Study Scheme & Syllabus

For
Ph.D. in Department of Chemistry

Program Code-CHE-501

Syllabi Applicable for Admissions in 2021 Onwards

Department of Chemistry

RIMT UNIVERSITY MANDIGOBINDGARH, PUNJAB

Program Name: Ph.D. in Chemistry

Program Code: CHE-501

Pattern of Course Work for Ph.D.Programme

Name of Course		Contact Hours/Week			Credit	Evaluation Scheme (% of Total Marks)					Exam Duration (Hours)
Code	Title	L	T	P		CWA	LWA	MTE	ETE	Total	
RMS 5 01 1	Research Methodology & Statistical Technique	5	0	0	5	16	---	24	60	100	3
CAR 5 02 M	Computer Applications in Research	3	0	0	3	16	---	24	60	100	3
*CHE 5031/ CHE 5032/ CHE 5033	Inorganic Chemistry/ Organic Chemistry/Physical Chemistry	5	0	0	5	16	---	24	60	100	3
MRP 5 04 M	Mini Project/Term Paper	-	-	-	2	---	---	---	100	100	3
Total											

*This course is to be suggested by guide/supervisor in specific domain area of research undertaken by the research candidate. The candidate must select any one from the following.

Optional subjects

CHE 5031 Inorganic Chemistry

CHE 5032 Organic Chemistry

CHE 5033 Physical Chemistry

L	T	P	CWA	LWA	MTE	ETE
Lecture	Tutorial	Practical	Class Work Assessment	Lab Work Assessment	Mid Term Exam	End Term Exam

Program Name: Ph.D. in Chemistry

Program Code: CHE-501

Vision & Mission of the University

VISION

To become one of the most preferred learning places a center of excellence to promote and nurture future leaders who would facilitate desired change in the society.

MISSION

- To impart teaching and learning through cutting-edge technologies supported by the world-class infrastructure.
- To empower and transform young minds into capable leaders and responsible citizens of India instilled with high ethical and moral values.
- To all-round development of students through education and innovation.

Program Name: Ph.D. in Chemistry

Program Code: CHE-501

Department of Chemistry

VISION

Our vision is to enhance our reputation as a world-class teaching and research institution which is recognized for its innovation, excellence, and discovery and attracts the best students and staff worldwide. Our main objective is to increase the proficient and positive use of knowledge and wisdom and to encourage fraternity among children, people, states, and nations, looking for a trueunderstanding among all, based on respect for the ideology, social belief, faith, race, and gender individual.

MISSION

- To provide a high-quality educational experience for undergraduate and graduate students that enables them to become leaders in their chosen professions.
- Department strives towards excellence in all the fields of teaching, research, and public service by developing outstanding research and academic programs and providing high-quality of education to best satisfy the learners.
- We, at the department of chemistry, constantly afford to enrich our syllabus. and programs according to current trends in higher education. All the courses in the program are. carefully designed based on the guideline of NTA and UGC.
- I invite you to explore our department website to cognize the academic and top-notch research of the department.
- To develop the leadership quality in the students in the field of science, innovation specially chemistry and chemistry involved in technology.

Program outcomes: Students will become acquainted with the professional environment of the chemistry and allied chemistry discipline within university. Students willdemonstrateknowledge of sources, concepts, and research methodologies, ethical knowledge in their field of study.

Program Name: Ph.D. in Chemistry

Program Code: CHE-501

PROGRAM OBJECTIVES

PEO1	To extend knowledge about an important chemistry-oriented topic through research
PEO2	To develop an understanding of the basic framework of the research process, research ethics and research articles
PEO3	Students will acquire the skills in handling scientific instruments, planning and execution of experiments.
PE04	To provide training to the PhD students to develop competencies needed to be an effective researcher.

