. oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, hydroxylation, Diels Alderreaction,1,2- and 1,4-addition reactions in conjugated dienes.

Reactions of alkynes; acidity, electrophilic and nucleophilic additions, hydration to form carbonyl compounds, Alkylation of terminal alkynes.

UNIT-III **12 h**

Alkanes and Cycloalkanes

General methods of preparation of alkanes- Wurtz and Wurtz Fittig reaction, Corey House synthesis, physical and chemical properties of alkanes, Isomerism and its effect on properties, Free radical substitutions; Halogenation, concept of relative reactivity v/s selectivity. Conformational analysis of alkanes (Conformations, relative stability and energy diagrams of Ethane, Propane and butane).

Nomenclature, Preparation by Freunds methods, heating dicarboxylic metal salts. Properties – reactivity of cyclopropane and cyclobutane by comparing with alkanes, Stability of cycloalkanes – Baeyer's strain theory, Sachse and Mohr predictions. Conformational structures of cyclobutane, cyclopentane, cyclohexane, with energy diagram, Conformations of monosubstituted cyclohexane.

Unit-IV General Chemistry – I

1. Atomic Structure **8 h**

Blackbody radiation, Planck's radiation law, photoelectric effect, Compton effect, de Broglie's hypothesis, Heisenberg's uncertainty principle. Postulates of quantum mechanics. Schrodinger wave equation and a particle in a box, energy levels, wave functions and probability densities.

2. Chemical Bonding **4 h**

Valence bond theory, hybridization, VB theory as applied to ClF_3, BrF_5, XeF_2. Molecular orbital theory – LCAO method, construction of M.O. diagrams for homo-nuclear and hetero-nuclear diatomic molecules (N_2, O_2, CO and NO).

UNIT-V: **12 h**

Stereochemistry of carbon compounds

Molecular representations- Wedge, Fischer, Newman and Saw-Horse formulae.

Optical isomerism: Optical activity- wave nature of light, plane polarized light, optical rotation and specific rotation.

Conformational and configurational isomerism- definition. Conformational isomerism of ethane and n-butane.

Chiral molecules- definition and criteria- absence of plane, center, and Sn axis of symmetry, Definition of enantiomers and diastereomers, Optical isomerism of examples Glyceraldehyde, Lactic acid, Alanine, trans -1,2-dichloro cyclopropane.

Chiral centers: definition- molecules with similar chiral carbon (Tartaric acid), definition of mesomers- molecules with dissimilar chiral carbons (2, 3-dibromopentane). Number of enantiomers and mesomers- calculation.

D, L, R,S and E,Z- configuration configurations with examples. Cahn-Ingold-Prelog rules. Racemic mixture- racemization and resolution techniques.

REFERENCE BOOKS:

1) Principles of physical chemistry by Puri, Sharma and Pathania
2) Text book of physical chemistry by K L Kapoor (Volumes 1-5)
3) Advanced physical chemistry by Bahl and Tuli
4) Physical chemistry A molecular approach by Donald A. Mcquarrie and John D. Simson.
5) Concise Inorganic Chemistry by J. D. Lee
6) Inorganic Chemistry by J. E. Huheey
7) Basic Inorganic Chemistry by Cotton and Wilkinson
8) Atkins, P.W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 10th Ed (2014).
9) Organic Chemistry by P. Y. Bruice
10) Organic Chemistry by Francis A Carey
11) Organic Chemistry by Ege
12) Organic Chemistry by R T Morrison and R. N. Boyd
13) Stereochemistry of Organic Compounds by E. L. Eliel

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	4	3
CO-2	2	2	3	2	3
CO-3	3	2	3	2	3
CO-4	2	3	2	3	3
CO-5	2	3	5	2	3

SEMESTER-II

I Year II Semester /II Semester

PRACTICAL-I:

R22NT209/ NTP1.2.1(21): COMPUTER LAB-I: (PROGRAMMING WITH C)

SYLLABUS

University Exam: 3 hours Internal Marks: 15 University Examination Marks: 35

1) Find out the given number is prime number or not using c program.
2) Write a C program to check whether the given number is Armstrong or not.
3) Write a C program to print the reverse of a given positive integer.
4) Write a C program to print multiplication table for a given number.
5) Write a C program to generate all the prime numbers between 1 and n, where n is a value supplied by the user.
6) Write a C program to find both the maximum and minimum number in a list of integers.
7) Write a C program that performs Addition of Two Matrices
8) Write a C program that performs Multiplication of Two Matrices
9) Write a program to perform various string operations
10) Write C program that implements searching of given item in a given list
11) Write a C program to sort a given list of integers in ascending order
12) Write a C program to perform Addition of two complex numbers using structures.
13) Write a C program to find the length of the string using Pointer.
14) Write a program to illustrate function calling mechanisms.
15) Write a program to illustrate enumerated data types.

SEMESTER-II

I Year II Semester /II Semester

PRACTICAL-II:

R22NT210/ NTP1.2.2(21): PHYSICS LAB-II: (WAVE OPTICS)

SYLLABUS

University Exam: 3 hours Internal Marks: 15 University Examination Marks: 35

COURSE OUTCOMES (PRACTICALS):

On successful completion of this practical course the student will be able to,

- Gain hands-on experience of using various optical instruments like spectrometer, polarimeter and making finer measurements of wavelength of light using Newton Rings experiment, diffraction grating etc.
- Understand the principle of working of polarimeter and the measurement of specific rotatory power of sugar solution
- Know the techniques involved in measuring the resolving power of telescope and dispersive power of the material of the prism.
- Be familiar with the determination of refractive index of liquid by Boy's method and the determination of thickness of a thin wire by wedge method.

MINIMUM OF 6 EXPERIMENTS TO BE DONE AND RECORDED

1) Determination of radius of curvature of a given convex lens-Newton's rings.
2) Resolving power of grating.
3) Study of optical rotation –polarimeter.
4) Dispersive power of a prism.
5) Determination of wavelength of light using diffraction grating-minimum deviation method.
6) Determination of wavelength of light using diffraction grating-normal incidence method.
7) Resolving power of a telescope.
8) Refractive index of a liquid-hallow prism
9) Determination of thickness of a thin wire by wedge method
10) Determination of refractive index of liquid-Boy's method.

RECOMMENDED CO-CURRICULAR ACTIVITIES:

MEASURABLE

- Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
- Student seminars (on topics of the syllabus and related aspects (individual activity)
- Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams)

- Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity)

GENERAL:

- Group Discussion
- Visit to Research Stations/laboratories and related industries.

RECOMMENDED ASSESSMENT METHODS:

- Some of the following suggested assessment methodologies could be adopted;
- The oral and written examinations (Scheduled and surprise tests),
- Practical assignments and laboratory reports,
- Efficient delivery using seminar presentations,
- Viva voce interviews.

SEMESTER-II

I Year II Semester /II Semester

PRACTICAL-II:

R22NT211/ NTP1.2.3(21): CHEMISTRY LAB-II:

(VOLUMETRIC ANALYSIS)

SYLLABUS

University Exam: 3 hours Internal Marks: 15 University Examination Marks: 35

COURSE OUTCOMES:

At the end of the course, the student will be able to;

- Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
- Understand and explain the volumetric analysis based on fundamental concepts learnt in ionic equilibria
- Learn and identify the concepts of a standard solutions, primary and secondary standards
- Facilitate the learner to make solutions of various molar concentrations. This may include: The concept of the mole; Converting moles to grams; Converting grams to moles; Defining concentration; Dilution of Solutions; Making different molar concentrations.

VOLUMETRIC ANALYSIS 50 M

1) Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2) Determination of Fe (II) using $KMnO_4$ with oxalic acid as primary standard.
3) Determination of Cu (II) using $Na_2S_2O_3$ with $K_2Cr_2O_7$ as primary standard.
4) Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$
5) Determination of hardness of water

GRAVIMETRIC ANALYSIS (ANY THREE OF THE FOLLOWING)

1) Determination of barium as barium sulphate
2) Determination of nickel as NiDMG complex

RECOMMENDED CO-CURRICULAR ACTIVITIES:

MEASURABLE

- Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
- Student seminars (on topics of the syllabus and related aspects (individual activity).
- Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams)

- Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity)

GENERAL

- Group Discussion
- Visit to Research Stations/laboratories and related industries

RECOMMENDED ASSESSMENT METHODS:

Some of the following suggested assessment methodologies could be adopted;

- The oral and written examinations (Scheduled and surprise tests),
- Practical assignments and laboratory reports,
- Efficient delivery using seminar presentations,
- Viva voce interviews.

THIRD SEMESTER

M.Sc. NANOTECHNOLOGY

SEMESTER-III

II Year I Semester /III Semester

R22NT301 / NT 2.1.1 (21): A COURSE IN CONVERSATIONAL SKILLS

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can be able to speak fluently in English	2
CO-2	Students may able to participate confidently in any social interaction	2
CO-3	Students can face any professional discourse	3
CO-4	Students can analyze and demonstrate critical thinking	3
CO-5	Students can enhance conversational skills by observing the professional interviews	3

UNIT I **12 h**

Speech : 1. Tryst with Destiny Jawaharlal Nehru

Interview: 2.Dad's death changed my life Virat Kohli

Skills: 3. Greetings

4. Introductions

UNIT II **12 h**

Speech : 1. Yes, We Can Barack Obama

Interview : 2. A Leader Should Know How to Manage Failure Dr.A.P.J.Abdul Kalam/ India Knowledge at Wharton

Skills : 3. Requests

4. Invitations

UNIT III **12 h**

Interview : 1. Nelson Mandela's Interview With Larry King

Speech: 2. Malala Yousafzai nobel peace prize speech

Skills : 3. Asking and Giving Information

4. Agreeing and Disagreeing

UNIT IV **12 h**

Speech: 1. The Fringe benefits of failure and the importance of imagination J.K Rowling

Interview : 2. Job Interview Skills

Skills : 3. Dialogue Building

4. Giving Instructions/Directions

UNIT V **12 h**

Speech : 1. You've Got to Find What You Love Steve Jobs

Interview: 2. Shashi Tharoor interview with Sumanto Chattopadhyay

Skills : 3. Group Discussions

4. Descriptions

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	4	2
CO-2	2	2	3	2	3
CO-3	3	2	3	2	2
CO-4	2	3	2	3	3
CO-5	2	2	3	2	2

SEMESTER-III

II Year I Semester /III Semester

R22NT302/ NT 2.1.2 (21): INTRODUCTION TO PYTHON

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can able to Write, Test and Debug Python Programs	2
CO-2	Students may able to Implement Conditionals and Loops for Python Programs	2
CO-3	Students can able to Use functions and represent Compound data using Lists, Tuples and Dictionaries	3
CO-4	Students can able to Read and write data from & to files in Python and develop Application using Python	3
CO-5	Students can learn various Applications of python by OOPs	3

Unit I **12 h**

Introduction to Python: Introduction, Python Overview, Getting Started with Python, Comments, Python Identifiers, Reserved Keywords, Variables, Standard Data Types, Operators, Statement and Expression, String Operations, Boolean Expressions, Control Statements, Iteration – while Statement, Input from Keyboard.

Unit II **12 hrs**

Functions: Introduction, Built-in Functions, Composition of Functions, User Defined Functions, Parameters and Arguments, Function Calls, The return Statement, Python Recursive Function, The Anonymous Functions, Writing Python Scripts

Unit III **12 h**

Strings- compound data type, len function, String operations, **Lists** - Values and accessing elements, operations on lists, methods, **Tuples** - Creating Tuples, Accessing Values, Assignment, variable-length argument, functions works on Tuples, **Dictionaries** – Creating, Accessing, Updating, Deleting, properties, operations in Dictionary.

Unit IV **12 h**

Files and Exceptions - Text Files – Opening and Closing a File, File Attributes, Read and Write operations, Files Related Methods; Directories, Exceptions, Exception with Arguments, User-Defined Exceptions.

Unit V **12 h**

Overview of OOP (Object-Oriented Programming) - Class Definition, Creating Objects, Objects as Arguments, Objects as Return Values, Built-in Class Attributes, Inheritance, Method Overriding, Data Encapsulation, Data Hiding

REFERENCE BOOKS:

1) E Balagurusamy, "Introduction to Computing and Problem-Solving using Python", McGraw Hill Education.
2) Paul Barry, "Head –First Python", O'Reilly, 2nd Edition.
3) Eric Matthes, Python Crash Course - A Hands-On, Project-Based Introduction to Programming, 2nd Edition, No Starch Press

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	4	2
CO-2	2	2	3	2	3
CO-3	3	2	3	2	2
CO-4	2	3	2	3	3
CO-5	2	2	3	2	2

SEMESTER-III

II Year I Semester /III Semester

R22NT303/ NT 2.1.3 (21): MATHEMATICS-III (ABSTRACT ALGEBRA)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can able to Basic concepts from abstract algebra, especially the notion of a group. Acquire the basic knowledge and structure of groups, subgroups and cyclic groups.	1
CO-2	Students can Get the significance of the notation of normal subgroups. Get the behavior of permutations and operations on them.	2
CO-3	Students can Study the homomorphisms and isomorphisms with applications.	2
CO-4	Students can able to Understand the Group theory and to prove the theorems.	3
CO-5	Students can able to Understand the applications of Numerical Analysis in various fields.	3

UNIT – I **12 h**

GROUPS:

Binary Operation – Algebraic structure – semi group-monoid – Group definition and elementary properties Finite and Infinite groups – examples – order of a group, Composition tables with examples.

UNIT – II **12 h**

SUBGROUPS:

Complex Definition – Multiplication of two complexes Inverse of a complex-Subgroup definition- examples-criterion for a complex to be a sub-groups. Criterion for the product of two subgroups to be a subgroup-union and Intersection of subgroups.

Co-sets and Lagrange's Theorem:

Cosets Definition – properties of Cosets–Index of a subgroups of a finite groups–Lagrange's Theorem.

UNIT –III **12 h**

NORMAL SUBGROUPS:

Definition of normal subgroup – proper and improper normal subgroup–Hamilton group – criterion for a subgroup to be a normal subgroup – intersection of two normal subgroups – Sub group of index 2 is a normal sub group –quotient group – criteria for the existence of a quotient group.

HOMOMORPHISM:

Definition of homomorphism – Image of homomorphism elementary properties of homomorphism – Isomorphism – automorphism definitions and elementary properties–kernel of a homomorphism – fundamental theorem on Homomorphism and applications.

UNIT – IV **12 h**

PERMUTATIONS AND CYCLIC GROUPS:

Definition of permutation – permutation multiplication – Inverse of a permutation – cyclic permutations – transposition – even and odd permutations – Cayley's theorem.

CYCLIC GROUPS: - Definition of cyclic group – elementary properties – classification of cyclic groups.

UNIT – V **12 h**

NUMERICAL ANALYSIS-1:

The bisection method, Newton-Rapson method, forward differences, backward differences, and Newton's general interpolation. Squares curve fitting procedures, fitting a straight line

CO-CURRICULAR ACTIVITIES:

Seminar/ Quiz/ Assignments/ Group theory and its applications / Problem Solving.

TEXT BOOK:

1) A text book of Mathematics for B.A. / B.Sc. Vol. II by B.V.S.S. SARMA and others, published by S.Chand & Company, New Delhi.

REFERENCE BOOKS:

1) Abstract Algebra by J.B. Fraleigh, Published by Narosa publishing house.
2) Modern Algebra by M.L. Khanna.
3) Rings and Linear Algebra by Pundir & Pundir, published by Pragathi Prakashan.
4) Introductory Methods of Numerical Analysis by S.S.Sastry, Prentice Hall India (4^{th} Edition)
5) Operational Mathematics by R.V.Churchil, MeGraw Hill company.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	4	2
CO-2	2	2	3	2	3
CO-3	3	2	3	2	2
CO-4	2	3	2	3	3
CO-5	2	2	3	2	2

SEMESTER-III

II Year I Semester /III Semester

R22NT 304/ NT 2.1.4 (21): PHYSICS – III

(THERMODYNAMICS)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can able to Understand the basic aspects of kinetic theory of gases, Maxwell-Boltzmann distribution law, equipartition of energies, mean free path of molecular collisions and the transport phenomenon in ideal gases	1
CO-2	Students can able to Gain knowledge on the basic concepts of thermodynamics, the first and the second law of thermodynamics, the basic principles of refrigeration, the concept of entropy, the thermodynamic potentials and their physical interpretations.	2
CO-3	Students can able to Understand the working of Carnot's ideal heat engine, Carnot cycle and its efficiency. Develop critical understanding of concept of Thermodynamic potentials, the formulation of Maxwell's equations and its applications.	2
CO-4	Students can able to Differentiate between principles and methods to produce low temperature and liquefy air and also understand the practical applications of substances at low temperatures.	3
CO-5	Students may Examine the nature of black body radiations and the basic theories.	3

UNIT-I: Kinetic Theory of gases: 12 h

Kinetic Theory of gases-Introduction, Maxwell's law of distribution of molecular velocities (qualitative treatment only) and its experimental verification, Mean free path, Degrees of freedom, Principle of equipartition of energy (Qualitative ideas only), Transport phenomenon in ideal gases: viscosity, Thermal conductivity and diffusion of gases.

UNIT-II: Thermodynamics: 12h

Introduction- Isothermal and Adiabatic processes, Reversible and irreversible processes, Carnot's engine and its efficiency, Carnot's theorem, Thermodynamic scale of temperature and its identity with perfect gas scale, Second law of thermodynamics: Kelvin's and Clausius statements, Principle of refrigeration, Entropy, Physical significance, Change in entropy in reversible and irreversible processes; Entropy and disorder-Entropy of Universe; Temperature-Entropy (T-S) diagram and its uses ; change of entropy when ice changes into steam.

UNIT-III: Thermodynamic Potentials and Maxwell's equations: 12h)

Thermodynamic potentials-Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy and their significance, Derivation of Maxwell's thermodynamic relations from thermodynamic potentials, Applications to (i) Clausius-Clayperon's equation (ii) Value of CP- CV (iii) Value of CP/CV (iv) Joule-Kelvin coefficient for ideal and Van der Waals' gases

UNIT-IV: Low temperature Physics: 12 h

Methods for producing very low temperatures, Joule Kelvin effect, Porous plug experiment, Joule expansion, Distinction between adiabatic and Joule Thomson expansion, Expression for Joule Thomson cooling, Liquefaction of air by Linde's method, Production of low temperatures by adiabatic demagnetization (qualitative), Practical applications of substances at low temperatures.

UNIT-V: Quantum theory of radiation: 12 h

Blackbody and its spectral energy distribution of black body radiation, Kirchoff's law, Wein's displacement law, Stefan-Boltzmann's law and Rayleigh-Jean's law (No derivations), Planck's law of black body radiation-Derivation, Deduction of Wein's law and Rayleigh-Jean's law from Planck's law, Solar constant and its determination using Angstrom pyroheliometer, Estimation of surface temperature of Sun.

REFERENCE BOOKS:

1) BSc Physics, Vol.2, Telugu Akademy, Hyderabad
2) Thermodynamics, R.C.Srivastava, S.K.Saha&AbhayK.Jain, Eastern Economy Edition.
3) Unified Physics Vol.2, Optics & Thermodynamics, Jai PrakashNath&Co.Ltd., Meerut
4) Fundamentals of Physics. Halliday/Resnick/Walker.C. Wiley India Edition 2007
5) Heat and Thermodynamics -N BrijLal, P Subrahmanyam, S.Chand& Co.,2012
6) Heat and Thermodynamics- MS Yadav, Anmol Publications Pvt. Ltd, 2000
7) University Physics, HD Young, MW Zemansky,FW Sears, Narosa Publishers, New Delhi

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	2	4	2
CO-2	2	2	2	2	2
CO-3	2	2	3	2	2
CO-4	2	3	2	3	3
CO-5	2	2	3	2	2

SEMESTER-III

II Year I Semester /III Semester

R22NT301/ NT 2.1.5 (21): CHEMISTRY-III (ORGANIC & INORGANIC CHEMISTRY)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students may be understand and apply the concept of aromaticity, basic aromatic electrophilic substitution reactions, influence of substituents	1
CO-2	Students can learn and identify many organic reaction mechanisms of alkyl halides and alcohols	2
CO-3	Students can analyze and demonstrate the carbonyl chemistry with FGI, reactions and their mechanism	3
CO-4	Students can understand and analyze the concepts of nuclear chemistry, nuclear reactions, nuclear decay	2
CO-5	Students can gain knowledge in Colloids, HSAB principle, symmetry elements, point groups and their applications	2

Organic Chemistry-I **36 h**

UNIT-I **12 h**

Benzene and its reactivity

Concept of aromaticity, Huckel's rule - application to Benzenoid (Benzene, Naphthalene) and Non - Benzenoid compounds (cyclopropenylcation, cyclopentadienyl anion and tropylium cation)

Reactions - General mechanism of electrophilic aromatic substitution, mechanism of nitration, Friedel- Craft's alkylation and acylation. Orientation of aromatic substitution - ortho, para and meta directing groups. Ring activating and deactivating groups with examples (Electronic interpretation of various groups like NO_2 and Phenolic). Orientation of (i) Amino, methoxy and methyl groups (ii) Carboxy, nitro, nitrile, carbonyl and sulphonic acid groups

(iii) Halogens (Explanation by taking minimum of one example from each type)

UNIT – II **12 h**

1. Chemistry of Halogenated Hydrocarbons:

Alkyl halides: Methods of preparation, nucleophilic substitution reactions– S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects; nucleophilic substitution vs. elimination.

Aryl halides: Preparation (including preparation from diazoniumsalts), nucleophilic aromatic substitution; S_NAr, Benzyne mechanism.

2. Alcohols & Phenols

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt Blanc Reduction; Oxidation of diols by periodic acid and lead tetraacetate, Pinacol- Pinacolone rearrangement;

Phenols: Preparation, Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

UNIT-III **12 h**

Carbonyl Compounds

Nomenclature of various carbonyl functional groups with 5 examples for each. Keto-enol tautomerism.

Structure, reactivity and preparation of aldehydes and ketones, Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives

Mechanisms of Aldol and Benzoin condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann haloform reaction and Baeyer-Villiger oxidation, α- substitution reactions, Clemmensen, wolf –kishner reductions and reduction with $LiAlH_4$ & $NaBH_4$).

Addition reactions of α,β-unsaturated carbonyl compounds: Michael addition.