PROGRAM OUTCOMES FOR Ph.D. CHEMISTRY

PO 1	To understandthe research methods, in-depth material characterization techniques, data collection, analysis, and conceptual understanding of research work, and research articles.
PO 2	To identify and critically evaluate research and publication of ethical issues within chemistry related area.
PO 3	The course includes both basic and advanced training about subject topics via technical writing and oral presentation.Enhance the techniques related to research.
PO 4	To develop critical thinking skills by addressing difficulties/numerical problems utilizing fundamental chemical ideas and expertise.
PO 5	To develop analytical, and communication skills in developing professional presentations and writing.
PO 6	To access and extract the desired information from the different scientific databases and resources
PO 7	To provide students the chance to work as part of a team in the laboratory, in the field, and in industry.
PO 8	To provide academic advancement and enhanced employment chances.

PROGRAM SPECIFIC OUTCOME

PSO 1	To bring together theory and research from education and other related disciplines to facilitate effective teaching and learning.
PSO 2	To develop an understanding and appreciation for the various kinds of research as well as their aspects.

PSO 3	To disseminate chemistry-oriented research at recognized national and international level

Name of School/Department: Chemistry Department

Programme Name: Ph.D. (Doctor of Philosophy) Chemistry

Programme Code: CHE 501

MAPPING OF PROGRAM SPECIFIC OUTCOMES (PSOs) WITH PROGRAM OUTCOMES (POs)

A broad relation between the program-specific outcomes and the program outcomes is given in the following table:

PROGRAM SPECIFIC OUTCOMES (PSOs)	PROGRAM OUTCOMES			
	PO1	**PO2**	**PO3**	**PO4**
PSO 1	3	2	3	2
PSO 2	3	3	1	2
PSO 3	1	3	2	3

Contribution:

"1" Slight (Low) Correlation

"2" Moderate (Medium) Correlation

"3" Substantial (High) Correlation

"-" Indicates there is no Correlation.

EVALUATION

1. There shall be two Mid Term Examination (MTE) of 24% Marks (24 marks) in each semester. Average of two is considered for final internal assessment.
2. There shall be continuous class work assessment (CWA) of 16% (16 Marks) of theory subjects
3. End Term examination (ETE) will be of 60% of total marks (60 marks).
4. Each practical examination shall be of 3 hours duration.
5. There shall be continuous lab work assessment (LWA) for practical of 40% marks (40 marks). The final examination will be of 60% marks (60 marks).

Pattern of end-semester question paper

The question paper consist of three sections A, B & C.

1. Section-A is compulsory consisting of 6 short answer type questions (2 marks) from the whole syllabus. Total marks to this section are 12. There will be no choice in this section.
2. Section-B consists of 8 questions. Students will attempt any six questions. Each question carries 4 Marks.
3. Section-C consists of 4 questions. Students will attempt any three questions. Each question carries 8 Marks.

Detailed Syllabus of Inorganic Chemistry

SUBJECT TITLE: Inorganic Chemistry
SUBJECT CODE: CHE-5031
SEMESTER: I
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)

Program Name: Ph.D. in Chemistry

Program Code: CHE-501

5	**0**	**0**	**5**

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Course objectives: To impart advanced knowledge and understanding of theoretical as well practical concept of chemistry especially inorganic, catalysis, instrumental chemistry and application of metal ions and metal-based chemicals.

Course Outcomes:

CO 1	Understand the potential concept related to chemistry.
CO 2	Interdisciplinary chemistry utilized in PhD programs
CO 3	The course includes both basic and advanced training about subject topics via technical writing and oral presentation.
CO 4	To develop critical thinking skills, use directly or indirectly beneficial to society

1. Symmetry and Group Theory (10 Hrs)

Symmetry elements, symmetry Operations symmetry elements commonly occurring molecules like NH3, CH4, SF6, PF5, SF4, Ni(CO)4, Fe(CO)5, determination of point groups, use of character table for determining the reducible and irreducible representation, determination of symmetry of atomic orbitals under different point groups, determination of atomic orbital involved in sp, sp2, sp3, dsp2, d2sp3 hybridization on basis of group theory and quantitative discussion on concept of hybridization

2. Nuclear Quadruple Resonance Spectroscopy: (7 Hrs.)

Introduction, experimental considerations, fundamentals of NOR spectroscopy, origin of EFG, measurement of energy differences between two nuclear spin states, the asymmetry parameter, effects of the magnetic field, interpretation of the spectra, application of the technique to halogen compounds, group elements, transition metals.