UNIT-IV **12 h**

Nuclear Chemistry

Introduction, forces in the nucleus, N/P ratio, modes of decay, half-life period, nuclear binding energy, radio activity and nuclear reactions, nuclear fission and fusion, separation of isotopes and applications of isotopes

UNIT-V **12h**

Colloids- Coagulation of colloids- Hardy-Schulze rule. Stability of colloids, Protection of Colloids, Gold number.

Hard and soft acids bases (HSAB):

Classification, Pearson's concept of hardness and softness, application of HSAB principles – Stability of compounds / complexes, predicting the feasibility of a reaction.

Molecular symmetry

Concept of symmetry in chemistry symmetry operations, symmetry elements. Rotational axis of symmetry and types of rotational axes. Planes of symmetry and types of planes. Improper rotational axis of symmetry. Inversion centre. Identity element. The symmetry operations of a molecule form a group. Flow chart for the identification of molecular point group.

REFERENCE BOOKS:

1) Organic Chemistry by P. Y. Bruice
2) Organic Chemistry by Francis A Carey
3) Organic Chemistry by Ege
4) Physical chemistry A molecular approach by Donald A. Mcquarrie and John D. Simon.

5) Physical chemistry by Puri & Sharma
6) Concise Inorganic Chemistry by J. D. Lee
7) Basic Inorganic Chemistry by Cotton and Wilkinson

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	3	2
CO-2	3	2	3	2	2
CO-3	2	2	3	2	2
CO-4	2	3	2	3	3
CO-5	3	2	3	2	2

SEMESTER-III

II Year I Semester /III Semester

PRACTICAL-I:

R22NT309/ NTP 2.1.1(21): COMPUTER LAB-II:

(INTRODUCTION TO PYTHON)

University Exam: 3 hours Internal Marks: 15 University Examination Marks: 35

SYLLABUS:

1) Write a program to demonstrate different number data types in Python.
2) Write a program to perform different Arithmetic Operations on numbers in Python
3) Write a program to create, concatenate and print a string and accessing sub-string from a given string.
4) Write a program to print the current date in the following format "Wed September 28 02:26:23 IST 2021"
5) Write a program to create, append, and remove lists in python
6) Write a program to demonstrate working with tuples in python
7) Write a program to demonstrate working with dictionaries in python
8) Write a python program to find largest of three numbers
9) Write a program to transpose a matrix.
10) Write a Python script that prints prime numbers less than n
11) Write a python program to find factorial of a number using Recursion
12) Write a function which accepts two numbers and returns their sum.
13) Write a Python Program that demonstrates the built-in functions
14) Write a script named copy2file.py. This script should prompt the user for the names of two text files. The contents of the first file should be input and written to the second file.
15) Write a program to catch on Divide by zero Exception. Add a finally block too.
16) Write a Python program to demonstrate classes and their attributes
17) Write a Python program to demonstrate multiple inheritances
18) Write a program that defines a class named Employee. Define two subclasses: Engineer and Manager. Every class should have a method named print Designation() that prints Engineer for Engineer class and Manager for Manager class.

SEMESTER-III

II Year I Semester /III Semester

PRACTICAL-II:

R22NT310/ NTP2.1.2(21): PHYSICS LAB-III: (THERMODYNAMICS)

University Exam: 3 Internal Marks: 15 University Examination Marks: 35

COURSE OUTCOMES:

On successful completion of this practical course, the student will be able to;

- Perform some basic experiments in thermal Physics, viz., determinations of Stefan's constant, coefficient of thermal conductivity, variation of thermo-emf of athermocouple with temperature difference at its two junctions, calibration of a thermocouple and Specific heat of a liquid.

MINIMUM OF 6 EXPERIMENTS TO BE DONE AND RECORDED

1) Specific heat of a liquid –Joule's calorimeter –Barton's radiation correction
2) Thermal conductivity of bad conductor-Lee's method
3) Thermal conductivity of rubber.
4) Measurement of Stefan's constant.
5) Specific heat of a liquid by applying Newton's law of cooling correction.
6) Heating efficiency of electrical kettle with varying voltages.
7) Thermo emf- thermo couple - Potentiometer
8) Thermal behavior of an electric bulb (filament/torch light bulb)
9) Measurement of Stefan's constant- emissive method
10) Study of variation of resistance with temperature - Thermistor.

RECOMMENDED CO-CURRICULAR ACTIVITIES:

MEASURABLE

- Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
- Student seminars (on topics of the syllabus and related aspects (individual activity))
- Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams)
- Field studies (individual observations and recordings as per syllabus content and related areas (Individual or team activity)
- Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity)

GENERAL

- Group Discussion
- Visit to Research Stations/laboratories and related industries
- Others

RECOMMENDED ASSESSMENT METHODS:

Some of the following suggested assessment methodologies could be adopted;

- The oral and written examinations (Scheduled and surprise tests),
- Problem-solving exercises,
- Efficient delivery using seminar presentations,
- Viva voce interviews.

SEMESTER-III

II Year I Semester /III Semester

PRACTICAL-III:

R22NT311/NTP 2.1.3(21): CHEMISTRY LAB-III

(ORGANIC QUALITATIVE ANALYSIS AND CHROMATOGRAPHY)

University Exam: 3 hours **Internal Marks: 15** **University Examination Marks: 35**

COURSE OUTCOMES:

At the end of the course, the student will be able to;

- Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
- Determine melting and boiling points of organic compounds
- Understand the application of concepts of different organic reactions studied in theory part of organic chemistry

ORGANIC QUALITATIVE ANALYSIS 40 M

Analysis of an organic compound through systematic qualitative procedure for functional group identification including the determination of melting point and boiling point with suitable derivatives.

Alcohols, Phenols, Aldehydes, Ketones, Carboxylic acids, Aromatic primary amines, amides and simple sugars

BASIC PRINCIPLES OF CHROMATOGRAPHY TECHNIQUES 10 M

1) **Paper Chromatography:** separation of colours
2) **Thin Layer Chromatography:** separation of amino acids, o- and p-nitrophenol
3) **Column Chromatography:** separation of amino acids, o- and p-nitrophenol

RECOMMENDED CO-CURRICULAR ACTIVITIES:

MEASURABLE

- Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
- Student seminars (on topics of the syllabus and related aspects (individual activity))
- Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams)
- Field studies (individual observations and recordings as per syllabus content and related areas (Individual or team activity)

- Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity)

GENERAL

- Group Discussion
- Visit to Research Stations/laboratories and related industries
- Others

RECOMMENDED ASSESSMENT METHODS:

Some of the following suggested assessment methodologies could be adopted;

- The oral and written examinations (Scheduled and surprise tests),
- Practical assignments and laboratory reports,
- Observation of practical skills,
- Efficient delivery using seminar presentations,
- Viva voce interviews.

FOURTH SEMESTER

M.Sc. NANOTECHNOLOGY

SEMESTER-IV

II Year II Semester /IV Semester

R22NT401/ NT 2.2.1 (21): MATHEMATICS-IV (REAL ANALYSIS)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can Get a clear idea about the real numbers and real valued functions.	2
CO-2	Students may Obtain the skills of analyzing the concepts and applying appropriate methods for testing convergence of a sequence or series.	2
CO-3	Students may able to Test the continuity and differentiability of the function	2
CO-4	Students can able to Test the Riemann integration of a function.	3
CO-5	Students can learn and Know the geometrical interpretation of mean value theorems.	3

UNIT – I **12 h**

REAL NUMBERS:

The algebraic and order properties of R, Absolute value and Real line, Completeness property of R, Applications of supremum property; intervals. (No question is to be set from this portion).

Real Sequences:

Sequences and their limits, Range and Boundedness of Sequences, Limit of a sequence and Convergent sequence. The Cauchy's criterion, properly divergent sequences, Monotone sequences, Necessary and Sufficient condition for Convergence of Monotone Sequence, Limit Point of Sequence, Subsequences and the Bolzano-weierstrass theorem – Cauchy Sequences – Cauchy's general principle of convergence theorem.

UNIT –II **12 h**

INFINITE SERIES:

Series: Introduction to series, convergence of series. Cauchy's general principle of convergence for series tests for convergence of series, Series of Non-Negative Terms.

1) P-test
2) Cauchy's nth root test or Root Test.
3) D'-Alemberts' Test or Ratio Test.
4) Alternating Series – Leibnitz Test.
5) Absolute convergence and conditional convergence.

UNIT – III **12 h**

CONTINUITY:

Limits: Real valued Functions, Boundedness of a function, Limits of functions. Some extensions of the limit concept, Infinite Limits. Limits at infinity. (No question is to be set from this portion).

Continuous functions: Continuous functions, Combinations of continuous functions, Continuous Functions on intervals, uniform continuity.

UNIT – IV **12 h**

DIFFERENTIATION AND MEAN VALUE THEORMS:

The derivability of a function, on an interval, at a point, Derivability and continuity of a function, Graphical meaning of the Derivative, Mean value Theorems; Rolle's Theorem, Lagrange's Theorem, Cauchy's Mean value Theorem

UNIT – V **12 h**

NUMERICAL ANALYSIS-2:

Nonlinear curve fitting, Curve fitting by a sum of exponentials. Trapezoidal rule, Simpson's 1/3 & 3/8 rules.

CO-CURRICULAR ACTIVITIES:

Seminar/ Quiz/ Assignments/ Real Analysis and its applications / Problem Solving.

REFERENCE BOOKS:

1) Introduction to Real Analysis by Robert G. Bartle and Donlad R. Sherbert, published by John Wiley.
2) A Text Book of B. Sc Mathematics by B.V.S.S. Sarma and others, published by S. Chand & Company Pvt. Ltd., New Delhi.
3) Elements of Real Analysis as per UGC Syllabus by Shanthi Narayan and Dr. M.D. Raisinghania, published by S. Chand & Company Pvt. Ltd., New Delhi.
4) Introductory Methods of Numerical Analysis by S.S. Sastry, Prentice Hall India (4th Edition)
5) Operational Mathematics by R.V. Churchil, MeGraw Hill company.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

Cos	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	2	2
CO-2	2	2	3	2	3
CO-3	2	2	3	2	2
CO-4	2	2	2	3	2
CO-5	2	2	3	2	2

SEMESTER-IV

II Year II Semester /IV Semester

R22NT402 / NT2.2.2 (21): MATHEMATICS-V

(LINEAR ALGEBRA)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must understand the concepts of vector spaces, subspaces, basises, dimension and their properties	1
CO-2	Students must understand the concepts of linear transformations and their properties	2
CO-3	Students must understand the concepts of Characteristic equations, Characteristic Values & Vectors of square matrix and their properties	2
CO-4	Students must analyze and apply Cayley- Hamilton theorem to problems for finding the inverse of a matrix and higher powers of matrices without using routine methods	3
CO-5	Students must analyze and apply tensor analysis in some of the physics Related Formulas	3

UNIT – I Vector Spaces-I: 12 h

Vector Spaces, General properties of vector spaces, n-dimensional Vectors, addition and scalar multiplication of Vectors, internal and external composition, Null space, Vector subspaces, Algebra of subspaces, Linear Sum of two subspaces, linear combination of Vectors, Linear span Linear independence and Linear dependence of Vectors.

UNIT –II Vector Spaces-II: 12 h

Basis of Vector space, Finite dimensional Vector spaces, basis extension, co-ordinates, Dimension of a Vector space, Dimension of a subspace, Quotient space and Dimension of Quotient space.

UNIT –III Linear Transformations: 12 h

Linear transformations, linear operators, Properties of L.T, sum and product of LTs, Algebra of Linear Operators, Range and null space of linear transformation, Rank and Nullity of linear transformations – Rank – Nullity Theorem.

UNIT –IV Matrix: 12 h

Matrices, Elementary Properties of Matrices, Inverse Matrices, Rank of Matrix, Linear Equations, Characteristic equations, Characteristic Values & Vectors of square matrix, Cayley – Hamilton Theorem.

UNIT –V Tensor Analysis: 12 h

Introduction, Transformation of Co-ordinates, Contravariant, Covariant and Mixed tensors, Addition and multiplication of tensors, contraction and Quotient Law. The line element, fundamental tensors.

CO-CURRICULAR ACTIVITIES:

Seminar/ Quiz/ Assignments/ Linear algebra and its applications / Problem Solving.

REFERENCE BOOKS:

1) Linear Algebra by J.N. Sharma and A.R. Vasista, published by Krishna Prakashan Mandir, Meerut- 250002.
2) Matrices by Shanti Narayana, published by S.Chand Publications.
3) Linear Algebra by Kenneth Hoffman and Ray Kunze, published by Pearson Education
4) (low priced edition), New Delhi.
5) Linear Algebra by Stephen H. Friedberg et. al. published by Prentice Hall of India Pvt. Ltd. 4th Edition, 2007.
6) Matrices and Tensors for Physicists by A W. Joshi

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	2	2
CO-2	2	2	3	2	3
CO-3	2	2	3	2	2
CO-4	2	3	2	3	2
CO-5	2	2	3	2	2

SEMESTER-IV

II Year II Semester /IV Semester

R22NT403 / NT2.2.3 (21): PHYSICS –IV

(ELECTRICITY, MAGNETISM AND ELECTRONICS)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can able to Understand the Gauss law and its application to obtain electric field in different cases and formulate the relationship between electric displacement vector, electric polarization, Susceptibility, Permittivity and Dielectric constant.	1
CO-2	Students learn and Distinguish between the magnetic effect of electric current and electromagnetic induction and apply the related laws in appropriate circumstances.	2
CO-3	Students can analyze and Understand Biot and Savart's law and Ampere's circuital law to describe and explain the generation of magnetic fields by electrical currents.	3
CO-4	Students can Develop an understanding on the unification of electric and magnetic fields and Maxwell's equations governing electromagnetic waves. Phenomenon of resonance in LCR AC-circuits, sharpness of resonance, Q- factor, Power factor and the comparative study of series and parallel resonant circuits.	2
CO-5	Students can be able to Describe the operation of p-n junction diodes, zener diodes, light emitting diodes and transistors. Understand the operation of basic logic gates and universal gates and their truth tables.	3

UNIT-I

1. Electrostatics: 6 h

Gauss's law-Statement and its proof, Electric field intensity due to (i) uniformly charged solid sphere and (ii) an infinite conducting sheet of charge, Deduction of Coulomb's law from Gauss law, Electrical potential–Equipotential surfaces, Potential due to a (i) dipole (ii)uniformly charged sphere

2. Dielectrics: 6 h

Dielectrics-Polar and Non-polar dielectrics- Effect of electric field on dielectrics,Dielectric strength, Capacitance of a parallel plate condenser with dielectric slab between the plates, Electric displacement D, electric polarization P,Relation between D, E and P, Dielectric constant and electric susceptibility.

UNIT-II

3. Magnetostatics: 6 h

Biot-Savart's law and its applications: (i) circular loop and (ii) solenoid, Divergence and curl of magnetic field, Ampere's Circuital Law and its application to Solenoid, Hall effect, determination of Hall coefficient and applications.

4. Electromagnetic Induction: 6 h

Faraday's laws of electromagnetic induction, Lenz's law, Self induction and Mutual induction, Self inductance of a long solenoid, Mutual inductance of two coils, Energy stored in magnetic field, Eddy currents and Electromagnetic damping

UNIT-III

5. Alternating currents: 6 h

Alternating current - Relation between current and voltage in LR and CR circuits, Phasor and Vector diagrams, LCR series and parallel resonant circuit, Q –factor, Power in ac circuits, Power factor.

6. Electromagnetic waves-Maxwell's equations: 6 h

Idea of displacement current, Maxwell's equations-Derivation, Maxwell's wave equation (with derivation), Transverse nature of electromagnetic waves, Poynting theorem (Statement and proof)

UNIT-IV

7. Basic Electronic devices: 12 h

PN junction diode, Zenerdiode andLight Emitting Diode (LED) and their I-V characteristics, Zener diode as a regulator- Transistors and its operation, CB, CE and CC configurations, Input and output characteristicsofa transistor in CE mode, Relation between alpha, beta and gamma; Hybrid parameters, Determination of hybrid parameters from transistor characteristics; Transistor as an amplifier.

UNIT-V:

8. Digital Electronics: 12 h

Number systems, Conversion of binary to decimal system and vice versa, Binary addition & Binary subtraction (1's and 2's complement methods), Laws of Boolean algebra, DeMorgan's laws-Statements and Proofs, Basic logic gates, NAND and NOR as universal gates, Exclusive-OR gate, Half adder and Full adder circuits.

REFERENCE BOOKS:

1) BSc Physics, Vol.3, Telugu Akademy, Hyderabad.
2) Electricity and Magnetism, D.N. Vasudeva. S. Chand & Co.
3) Electricity and Magnetism, B.D.Duggal and C.L.Chhabra. Shobanlal& Co.
4) Electricity, Magnetism with Electronics, K.K.Tewari, R.Chand& Co.,
5) Electricity and Magnetism, R.Murugeshan, S. Chand & Co.
6) Principles of Electronics, V.K. Mehta, S.Chand& Co.,
7) Digital Principles and Applications, A.P. Malvino and D.P.Leach, McGrawHill Edition.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
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CO-1	3	2	3	4	2
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CO-4	2	2	2	3	2
CO-5	3	2	3	2	2

SEMESTER-IV

II Year II Semester /IV Semester

R22NT404 / NT 2.2.4 (21): PHYSICS –IV (MODERN PHYSICS)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can Develop an understanding of the concepts of Atomic and Modern Physics, basic elementary quantum mechanics and nuclear physics. Develop critical understanding of the concept of Matter waves and Uncertainty principle.	2
CO-2	Students can understand and get familiarized with the principles of quantum mechanics and the formulation of Schrodinger wave equation and its applications.	2
CO-3	Students can able to Examine the basic properties of nuclei, characteristics of Nuclear forces, salient features of Nuclear models and different nuclear radiation detectors.	3
CO-4	Studnets can be able to understand and learn the classification of Elementary particles based on their mass, charge, spin, half life and interaction. Get familiarized with the nano materials, their unique properties and applications.	3
CO-5	Students can understand and Increase the awareness and appreciation of superconductors and their practical applications.	3

UNIT-I:

1. Atomic and Molecular Physics: 12 h

Vector atom model and Stern-Gerlach experiment, Quantum numbers associated with it, Angular momentum of the atom, Coupling schemes, Spectral terms and spectral notations, Selection rules, Intensity rules, Fine structure of Sodium D-lines, Zeeman effect, Experimental arrangement to study Zeeman effect; Raman effect, Characteristics of Raman effect, Experimental arrangement to study Raman effect, Quantum theory of Raman effect, Applications of Raman effect.

UNIT-II:

2. Matter waves & Uncertainty Principle: 12 h

Matter waves, de Broglie's hypothesis, Wave length of matter waves, Properties of matter waves, Davisson and Germer's experiment, Phase and group velocities, Heisenberg's uncertainty principle for position and momentum& energy and time, Illustration of uncertainty principle using diffraction of beam of electrons (Diffraction by a single slit) and photons (Gamma ray microscope), Bohr's principle of complementarily.

UNIT-III:

3. Quantum (Wave) Mechanics: 12 h

Basic postulates of quantum mechanics, Schrodinger time independent and time dependent wave equations-Derivations, Physical interpretation of wave function, Eigen functions, Eigen values, Application of Schrodinger wave equation to (i) one dimensional potential box of infinite height (Infinite Potential Well) and (ii) one dimensional harmonic oscillator.

UNIT-IV:

4. Nuclear Physics: 12 h

Nuclear Structure: General Properties of Nuclei, Mass defect, Binding energy; *Nuclear forces*: Characteristics of nuclear forces- Yukawa's meson theory; *Nuclear Models*: Liquid drop model, The Shell model, Magic numbers; *Nuclear Radiation detectors*: G.M. Counter, Cloud chamber, Solid State detector; *Elementary Particles*: Elementary Particles and their classification

UNIT-V:

5. Nano materials: 7 h

Nano materials – Introduction, Electron confinement, Size effect, Surface to volume ratio, Classification of nano materials– (0D, 1D, 2D); Quantum dots, Nano wires, Fullerene, CNT, Graphene (Mention of structures and properties), Distinct properties of nano materials (Mention-*mechanical, optical, electrical, and magnetic properties*); Mention of applications of nano materials: (*Fuel cells, Phosphors for HD TV, Next Generation Computer chips, elimination of pollutants, sensors*)

6. Superconductivity: 5 h

Introduction to Superconductivity, Experimental results-critical temperature, critical magnetic field, Meissner effect, Isotope effect, Type I and Type II superconductors, BCS theory (elementary ideas only), Applications of superconductors

REFERENCE BOOKS:

1) BSc Physics, Vol.4, Telugu Akademy, Hyderabad
2) Atomic Physics by J.B. Rajam; S. Chand& Co.,
3) Modern Physics by R. Murugeshan and Kiruthiga Siva Prasath. S. Chand & Co.
4) Concepts of Modern Physics by Arthur Beiser. Tata McGraw-Hill Edition.
5) Nuclear Physics, D.C. Tayal, Himalaya Publishing House.
6) S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publ. Co.)
7) K.K. Chattopadhyay & A.N. Banerjee, Introd.to Nanoscience and Technology (PHI Learning Priv. Limited).
8) Nano materials, A K Bandopadhyay. New Age International Pvt Ltd (2007)
9) Textbook of Nanoscience and Nanotechnology, BS Murthy, P Shankar, Baldev Raj, BB Rath and J Murday-Universities Press-IIM

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
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CO-1	2	2	3	4	2
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CO-4	2	2	2	3	2
CO-5	2	2	3	2	2

SEMESTER-IV

II Year II Semester /IV Semester

R22NT405/ NT 2.2.5 (21): CHEMISTRY-IV

(INORGANIC AND PHYSICAL CHEMISTRY)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must understand the concept of coordination compounds, their structure and stereochemistry predictions, properties and reactions	2
CO-2	Students must grasp the reactions mechanisms and spectral properties of coordination compounds	2
CO-3	Students must develop a solid understanding of basic knowledge in bioinorganic chemistry and oxygen transportation phenomenon	2
CO-4	Students must understand and solve the problems in catalysis, enzyme catalysis and photochemistry	3
CO-5	Students must gain knowledge in phase analysis and purification of mixtures of metals from molten metals with solid phases and apply them in research	3

Inorganic Chemistry-3

UNIT-I: Coordination Chemistry: 12 h

IUPAC nomenclature, Structural and stereoisomerism in coordination complexes with 4 and 6 coordination numbers. Werner's theory and Sidgwick's concept, Valence bond theory, Inner and outer orbital complexes, its limitations, crystal field theory, splitting of d-orbital in octahedral and tetrahedral symmetry, low spin and high spin complexes, factors affecting crystal-field splitting energy, tetragonal distortion of octahedral complexes, square-planar complexes, Jahn-Teller distortion

UNIT-II: Spectral and magnetic properties of metal complexes: 12 h

Types of magnetic behavior, spin-only formula, calculation of magnetic moments, experimental determination of magnetic susceptibility – Gouy method.