3. Mössbauer Spectroscopy: (7 Hrs.)

Experimental considerations, the spectrum and its parameters, simple spin states (I 1/2, 3/2), higher spin states (I > 3/2), magnetic splitting significance of parameters obtained from spectra, quadruple splitting, additive model, interpretation of Mössbauer spectra of 57Fe, 119Sn.

4. Electron Paramagnetic Resonance Spectroscopy: (7 Hrs.

Introduction, principle, Presentation of spectrum, hyperfine splitting in isotropic systems involving more than one nucleus, esr spectrum of benzene radical anion, methyl radical. CH2OH cyclopentedienylcycloheptatrienyl radical, pyrazine anion, pyrazine anion with ^{23}Na and ^{39}K counter ion and Nitrosylnitroxide, Factors affecting magnitude of g values, zero field splitting and Krammer's degeneracy.Qualitative survey of EPR spectra of first row transition metal ion complexes (d1, d2, d3, low spin d5, high spin d6, d7, d9 system). Spectra of triplet states.

5. X-ray Diffraction Methods of Analysis (9 hrs.)

Production of X-rays, solid state symmetry, reciprocal lattice, Bragg's law in reciprocal space, the powder method, interpretation of powder pattern of a cubic system, particle size determination by powder method, qualitative and quantitative analysis using powder method. X-ray fluorescence spectroscopy, X-rays emission method, applications(qualitative and quantitative).

6. Photoelectron Spectroscopy: (6hrs)

Introduction, photoelectron spectroscopy, chemical shift, X-ray photoelectron spectroscopy, molecular orbital diagrams of nitrogen and oxygen and their XPS spectra-ESCA, ultraviolet photoelectron spectroscopy (UPS), PES spectrum of nitrogen sample, vibrational structure in the N_2 UPS spectrum, chemical shifts in XPS, exchange splitting and shake up process.

Recommended Book:

1. Advanced Inorganic Chemistry F.A Cotton 6th addition chapter 21 and 22, p. 1167-1294.
2. James E. Huheey: Inorganic Chemistry Principles of Structure and reactivity, Harber& Row, Publishers Inc. New York 1972.

Detailed Syllabus of Organic Chemistry

SUBJECT TITLE: Organic Chemistry
SUBJECT CODE: CHE 5032
SEMESTER: I

Program Name: Ph.D. in Chemistry

Program Code: CHE-501

CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
5	0	0	5

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Course objectives: To impart the advance understanding oforganic chemistry, organocatalysis,mechanistic understanding of selectivity, stereo-selectivity and synthetic strategy, methodology, and catalysis, which will be useful for explaining the result obtained in research outcome.

Course Outcomes:

CO 1	Understand the potential concept related to organic chemistry.
CO 2	Good hold on the fundamental knowledge of chemistry to seek solutions for complex problems in the area of Organic chemistry
CO 3	The course includes both basic and advanced training about subject synthesis and structure of organic compounds
CO 4	To develop skills properties and reactivity of main group organometallics, organo-transition metal chemistry in formulating a research work plan in a scientific manner.

Biocatalysis in Organic Chemistry:

Introduction to Biocatalysis. Application of Biocatalysts: Hydrolytic reactions, mechanistic and kinetic aspects, hydrolysis of amide bond, ester hydrolysis, hydrolysis and formation of phosphate esters, hydrolysis of epoxides, hydrolysis of nitriles. Reduction reactions: recycling of cofactors, reduction of aldehydes, ketones and carbon-carbon double bonds with whole cells.