Reactivity of metal complexes:

Labile and inert complexes, ligand substitution reaction s – S_N^1 and S_N^2, substitution reactions in square planar complexes – Trans effect and its applications.

Stability of metal complexes:

Thermodynamic stability and kinetic, stability, factors affecting the stability of metal complexes, chelate effect, determination of composition of complex by Job's method

Electronic spectra of coordination complexes

Spitting of d-terms in octahedral field, Selection rules, Orgel diagram, Charge transfer spectra.

UNIT-III: Bioinorganic chemistry: 12 h

Essential elements, biological significance of Na, K, Mg, Ca, Fe, Co, Ni, Cu, Zn and chloride, Toxicity of Hg, Pb, Cd and As ions, use of chelating agents in medicine.

Metalloporphyrins – dioxygen binding and transportation, hemoglobin, structure and function, the physiology of hemoglobin and myoglobin, Chlorophyll, structure and role in photosynthesis, rubredoxin, ferredoxin models.

Physical Chemistry-3

Unit IV: Enzyme catalysis: 12 h

Catalysis introduction, Nomenclature and Classification of enzymes, characteristics of enzyme catalysis (specificity, inhibitors, lock & key model). Kinetics of enzyme catalyzed reactions Michaelis Menton law, significance of Michaelis constant (Km) and maximum velocity (Vmax). Factors effecting enzyme catalysis effect of temperature, pH, concentration and inhibitor.

Photochemistry:

Difference between thermal and photochemical processes. Laws of photochemistry – Draper's law and Stark – Einstein's law of photochemical equivalence, Quantum yield. Photochemical hydrogen – chlorine, hydrogen – bromine reactions, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing). Photosensitized reactions – energy transfer processes (simple example).

UNIT-V: Phase rule: 12 h

Concept of phase, components, degrees of freedom. Thermodynamic derivation of Gibbs phase rule. Phase diagram of one component system - water system, Study of Phase diagrams of Simple eutectic systems i) Pb-Ag system, desilverisation of lead ii) NaCl-Water system, Congruent and incongruent melting point- Definition and examples for systems having congruent and incongruent melting point, freezing mixtures. three component solid-liquid systems.

Surface Chemistry: Adsorption, Physical and chemical adsorption, Freundlich, Langmuir adsorption isotherms. Applications of isotherms.

REFERENCE BOOKS:

1) Physical chemistry A molecular approach by Donald A. Mcquarrie and John D. Simon.
2) Physical chemistry by Puri, Sharma, Pathania
3) Physical chemistry by Peter Atkins, Julio D. Paula
4) Chemical Kinetics by K J Laidler
5) Physical Chemistry by K L Kapoor, Volumes 1-5.
6) Concise Inorganic Chemistry by J.D.Lee
7) Basic Inorganic Chemistry by Cotton and Wilkinson
8) Inorganic Chemistry by J.E.Huheey

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	2	2
CO-2	2	2	3	2	3
CO-3	2	2	3	2	3
CO-4	2	2	2	3	2
CO-5	2	2	3	2	2

SEMESTER-IV

II Year II Semester /IV Semester

R22NT406/ NT 2.2.6 (21): CHEMISTRY-V

(MOLECULAR SPECTROSCOPY)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must understand the nature of electromagnetic radiation, different spectroscopic techniques for the characterization of materials.	1
CO-2	Students must understand the fundamental and physical concepts associated with rotational, vibrational and electronic spectroscopic techniques	2
CO-3	Students must able to analyze and demonstrate structure and composition of inorganic compounds using Raman, Mossbauer, XPS and ESR spectroscopic techniques.	2
CO-4	Students must practice the spectroscopic knowledge in solving the structure of molecules	3
CO-5	Students must able to analyze and apply the spectroscopic knowledge in solving the structure of molecules in real time research	3

UNIT – I: 12 h

Nature of electromagnetic radiation, Interaction of electromagnetic radiation with molecules and various types of spectra; width of spectral lines, intensity of spectral lines,

Rotational (microwave) spectroscopy: Rotation of molecules (linear molecules, symmetric, spherical and asymmetric tops), Selection rules (active and non-active molecules)

Rotational spectra of diatomic molecules: Rigid diatomic molecules, intensities of spectral lines, effect of isotopic substitution, non-rigid rotator

Rotational spectra of polyatomic molecules: linear molecules, symmetric top molecules

determination of bond lengths of diatomic and linear triatomic molecules,

UNIT-II: Vibrational spectroscopy 12 h

Energy levels of simple harmonic oscillator, molecular vibration spectrum, selection rules. Determination of force constant. Qualitative relation of force constant to bond energies.

Anharmonic motion of real molecules and energy levels.

Diatomic vibrating rotator, vibration-rotation spectrum of CO, breakdown of Born-Oppenheimer approximation

Modes of vibrations in polyatomic molecules, modes of vibrations in H_2O, CO_2 and selection rules.

Characteristic absorption bands of various functional groups. Finger print nature of infrared spectrum, sample preparation and instrumentation

UNIT-III: Raman and Mossbauer Spectroscopy **12 h**

Raman: Concept of polarizability, Quantum and classical theories of Raman effect.

Pure rotational spectra of linear molecules, symmetric, spherical and asymmetric tops.

Vibrational Raman spectra, Raman active vibrations of H_2O and CO_2 and rule of mutual exclusion, selection rules, instrumentation.

Mossbauer: Mossbauer Effect, Recoil less Emission and Absorption, The Mossbauer spectrometer, Experimental Methods, Chemical shift, Magnetic Hyperfine interactions.

UNIT-IV: Electronic Spectroscopy **12 h**

Electronic spectroscopy of atoms: electronic wave function, hydrogen atom spectrum, electronic angular momentum, fine structure of hydrogen atom, spectrum of lithium and hydrogen like species, angular momentum of many electron atoms, term symbols.

Franck-Condon principle, concept of dissociation energy, spectrum of hydrogen molecule.

Photoelectron spectroscopy-UPES, XPES introduction only

UNIT-V: ESR Spectroscopy **12 h**

Principles, theory, instrumentation, hyperfine interactions, factors influencing g value, determination of 'g' value, applications-structure determination of free radicals, organic free radicals, inorganic ions.

REFERENCE BOOKS:

1) Fundamentals of Molecular Spectroscopy by C. N. Banwell and E. M. McCash
2) R. Sindhu, Molecular Spectroscopy, Tata McGraw Hill, 1986
3) J. D. Graybeal, Molecular Spectroscopy, Mc-Graw Hill, 1988
4) G. M. Barrow, Introduction to Molecular Spectroscopy, Mc-Graw Hill, 1964

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	3	2
CO-2	2	2	3	2	3
CO-3	2	2	3	2	3
CO-4	2	2	2	3	2
CO-5	2	2	3	2	2

SEMESTER-IV

II Year II Semester /IV Semester

PRACTICAL-I:

R22NT407/NTP 2.2.1 (21): MATHEMATICS LAB-I

University Exam: 3 hours Internal Marks: 15 University Examination Marks: 35

COURSE OUTCOME:

After completion of this course, student will get an idea about writing the proof of a theorem and solution of various problems

SOLUTION OF THEOREMS AND PROBLEM SOLVING ON THE FOLLOWING CONCEPTS:

1) Real Sequences
2) Infinite Series
3) Continuous Functions
4) Mean Value Theorems
5) Numerical Analysis
6) Vector Spaces
7) Linear Transformations
8) Matrix Form of Linear Transformations

RECOMMENDED CO-CURRICULAR ACTIVITIES:

MEASURABLE

1) Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
2) Student seminars (on topics of the syllabus and related aspects (individual activity))
3) Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams)
4) Field studies (individual observations and recordings as per syllabus content and related areas (Individual or team activity)
5) Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity)

GENERAL

1) Group Discussion
2) Visit to Research Stations/laboratories and related industries
3) Others

RECOMMENDED ASSESSMENT METHODS:

- Some of the following suggested assessment methodologies could be adopted;
- The oral and written examinations (Scheduled and surprise tests),
- Practical assignments and laboratory reports,
- Observation of practical skills,
- Efficient delivery using seminar presentations,
- Viva voce interviews.

SEMESTER-IV

II Year II Semester /IV Semester

PRACTICAL-II:

R22NT408/NTP 2.2.2 (21): PHYSICS LAB-IV: (ELECTRONICS)

University Exam: 3 hours Internal Marks: 15 University Examination Marks: 35

PRACTICAL COURSE IV: ELECTRICITY, MAGNETISM AND ELECTRONICS

COURSE OUTCOMES:

On successful completion of this practical course the student will be able to;

- Measure the current sensitivity and figure of merit of a moving coil galvanometer.
- Observe the resonance condition in LCR series and parallel circuit
- Learn how a sonometer can be used to determine the frequency of AC-supply.
- Observe the variation of magnetic field along the axis of a circular coil carrying current using Stewart and Gee's apparatus.
- Understand the operation of PN junction diode, Zener diode and a transistor and their V-I characteristics.
- Construct the basic logic gates, half adder and full adder and verify their truth tables. Further, the student will understand how NAND and NOR gates can be used as universal building blocks.

MINIMUM OF 6 EXPERIMENTS TO BE DONE AND RECORDED

1) Figure of merit of a moving coil galvanometer.
2) LCR circuit series/parallel resonance, Q factor.
3) Determination of ac-frequency –Sonometer.
4) Verification of Kirchoff's laws and Maximum Power Transfer theorem.
5) Field along the axis of a circular coil carrying current-Stewart & Gee's apparatus.
6) PN Junction Diode Characteristics
7) Zener Diode –V-I Characteristics
8) Zener Diode as a voltage regulator
9) Transistor CE Characteristics- Determination of hybrid parameters
10) Logic Gates- OR,AND,NOT and NAND gates. Verification of Truth Tables.
11) Verification of De Morgan's Theorems.
12) Construction of Half adder and Full adders-Verification of truth tables

RECOMMENDED CO-CURRICULAR ACTIVITIES:

MEASURABLE

- Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
- Student seminars (on topics of the syllabus and related aspects (individual activity))
- Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams)
- Field studies (individual observations and recordings as per syllabus content and related areas (Individual or team activity)
- Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity)

GENERAL

1) Group Discussion
2) Visit to Research Stations/laboratories and related industries
3) Others

RECOMMENDED ASSESSMENT METHODS:

- Some of the following suggested assessment methodologies could be adopted;
- The oral and written examinations (Scheduled and surprise tests),
- Practical assignments and laboratory reports,
- Observation of practical skills,
- Efficient delivery using seminar presentations,
- Viva voce interviews.

SEMESTER-IV

II Year II Semester /IV Semester

PRACTICAL-III:

R22NT409/NTP 2.2.3 (21): CHEMISTRY LAB-IV

(CONDUCTOMETRIC AND POTENTIOMETRIC TITRIMETRY)

University Exam: 3 hours Internal Marks: 15 University Examination Marks: 35

COURSE OUTCOMES:

At the end of the course, the student will be able to;

- Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
- Apply concepts of electrochemistry in experiments
- Be familiar with electro analytical methods and techniques in analytical chemistry which study an analyte by measuring the potential (volts) and/or current (amperes) in an electrochemical cell containing the analyte

CONDUCTOMETRIC AND POTENTIOMETRIC TITRIMETRY 50 M

1) **Conductometric titration**- Determination of concentration of HCl solution using standard NaOH solution.
2) **Conductometric titration**- Determination of concentration of CH_3COOH Solution using standard NaOH solution.
3) **Conductometric titration**- Determination of concentration of CH_3COOH and HCl in a mixture using standard NaOH solution.
4) **Potentiometric titration**- Determination of Fe (II) using standard $K_2Cr_2O_7$ solution.
5) Determination of rate constant for acid catalysed ester hydrolysis.
6) Determination of equilibrium constant of $KI + I_2 = KI_3$

RECOMMENDED CO-CURRICULAR ACTIVITIES:

MEASURABLE

1) Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
2) Student seminars (on topics of the syllabus and related aspects (individual activity))
3) Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams)

4) Field studies (individual observations and recordings as per syllabus content and related areas (Individual or team activity)
5) Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity)

GENERAL

1) Group Discussion
2) Visit to Research Stations/laboratories and related industries
3) Others

RECOMMENDED ASSESSMENT METHODS:

- Some of the following suggested assessment methodologies could be adopted;
- The oral and written examinations (Scheduled and surprise tests),
- Practical assignments and laboratory reports,
- Observation of practical skills,
- Efficient delivery using seminar presentations,
- Viva voce interviews.

FIFTH SEMESTER

M.Sc. NANOTECHNOLOGY

SEMESTER-V

III Year I Semester /V Semester

R22NT501: MATHEMATICS-VI (NUMERICAL METHODS)

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students can able to Understand the subject of various numerical methods that are used to obtain approximate solutions	Remember-1
CO-2	Students can able to learn various finite difference concepts and interpolation methods.	Understand-2
CO-3	Students can able to analyze and Work out numerical differentiation and integration whenever and wherever routine methods are not applicable.	Analyze-3
CO-4	Students can able to Find numerical solutions of ordinary differential equations by using various numerical methods.	Evaluate-4
CO-5	Students can able to Analyze and evaluate the accuracy of numerical methods	Apply-5

Unit – 1: Finite Differences and Interpolation with Equal intervals (12h)

Introduction, Forward differences, Backward differences, Central Differences, Symbolic relations, nth Differences of Some functions, Advancing Difference formula, Differences of Factorial Polynomial, Summation of Series. Newton's formulae for interpolation. Central Difference Interpolation Formulae.

Unit – 2: Interpolation with Equal and Unequal intervals (12h)

Gauss's Forward interpolation formulae, Gauss's backward interpolation formulae, Stirling's formula, Bessel's formula. Interpolation with unevenly spaced points, divided differences and properties, Newton's divided differences formula. Lagrange's interpolation formula, Lagrange's Inverse interpolation formula.

Unit – 3: Numerical Differentiation (12h)

Derivatives using Newton's forward difference formula, Newton's back ward difference formula, Derivatives using central difference formula, Stirling's interpolation formula, Newton's divided difference formula, Maximum and minimum values of a tabulated function.

Unit – 4: Numerical Integration (12h)

General quadrature formula one errors, Trapezoidal rule, Simpson's1/3– rule, Simpson's 3/8 – rule, and Weddle's rules, Euler – McLaurin Formula of summation and quadrature, The Euler transformation.

Unit – 5: Numerical solution of ordinary differential equations (12h)

Introduction, Solution by Taylor's Series, Picard's method of successive approximations, Euler's method, Modified Euler's method, Runge – Kutta methods.

CO-CURRICULAR ACTIVITIES

Seminar/ Quiz/ Assignments/ Linear algebra and its applications / Problem Solving.

REFERENCE BOOKS:

1) S.S.Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi-110001, 2006.
2) P.Kandasamy, K.Thilagavathy, Calculus of Finite Differences and Numerical Analysis. S. Chand & Company, Pvt. Ltd., Ram Nagar, New Delhi-110055.
3) R.Gupta, Numerical Analysis, Laxmi Publications (P) Ltd., New Delhi.
4) H.C Saxena, Finite Differences and Numerical Analysis, S. Chand & Company Pvt. Ltd., Ram Nagar, New Delhi-110055.
5) S.Ranganatham, Dr.M.V.S.S.N.Prasad, Dr.V.Ramesh Babu, Numerical Analysis, S. Chand & Company Pvt. Ltd., Ram Nagar, New Delhi-110055.
6) Web resources suggested by the teacher and college librarian including reading material.

IV. CO-CURRICULAR ACTIVITIES:

A) MANDATORY:

1) For Teacher: Teacher shall train students in the following skills for 15 hours, by taking relevant outside data (Field/Web).

- Applications of Newton's forward and back ward difference formulae.
- Applications of Gauss forward and Gauss back ward, Stirling's and Bessel's formulae.
- Applications of Newton's divided differences formula and Lagrange's interpolation formula.
- Various methods to find the approximation of a definite integral.
- Different methods to find solutions of Ordinary Differential Equations.

2) For Student: Fieldwork/Project work;

Each student individually shall undertake Fieldwork/Project work and submit a report not exceeding 10 pages in the given format on the work done in the areas like the following, by choosing any one of the aspects.

- Collecting the data from the identified sources like Census department or Electricity department, by applying the Newton's, Gauss and Lagrange's interpolation formula, making observations and drawing conclusions. (Or)
- Selection of some region to find the area by applying Trapezoidal rule, Simpson's1/3–rule, Simpson's 3/8 – rule, and Weddle's rules. Comparing the solutions with analytical solution and concluding which one is the best method. (Or)
- Finding solutionof the ODE by Taylor's Series, Picard's method of successive approximations, Euler's method, Modified Euler's method, Runge–Kutta methods. Comparing the solutions with analytical solution, selecting the best method.
- Max. Marks for Fieldwork/Project work Report: 05.
- Suggested Format for Fieldwork/Project work Report: Title page, Student Details, Index page, Stepwise work-done, Findings, Conclusions and Acknowledgements.
- Unit tests (IE).

B) SUGGESTED CO-CURRICULAR ACTIVITIES:

1) Assignments/collection of data, Seminar, Quiz, Group discussions/Debates
2) Visits to research organizations, Statistical Cells, Universities, ISI etc.
3) Invited lectures and presentations on related topics by experts in the specified area

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	4	2
CO-2	2	2	3	2	3
CO-3	2	2	3	2	3
CO-4	2	2	2	3	2
CO-5	2	2	3	2	3

SEMESTER-V

III Year I Semester /V Semester

R22NT502: MATHEMATICS-VII

(MULTIPLE INTEGRALS AND APPLICATIONS OF VECTOR CALCULUS)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must learn multiple integrals as a natural extension of a definite integral to a function of two variables in the case of double integral / three variables in the case of triple integral.	2
CO-2	Students must learn applications in terms of finding surface area by double integral and volume by triple integral.	2
CO-3	Students must be able to determine the gradient, divergence and curl of a vector and vector identities.	3
CO-4	Students must be able to analyze and evaluate line, surface and volume integrals.	3
CO-5	Students must understand relation between surface and volume integrals (Gauss divergence theorem), relation between line integral and volume integral (Green's theorem), relation between line and surface integral (Stokes theorem)	3

Unit – 1: Multiple integrals-I (12h)

Introduction, Double integrals, Evaluation of double integrals, Properties of double integrals. Region of integration, double integration in Polar Coordinates, Change of variables in double integrals, change of order of integration.

Unit – 2: Multiple integrals-II (12h)

Triple integral, region of integration, change of variables. Plane areas by double integrals, surface area by double integral. Volume as a double integral, volume as a triple integral.

Unit – 3: Vector differentiation (12h)

Vector differentiation, ordinary derivatives of vectors. Differentiability, Gradient, Divergence, Curl operators, Formulae involving the separators.

Unit – 4: Vector integration (12h)

Line Integrals with examples. Surface Integral with examples. Volume integral with examples.

Unit – 5: Vector integration applications (12h)

Gauss theorem and applications of Gauss theorem. Green's theorem in plane and applications of Green's theorem. Stokes's theorem and applications of Stokes theorem.

REFERENCE BOOKS:

1) Dr. M Anitha, Linear Algebra and Vector Calculus for Engineer, Spectrum University Press, SR Nagar, Hyderabad-500038, INDIA.
2) Dr.M.Babu Prasad, Dr.K.Krishna Rao, D.Srinivasulu, Y.AdiNarayana, Engineering Mathematics-II, Spectrum University Press, SR Nagar, Hyderabad-500038,INDIA.
3) V. Venkateswararao, N. Krishnamurthy, B.V.S.S.Sarma and S.Anjaneya Sastry, A text Book of B.Sc., Mathematics Volume-III, S. Chand & Company, Pvt. Ltd., Ram Nagar, NewDelhi-110055.
4) R.Gupta, Vector Calculus, Laxmi Publications.
5) P.C. Matthews, Vector Calculus, Springer Verlag publications.
6) Web resources suggested by the teacher and college librarian including reading material.

IV. CO-CURRICULAR ACTIVITIES:

A) MANDATORY:

For Teacher: Teacher shall train students in the following skills for 15 hours,
by taking Relevant outside data (Field/Web).

1) The methods of evaluating double integrals and triple integrals in the class room and train to evaluate These integrals of different functions over different regions.
2) Applications of line integral, surface integral and volume integral.
3) Applications of Gauss divergence theorem, Green's theorem and Stokes's theorem.

For Student: Fieldwork/Project work Each student individually shall undertake Fieldwork/Project work and submit a report not exceeding 10 pages in the given format on the work-done in the areas like the following, by choosing any one of the following aspects.

1) Going through the web sources like Open Educational Resources to find the values of double and triple integrals of specific functions in a given region and make conclusions. (or)
2) Going through the web sources like Open Educational Resources to evaluate line integral, surface integral and volume integral and apply Gauss divergence theorem, Green's theorem and Stokes theorem and make conclusions.
3) Max. Marks for Fieldwork/Project work Report: 05.
4) Suggested Format for Fieldwork/Project work Report: Title page, Student Details, Index page, Stepwise work-done, Findings, Conclusions and Acknowledgements.

UNIT TESTS (IE). B) SUGGESTED CO-CURRICULAR ACTIVITIES:

1) Assignments/collection of data, Seminar, Quiz, Group discussions/Debates
2) Visits to research organizations, Statistical Cells, Universities, ISI etc.
3) Invited lectures and presentations on related topics by experts in the specified

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	3	2
CO-2	2	2	3	2	3
CO-3	3	2	3	2	2
CO-4	2	2	2	2	2
CO-5	2	2	3	2	2

SEMESTER-V

III Year I Semester /V Semester

R22NT503: PHYSICS-VI (LASERS)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can able to understand the introduction on Lasers	Remember-1
CO-2	Students can be able to learn the Use of lasers in various industries.	Understand-2
CO-3	Studnets can get in-depth analysis of Working and principsle of lasers	Analyze-3
CO-4	Students can learn about Types of lasers.	Evaluate-4
CO-5	Studnets can be able to get the Industrial importance. Skills to be needed	Apply-5

UNIT – 1 **12h**

Introduction: Directionality, Intensity, Monochromaticity, Coherence; Masers: Two level Maser system-Ammonia maser, Hydrogen maser, three level maser system

UNIT – 2 **12h**

Coherence: Temporal Coherence, Spatial coherence; shape and width of the spectral lines; Line broadening mechanisms: natural or intrinsic broadening, collision broadening, Doppler broadening

UNIT – 3 **12h**

Basic Principles of Lasers-Population of inversion; Laser pumping-two level system, three level system, threshold condition, quantum yield;

UNIT – 4 **12h**

Ruby laser – three level system; Helium- Neon laser; CO_2 laser; Central features of semiconductor lasers, Intrinsic semiconductor lasers, Doped semiconductors, condition for laser action, advantages of semiconductor lasers

UNIT – 5 **12h**

Applications of lasers-Counting of atoms, Isotope separation, Lasers in chemistry, Ranging, Lasers in astronomy, Lasers in Biology, medicine, industry

TEXT BOOKS:

1) Lasers and Non-linear Optics by B.B. Laud
2) Lasers: Fundamentals and Applications by Ajoy Ghatak and K. Thyagarajan
3) An Introduction to Lasers Theory and Applications M. N. Avadhanulu

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	2	2
CO-2	2	2	3	2	3
CO-3	3	2	3	2	2
CO-4	2	2	2	3	2
CO-5	3	2	3	2	3

SEMESTER-V

III Year I Semester /V Semester

R22NT504: PHYSICS-VII (FIBER OPTICAS)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can able to Understand the principles of fiber-optic communication, the components and the bandwidth advantages.	Remember-1
CO-2	Students can able to learn the properties of the optical fibers and optical components.	Understand-2
CO-3	Students may be able to Understand operation of lasers, LEDs, and detectors	Analyze-3
CO-4	Students can able to Analyze system performance of optical communication systems	Evaluate-4
CO-5	Students can able to learn about various applications of fibers	Apply-5

UNIT 1 **12h**

Introduction to fibers: Reflection at a plane interface-Brewster angle, Total internal reflection; Maxwell's Equations: Maxwell's Equation in a Source-Free Region, Electromagnetic Wave, Free-Space Propagation, Propagation in a Dielectric Medium; Reflection and Refraction; Refraction; Phase Velocity and Group Velocity; Polarization of Light; Fiber Structure; Ray Propagation in Fibers, Multi-Mode and Single-Mode Fibers; Dispersion in Multi-Mode Fibers; Graded-Index Multi-Mode Fibers;

UNIT 2 **12h**

Modes of a Step-Index Optical Fiber-Guided Modes; Radiation Modes; Excitation of Guided Modes; Comparison between Multi-Mode and Single-Mode Fibers; The Numerical aperture, coherent bundle, attenuation in optical fibers, pulse dispersion in step index optical fibers, loss mechanisms- absorptive losses, radiative losses; material dispersion,

UNIT 3 **12h**

TE and TM modes in planar waveguides, TE modes of a symmetric step index planar waveguide, TM modes of a symmetric step index planar waveguide, power associated with a mode, excitation of guided modes; Waveguide dispersion, expression for group delay and waveguide dispersion, empirical formula for step index fibers, dispersion shifted fibers, single mode operation, splice loss, bend loss;

UNIT 4 **12h**

Sources for optical fiber communication- communication requirements, absorption and emission of radiation, condition for amplification by stimulated emission, resonator modes; semiconductor lasers, energy bands and carrier distribution in semiconductors, absorption and emission in a semiconductor, optical gain in a semiconductor;.

UNIT 5 **12h**

Detectors for optical fiber communication – principle of optical detection, PIN photodetector, responsivity and quantum efficiency, speed of response, Avalanche photodiodes; short noise, thermal noise, signal to noise ratio (SNR), optical amplification, applications of optical fibers

TEXT BOOKS:

1) Optical fiber communications by G. Keiser
2) Fiber optic communications-fundamentals and applications by Shiva kumar and M. Jamal Deen
3) Introduction to fiber optics by Ajoy Ghatak and k.Thyagarajan

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	2	3
CO-2	2	2	3	2	3
CO-3	2	2	3	2	2
CO-4	2	2	2	3	3
CO-5	2	2	3	2	2

SEMESTER-V

III Year I Semester /V Semester

R22NT505: CHEMISTRY-VI (ORGANIC & PHYSICAL CHEMISTRY)

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students must understand the structures, bonding nature, biological functions of carbohydrates and amino acids	1
CO-2	Students must understand and solve the problems associated with kinetics of reactions	2
CO-3	Students must be able to learn and analyze the concept of electron flow in the solutions, concept of batteries, calculation of EMF	3
CO-4	Students must be able to apply the electrochemistry concepts to quantitative titrimetric analysis and the principles of fuel cells	2
CO-5	Students must be able to apply the concepts of Biomolecules, kinetics and electrochemistry in day-to-day applications	3

UNIT-I: **12 hrs**

Carbohydrates: Occurrence, classification and their biological importance, Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides– Elementary treatment of maltose, lactose and sucrose. Polysaccharides–Elementary treatment of starch.

UNIT- II: **12 hrs**

Amino acids and proteins

Introduction: Definition of Amino acids, Natural and essential amino acids - definition and examples, classification of alpha amino acids into acidic, basic and neutral amino acids with examples. Methods of synthesis: General methods of synthesis of alpha amino acids (specific examples - Glycine, Alanine, valine) by following methods: a) from halogenated carboxylic acid b) Gabriel Phthalimide synthesis c) strecker's synthesis.

Physical properties: Zwitterion structure - salt like character - solubility, melting points, amphoteric character, definition of isoelectric point.

Chemical properties: General reactions due to amino and carboxyl groups - lactams from gamma and delta amino acids by heating- peptide bond (amide linkage). Structure and nomenclature of peptides and proteins.

Nucleic Acids: Basic structures of RNA, DNA

Unit III: **12 hrs**

Chemical Kinetics:

Rate of reaction, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light, catalyst. Definition of order and molecularity. Derivation of integrated rate equations and half-life for zero, first, second, third order reactions and examples. Derivation for time half change. Methods to determine the order of reactions. Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Theories of reaction rates – collision theory and activated complex theory of bimolecular reaction, parallel reactions.

Unit IV: **12 hrs**

Electrochemistry-I

Specific conductance, equivalent conductance and molar conductance- Definition and effect of dilution. Ionic mobility, Strong and weak electrolytes, Kohlrausch's law and its applications, Definition of transport number, determination of transport number by Hittorf's method. Debye-Huckel-Onsagar's equation for strong electrolytes (elementary treatment only), Application of conductivity measurements- determination of degree of dissociation, ionic product of water, dissociation constant of an acid, solubility, solubility product and conductometric titrations.

Unit V: **12 hrs**

Electrochemistry-II

Electrochemical Cells- Single electrode potential, Types of electrodes with examples: Metal-metal ion, Gas electrode, Inert electrode, Redox electrode, Metal- insoluble metal salt electrode. Determination of ΔG, ΔH, ΔS. Concentration cells, Determination of EMF of a cell, Nernst equation, Applications of EMF measurements- determination of pH using hydrogen, quinhydrone and glass electrodes. Potentiometric titrations- acid-base, redox and precipitation titrations.

Fuel cells- Basic concepts, examples and applications

REFERENCE BOOKS:

1) Physical Chemistry by Puri, Sharma, Pathania
2) Text book of physical chemistry by K L Kapoor Volumes 1-5
3) A textbook of qualitative inorganic analysis by A.I. Vogel
4) Organic Chemistry by P Y Bruice
5) Organic Chemistry by Ege
6) Organic Chemistry by F A Carey
7) Organic Chemistry by Morrison & Boyd
8) Chemical Kinetics by K J Laidler

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	2	2
CO-2	2	2	3	2	2
CO-3	2	2	3	2	3
CO-4	2	2	2	3	2
CO-5	3	2	3	3	2

SEMESTER-V

III Year I Semester /V Semester

R22NT506: CHEMISTRY-VII (ORGANIC SPECTROSCOPY)

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students must be able to understand the basic principles of UV-Visible, IR, NMR and Mass spectroscopic techniques	Remember-1
CO-2	Students must be able to understand the concepts of analysis of spectra of various simple organic molecules	Understand-2
CO-3	Students must develop a solid understanding on the sample preparation and spectra acquisition techniques	Analyze-3
CO-4	Students must be able to apply these concepts to characterize the organic compounds	Evaluate-4
CO-5	Students must be able to apply these concepts to solve the combined structural elucidation problems of the organic compounds	Apply-5

UNIT – I : Introduction, UV-Visible **12 hrs**

General features of absorption spectroscopy, Beer – Lambert's law and its limitations, transmittance, Absorbance, and molar absorptivity.

Instrumentation: Single and double beam spectrophotometers.

Energy levels of molecular orbitals (σ, π, n). Selection rules for electronic spectra. Types of electronic transitions in molecules.

Concept of chromophore. bathochromic and hypsochromic shifts.

Factors influencing lmax values (effect of conjugation, solvent effects, sterical crowding).

Woodward-Fieser rules for Dienes, conjugated carbonyls and aromatic compounds.

Application of Visible spectrophotometer for quantitative analysis of

1. Iron (III) with thiocynate
2. Iron (II) with o-Phenonthroline

UNIT-II: ^{1}H NMR, **12 hrs**

Principles of nuclear magnetic resonance, instrumentation, equivalent and non-equivalent protons, position of signals, Chemical shift, magnetic anisotropy with examples, NMR splitting of signals - spin-spin coupling, coupling constants. Spin-spin interactions related to first order and higher order spectra (AB, A_2, AX, AB_2, ABC, AMX), temperature dependence of spectra, Applications of NMR with suitable examples – carbonyls, aromatic compounds, alcohols. Ex- acetaldehyde, ethyl acetate, toluene and acetophenone.

UNIT-III: ^{13}C NMR, IR **12 hrs**

^{13}C NMR: Chemical shift values, ^{1}H coupled and de-coupled spectra, off-resonance decoupling, calculation of chemical shift values for alkenes and aromatic compounds, interpretation of ^{13}C spectra of cyclohexanone, cyclohexanol, o-, m- and p-xylenes

Basic concept on NOE, DEPT, ^{13}C spectra of NMR solvents, carbon coupling with ^{19}F and ^{31}P.

IR: Different Regions in Infrared radiations. Modes of vibrations in diatomic and polyatomic molecules. Characteristic absorption bands of various functional groups. Interpretation of spectra - alkanes, alkenes, alkynes, aromatic rings, alcohols, carbonyls, nitriles and amines with one example to each. Importance of Hydrogen bonding and finger print region, sample preparation

UNIT-IV: Mass Spectrometry **12 hrs**

Basic principles, instrumentation, Molecular ion / parent ion, fragment ions / daughter ions, nitrogen rule. Theory – formation of parent ions. Representation of mass spectrum. Identification of parent ion, (M+1), (M+2), base peaks

(Relative abundance 100%) Determination of molecular formula, calculation of number of carbons, use of isotopes, isotopic ratio data of halogens, nitrogen rule, Mc Lafferty rearrangement, α and β cleavages, Mass spectra of ethylbenzene, n-butyl benzene, butanone, 2-octanone, acetophenone, butyraldehyde, methyl benzoate, n-butyl amine and 1- propanol, 2-hexanol, 2-pentanone, bromobenzene, 2-chloropropane.

UNIT-V: Combined Problems 12 **12 hrs**

Combined spectral interpretation

Interpretation of IR, UV-Visible, ^{1}H-NMR, ^{13}C NMR and mass spectral data of the following compounds. 1.Phenyl acetylene 2. Acetophenone 3. Cinnamic Acid 4. para-nitro aniline 5. Benzaldehyde 6. P-xylene 7. Ethyl acetate 8. Phenyl ethyl ketone 9. 10.

REFERENCE BOOKS:

1) Organic spectroscopy by Pavia
2) Organic spectroscopy by Silverstein

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	2	2
CO-2	2	2	3	2	2
CO-3	3	2	2	2	3
CO-4	2	2	2	3	2
CO-5	2	2	3	2	2

SEMESTER-V

III Year I Semester OR V Semester

PRACTICAL-I:

R22NT507: MATHEMATICS LAB - II

University Exam: 3 hours **Internal Marks: 15** **University Examination Marks: 35**

COURSE OUTCOME:

After completion of this course, student will get an idea about writing the proof of a theorem and solution of various problems.

SOLUTION OF THEOREMS AND PROBLEM SOLVING ON THE FOLLOWING CONCEPTS:

1) Applications of Newton's forward and back ward difference formulae.
2) Applications of Gauss forward and Gauss back ward, Stirling's and Bessel's formulae.
3) Applications of Newton's divided differences formula and Lagrange's interpolation formula.
4) Line Integrals with examples
5) Surface Integral with examples.
6) Volume integral with examples.
7) Gauss theorem and applications of Gauss theorem.
8) Green's theorem in plane and applications of Green's theorem
9) Stokes's theorem and applications of Stokes theorem.

RECOMMENDED CO-CURRICULAR ACTIVITIES:

MEASURABLE

1) Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
2) Student seminars (on topics of the syllabus and related aspects (individual activity))
3) Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams)
4) Field studies (individual observations and recordings as per syllabus content and related areas (Individual or team activity)
5) Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity)

GENERAL

1) Group Discussion
2) Visit to Research Stations/laboratories and related industries
3) Others

RECOMMENDED ASSESSMENT METHODS:

1) Some of the following suggested assessment methodologies could be adopted;
2) The oral and written examinations (Scheduled and surprise tests),
3) Practical assignments and laboratory reports,
4) Observation of practical skills,
5) Efficient delivery using seminar presentations,
6) Viva voce interviews.

SEMESTER-V

III Year I Semester OR V Semester

PRACTICAL-II:

R22NT508: PHYSICS LAB-V: (FIBER OPTICAS)

University Exam: 3 hours **Internal Marks: 15** **University Examination Marks: 35**

SEMESTER-V

III Year I Semester /V Semester

PRACTICAL-III:

R22NT509: CHEMISTRY LAB-V

(ORGANIC PREPARATIONS & IR ANALYSIS)

University Exam: 3 hours **Internal Marks: 15** **University Examination Marks: 35**

COURSE OUTCOMES:

On the completion of the course, the student will be able to do the following**:**

1) How to use glassware, equipment and chemicals and follow experimental procedures in the laboratory
2) How to calculate limiting reagent, theoretical yield, and percent yield
3) How to engage in safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents appropriately
4) How to dispose of chemicals in a safe and responsible manner
5) How to perform common laboratory techniques including reflux, distillation, recrystallization, vacuum filtration.
6) How to create and carry out work up and separation procedures
7) How to critically evaluate data collected to determine the identity, purity, and percent yield of products and to summarize findings in writing in a clear and concise manner

ORGANIC PREPARATIONS: 40M

1) Acetylation of one of the following compounds:
   amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:
   a. Using conventional method.
   b. Using green approach

2) Benzoylation of one of the following amines
   (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine)

3) Nitration of any one of the following:
   a. Acetanilide/nitrobenzene by conventional method
   b. Salicylic acid by green approach (using ceric ammonium nitrate).

IR SPECTRAL ANALYSIS 10M

IR Spectral Analysis of the following functional groups with examples

a) Hydroxyl groups b) Carbonyl groups

c) Amino groups d) Aromatic groups

SIXTH SEMESTER

M.Sc. NANOTECHNOLOGY

SEMESTER-VI

III Year II Semester /VI Semester

R22NT601: PROJECT WORK-I

INTERNAL MARKS: 100 (Viva-Voce) **THEORY MARKS: 200 (Dissertation)**

CREDITS: 12 **SEMESTER (MARKS): 300**

SEVENTH SEMESTER

M.Sc. NANOTECHNOLOGY

SEMESTER-VII

IV Year I Semester /VII Semester/ I Semester (Lateral Entry)

R22NT701: CLASSICAL AND STATISTICAL MECHANICS

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students can able to learn the Introduction to basic ideas about Newtonian mechanics	Remember-1
CO-2	Students can able to understand Initiation of mechanical system through derivative and problematic approaches	Understand-2
CO-3	Students can learn the Study of motion of the body in different systems of equation. Enriched skills to analyze critically Hamilton's –Jacobi equation	Analyze-3
CO-4	Students can able to Understand the various fundamental science methods in industrial application	Evaluate-4
CO-5	Students can able to get and understand the Enhanced employability skills by resolving system with practical approach	Apply-5

UNIT – 1 **12h**

Newton's laws of motion, validity of Newton's laws; Mechanics of a particle-Conservation of linear momentum, angular momentum, energy; work-energy theorem; center of mass; degrees of freedom-configuration space; Constraints-Holonomic, nonholonomic; Generalized co-ordinates; Principle of virtual work., D'Alembert's principle, Lagrangian equations from D'Alembert's principle.

UNIT – 2 **12h**

Lagrangian equations in presence of non-conservative forces (Rayleigh's dissipation function), Generalized potential, Hamilton's principle and Lagrange's Equations, Hamiltonian Dynamics-Generalized momentum and cyclic coordinates, Hamilton's Equations, Two-body central force problem-Reduction of two-body central force problem to the equivalent one-body problem.

UNIT – 3 **12h**

central force and motion in a plane, Equations of motion under central force and first integrals, differential equation for an orbit,. Inverse square law of force, Kepler's First law, Second law and Third law; scattering in a central force field. Modified Hamilton's principle, Δ-variation, Principle of least action, Poisson's brackets, Angular momentum and Poisson brackets, Phase space.

UNIT – 4 **12h**

The Hamilton-Jacobi equation, Hamilton's characteristic function, Action and Angle variables. Statistical Methods-Macroscopic and Microscopic systems, Macro and micro states, phase space, cells in phase space, classical statistics, quantum statistics, basic postulates of quantum statistics.

UNIT – 5 **12h**

Maxwell-Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics, Comparision of three statistics, Density of states-Phase volume and engenstates, Planks blackbody formula, Energy of a Fermi-Dirac system.

TEXT BOOKS:

1) Classical Mechanics by J.C. Upadhyaya
2) Classical Mechanics by G. Aruldhas
3) Classical Mechanics by H. Goldstein
4) Classical Mechanics by Gupta Sl, Kumar V
5) Engineering Physics by G.Aruldhas

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	2	2
CO-2	2	2	2	2	2
CO-3	2	2	2	2	3
CO-4	2	2	2	3	2
CO-5	3	2	3	2	2

SEMESTER-VII

IV Year I Semester /VII Semester/ I Semester (Lateral Entry)

R22NT702: SOLID STATE PHYSICS

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students must be able to get a basic idea about solids, crystal and their structures	1
CO-2	Students can able to get knowledge about Various crystal structure determination methods	2
CO-3	Students can learn about other physical properties and the importance of solids	3
CO-4	Students can able to understand one dimensional linear lattice and diatomic lattice and the importance of Einstein's theory and Debye's theory of specific heat	3
CO-5	Students can able to get the basic idea and understand superconductivity	2

UNIT – 1

Periodic array of atoms, Unit cell, Symmetry considerations, Classification of crystals, Bravais lattices in three dimensions, Crystal Planes and Miller indices, Spacing of planes in crystal lattices, simple crystal structures-bcc, fcc, sc, diamond and NaCl, ZnS.

UNIT – 2

Diffraction, Bragg's law, Reciprocal lattice-reciprocal lattice vector, properties of reciprocal lattice, Brillouin zones, reciprocal lattice to sc, fcc and bcc; geometrical structure factor; x-ray diffraction methods-laue method, rotating crystal method and powder method.

UNIT – 3

Elastic vibrations of continuous media, vibrational modes of finite one-dimensional lattice of identical atoms, vibrational modes of a diatomic linear lattice, quantization of lattice vibrations, phonon momentum; heat capacity, The Einstein model, Debye model, Thermal conductivity;

UNIT 4

Free electron model, free electron gas in one-dimentional, free electron gas in three-dimensional box, ratio of thermal conductivity to electrical conductivity, Hall effect; Bloch's theorm, Kronig Penney model, Effective mass, The Hole, Tight-binding approximation, Density of states, De Hass-Van Alphen effect, Fermi surfaces.

UNIT 5

Superconductivity: Basic experimental facts – zero resistance, effect of magnetic field, Meissner effect, persistent current, Isotope effect Thermodynamic properties, specific heat, entropy. Type I and Type II superconductors. Elements of BCS theory-Cooper pairs. Applications. High temperature superconductors (general information)

TEXT BOOKS:

1) Introduction to Solid State Physics, C. Kittel, 5th edition,
2) Solid State Physics, A.J.Dekker.
3) A text book of solid state physics by S.L.Kakani and C.Hemrajani

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	2	2
CO-2	2	2	3	2	3
CO-3	2	2	2	2	3
CO-4	2	2	2	3	2
CO-5	3	2	3	2	2

SEMESTER-VII

IV Year I Semester /VII Semester/ I Semester (Lateral Entry)

R22NT703: NANOTECHNOLOGY-SMALL MOLECULES CHEMISTRY

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students can able to understand and learn history and the basic concepts of Nanoscience	1
CO-2	Students must develop a solid understanding about various nanomaterials	2
CO-3	Students can able to understand and learn various electrical and magnetic properties of nanomaterials	2
CO-4	Students can able to learn and apply the concepts of synthesis of nanomaterials	3
CO-5	Students can able to learn and apply the principles and structure analysis by various spectroscopic techniques	3

UNIT-I: Background and history of Nano-World **12 hrs**

Emergence of Nanoscience with special reference to Feynman and Drexler; Concept of confinement, strong and weak confinement with suitable example; Basic concept of quantum well, quantum wire and quantum dot. Concept of Surface and Interfacial Energies.

Size effect of Nanomaterials: Role of particle size - Size, shape, density, melting point, specific surface area and band gap variation.

UNIT-II **12 hrs**

Classification of Nanomaterials

Inorganic nanomaterials: Fullerenes, carbon nanotubes, graphene, zeolite minerals, montmorillonite

Organic nanomaterials: dendrimers, micelles.

Bionanomaterials: concept of biomimetrics, bioceramic implants.

Lithium-ion battery materials – electrode and electrolyte materials.

Solid Oxide Fuel Cells- material aspects, CO_2 reduction technologies.

UNIT-III **12 hrs**

Optical properties

Photonic crystals, optical properties of semiconductors, Fluorescence/luminescence, photoluminescence, optically excited emission, electroluminescence, Laser

Electronic properties Energy Bands and Gaps of Semiconductors, intrinsic and extrinsic semiconductors, Effective masses, Fermi Surfaces.

Localized particles: - Donors, Acceptors and deep Traps, Mobility, Excitons, density of states

Magnetic properties

Introduction of magnetic materials, various types- dia, para, ferro, ferri and anti-ferromagnetic materials, basics of ferromagnetism, magnetic moment, magnetic susceptibility.

magnetic properties of bulk nanostructures, magnetic clusters, soft and hard magnets, Magnetic hysteresis – Superparamagnetism

UNIT-IV **12 hrs**

Intermolecular Interactions

Intermolecular interactions in organic and biomolecules - electrostatic, electrical double layer, van der Waals, H-bonding, Hydrophobic interactions.

Synthetic methods

Introduction, top-down and bottom-up approaches, nucleation, growth mechanics, Nanometals by chemical reduction, co-precipitation method, Inert gas condensation, sputtering, physical vapour deposition, Chemical Vapor Deposition, laser ablation, plant extracts and bacteria for nano-particle synthesis, Self-assembly, Electrochemical Approaches

UNIT-V **12 hrs**

Characterization techniques

XRD-principle, instrumentation, analysis

SEM-principle, instrumentation, sample-electron interactions

TEM-principle, instrumentation, sample-electron interactions

AFM- principle, instrumentation, different modes

STEM- principle, instrumentation, analysis

DLS- principle, instrumentation, analysis

REFERENCE BOOKS:

1) Poole C P and Owens F J, Introduction to Nanotechnology, Wiley-Interscience 2003.
2) Cao G, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press 2004.
3) Basic concepts and physical properties, Wiley-VCH 2004.
4) Chawla K Krishnan, Composite Materials –Science and Engineering, Springer, 2012.
5) Robert J. Young and Peter A. Lovell, Introduction to Polymers, 3rd Ed., CRC Press, 2011.
6) Bradley D. Fahlman, Materials Chemistry, 2nd Ed., Springer, 2011.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	3	2
CO-2	2	2	3	2	3
CO-3	3	2	2	2	3
CO-4	2	2	2	3	2
CO-5	2	2	3	2	2

SEMESTER-VII

IV Year I Semester /VII Semester/ I Semester (Lateral Entry)

R22NT704A: ATOMIC PHYSICS (ELECTIVE– A)

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students must be able to develop a solid understanding on atomic spectra	1
CO-2	Students must be able to develop a solid understanding on types of atomic spectra and transition levels between ground and excited states.	2
CO-3	Students must analyze the molecular spectra on electric and magnetic field applications	2
CO-4	Students must understand and apply the features of molecular spectra and types of molecular spectras	3
CO-5	Students must analyze and apply molecular spectra	3

UNIT – 1 **12h**

Atomic Spectra, Bohr's postulates, Bohr's correspondence principle, orbital angular momentum, Bohr Magneton, Larmor's precession, Space quantization, Electron spin, coupling of angular moment, Spectral terns and notations, Stern-Gerlach experiment.

UNIT – 2 **12h**

Spin-orbit interaction, Hydrogen fine structure, Lamb shift, Pauli's principle, L-S coupling, selection rule for multielectron atoms in L-S coupling, j-j coupling, selection rules for j-j coupling;

UNIT – 3 **12h**

Features of Alkali spectra, Features of Alkali Earth Spectra, Normal Zeeman Effect, Anomalous Zeeman Effect, Paschen-Back Effect, weak field Stark Effect in Hydrogen atom, Strong field Stark Effect in Hydrogen atom

UNIT – 4 **12h**

Types of molecular spectra, salient features of rotational spectra, Rigid rotator, Isotope effect; Vibrational-rotational spectra—features, harmonic oscillator, isotope effect; Features of electronic spectra, Frank-Condon principle

UNIT – 5 **12h**

Nature of Raman effect, Raman spectra and molecular structure;.Luminescence, Mechanism of Fluorescent Emission, Mechanism of Phosphorescent emission, comparison between Fluorescence spectrum and Raman spectrum

TEXT BOOKS:

1) Atomic and Molecular Physics by Rajkumar
2) Atomic and Molecular Physics-Introduction to Advanced topics by R Srivatsava
3) Atomic Spectroscopy by KP Rajappan Nair

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	2	3
CO-2	2	2	3	2	2
CO-3	2	2	2	2	3
CO-4	2	2	3	3	2
CO-5	3	2	3	2	2

SEMESTER-VII

IV Year I Semester /VII Semester/ I Semester (Lateral Entry)

R22NT704B: MAGNETIC MATERIALS (ELECTIVE–B)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must understand the Magnetism and Magnetic materials behavior and applications	1
CO-2	Students must be able to develop a solid understanding on various types magnetic materials	2
CO-3	Students must learn about the domine structure of magnetic materials	3
CO-4	Students must analyze and apply the concepts of oriented magnetic materials	2
CO-5	Students must analyze and apply the concepts of magnetic materials	3

Unit1 **12h**

Generation of a Magnetic Field, Biot-Savart Law, Ampère's Circuital Law, Magnetic Flux, Electromagnetic Induction, Magnetic Dipole, Maxwell's Equations of the Electromagnetic Field.

Unit 2 **12h**

Magnetic Moment, Magnetic Dipole Moment *m*, Force on a Dipole Suspended in a Magnetic Field, Magnetization, Relationship between *H*, *M*, and *B*, Saturation Magnetization, Permeability and Susceptibility.

Unit 3 **12h**

Diamagnets, Paramagnets, and Ferromagnets, Susceptibilities of Diamagnetic and Paramagnetic Materials, Other Types of Magnetic Materials, Magnetic Properties of Ferromagnets- Permeability, Retentivity, Hysteresis , Saturation Magnetization, Remanence , Coercivity and Curie Temperature.

Unit 4 **12h**

Hard and Soft Magnetic Materials, Electromagnets, Magnetic Recording Materials, Permanent Magnets, Ceramic Magnets.

Unit 5 **12h**

Nanoscale Magnetism, Magnetization and Curie point, Anisotropy and domain structure, Giant magnetoresistance, Small particles, superparamagnetism, quantum dots, molecular clusters, single and two phase nanostructures

TEXT BOOKS:

1) Introduction to Magnetism and Magnetic Materials by David Jiles
2) Magnetism and Magnetic Materials by J.M.D. Coey

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	2	2
CO-2	2	2	3	2	2
CO-3	3	2	2	2	3
CO-4	2	2	2	3	2
CO-5	2	2	3	2	2

SEMESTER-VII

IV Year I Semester /VII Semester/ I Semester (Lateral Entry)

R22NT704C: MATHEMATICS-VIII (ELECTIVE–C)

(INTEGRAL TRANSFORMS WITH APPLICATIONS)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Student must be evaluate Laplace transforms of certain functions, find Laplace transforms of derivatives and of integrals	1
CO-2	Students must determine properties of Laplace transform which may be solved by application of special functions namely Dirac delta function, error function, Bessel function and periodic function.	2
CO-3	Students must understand properties of inverse Laplace transforms, find inverse Laplace transforms of derivatives and of integrals.	2
CO-4	Students must be able to solve ordinary differential equations with constant/ variable coefficients by using Laplace transform method.	3
CO-5	Students must be able to comprehend the properties of Fourier transforms and solve problems related to finite Fourier transforms.	3

Syllabus:

Unit – 1: Laplace transforms- I (12h)

Definition of Laplace transform, linearity property-piecewise continuous function. Existence of Laplace transform, functions of exponential order and of class A. First shifting theorem, second shifting theorem and change of scale property.

Unit – 2: Laplace transforms- II (12h)

Laplace Transform of the derivatives, initial value theorem and final value theorem. Laplace transforms of integrals. Laplace transform of tn . f (t), division by t, evolution of integrals by Laplace transforms. Laplace transform of some special functions-namely Dirac delta function, error function, Bessel function and Laplace transform of periodic function.

Unit – 3: Inverse Laplace transforms (12h)

Definition of Inverse Laplace transform, linear property, first shifting theorem, second shifting theorem, change of scale property, use of partial fractions. Inverse Laplace transforms of derivatives, inverse Laplace transforms of integrals, multiplication by powers of ‘p’, division by ‘p’. Convolution, convolution theorem proof and applications.

Unit – 4: Applications of Laplace transforms (12h)

Solutions of differential equations with constants coefficients, solutions of differential equations with variable coefficients. Applications of Laplace transforms to integral equations- Abel's integral equation. Converting the differential equations into integral equations, converting the integral equations into differential equations.

Unit – 5: Fourier transforms (12h)

Integral transforms, Fourier integral theorem (without proof), Fourier sine and cosine integrals. Properties of Fourier transforms, change of scale property, shifting property, modulation theorem. Convolution. Convolution theorem for Fourier transform, Parseval's Identify, finite Fourier transforms.

REFERENCE BOOKS:

1) Dr. S.Sreenadh, S.Ranganatham, Dr.M.V.S.S.N. Prasad, Dr. V.Ramesh Babu, Fourier series and Integral Transforms, S. Chand & Company, Pvt. Ltd., Ram Nagar, New Delhi-110055.
2) A.R. Vasistha, Dr. R.K. Gupta, Laplace Transforms, Krishna Prakashan Media Pvt. Ltd. Meerut.
3) M.D.Raisinghania, H.C. Saxsena , H.K. Dass, Integral Transforms, S. Chand & Company Pvt. Ltd., Ram Nagar, New Delhi-110055.
4) Dr. J.K. Goyal, K.P. Gupta, Laplace and Fourier Transforms, Pragathi Prakashan, Meerut.
5) Shanthi Narayana , P.K. Mittal, A Course of Mathematical Analysis, S. Chand & Company Pvt.Ltd. Ram Nagar, New Delhi-110055.
6) Web resources suggested by the teacher and college librarian including reading material. IV. Co.

CURRICULAR ACTIVITIES:

A) MANDATORY:

For Teacher: Teacher shall train students in the following skills for 15 hours, by taking Relevant outside data (Field/Web).

1) Demonstrate sufficient conditions for the existence of the Laplace transform of a function.
2) Evaluation of Laplace transforms and methods of finding Laplace transforms.
3) Evaluations of Inverse Laplace transforms and methods of finding Inverse Laplace transforms.
4) Fourier transforms and solutions of integral equations.

For Student: Fieldwork / Project work; Each student individually shall undertake Fieldwork/Project work and submit a report not exceeding 10 pages in the given format on the work-done in the areas like the following, by choosing any one of the aspects.

1) Going through web sources like Open Educational Resources on Applications of Laplace transforms and Inverse Laplace transforms to find solutions of ordinary differential equations with constant /variable coefficients and make conclusions. (or)
2) Going through web sources like Open Educational Resources on Applications of convolution theorem to solve integral equations and make conclusions. (or)
3) Going through the web source like Open Educational Resources on Applications of Fourier transforms to solve integral equations and make conclusions.
4) Max. Marks for Fieldwork/Project work Report: 05.
5) Suggested Format for Fieldwork/Project work Report: Title page, Student Details, Index page, Stepwise work-done, Findings, Conclusions and Acknowledgements.
6) Unit tests (IE).

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	2	3
CO-2	2	2	3	2	2
CO-3	2	2	2	2	3
CO-4	2	2	2	3	2
CO-5	3	2	3	2	3

SEMESTER-VII

IV Year I Semester OR VII Semester OR First Semester (Lateral Entry)

PRACTICAL-I:

R22NT705: PHYSICS LAB-VI: (SOLID STATE PHYSICS)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

SEMESTER-VII

IV Year I Semester OR VII Semester OR First Semester (Lateral Entry)

PRACTICAL-II:

R22NT706: NANOMETERIALS LAB-I: (SYNTHESIS OF NANOMATERIALS)

(IV Year I Semester OR VII Semester OR First Semester (Lateral Entry))

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

OBJECTIVES:

1) Students are introduced with simple synthesis techniques
2) Students will understand the procedures to conduct a synthesis reaction
3) Students will acquire skills in maintain the reaction conditions and purification steps

1) Synthesis of Ag, Au nanoparticles through chemical reduction method
2) Synthesis of CdS quantum dots through microemulsion method
3) Synthesis of GO using Hummers method
4) Synthesis of two polymers-Bakelite and
5) Determination of CMC of SDS and CTAB using conductivity measurement technique.
6) Synthesis of any two metal oxide nanomaterials through co-precipitation, hydrolysis and hydrothermal methods.

EIGHTH SEMESTER

M.Sc. NANOTECHNOLOGY

SEMESTER-VIII

IV Year II Semester /VIII Semester/ II Semester (Lateral Entry)

R22NT801: QUANTUM MECHANICS

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students may be able to understand the importance of quantum mechanics, origin of quantum mechanics	1
CO-2	Students may be able to learn the evaluation of problems with quantum mechanics	2
CO-3	Students may be able to understand the concept of angular momentum	3
CO-4	Students may be able to learn about hydrogen molecule and Einstein's coefficients	3
CO-5	Students may be able to understand application of perturbation theory on various quantum mechanical problems	3

UNIT – 1 **12 h**

Limitations of Classical physics, inadequacy of quantum theory, wave-particle duality, uncertainity principle, Time-Dependent Schrodinger Equation, Ehrenfest Theorem, Stationary states, Eigenfunctions and Eigen values, Hermitian, unitary, projection operator, Postulates of Quantum Mechanics, Linear vector space and operator, Dirac's Notation, One dimentional square well potential with finite walls, potential barrier.

UNIT – 2 **12 h**

Harmonic oscillator-Schrodinger method, Particle moving in a spherically symmetric potential, system of two interacting particles, Hydrogen Atom, Free particle, Three dimensional square well potential. Heisenberg method, Matrix representation of Wavefunctions, Operators, Properties of Matrix elements,

UNIT – 3 **12 h**

Schrodinger Equation in matrix form, eigen value problems, Unitary transformations, Harmonic Oscillator-Matrix method, Angular momentum operators, Angular momentum commutation relations, Eigen values of L^2, L_z, General angular momentum, Eigen values of J^2 and J_z.

UNIT – 4 **12 h**

Time-Independent Perturbation Theory-Nondegenerate levels, Degenerate levels, Anharmonic oscillator:First order correction, Ground state of Helium, Spin-orbit interaction, Variational principle, Variation method for excited states, WKB method, validity of WKB method.

UNIT – 5 **12 h**

Time-dependent perturbation theory- First order perturbation, Transitions to continuum states, absorption and emission of radiation, Einstein's A, B coefficients; Many electron atoms-indistinguishable particles, pauli principle; Scattering cross-section, Scattering amplitude, partial waves, partial wave analysis, Born approximation, validity of Born approximation

TEXT BOOKS:

1) Quantum Mechanics by Aruldhas
2) Quantum Mechanics by Merzbacker
3) Quantum Mechanics by Schiff

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	2	2
CO-2	2	2	3	2	2
CO-3	3	2	2	2	3
CO-4	2	2	2	3	2
CO-5	2	2	3	2	2

SEMESTER-VIII

IV Year II Semester /VIII Semester/ II Semester (Lateral Entry)

R22NT802: SYNTHESIS OF NANOMATERIALS

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must understand the concepts of Nanomaterial synthesis	1
CO-2	Students must learn and apply the physical synthesis methods	2
CO-3	Students must learn and practice the chemical synthesis methods	3
CO-4	Students must learn and practice various biological synthetic methods	3
CO-5	Students must apply the synthesis protocols to optimize the methods for materials with specific application	3

The course is intended to cover the two groups of synthesis of nanostructure namely top-down and bottom-up approaches, various synthesis methods, including biological methods, advantages and disadvantages etc.

OUTCOME OF THE STUDY:

1) The students will be exposed to various structure specific synthesis methods, their advantages etc.
2) To know Top-down to Bottom-up approach techniques
3) To optimize the methods for specific material application

UNIT-I **12h**

Introduction, top-down and bottom-up approaches, nucleation, growth mechanics, confined nucleation and/or growth, templated nucleation and/or crystallization.

Chemical methods: Nanocrystals by chemical reduction, photochemical synthesis, co-precipitation method, Nanocrystals of semiconductors and other materials by arrested precipitation, emulsion synthesis.

UNIT-II **12h**

Physical methods: Vacuum synthesis, Inert gas condensation, vapor condensation, Arc discharge, RF-plasma, ball milling, molecular beam epitaxy, sputtering, physical vapour deposition, laser ablation.

UNIT-III **12h**

Thermolysis route - spray pyrolysis and solvated metal atom dispersion, sol-gel method, solvothermal and hydrothermal routes, solution combustion synthesis, Chemical vapor synthesis and Chemical Vapor Deposition.

UNIT-IV **12h**

Template based synthesis of nanomaterials.

Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films,

Electrochemical Approaches: anodic oxidation of alumina films, porous silicon, and pulsed electrochemical deposition.

UNIT-V **12h**

Biological methods: Principles of green chemistry, use of bacteria, fungi, actinomycetes, biomolecules, plant extracts for nano-particle synthesis.

TEXT BOOKS:

1) Inorganic Materials Synthesis and Fabrication by J.N. Lalena, D.A. Cleary, E.E. Carpenter, N.F.
2) Dean, John Wiley & Sons Inc.
3) Introduction to Nano Technology by Charles P. Poole Jr and Frank J. Owens. Wiley India Pvt Ltd.
4) The Chemistry of nanomaterials: Synthesis, Properties and Applications, Vol-I by C.N.R.
5) Rao, A. Muller and A.K. Cheetham
6) The Physics of Micro/Nano- Fabrication by Ivor Brodie and Julius J.Muray

REFERENCE BOOKS:

1) Encyclopedia of Nanotechnology by M.Balakrishna Rao and K.Krishna Reddy, Vol I to X, Campus books.
2) Encyclopedia of Nanotechnology by H.S. Nalwa
3) Nano: The Essentials – Understanding Nano Scinece and Nanotechnology – by T.Pradeep; Tata Mc.Graw Hill
4) 4.G. Cao, Nanostructures & Nanomaterials: Synthesis, Properties &Applications , Imperial College Press, 2004.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	2	2	2
CO-2	2	2	3	2	2
CO-3	3	2	2	2	3
CO-4	2	2	2	3	3
CO-5		2	3	2	2

SEMESTER-VIII

IV Year II Semester /VIII Semester/ II Semester (Lateral Entry)

R22NT803: BASIC CHARACTERIZATION OF NANOMATERIALS

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students may be able to learn the basic principle of spectroscopic techniques	1
CO-2	Students can understand and practice these spectroscopic techniques in the structure and properties analysis	2
CO-3	Students may be able to learn and apply the porosity technique	3
CO-4	Students may be able to understand the concepts of SEM, TEM and AFM	3
CO-5	Students may be able to get the knowledge on application of these techniques in the complete structural analysis of nanomaterials	3

UNIT-I: SCANNING ELECTRON MICROSCOPY 12 h

Basic design of the scanning electron microscopy – Modes of operation– Backscattered electrons – secondary electrons- X-rays – typical forms of contrast– Resolution and contrast – enhancement – Specimen Preparation, Replicas Various-application of SEM.

UNIT-II: TRANSMISSION ELECTRON MICROSCOPY: 12 h

Basic principles - Modes of operation – Specimen preparation – Diffraction in imperfect crystals – Dislocations – precipitates – Structure of Grain boundaries and interfaces- HRTEM use in nanostructures.

UNIT-III: SIZE AND COMPOSITION MEASUREMENT 12 h

Dynamic light scattering technique, principle, instrumentation, measurement of particle size measurement, UV-Visible band gap measurement

Determination of composition: XPS, EDX and elemental mapping

UNIT-IV: ATOMIC FORCE MICROSCOPY 12 h

Basic concepts-Interaction force-AFM and the optical lever- Scale drawing- AFM tip on nanometer scale structures- force curves, measurements and manipulations-feedback control-different modes of operation –contact, non-contact and tapping mode-Imaging and manipulation of samples in air or liquid environments-Imaging soft samples.

UNIT-V: X-RAY POWDER DIFFRACTION AND POROSITY 12 h

Powder diffraction technique – Determination of accurate lattice parameters – indexing of planes – profile analysis – particle size analysis using Scherrer's formula, use of origin, JCPDF, Expert high score in XRD analysis.

Surface area and Porosity- BET adsorption isotherm, classification of isotherms, adsorption-desorption hysteresis, calculation of pore size, surface area, pore volume, instrumentation.

REFERENCE BOOKS:

1) J.Goldstein, D. E. Newbury, D.C. Joy, and C.E. Lym, "Scanning Electron Microscopy and X-ray Microanalysis", 2003.
2) S.L. Flegler, J.W. Heckman and K.L. Klomparens, "Scanning and Transmission Electron Microscopy: A Introduction", WH Freeman & Co, 1993.
3) P.J.Goodhew, J.Humphreys, R.Beanland, "Electron Microscopy and Analysis",
4) R.Haynes, D.P.Woodruff and T. A. Talchar, "Optical Microscopy of Materials", Cambridge University press, 1986.
5) B.D. Cullity, "Elements of X-ray Diffraction", Addison Wiley-1978.
6) Characterization of nanomaterials: Advances and Technologies by Sneha Mohan Bhagyaraj,
7) Text book of Nanoscience and Nanotechnology, B S Moorthy, Springer & Universities Press-IIM Series.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	2	3
CO-2	2	2	3	2	2
CO-3	3	2	3	2	3
CO-4	2	2	2	3	3
CO-5	2	2	3	2	3

SEMESTER-VIII

IV Year II Semester /VIII Semester/ II Semester (Lateral Entry)

R22NT804A: PHYSICS AND CHEMISTRY OF MATERIALS

(ELECTIVE–A)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must learn various types of Materials	1
CO-2	Students must learn and practice synthetic methods of composites	2
CO-3	Students must learn and understand the properties and practical applications of ceramics	3
CO-4	Students will understand the principles of polymers and electronics	2
CO-5	Students must apply the concepts of synthesis, properties and applications in the development of new materials	3

Unit-I **12 h**

Classification of materials: Types of materials, Metals, Ceramics, composites, polymers, semiconductors.

Composites

Types of composite materials, the concept of load transfer, matrix materials - polymers, metals and ceramics, Reinforce materials – fibers, glass, carbon, organic and metallic fibers, fiber packing arrangements, particle reinforced composites, fiber reinforced composites, structural composites, synthesis and applications.

Unit-II **12 h**

Fabrication of composites

Polymer matrix composites – liquid resin impregnation routes, pressurized consolidation of resin pre-pregs, consolidation of resin moulding compounds, injection moulding of thermoplastics, hot press moulding of thermoplastics – metal composites – squeeze infiltration, stir casting, spray deposition, powder blending and consolidation, diffusion bonding of foils, physical vapour deposition – ceramic composites – powder based routes, reactive processing, layered ceramic composites, carbon/carbon composites.

Unit-III **12 h**

Ceramics

Ceramics based on clay raw materials

Porcelain, Earthenware, Stoneware, Bricks and related products.

STRUCTURAL CERAMICS Oxide ceramics (MgO-Al_2O_3-SiO_2),– zirconia, alumina, silica, magnesia and, titania, mullite – carbides – silicon carbide, boron carbide, tungsten carbide, titanium carbide – nitrides – silicon nitride, boron nitride, titanium nitride, borides, filicides, - sialon.

ELECTRONIC-CERAMICS Ceramic insulators and capacitors – ferroelectric ceramics – barium titanate, PZT, PLZT materials – magnetic ceramics – spinal ferrites, zinc ferrites, garnets – superconducting ceramics – varistors and fuel cells.

GLASS CERAMICS

Principles of controlled crystallization, Main types of technical glass ceramics, Glass-ceramics from cheap natural and waste raw materials

Unit-IV **12 h**

Polymers

Classification of polymers, chemistry of polymerization, chain polymerization, step polymerization, coordination polymerization – Preparation and industrial application of polyethylene, PVC, Teflon, polyacrylonitrile, terylene and Nylon66. Introduction to biodegradability, tacticity.

Molecular weight of polymers-number average and weight average molecular weight, degree of polymerization, determination of molecular weight of polymers by viscometry, Osmometry and light scattering methods, amorphous state, glass transition temperature, the crystalline state.

Unit-V **12 h**

Transport properties

Non- stoichiometry: Preliminary aspects, Defects in solids: Stoichiometric and non-stoichiometric defects - point defects - Schottky and Frenkel defects and properties- colour centres. Electronic conductors – metals, semiconductors, superconductors - Ionic conductors – fast ion conductors, solid electrolytes, mixed conductors- measurements - two and four probe measurements, impedance measurements.

REFERENCE BOOKS:

1) Poole C P and Owens F J, Introduction to Nanotechnology, Wiley-Interscience 2003.
2) Chawla K Krishnan, Composite Materials –Science and Engineering, Springer, 2012.
3) Robert J. Young and Peter A. Lovell, Introduction to Polymers, 3rd Ed., CRC Press, 2011.
4) Bradley D. Fahlman, Materials Chemistry, 2nd Ed., Springer, 2011.
5) Organic Chemistry by P Y Bruice
6) Physical Chemistry by Puri & Sharma

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	2	2
CO-2	2	2	3	2	2
CO-3	3	2	2	2	3
CO-4	2	2	3	3	2
CO-5	2	2	3	2	3

SEMESTER-VIII

IV Year II Semester /VIII Semester/ II Semester (Lateral Entry)

R22NT804B: ADVANCED QUANTUM MECHANICS (ELECTIVE–B)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students may be able to understand the Molecular quantum mechanics	1
CO-2	Students may be able to learn the analogy of perturbation theory and application	2
CO-3	Students may be able to learn about emission and scattering	3
CO-4	Students may be able to understand the 4-dimensional space in Quantum Mechanics	3
CO-5	Students may be able to understand the application to Molecular Orbital theory	3

Unit 1 **(12h)**

Symmetry Transfermations, Translation in space: Conservation of linear momentum, Rotation in space: Conservation of angular momentum, Space inversion: Parity conservation, Time reversal;

Unit 2 **(12h)**

General Angular momentum, Angular momentum matrices, Basic concept of Time independent perturbation theory, spin-orbit interaction, WKB method

Unit 3 **(12h)**

Introduction to Time dependent perturbation theory, Absorption and Emission of Radiation, Einsteins A and B coefficients, Raman scattering; Rayleigh scattering,

Unit 4 **(12h)**

Klein-Gordon Equation, Dirac's equation for a free particle, Dirac Matrices, probability density, plane wave solution, Negative energy states, Lamb shift

Unit 5 **(12h)**

Born-Oppenheimer Approximation, Molecular Orbital Method, MO treatment of Hydrogen molecule, Valance bond method, refinements of simple MO and VB approximations, Directed Bonds, Hybridization

TEXT BOOK:

1) Quantum Mechanics by G Aruldhas

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	2	2	2
CO-2	2	2	3	3	3
CO-3	2	2	3	2	3
CO-4	2	2	2	3	3
CO-5	3	2	3	2	3

SEMESTER-VIII

IV Year II Semester /VIII Semester/ II Semester (Lateral Entry)

R22NT804C: MATHEMATICS-IX (ELECTIVE–C) (MATHEMATICAL SPECIAL FUNCTIONS)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must understand the Beta and Gamma functions, their properties and relation between these two functions, understand the orthogonal properties of Chebyshev polynomials and recurrence relations.	1
CO-2	Students must find power series solutions of ordinary differential equations.	2
CO-3	Students must be able to solve Hermite equations and write the Hermite Polynomial of order (degree) n, also find the generating function for Hermite Polynomials, study the orthogonal properties of Hermite Polynomials and recurrence relations.	2
CO-4	Students must be able to solve Legendre equation and write the Legendre equation of the first kind, also find the generating function for Legendre Polynomials, understand the orthogonal properties of Legendre Polynomials.	3
CO-5	Students must be to solve Bessel equation and write the Bessel equation of first kind of order n, also find the generating function for Bessel function and understand the orthogonal properties of Bessel function.	3

Unit – 1: Beta and Gamma functions, Chebyshev polynomials (12h)

Euler's Integrals-Beta and Gamma Functions, Elementary properties of Gamma Functions, Transformation of Gamma Functions. Another form of Beta Function, Relation between Beta and Gamma Functions. Chebyshev polynomials, orthogonal properties of Chebyshev polynomials, recurrence relations, generating functions for Chebyshev polynomials.

Unit – 2: Power series and Power series solutions of ordinary differential equations (12h)

Introduction, summary of useful results, power series, radius of convergence, theorems on Power series, Introduction of power series solutions of ordinary differential equation,Ordinary and singular points, regular and irregular singular points, power series solution.

Unit – 3: Hermite polynomials (15h)

Hermite Differential Equations, Solution of Hermite Equation, Hermite polynomials, generating function for Hermite polynomials. Other forms for Hermite Polynomials, Rodrigues formula for Hermite Polynomials, to find first few Hermite Polynomials. Orthogonal properties of Hermite Polynomials, Recurrence formulae for Hermite Polynomials.

Unit – 4: Legendre polynomials (12h)

Definition, Solution of Legendre's equation, Legendre polynomial of degree n, generating function of Legendre polynomials. Definition of Pn(x) and Qn(x), General solution of Legendre's Equation (derivations not required) to show that Pn(x) is the coefficient of $\square^n$, in the expansion of $(1 - 2x\square + \square^2)^{\frac{-1}{2}}$,Orthogonal properties of Legendre's polynomials, Recurrence formulas for Legendre's Polynomials.

Unit – 5: Bessel's equation (12h)

Definition, Solution of Bessel's equation, Bessel's function of the first kind of order n, Bessel's function of the second kind of order n. Integration of Bessel's equation in series form=0, Definition of Jn(x), recurrence formulae for Jn(x). Generating function for Jn(x), orthogonally of Bessel functions.

CO-CURRICULAR ACTIVITIES:

Seminar/ Quiz/ Assignments/ Linear algebra and its applications / Problem Solving.

REFERENCE BOOKS:

1) Dr.M.D.Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Company Pvt. Ltd., Ram Nagar, New Delhi-110055.
2) J.N.Sharma and Dr.R.K.Gupta, Differential equations with special functions, Krishna Prakashan Mandir.
3) Shanti Narayan and Dr.P.K.Mittal, Integral Calculus, S. Chand & Company Pvt. Ltd., Ram Nagar, New Delhi-110055.
4) George F.Simmons, Differential Equations with Applications and Historical Notes, Tata McGRAW-Hill Edition, 1994.
5) Shepley L.Ross, Differential equations, Second Edition, John Willy & sons, New York, 1974.
6) Web resources suggested by the teacher and college librarian including reading material.

IV. CO-CURRICULAR ACTIVITIES:

A) MANDATORY:

For Teacher: Teacher shall train students in the following skills for 15 hours,

I) By taking relevant outside data (Field/Web).

1) Beta and Gamma functions, Chebyshev polynomials.
2) Power series, power series solutions of ordinary differential equations,
3) Procedures of finding series solutions of Hermite equation, Legendre equation and Bessel equation.
4) Procedures of finding generating functions for Hermite polynomials, Legendre Polynomials and Bessel's function.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	3	2	2	2
CO-2	2	2	3	2	2
CO-3	3	2	3	2	3
CO-4	2	3	2	3	3
CO-5	2	3	3	2	2

SEMESTER-VIII

IV Year II Semester OR VIII Semester OR Second Semester (Lateral Entry)

PRACTICAL-I:

R22NTP805: MATERIALS PHYSICS LAB

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

SEMESTER-VIII

IV Year II Semester OR VIII Semester OR Second Semester (Lateral Entry)

PRACTICAL-II:

R22NTP806: NANOMETERIALS LAB – II:

(SYNTHESIS AND CHARACTERIZATION)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

OBJECTIVES:

1) Students are introduced with simple characterization techniques
2) Students will understand the sample preparation to collect the data for the prepared samples
3) Students are introduced to data analysis apps
4) Students will acquire skills in characterization of various nanomaterials

1) Synthesis of Ag, Au nanoparticles through green chemistry methods and their optical properties using UV-Visible spectroscopy
2) Synthesis of SiO_2 and TiO_2 through sol-gel technique and their XRD analysis
3) Synthesis of RGO using chemical and green reduction methods, its analysis through SEM, TEM and Raman techniques
4) Contact angle measurement experiment.
5) Use of origin software for data processing
6) Determination of Particle size using XRD technique and DLS
7) Synthesis of semiconducting nano structured materials by co-precipitation technique and to calculate the absorption coefficient & optical bandgap using UV-Vis spectrometer

SEMESTER-VIII

IV Year II Semester OR VIII Semester OR Second Semester (Lateral Entry)

PRACTICAL-III:

R22NTP807: COMPREHENSIVE VIVA- VOCE

(VII & VIII SEMESTERS)

University Exam: 3 hours Internal Marks: 0 University Examination Marks: 50

1) The students will be analyzed with questions covering VII & VIII semester topics.

NINTH SEMESTER

M.Sc. NANOTECHNOLOGY

SEMESTER-IX

V Year I Semester /IX Semester/ III Semester (Lateral Entry)

R22NT901: CONDENSED MATTER PHYSICS

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students may be able to learn the properties of crystalline and amorphous materials	1
CO-2	Students may be able to understand the energy and defects of solid materials	2
CO-3	Students may be able to get the knowledge about Dielectrics and Ferroelectrics	3
CO-4	Students may be able to understand and learn about defects of solids and origin and evaluation of colour centers	3
CO-5	Students may be able to learn and get knowledge about applications of Various crystal growth techniques	3

UNIT – 1 **12 h**

Defects: Properties of metallic lattices and simple alloys: The structure of metals – classification of lattice defects. Configurational -entropy –The number of vacancies and interstitial as function of temperature –The formation of lattice defects in metals. Edge and screw dislocation The Frank read mechanism of dislocation multiplication.

UNIT – 2 **12 h**

Macroscopic description of the static dielectric constant, The static electronic and ionic polarizabilities of molecules, Orientational Polarization, The internal field according to Lorentz, The static dielectric constant of solids, Clasius -Mosetti equation The complex dielectric constant and dielectric losses, Dielectric losses and relaxation time, Cole-Cole diagrams. The classical theory of electronic polarization and optical absorption.

UNIT – 3 **12 h**

Ferroelectric : General properties of ferroelectric materials. Classification and properties of representative ferroelectrics, the dipole theory of ferroelectricity, objections against the dipole theory; Ferroelectric domains.

UNIT – 4 **12 h**

Optical and thermal electronic excitation in ionic crystals, The ultraviolet spectrum of the alkali halides; excitons, Illustration of electron-hole interaction in single ions, Qualitative discussion of the influence of lattice defects on the electronic levels; The transformation of F centers into F1 centers and vice-versa, Photoconductivity in crystals containing excess metal; Color centers resulting from excess halogen, Color centers produced by irradiation with X-rays. Luminescence General remarks, Excitation and emission, Decay mechanisms, The sulfide phosphors, Electroluminescence.

UNIT – 5 **12 h**

Bridgeman-Czochralski-liquid encapsulated czochralski (LEC) growth technique-zone refining and floating zone growth-chemical vapour deposition (CVD)-Molecular beam epitaxy (MOVPE)-vapour phase epitaxy-hydrothermal growth-Growth from melt solutions-Flame fusion method.

TEXT BOOKS:

1) Solid State Physics by AJ Dekker
2) Solid State Physics by S.O.Pillai
3) Engineering Physics by Avadhanulu

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	3	2	3	3
CO-2	2	3	3	3	2
CO-3	3	3	2	2	3
CO-4	2	3	3	3	3
CO-5	2	2	3	3	3

SEMESTER-IX

V Year I Semester /IX Semester/ III Semester (Lateral Entry)

R22NT902: ELECTROMAGNETIC THEORY

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must learn the interaction of Electric, Magnetic and Electromagnetic interaction on a charged particle	1
CO-2	Students must be able to develop a solid understanding of magnetic fields on conductors, semiconductors and insulators	2
CO-3	Students must learn effect of electromagnetic fields	3
CO-4	Students must be able to evaluate electromagnetic fields on different media	2
CO-5	Students must be able to analyze and use the applications of electromagnetic in various fields	3

UNIT – 1 **12 h**

Del operator in cylindrical and spherical coordinates, Colomb's law, Gauss's law, Continious charge distribution, Potenial energy of a system of charges, dipole in a uniform electric field, multipole expansion of potential due to a charge distribution.

UNIT – 2 **12 h**

Two postulates and Biot Savart's law, Ampere's circuital law, Magnetic field due to current in a cylindrical conductor of finite diameter, Magnetic Scalar potential, Magnetic Vector potential, magnetic vector potential due to magnetic dipole, electromotive force, Faraday's law, Energy stored in a magnetic field

UNIT – 3 **12 h**

Equation of continuity, Maxwell equations in some particular cases, electromagnetic energy and Poynting theorem, Poynting vector, Electromagnetic waves-in free space, EM waves in nonconducting isotropic medium, EM waves in conducting medium

UNIT – 4 **12 h**

Waveguides, types of propagation:TM, TE and TEM modes, application of waveguides; Electromagnetic vector and scalar potentials Larentz gauge, Coulomb gauge, spherical waves

UNIT – 5 **12 h**

Retarded Potentials; Lienard-Wiechert Potentials-Point charge, Distribution of charges; development of radiation from an oscillating dipole; radiation from a thin linear antenna; Propagation of Radio waves-Types of wave propagation, propagation of ground waves, space waves, atmospheric effects on space wave propagation

TEXT BOOKS:

1) Electromagnetic field theory and wave propagation by Uma Mukharji
2) Electromagnetic theory and Electrodynamics by Satya prakash
3) Electromagnetic theory fundamentals by Huserjin Hiziroglu
4) Electromagnetic theory and applications AK Saxena

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	2	3	2
CO-2	2	3	3	2	2
CO-3	2	2	2	2	3
CO-4	2	2	2	3	3
CO-5	2	2	3	2	3

SEMESTER-IX

V Year I Semester /IX Semester/ III Semester (Lateral Entry)

R22NT903A: CHEMICAL AND BIOSENSORS (ELECTIVE–A)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students may be able to understand engineering principles, processes and extend to sensor development	1
CO-2	Students may be able to learn the concept of various chemical, electrochemical and biosensors.	2
CO-3	Students may be able to get the knowledge on the principles of gas sensors used in industries such as automobile, textile, chemical, mining *etc.*	3
CO-4	Students may be able to understand about wide range of chemical sensing methods and material characteristics applied in biosensors.	3
CO-5	Students may be able to learn and apply these principles to design and fabricate sensors for various industrial applications	3

Unit-I **12 h**

Basics of Sensors, Data Analysis and Transduction

Basics of sensing, sensor elements, Characteristics, data analysis, error and statistical analysis. Resolution, sensitivity. Elements of a Chemical Sensor, Electrochemical Transducers – Introduction, Potentiometry and Ion-Selective Electrodes: The Nernst Equation, Voltammetry and Amperometry, Conductivity, Field-Effect Transistors, Modified Electrodes, Thin-Film Electrodes and Screen-Printed Electrodes, Photometric processes, Ultraviolet and Visible Absorption Spectroscopy, Fluorescence Spectroscopy, Luminescence Optical Transducers Device Construction.

Unit-II **12 h**

Sensing elements

Ionic Recognition, Molecular Recognition - Chemical Recognition Agents: Thermodynamic - Complex Formation, Kinetic-Catalytic Effects, Kinetic Selectivity, Molecular Recognition - Spectroscopic Recognition, Molecular Recognition - Biological Recognition Agents.

Performance Indicators

Selectivity: Ion-Selective Electrodes, Enzymes, Antibodies, Receptors and Others, Sensitivity: Range, Linear Range and Detection Limits, Time Factors: Response Times, Recovery Times and Lifetimes Precision, Accuracy and Repeatability, Factors Affecting the Performance of biosensors: Amount of Enzyme, Immobilization Method, pH of Buffer.

Unit-III **12 h**

Chemi-resistive, Potentiometric and Amperometric Sensors

Fundamentals of Chemi-resistive sensors, parameters involved. Potentiometric Sensors - Ion-Selective Electrodes: Examples of Ion-Selective Electrodes, Gas Sensors - Gas-Sensing Electrodes. Potentiometric Biosensors: pH-Linked, Ammonia-Linked, Carbon Dioxide-Linked, Iodine-Selective, Silver Sulfide-Linked. Amperometric Sensors: Direct Electrolytic Methods, The Three Generations of Biosensors, First Generation - The Oxygen Electrode, Second Generation – Mediators, Third Generation - Directly Coupled Enzyme Electrodes, NADH/NAD+, Examples of Amperometric Biosensors, Amperometric Gas Sensors.

Unit-IV **12 h**

Conductivity Sensors and Capacitive Sensors

Biosensors, Semiconducting Oxide Sensors, Resistive and Capacitive Gas Sensors: Gas Sensors Based on Polycrystalline Semiconductors, Polymers and Gels, Resistive and Capacitive Sensors for Liquids. Chemically Sensitive Field-Effect Transistors (CHEMFETs), Ion-Selective Field-Effect Transistors (ISFETs), FET-Based Biosensors (ENFETs).

Unit-V **12 h**

Optical Sensors and Biosensors

Optical Fibres as a Basis for Optical Sensors, Fibre Sensors Without Chemical Receptors (Mediators), Optodes: Fibre Sensors with a Chemical Receptor, Optodes with Simple Receptor Layers, Optodes with Complex Receptor Layers, Sensors with Planar Optical Transducers: Surface Plasmon Resonance and Resonant-Mirror Prism Couplers, Optical Biosensors: Optical Enzyme Sensors, Optical Bio-affinity Sensors, Optical DNA Sensors.

Mass-Sensitive Sensors and Thermal Sensors

The Piezo-Electric Effect: Principles, Gas Sensor Applications, Biosensor Applications, The Quartz Crystal Microbalance, Surface Acoustic Waves, Plate Wave Mode, Evanescent Wave Mode, Lamb Mode, Thickness Shear Mode, Thermal Sensors: Thermistors, Catalytic Gas Sensors, Thermal Conductivity Devices. Lithographic methods for sensor fabrication.

REFERENCE BOOKS:

1) B. R. Eggins, *Chemical Sensors and Biosensors*, 1st Edition, John Wiley Sons Ltd, 2010.
2) P. Grundler, *Chemical Sensors: Introduction for Scientists and Engineers*, 1st Edition, Springer, New York, 2007.
3) J. Janata, *Principles of Chemical sensors*, 2nd Edition, Springer, 2014.
4) F.-G. Banica, *Chemical Sensors and Biosensors Fundamentals and Applications*, 1st Edition, John Wiley Sons Ltd, 2012.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	2	2	2
CO-2	3	2	3	2	3
CO-3	2	3	3	2	3
CO-4	2	3	2	3	3
CO-5	3	3	3	2	3

SEMESTER-IX

V Year I Semester /IX Semester/ III Semester (Lateral Entry)

R22NT903B: ADVANCED CHARACTERIZATION OF NANOMATERIALS (ELECTIVE–B)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must understand and apply the principles of electron spectroscopy	1
CO-2	Students must learn and apply advanced imaging and synthesis techniques	2
CO-3	Students must learn and apply mechanical and electrical properties of nanomaterials	3
CO-4	Students must understand and learn the principles of SERS and Fluorescence spectroscopy techniques	2
CO-5	Students must apply these concepts for real time samples	3

UNIT-I: **12 h**

Understanding of micro structural developments in nanomaterials using optical microscopy. Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) approach. High resolution Transmission Electron Microscopy (HRTEM).

UNIT-II: **12 h**

Characterizing nanomaterials using techniques based on scanning probe microscopy principle namely Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM), Magnetic Force Microscopy (MFM) etc. Chemical Force Microscopy (CFM), Focused Ion Beam (FIB), Nanolithography.

UNIT-III: **12 h**

Magnetic measurements using vibrating sample magnetometer (VSM)- magnetic force microscopy (MFM) - Electron Paramagnetic Resonance (EPR)-Nuclear Magnetic Resonance (NMR) spectroscopy – Mechanical properties-micro hardness - nanoindentation, elastic and plastic deformation- fracture toughness, superplasticity.

UNIT-IV: **12 h**

I-V/C-V - Hall - Quantum Hall effects - Kelvin-probe measurements – Seebeck coefficient measurements, measurement of resistivity and band gap by four-point probe method, Deep leevl transient spectroscopy (DLTS) - FET characteristics, SQUID

UNIT-V: **12 h**

SERS – principle, SPR effect, enhancement mechanisms, hot spots, SERS labels, structure, applications

Fluorescence-Principle, instrumentation and applications to nanomaterials.

REFERENCE BOOKS:

1) The structure and properties of materials by R.M.Rose, L.A.Shepard and J. Wulff, Wiley Eastern Ltd., 1966.
2) Semiconductor Devices – Physics and Technology by S.M. Sze, Wiley, 1985.
3) Semiconductor Material and Device Characterization by D. K. Schroder, John Wiley & Sons,New York, 1998.
4) Encyclopedia of Materials Characterization by C. Richard Brundle Charles A. Evans, Jr.Shaun Wilson ,Butterworth-Heinemann, 1992.
5) Modern Raman Spectroscopy: A Practical Approach by E Smith and G Dent.
6) Surface area and Porosity-Surface area and porosity determinations by Physisorption, JB Condon, Elsevier publications
7) SERS-Coordination Chemistry Reviews 371 (2018) 11-37, Chemical Reviews 118, 2018, 4946-4980, Chemical Reviews 2015, 10489-10529, CRC book chapter,2021-SERS nanomaterials for nano-device processing in cancer diagnosis.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	2	2	3
CO-2	2	2	3	2	2
CO-3	3	2	2	2	3
CO-4	2	2	2	3	3
CO-5	3	2	3	3	3

SEMESTER-IX

V Year I Semester /IX Semester/ III Semester (Lateral Entry)

R22NT903C: SUPERCONDUCTIVITY (ELECTIVE–C)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students may be able to understand the Basics to advanced superconductivity and its applications	1
CO-2	Students may be able to learn and understand the behaviour of superconductors	2
CO-3	Students may be able to understand and learn about type-2 superconductors	3
CO-4	Students may be able to analyze and evaluate superconductors in depth	3
CO-5	Students may be able to learn about various applications and importance of superconductors	3

Unit 1 **12h**

Critical Temperature; Low Temperatures, The Meissner Effect, Magnetic Field, Ideal Diamagnetism, Phase Transition

Unit 2 **12h**

Specific Heat, Two Types of Electrons, Critical Current, Penetration Depth of a Magnetic Field in Superconductor, The Influence of the Superconductor Shape on Magnetic Field Penetration and Superconducting Transition.

Unit 3 **12h**

The Intermediate State, Type I1 Superconductors, Vortices, Vortex Motion, Capture of Magnetic Flux, Influence of a Crystal Lattice.

Unit 4 **12h**

Phonons, Electron-Phonon Interaction, Formation of Electron Pairs, Boundary of a Superconductor, Two Basic Properties of Superconductors

Unit 5 **12h**

Applications of Superconductivity: Tempting but Difficult Magnets, Superconducting Wires, Applications of Superconducting Magnets, Josephson Effects. An Application of Weak Superconductivity - SQUIDS

TEXT BOOK:

1) Superconductivity by VL Ginzburg

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	2	2	2
CO-2	2	2	3	2	2
CO-3	3	2	2	2	3
CO-4	2	2	2	3	3
CO-5	2	2	3	2	2

SEMESTER-IX

V Year I Semester /IX Semester/ III Semester (Lateral Entry)

R22NT904A: CARBON NANOSCIENCE AND IT'S APPLICATIONS (ELECTIVE–A)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must learn the principles and structures of various carbon-based nanomaterials	1
CO-2	Students must learn principles in the synthesis and applications of these materials	2
CO-3	Students must apply the principles of Characterization to carbon-based nanomaterials	3
CO-4	Students must learn the applications of carbon-based materials	2
CO-5	Students must apply this knowledge in developing new carbon-based nanomaterials for new applications	3

Unit-I **12 h**

Introduction – Carbon molecules, classification, nature of the carbon bond, new carbon structures, discovery of C60-structure of C60 and its crystal, from a Graphene Sheet to a Nanotube, Single wall and Multi walled Nanotubes, Zigzag and Armchair Nanotubes, Euler's Theorem in Cylindrical and Defective CNTs

Unit-II **12 h**

Structure of Higher Fullerenes, Growth Mechanisms; Production and Purification- Fullerene Preparation by Pyrolysis of Hydrocarbons, Partial Combustion of Hydrocarbons, Arc Discharge Methods, Production by Resistive Heating, Rational Synthesis; Physical Properties, Spectroscopic Properties, Thermodynamic Properties; Chemical Properties- Hydrogenation and Halogenation, Nucleophilic Addition to Fullerenes.

Unit-III **12 h**

The Structure of Carbon Nanotubes- Nomenclature, Structure of Single-Walled Carbon Nanotubes and Structure of Multiwalled Carbon Nanotubes; Structure and Production of Further Tubular Carbon Materials- Spectroscopic Properties of Carbon Nanotubes- Raman and Infrared Spectroscopy of Carbon Nanotubes, Absorption and Emission Spectroscopy of Carbon Nanotubes, ESR-Spectroscopic Properties of Carbon Nanotubes.

Unit-IV **12 h**

Graphene, GO, RGO, Structure of graphene; Preparation of graphene – synthesis of graphene by various physical and chemical methods and Purification; Electronic Properties, Band Structure of Graphene - Mobility and Density of Carriers - Quantum Hall Effect - Spectroscopic Properties of graphene -UV-Visible, XRD, Raman,

Unit-V **12 h**

Applications: Application of Fullerene, CNT, Graphene and other carbon nanomaterials Mechanical, Thermal Applications, Electronic Applications, Raman SERS and biological Applications.

REFERENCE BOOKS:

1) Carbon Nanotubes: Properties and Applications- Michael J. O'Connell.
2) Carbon Nanotechnology- Liming Dai.
3) Nanotubes and Nanowires- CNR Rao and A Govindaraj RCS Publishing.
4) Physical properties of Carbon Nanotube-R Satio.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	2	2	3
CO-2	2	3	3	2	3
CO-3	3	3	3	2	3
CO-4	2	3	3	2	3
CO-5	3	3	3	2	3

SEMESTER-IX

V Year I Semester /IX Semester/ III Semester (Lateral Entry)

R22NT904B: ENVIRONMENTAL NANOTECHNOLOGY AND BIOSAFETY

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Learn the principles of environmental toxicity	1
CO-2	Learn the principles and toxicity nature of nanomaterials	2
CO-3	Learn the Environmental applications of nanomaterials	3
CO-4	Learn the remediation technologies to minimize the toxicology of nanomaterials	3
CO-5	Apply the principles of nanomaterials to environmental toxicity and bio toxicity	3

UNIT-I: Introduction **12 h**

Overview of physical, chemical and biological processes concerning the environment; types, transport and transformation processes of contaminants in air, water and soil; effects of contaminants on environment. Environmental impacts of nanomaterials - Exposure and risk assessment, Dose-response, mechanisms of toxicity; ecotoxicological impacts of nanomaterials.

UNIT-II: Environmental applications of nanomaterials **12 h**

Mechanism for remediation of aqueous contaminants, photocatalyst; membranes incorporating nanomaterials, transport processes in membrane technology; nanomaterial based adsorbents for water and wastewater treatment – adsorption at metal oxide surfaces, hybrid adsorbents; case studies. Hierarchical self-assembled nano-structures and nanomaterials for adsorption of heavy metals.

UNIT-III: **12 h**

Analytical methodologies for studying impact of nanomaterials in environment – Atomic absorption spectrometry, inductively coupled plasma spectrometry, chromatography, thermal methods, hyphenated techniques.

UNIT-IV: Biotoxicity **12 h**

entry routes for nanoparticles in the human body: lungs, intestinal tract and skin, Deposition and translocation in the body, Attributes contribute to nanomaterials toxicity.

nanoparticles interaction with the biological membrane, uptake and toxicological effects of different nanoparticles.

Mechanisms of nanomaterial toxicity: oxidative stress, ecotoxicity, genotoxicity, hemolytic toxicity, mutagenicity and immunotoxicity.

UNIT-V: Biotoxicity analysis **12 h**

Assessment of nanomaterial toxicity: In vitro toxicity assessment-cell viability, lactate dehydrogenase release, reactive oxygen species generation, change in mitochondrial membrane potential and nuclear fragmentation. In vivo toxicity assessment: inflammatory response, acute toxicity studies, LD50 determination, histopathological studies.

REFERENCE BOOKS:

1) Wiesner, M.R., and Bottero, J.Y. (Ed.) "Environmental Nanotechnology: Applications and Impacts of Nanomaterials" McGraw-Hill, New York. 2007
2) Diallo, M., Duncan, J., Savage, N., Street, A., and Sustich, R. (Eds). "Nanotechnology Applications for Clean Water" William Andrew. 2008
3) Lead J., and Smith, E. "Environmental and Human Health Impacts of Nanotechnology" John Wiley & Sons. 2009
4) Skoog, D.A., Holler, F.J., and Crouch S.R. "Instrumental Analysis" Clenage Learning India Private Limited, New Delhi. 2007
5) Masters, G.M. and Ela, W.P. "Introduction to Environmental Engineering and Science" Prentice Hall. 2007

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	2	3
CO-2	2	3	3	3	3
CO-3	3	3	3	3	2
CO-4	2	2	2	3	3
CO-5	3	2	2	3	3

SEMESTER-IX

V Year I Semester /IX Semester/ III Semester (Lateral Entry)

R22NT904C: BASICS OF NANOTECHNOLOGY (ELECTIVE–C)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must learn the basics in Nanotechnology - history, basic nanostructures and properties	1
CO-2	Students must learn and apply various chemical synthesis methods of nanomaterials	2
CO-3	Students must learn and apply various physical synthesis methods of nanomaterials	2
CO-4	Students must learn and apply various characterization techniques of nanomaterials	3
CO-5	Students must learn and apply characterization of properties of nanomaterials such as porous natures, composition and bandgap	3

UNIT-I: Background and history of Nano-World **12 h**

Emergence of Nanoscience with special reference to Feynman and Drexler; Concept of confinement, strong and weak confinement with suitable example; Basic concept of quantum well, quantum wire and quantum dot. Concept of Surface and Interfacial Energies.

Size effect of Nanomaterials: Role of particle size - Size, shape, density, melting point, specific surface area and band gap variation.

UNIT-II: Synthesis-1 **12 h**

Introduction, top-down and bottom-up approaches, nucleation, growth mechanics, confined nucleation and/or growth, templated nucleation and/or crystallization. chemical reduction, co-precipitation, Nanocrystals of semiconductors by arrested precipitation, emulsion synthesis. sol-gel method, solvothermal and hydrothermal routes, solution combustion synthesis,

UNIT-III: Synthesis-2 **12 h**

Synthesis-2: ball milling, Vacuum synthesis, Inert gas condensation, sputtering, physical vapour deposition, Chemical Vapor Deposition. laser ablation, Lithography.

Template based synthesis of nanomaterials, Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films.

Principles of green chemistry, use of biomolecules, plant extracts for nanoparticle synthesis.

UNIT-IV: Characterization Techniques-1 **12 h**

XRD-principle, instrumentation, analysis

SEM-principle, instrumentation, sample-electron interactions

TEM-principle, instrumentation, sample-electron interactions

AFM- principle, instrumentation, different modes

UNIT-V: Characterization Techniques-1I **12 h**

Surface area and Porosity- BET adsorption isotherm, classification of isotherms, adsorption-desorption hysteresis, calculation of pore size, surface area, pore volume, instrumentation.

Dynamic light scattering technique, principle, instrumentation, measurement of particle size, UV-Visible band gap measurement.

Determination of composition: XPS, EDX and elemental mapping.

REFERENCE BOOKS:

1) Nanoworld: An introduction to Nanoscience and Nanotechnology, by CNR Rao
2) Introduction to Nanotechnology by Charles P. Poole Jr and Frank J. Owens. Wiley India Pvt Ltd.
3) Encyclopedia of Nanotechnology by M.Balakrishna Rao and K.Krishna Reddy, Vol I to X, Campus books.
4) Encyclopedia of Nanotechnology by H.S. Nalwa
5) Nano: The Essentials – Understanding Nano Scinece and Nanotechnology – by T. Pradeep; Tata Mc.Graw Hill

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	2	3
CO-2	2	3	3	3	3
CO-3	3	3	3	2	2
CO-4	2	3	3	3	3
CO-5	3	2	3	2	3

SEMESTER-IX

V Year I Semester OR IX Semester OR Third Semester (Lateral Entry)

PRACTICAL-I:

R22NT905: CONDENSED MATTER PHYSICS LAB

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

SEMESTER-IX

V Year I Semester OR IX Semester OR Third Semester (Lateral Entry)

PRACTICAL-II:

R22NT906: NANOMETERIALS LAB – III:

(KNOWLEDGE ON LATEST RESEARCH TOPICS)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

OBJECTIVES:

1) Students will take literature review
2) Students will attend seminars/conferences
3) Students learn writing scientific reports

SYLLABUS:

Students are introduced to selection of a research topic and literature review on papers published in the last 5 years and prepare a report

1) Students are encouraged to attend minimum 2 seminars/conferences and prepare a report
2) Students are encouraged to visit 2 research labs from premier institutions and prepare a report
3) Students must submit a report of about 10 – 20 pages and attend a viva for final evaluation.
4) Students must give a seminar for 10 min on this topic.
5) The performance of the student shall be evaluated based on the three reports, seminar and viva by internal committee.

TENTH SEMESTER

M.Sc. NANOTECHNOLOGY

SEMESTER-X

V Year II Semester /X Semester/ IV Semester (Lateral Entry)

R22NT1001: NUCLEAR AND PARTICLE PHYSICS

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must develop a solid understanding on the concepts of nuclear structure of radiation.	1
CO-2	Students must develop a solid understanding on the concepts of radioactivity, decays and detection of radiation.	2
CO-3	Students must develop a solid understanding on the concepts of decays of radiation.	3
CO-4	Students must develop a solid understanding on the concepts of detection of radiation.	2
CO-5	Students must analyze and apply the concepts of nuclear physics and elementary particles	3

UNIT – 1 **12h**

Nuclear structure, nuclear forces, nuclear stability, Mass defect and packing fraction, Nuclear Spin and Angular momentum of nucleus, Nuclear magnetic dipole moment, electric quadrupole moment, parity;

UNIT – 2 **12h**

Liquid drop model, semi-empirical mass formula, magic numbers, shell model collective model; Nuclear fission, energy released in fission, four factor formula, nuclear reactor, Nuclear fusion, conditions for maintained fusion reactions;

UNIT – 3 **12h**

Properties of alfa, beta and gamma rays, mean lifetime period of a radio element, half-life period radioactive dating, induced radioactivity, Alfa decay, Geiger Nuttal Law, range of alfa particles; Gamow's theory of alfa decay; Beta decay, beta ray spectra, explanation of continuous beta ray spectra, internal conversion,

UNIT – 4 **12h**

Gamma decay, Gamma ray spectra, Interaction of gamma rays with matter; Cyclotron, Synchro-cyclotron; Ionization Chamber, Geiger-Muller (GM) counter, Scintillation counter, Bubble chamber, production of neutrons, detection of neutrons, production and detection of gamma photons;

UNIT – 5 **12h**

Applications of Nuclear Techniques-Nuclear Magnetic Resonance, Determination of Nuclear Magnetic Moment, Radioactive tracer technique; Elementary particles, Classification of Elementary particles, properties of Leptons, Mesons, Baryons, Description of strange particles, Quarks and Gluons., Primary and Secondary cosmic rays

TEXT BOOKS:

1) Nuclear Physics by Satya Prakash
2) Fundamentals of Nuclear Physics by Jahan Singh
3) Nuclear Physics by Dr. D.P. Mittal
4) Modern Physics by R. Murugeshan
5) Nuclear Physics by G. Chatwal
6) Nuclear and Particle physics by Suresh Chandra and Mohit K Sharma

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	3	2	2	2
CO-2	2	3	3	3	3
CO-3	2	2	2	3	3
CO-4	3	3	3	3	2
CO-5	3	3	2	2	3

SEMESTER-X

V Year II Semester /X Semester/ IV Semester (Lateral Entry)

R22NT1002: ADVANCED PHYSICS

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must learn the complete profile of advanced Physics	1
CO-2	Students must develop a solid understanding on the concepts of various advanced functional materials	1
CO-3	Students must develop a solid understanding and applications of properties of materials	2
CO-4	Students must understand energy sources and applications	2
CO-5	Students must develop an advanced understanding of celestial bodies and theory of evaluation of universe	3

UNIT – 1 **12h**

Material science, Atoms, Molecules and Brownian motion, types of solid, polymer, Use of materials, Metals and alloys

UNIT – 2 **12h**

Deformation and dislocation, strengthening metals, cracks and fracture, fatigue and creep, composite materials

UNIT – 3 **12h**

Conduction in solids, Current and charge, Electrolysis, Electric cells, Thermoelectric effect; Heat and Internal Energy, Expansion of solids, thermal conductivity

UNIT – 4 **12h**

Energy sources, Energy transfer, Fuels and pollution, solar energy, wind energy, water power, Biofuels, Geothermal energy

UNIT – 5 **12h**

Forces of nature, Exchange nature of forces, Chaos theory, formation of solar system, Dark matter Future of Universe, Big-Bang theory

REFERENCE BOOKS:

1) Advanced Physics by Tom Duncan
2) Advanced Physics by

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	3	3	2	3
CO-2	2	2	3	3	2
CO-3	3	3	3	3	3
CO-4	2	3	3	2	2
CO-5	3	3	2	3	3

SEMESTER-X

V Year II Semester /X Semester/ IV Semester (Lateral Entry)

R22NT1003A: NANOMATERIALS FOR SUSTAINABLE ENERGY (ELECTIVE–A)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students may be able to understand and learn various green energy generation techniques	1
CO-2	Students may be able to understand the structure-composition-performance relationships of energy materials and devices	3
CO-3	Students may be able to learn and apply principles of prototype clean energy conversion & storage devices such as batteries, fuel cells	2
CO-4	Students may be able to understandand apply green hydrogen generation	3
CO-5	Students may be able to analyze and apply various electrocatalysis systems for clean energy production	3

Unit-I Introduction **12 h**

Nanotechnology for sustainable energy- Energy conversion process, indirect and direct energy conversion-Materials for light emitting diodes, batteries, catalytic reactors, solar energy, capacitors-fuel cells, Electrochemical cell, Faradays laws, electrode potential,

Unit-II Nanomaterials in Energy Conversion Systems **12 h**

Nanomaterials for fuel cells, Principles, proton exchange membrane fuel cell, direct methanol fuel cell, carbon material for energy storage, hydrogen storage in carbon nanotubes, use of nanoscale catalysts to save energy and increase the productivity in industry, Rechargeable batteries based on nanomaterials, Nano-electrochemical systems and novel microfluidic devices.

Unit-III Electrochemical Energy Storage Systems **12 h**

Batteries: Primary, Secondary, Lithium, solid-state and molten solvent batteries; Lead Lead acid batteries; Nickel Cadmium Batteries; Advanced Batteries. Role of carbon nano-tubes in electrodes, electrode materials-carbon and metal oxide based materials.

Principles of Photovoltaic energy conversion, types of Photovoltaic cells, dye sensitized and quantum dot sensitized voltaic cells, Perovskite based solar cells.

Unit-IV Hydrogen Energy **12 h**

Hydrogen Production Methods: from fossil fuels, electrolysis, thermal decomposition, photochemical, photocatalytic, hybrid; Hydrogen storage methods: metal hydrides, metallic alloy hydrides, carbon nano-tubes etc.

Unit-V Electrocatalysis **12 h**

Electrocatalysis – cell setup, electrodes, electrolyte; electrochemical characterization of catalysts – cyclic voltammetry, linear sweep voltammetry, electrochemical active surface area, faradaic efficiency, Electrocatalytic energy conversion reactions - hydrogen evolution reaction (HER) – Pt

based catalysts, oxygen evolution reaction (OER); electrochemical CO_2 reduction reaction (eCO_2RR) – different products produced from CO_2, formate giving catalysts, highly reduced carbon products - importance of copper.

REFERENCE BOOKS:

1) J. Twidell and T. Weir, Renewable Energy Resources, E & F N Spon Ltd, London, (1986).
2) Martin A Green, Solar cells: Operating principles, technology and system applications, Prentice Hall Inc, Englewood Cliffs, NJ, USA, (1981).
3) H J Moller, Semiconductor for solar cells, Artech House Inc, MA, USA, (1993).
4) Ben G Streetman, Solis state electronic device, Prentice Hall of India Pvt Ltd., New Delhi (1995).
5) M.A. Kettani, Direct energy conversion, Addision Wesley Reading, (1970).
6) Linden, Hand book of Batteries and fuel cells, Mc Graw Hill, (1984).
7) Hoogers, Fuel cell technology handbook. CRC Press, (2003).
8) Vielstich, Handbook of fuel cells: Fuel cell technology and applications, Wiley, CRC Press, (2003).
9) Giménez, S., & Bisquert, J. (2016). Photoelectrochemical solar fuel production. *From basic principle to advanced devices. Cham: Springer*.
10) Hori, Y. I. (2008). Electrochemical CO2 reduction on metal electrodes. *Modern aspects of electrochemistry*, 89-189.
11) Nitopi, S., Bertheussen, E., Scott, S. B., Liu, X., Engstfeld, A. K., Horch, S., ... & Chorkendorff, I. (2019). Progress and perspectives of electrochemical CO2 reduction on copper in aqueous electrolyte. *Chemical reviews*, *119*(12), 7610-7672.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	3	3	3	3
CO-2	3	3	3	3	2
CO-3	3	2	3	3	3
CO-4	2	3	3	2	3
CO-5	3	3	3	3	3

SEMESTER-X

V Year II Semester /X Semester/ IV Semester (Lateral Entry)

R22NT1003B: ADVANCED NANOBIOTECHNOLOGY (ELECTIVE–B)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must understand the research-oriented concepts of tissue engineering and drug delivery.	1
CO-2	Students must understand the toxicity of Nanomaterials, and evaluation of biocompatibility of nanomaterials.	3
CO-3	Students must learn the concepts of nanomaterial toxicity in bio-applications	3
CO-4	Students must develop a solid understanding and evaluation of tissue engineering mechanisms	2
CO-5	Students must u learn and apply the applications of nanomaterials in drug delivery processes	3

Unit –I **(12 h)**

Synthetic Materials in Medicine, properties of Materials: Bulk Properties of Materials, Surface Properties of Materials. Classes of Materials Used in Medicine: Structure and Properties of Metals, Ceramics, Glasses, and Glass-Ceramics, Polymers, Hydrogels, Family of Carbon Nanomaterials, Bioresorbable and Bioerodible Materials, Composites, Thin Films, Grafts and Coatings, Biologically Functional Materials.

Unit –II **(12 h)**

Biological Interactions with Materials

Introduction, Biocompatibility, Toxicity, Cytotoxicity, Hypersensitivity, Carcinogenicity, Interaction of Materials with Soft Tissues, Inflammation, Granulation Tissue Formation, Foreign Body Reaction, Fibrosis, Modification of Blood-Biomaterial Interactions, Interaction with Blood by Heparin, Interactions with Proteins, Cell Adhesion, Interactions with Hard Tissues, The Vroman Effect, Adhesion of Osteoblasts, Osseointegration, Fibrous Capsule Formation, Safety Testing of Biomaterials.

Unit –III **(12 h)**

Nanotoxicology

Introduction, Toxicity of nanoparticles, Types of Nanoparticles causing Toxicity, Target organ toxicity, Exposure, Uptake, and Barriers, Experimental Models in Nanotoxicology- In vitro Models, In Vivo Models, Predicting Penetration and Fate of Nanoparticlesin the Body, Toxicity Mechanisms - Mechanisms for Radical Species Production, General Genotoxicity Mechanisms, Detection and Characterization of Genotoxicity.

Unit –IV **(12 h)**

Tissue engineering

Introduction, Stem cells, Morphogenesis, Generation of tissue in the embryo, Tissue homeostasis, Cellular signaling, Extracellular matrix as a biologic scaffold for tissue engineering, Natural polymers in tissue engineering applications, Degradable polymers for tissue engineering, Degradation of bioceramics.Cell source, Cell culture: harvest, selection, expansion, and differentiation, Cell nutrition, Cryobiology, Scaffold design and fabrication, Controlled release strategies in tissue engineering.

Unit –V **(12 h)**

Drug Delivery Systems

Fundamentals of Drug Nanoparticles: Production, Size, Surface area, Suspension and Settling, Magnetic and Optical Properties, Biological Transport. Manufacturing of Nanoparticles: Ball-Milling, High-Pressure Homogenization, Spray-Drying Production in Nonaqueous Liquids, Hot-Melted Matrices, Pelletization Techniques, Direct Compress. Delivery of Nanoparticles: Brain Delivery, Ocular Drug Delivery, Gene Delivery Systems, Carriers in Cancer Therapy, Cardiovascular System, Vascular Delivery to the Lungs, Targeting Lymphatics.

REFERENCE BOOKS:

1) Biomaterials Science, An Introduction to Materials in Medicine, Edited by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, Academic Press, A division of Harcourt Brace & Company, 525 B Street, Suite 1900, San Diego, California 92101-4495, USA.
2) The Chemistry of Medical and Dental Materials, John W. Nicholson, RSC Materials Monographs, Published by The Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge CB4 OWF, UK. ISBN 0-85404-572-4.
3) Tissue Engineering, Clemens van Blitterswijk, Peter Thomsen, Anders Lindahl, Jeffrey Hubbell, David Williams, Ranieri Cancedda, Joost de Bruijn, Jérôme Sohier, Academic Press, Elsevier, 84 Theobald's Road, London WC1X 8RR, UK, 30 Corporate Drive, Suite 400, Burlington, MA 01803, USA, 525 B Street, Suite 1900, San Diego, CA 92101-4495, USA, 2008 ISBN: 978-0-12-370869-4.
4) Nanoscale Technology in Biological Systems, Edited by Ralph S. Greco, Fritz B. Prinz, R. Lane Smith, CRC PRESS, Boca Raton London New York Washington, D.C. Copyright © 2005 by Taylor & Francis
5) Nanoparticulates Drug Carriers, Edited by Vladimir P Torchilin, 2006, Imperial College Press, 57 Shelton Street, Covent Garden, London WC2H 9HE, ISBN 1- 86094-630-5
6) Nanoparticle Technology for Drug Delivery. Edited by Ram B. Gupta, Uday B. Kompella, 2006, Taylor & Francis Group, 270 Madison Avenue, New York, NY 10016.
7) Biological Nanostructures and Applications of Nanostructures in Biology. Electrical, Mechanical, and Optical Properties. Edited by Michael A. Stroscio and Mitra Dutta, 2004, Kluwer Academic Publishers, New York, Boston, Dordrecht, London, Moscow, eBook ISBN: 0-306-48628-8, Print ISBN: 0-306-48627-X
8) Biomedical Nanostructures. Edited by Kenneth E. Gonsalves, Craig R. Halberstadt, Cato T. Laurencin, Lakshmi S. Nair, Wiley-Interscience A John Wiley & Sons, Inc., Publication, 2008.
9) Dendrimer based Nanomedicine, Edited by Istvan J. Majoros, James R. Baker, 2008, Pan Stanford Publishing Pte. Ltd.
10) Nanoparticulate Drug Delivery Systems, Edited by Deepak Thassu, Michel Deleers, Yashwant Pathak, 2007, Informa Healthcare USA, Inc., 270 Madison Avenue, New York, NY 10016, ISBN-13: 978-0-8493-9073-9.
11) Nanofabrication towards Biomedical Applications, Techniques, Tools, Applications, and Impact. C. S. S. R. Kumar, J. Hormes, C. Leuschner, 2005, Wiley -VCH Verlag GmbH & Co. KGaA, Weinheim, ISBN-13 978-3-527-31115-6, ISBN-10 3-527-31115- 7.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	2	3	3	2
CO-2	2	3	3	2	3
CO-3	3	3	3	2	3
CO-4	3	2	3	3	3
CO-5	3	3	3	2	3

SEMESTER-X

V Year II Semester /X Semester/ IV Semester (Lateral Entry)

R22NT1003C: NANOSTRUCTURE FABRICATION AND METROLOGY (ELECTIVE–C)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must understand the concepts of Fabrication and Metrology processes through lithography as well as non-lithography technology	1
CO-2	Students must learn the concepts of optical, electron beam and X-ray lithography techniques	2
CO-3	Students must be able to apply the concepts on Lithography as well as non-lithography in the easy way to handle the fabrication tools in industry.	2
CO-4	Students must be able to develop advanced nanomaterials preparation with uniformity	3
CO-5	Students must get acquainted with testing protocol – important for device technology and apply them in research	3

UNIT-I **(12 h)**

Principles of Photolithography

Overview of lithographic process-Classification – Optical principles, Fresnel and Fraunhofer diffraction – Exposure methods –contact, proximity and projection printing – Mask Fabrication– Photoresist – positive and negative – properties of photoresist–Dill parameter – Projection system – Steppers and scanners – Cleanroom design and facilities.

UNIT-II **(12 h)**

Advances in Optical Lithography and Pattern transfer

Limitations of Optical Lithography – Lasers for Lithography – Deep and extreme UV lithography – Near field optical microscopy – Interference optical lithography – Maskless optical lithography– Resolution Enhancement Techniques–Vacuum techniques – Oxidation – Diffusion- Metallization - Doping techniques – ion implantation

UNIT-III **(12 h)**

Electron (E) - Beam Lithography: Electron Optics – Process, E beam sources, Raster and Vector scan – Proximity/Projection printing - SCALPEL – Direct writing – Interaction of electron with substrate – Electron Beam resist – E beam applications.

X-ray Lithography: Principle, X-ray sources, system and components – resists, mask preparation, resolution enhancement.

Ion Beam Lithography: Focused Ion Beam – Process, Ion Source, Ion Column – Masked Ion Beam Lithography and Ion Projection Lithography.

UNIT-IV **(12 h)**

Non-lithographic patterning

Template based fabrication –Nanostencil, Nanoimprint and Nanosphere Lithography in device fabrication– Soft Lithography, Microcontact Printing – Inkjet and Screen Printing – 3D printing - Stereolithography - Principle and methods of Nanowire Formation - Assembly, Integration -Additive and subtractive techniques of nano fabrication – Anodic Oxidation, Dip Pen Lithography

UNIT-V **(12 h)**

Metrology

Critical dimension (CD) – optical line width, defects, thickness and reflectance tools – ellipsometry – reflectometry – scatterometry – photoacoustic metrology –Electrical measurement – Dopant Concentration measurement techniques- surface defects - confocal microscopy, CD-SEM, TEM–AFM 3D surface mapping.

REFERENCE BOOKS:

1) Chris Mack, Fundamental Principle of Optical Lithography, John-Wiley & Sons, Inc., Sussex, 2007, ISBN: 978-0-470-01893-4.
2) Zheng Cui, Micro-Nanofabrication Technologies and Applications, Springer-Verlag, Beijing, 2005, ISBN: 9783540289227.
3) U. Okoroanyanwu, Chemistry and Lithography, SPIE Press, Washington, 2011, ISBN: 9781118030028.
4) Michael Quirk, Julian Serda, Semiconductor Manufacturing Technology, Prentice-Hall Inc., New Jersey, 2001, ISBN: 9780130815200
5) Horst Czichos, Tetsuya Saito, Leslie Smith, Springer Handbook of Materials Measurement Methods, Springer, New York, 2006, ISBN: 978-3-540-20785-6
6) Garry P. Wiederrecht, Handbook of Nanofabrication, First Edition, Elsevier, Amsterdam, 2010, ISBN: 9780123751768.
7) Zheng Cui, Nanofabrication Principles, Capabilities and Limits, Springer, New York, 2008, ISBN:978-0-387-75576-2.
8) Ampere A Tseng, Nanofabrication Fundamentals and Applications, World Scientific, Singpore, 2008, ISBN:987-981-270-076-6.
9) Mark James Jackson, Microfabrication and Nanomanufacturing, Taylor & Francis, Boca Raton, 2005, ISBN:978-1-4200-2827-0.
10) Harry J. Levinson, Principles of Optical Lithography, SPIE Press, Third Edition, Washington, 2010, ISBN:9780819456601.
11) Ray F. Egerton, Physical Principles of Electron Microscopy – An Introduction to TEM, SEM and AFM, Springer, New York, 2005, ISBN:978-0387-25800-0.
12) John A. Rogers and Hong H. Lee, Unconventional nanopatterning technique and applications, John Wiley & Sons, Inc., New York, 2009, ISBN:978-0-470-009957-5.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	3	2	3	2
CO-2	2	2	3	2	3
CO-3	2	2	3	2	3
CO-4	3	3	3	3	3
CO-5	3	2	3	3	2

SEMESTER-X

V Year II Semester /X Semester/ IV Semester (Lateral Entry)

R22NT1004A: INDUSTRIAL NANOTECHNOLOGY (ELECTIVE–A)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students must understand the advantages of Nanotechnology based applications in various industries.	1
CO-2	Students must understand the future technological advantages and increasing role of Nanotechnology in each industry.	2
CO-3	Students must understand and apply the concepts of Nanomaterials in electronics and electrochemical industry	3
CO-4	Students must understand and apply the concepts of Nanomaterials in textile and agriculture industry	3
CO-5	Students must understand and apply the concepts of Nanomaterials in food and cosmetics	3

UNIT-I **(12 h)**

Nanotechnology in Electrical and Electronics Industry

Advantages of nano electrical and electronic devices -Electronic circuit chips -Nanosensors and Actuators, Optical switches - Diodes and Nano-wire transistors -Data memory-Lighting and Displays - Filters (IR blocking) - Quantum optical devices- Energy storage devices - Photovoltaic cells -Lead-free solder - EMI shielding.

UNIT-II **(12 h)**

Nanotechnology in Electrochemical Industry

Electrocatalysis, Electrolytic production of metal nanopowders, Secondary recovery of metals: Importance and approaches with respect to lead, silver and gold. - Electochemical deposition of Nanostructured metals and metal nanocomposites - Electrospinning for the production of 1-D Nano-metal oxides - Electrochemical exfoliation for Graphene production - Electro-painting - Electrochemical preparation of conducting polymers.

UNIT-III **(12 h)**

Nanotechnology in Textile Industry

Nanofibre production: Electrospinning - Controlling morphologies of nanofibers - Nano-filled polypropylene fibers; Nanotechnology for coating and structuring of textiles; **Bionics:** Swim- suits with shark-skin effect, Soil repellence, Lotus effect - Nano finishing in textiles - UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes; **Modern textiles:** Lightweight bulletproof vests and shirts, Colour changing property, Waterproof and Germ proof clothes.

UNIT-IV **(12 h)**

Nanotechnology in Agriculture

Nanotechnology in Agriculture - Precision farming, Smart delivery system -Nanofertilizers- Nanourea and mixed fertilizers - Nanofertigation - Nanopesticides, Nano-seed Science.

UNIT-V **(12 h)**

Nanotechnology in Food Industry: Nanopackaging for enhanced shelf life - Smart/Intelligent packaging - Food processing and Food safety and bio-security - Food analysis and contaminant detection.

Cosmetics Industry: Formulation of Gels, Shampoos, Hair-conditioners (Micellar self-assembly and its manipulation) - Sun-screen dispersions for UV protection using titanium oxide -Colour cosmetics.

REFERENCE BOOKS:

1) P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006.
2) Jennifer Kuzma and Peter VerHage, Nanotechnology in Agriculture and Food Production, Woodrow Wilson International Center, (2006).
3) P. J. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead Publishing Limited, Cambridge, (2007).
4) Q. Chaudry, L.Castle and R. Watkins Nanotechnologies in Food, RSC Publications, 2010.
5) M.R. Rifi and F.H. Covitz, Industrial Electrochemistry, Marcel Dekker Inc, New York, 1974.
6) Y-W. Mai,Polymer Nano composites, Woodhead publishing, (2006).
7) Udo H. Brinker, Jean-Luc Mieusset (Eds.), Molecular Encapsulation: Organic Reactions in Constrained Systems,Wiley Publishers (2010).
8) Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun.
9) Lynn J. Frewer, Willem Norde, R. H. Fischer and W. H. Kampers, Nanotechnology in the Agri-food sector, Wiley-VCH Verlag, (2011).
10) E. Raub & K. Muller, Fundamentals of Metal deposition, Elsevier publishing Co, New York, 1967.
11) A.J. Bard & L.R. Faulkner, Electrochemical methods – Fundamentals & Applications, John Wiley & Sons, 3rd Edition, 2001.
12) W.N.Chang, Nanofibers Fabrication, Performance and Applications, Nova Science Publishers Inc., (2009).
13) K.I. Popov, S.S. Djokic and B.N. Grgur, Fundamentals of Electrometallurgy, Kluwer Academic publishing, 2002.

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	3	2	3	2
CO-2	2	2	3	3	3
CO-3	3	2	3	3	2
CO-4	2	3	3	2	3
CO-5	2	3	2	3	2

SEMESTER-X

V Year II Semester /X Semester/ IV Semester (Lateral Entry)

R22NT1004B: NANOMATERIALS IN MEDICINE (ELECTIVE–B)

SYLLABUS (60 Hours)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

COURSE OUTCOMES		LEVEL
CO-1	Students will be able to understand the basic concepts of Nanomedicine	1
CO-2	Students must learn the principles of Nanomaterials in drug release, drug carrier, targeted drug delivery, imaging and diagnosis	2
CO-3	Students must develop a solid understanding on the concepts of drug delivery systems based on nanomaterials	3
CO-4	Students must understand and apply the principles of Polymers and dendrimers in diagnosis	2
CO-5	Students must learn and apply Tissue engineering in diagnosis	3

UNIT-I **(12 h)**

Introduction: Concept of nanomedicines, Rationale for designing of nanomedicines, Materials for preparation of nanomedicines, Different structures of nanomedicines.

Cellular nanoparticle interaction and receptor-mediated endocytosis: Transport of nanoparticles across the biological barriers, parameters affecting binding and uptake of nanoparticles-size, shape, surface charge, protein corona, surface modification. Different mechanisms of receptor-mediated endocytosis.

UNIT-II **(12 h)**

Nanotechnology in imaging and diagnosis: Basic concept of nanotechnology in imaging, Different nanomaterials for imaging and diagnosis, Applications of nanomaterials in MRI, computed tomography and image guided disease treatment.

UNIT-III **(12 h)**

Introduction to drug delivery systems: Basics of drug delivery, Types-polymer, lipid, metal-based drug delivery system. Drug targeting strategies for site specific drug delivery-passive and active targeting, time and rate-controlled drug delivery.

UNIT-IV **(12 h)**

Polymer based drug nanocarriers: Classification and types of polymeric nanocarriers, Different methods of polymeric nanocarrier preparation: Precipitation, Emulsion diffusion/Solvent evaporation, Salting out etc. Various applications of polymeric nanocarriers: Theranostic, Imaging.

Dendritic nanostructures for drug delivery: Introduction of different dendritic nanostructures, chemical structures, types of dendrimers, methods of preparation-convergent and divergent, physicochemical properties of dendrimers, interaction between drug molecules and dendrimers, applications of dendrimers

UNIT-V **(12 h)**

Tissue Engineering:

definitions - basic principles - structure-function relationships – Biomaterials: metals, ceramics, polymers (synthetic and natural) – Biodegradable materials - native matrix - Tissue Engineering and Cell-Based Therapies -Tissue Morphogenesis and Dynamics- Stem Cells and Lineages - Cell-Cell Communication, skin tissue engineering, Biomaterial scaffolds, Organization- Cell Isolation and Culture - ECM and Natural Scaffold Materials- Scaffold Fabrication and Tailoring

REFERENCE BOOKS:

1) Nanotechnology in Modern Medical Imaging and Interventions. Xiaoming Yang. Nova Science Publisher.
2) The Clinical Nanomedicine Handbook. By Sara Brenner. CRC Press
3) Nanomedicines and Nanoproducts: Applications, Disposition, and Toxicology in the Human Body. Eiki Igarashi.
4) Novel Drug Delivery Systems. by Yie W. Chien
5) Introduction to Novel Drug Delivery Systems By N.K. Jain
6) 6.. Application of Nanotechnology in Drug Delivery: Edited by Ali Demir Sezer, ISBN 978-953-51-1628-8, 552 pages, Publisher: InTech,
7) Introduction to Novel Drug Delivery Systems By N.K. Jain
8) Understanding Nanomedicine: An Introductory Textbook by Rob Burgess. 2012 CRC Press
9) Nanomedicine for Drug Delivery and Therapeutics, Editor(s): Ajay Kumar Mishra, 2013, Wiley
10) Biomaterials and Nanotechnology for Tissue Engineering by S Sethuraman, U M Krishnan, A Subramanian, 2016, CRC Press

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	3	2
CO-2	2	3	3	2	3
CO-3	3	2	2	3	2
CO-4	2	3	3	3	3
CO-5	2	3	2	3	3

SEMESTER-X

V Year II Semester /X Semester/ IV Semester (Lateral Entry)

R22NT1004C: LIQUID CRYSTALS (ELECTIVE–C)

SYLLABUS (60 Hours)

University Exam: 3 hours **Internal Marks: 30 University Examination Marks: 70**

COURSE OUTCOMES		LEVEL
CO-1	Students must understand the Liquid crystals	1
CO-2	Students must learn the structure and various kinds of liquid crystals	2
CO-3	Students must understand the defects and temperature effects in liquid crystals	2
CO-4	Students must learning of various phases of liquid crystals	3
CO-5	Students must be able to use the applications and features of liquid crystals	3

Unit 1 **12h**

Classification of liquid crystals, Building Blocks, Small organic molecules, long helical rods, polymers, associated structures

Unit 2 **12h**

Nematics and Cholesterics, Uniaxial nematics, Nematics of different symmetry, Cholesterics

Unit 3 **12h**

Smectics A, Smectics C, Hexatic smectics, crystalline smectics, The D-Phase, Lyotropic liquid crystals; Defects in liquid crystals

Unit 4 **12h**

Columnar phases, Hexagonal phases, rectangular and oblique phases, antiphases, Mesophases of Disc like molecules.

Unit 5 **12h**

Long, Quasilong, and short-range order, Poor Man's elasticity of liquid crystals, fluctuations, remarkable features of liquid crystals,

TEXT BOOKS:

1) The Physics of liquid crystals, by PG de Gennes and Prost
2) Liquid crystals fundamentals by Shri singh

COURSES OUTCOMES-PROGRAM OUTCOMES (CO-PO) MAPPING:

COs	PROGRAM OUTCOMES				
	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	3	2	3	3	2
CO-2	2	2	3	2	3
CO-3	3	3	3	3	2
CO-4	2	3	2	3	3
CO-5	3	2	3	3	3

SEMESTER-X

V Year II Semester OR X Semester OR Fourth Semester (Lateral Entry)

PRACTICAL-I:

R22NT1005: NANOMETERIALS LAB - IV: (MINI PROJECT)

University Exam: 3 hours Internal Marks: 30 University Examination Marks: 70

OBJECTIVES:

- Students will carry out bench work
- Students will use various synthesis processes and characterization techniques
- Students will learn writing scientific reports

SYLLABUS:

1) Supports advance research capabilities undertaking a major, individual, related project Develop communication skills, both written and oral, to specialized in Nanoscience and Technology.
2) Students are required to carry out a research project for one full semester related to Nanoscience and Nanotechnology and submit a project report. Each student is assigned with a supervisor among the faculty members of the Acharya Nagarjuna University.
3) The student has to present the work and undergo viva.
4) The performance of the student shall be evaluated based on the project thesis and viva by internal committee.

SEMESTER-X

V Year II Semester OR X Semester OR Fourth Semester (Lateral Entry)

PRACTICAL-II:

R22NT1006: NANOMETERIALS LAB - V:

(PAPER WRITING AND COMMUNICATION)

University Exam: 3 hours **Internal Marks: 30** **University Examination Marks: 70**

OBJECTIVES:

- Students will learn writing scientific reports
- Students will understand the importance of plagiarism tools in publishing

SYLLABUS:

1) Students are encouraged to write a research paper either from the original work carried out in the MINI PROJECT course or a review paper (topic must be approved by the internal guide) on a latest research topic out of their interest.
2) Students are further encouraged to communicate this for journals after plagiarism
3) Students will learn the writing skills and scientific terminology used in the field of nanotechnology
4) Students thus are familiarized with undertaking a research project, writing a paper and communication to a journal.
5) The performance of the student shall be evaluated based on the paper write up and viva by an internal committee.

SEMESTER-X

V Year II Semester OR X Semester OR Fourth Semester (Lateral Entry)

PRACTICAL-III:

R22NT1007: COMPREHENSIVE VIVA- VOCE (IX & X SEMESTERS)

University Exam: 3 hours **Internal Marks: 0** **University Examination Marks: 50**

1) The students will be analyzed with questions covering IX & X semester topics.

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