Oxidation reactions: oxidation of alcohols and aldehydes; oxygenation reactions, hydroxylation of alkanes and aromatic compounds, epoxidation of alkene, sulfoxidation reactions, formation of peroxides, dihydroxylation of aromatic compounds; peroxidation reactions. Enzymes in

organicsolvents: ester synthesis, lactone synthesis, amide synthesis, peptide synthesis, peracid synthesis, redox reactions, medium engineering. (Books1,2,3)

Organocatalysis in Organic Synthesis:

Introduction.Enamine catalysis: Aldol and Mannich type reactions, α-heteroatom functionalization, direct conjugate additions via enamine activation. Iminium catalysis: the catalysis concept, cycloaddition reactions, 1,4-addition reactions, transfer hydrogen, cascadereactions. Ammonium ions as chiral templates: Homogeneous catalysis with chiral quaternary ammonium salts, Heterogeneous catalysis- chiral phase transfer catalysis. Morita-Baylis-Hillman reaction: addition of ketones and aldehydes to activated olefins, asymmetric MBH reactions. Asymmetric proton catalysis: conjugate addition reactions, hydrocyanation reactions, mannich reactions, aza-henry reaction, acyl Pictet-Spengler reaction, azaFriedel- Crafts reaction. Chiral Lewis bases as catalysts: allylation reactions, propargylation reactions, hydrocyanationandisonitrile addition, aldol type reactions, reduction of imines, epoxide ring opening. Asymmetric acyl transfer reactions. Nucleophilic N-Heterocyclic carbenes.Ylide based reactions. Organocatalytic oxidation and reduction reactions.(4,5,6) **(25hrs.)**

Inorganic Catalysis: (a). Fundamental reaction steps of transition metal catalyzed reaction. Coordinative unsaturation, oxidative-addition, reductive elimination reactions, migratory insertion and elimination reactions. Cleavage of C-H bonds, nucleophilic and electrophilic addition and abstraction. (b)Homogeneous and heterogeneous catalysis using transition metal complexes.Catalytic hydrocyanation, hydrosilylation and hydroboration reactions of olefins.alkene isomerization, Hydroformylation reaction of unsaturated compounds, carbonylation reactions: Reppecarbonylation. Olefin metathesis: synthesis of Grubbs and Schrock catalysts, mechanism of olefin metathesis, C-C cross coupling reactions, Olefin oligomerization and polymerization using metallocne and post metallocne based catalysts, oligomerisation using SHOP. Fischer-Tropsch reactions and water gas shift reaction. **(20hrs.)**

Recommended Books:

1. Bio-transformations in Organic Chemistry: A Textbook by Kurt Faber 5th Edition Publisher: Springer-Verlag, New York, 2009.

2. Biocatalysis. Fundamentals and Applications by A. S. Bommarius (Georgia Institute of Technology) and B. R. Riebel (Emory University).Wiley-VCH, Weinheim, Germany. 2004.

3. The Organic Chemistry of Enzyme-Catalyzed Reactions by R. B. Silverman, Academic Press, New York, 2000.

4. Asymmetric Organo-catalysis – From Biomimetic Concepts to Applications in Asymmetric Synthesis By A. Berkessel and H. Groger. Publisher: Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2005.

5. Enantio-selective Organocatalysis: Reactions and Experimental Procedures Edited by Peter I. Dalko Publisher: Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2007.

6. Organo catalysis Reetz, M.T.; List, B.; Jaroch, S.; Weinmann, H. (Eds.) Series: Ernst Schering Foundation Symposium Proceedings 2007-2, Publisher: Springer-Verlag, Berlin Heidelberg, 2008.

7. Robert H. Crabtree, The Organometallic Chemistry of the Transition Metals, 4th edition a John Wiley & Sons, Inc., Publication, 2005.

Detailed Syllabus of Physical Chemistry

SUBJECT TITLE: Physical Chemistry
SUBJECT CODE: CHE 5033
SEMESTER: I
CONTACT HOURS/WEEK:

Program Name: Ph.D. in Chemistry

Program Code: CHE-501

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
5	0	0	5

Internal Assessment: 40
End Term Exam: 60
Duration of Exam- 3 Hrs

Course objectives: To impart the advance understanding of crystal structure of solid materials, different preparation, and characterization techniques, that are very much necessary for high research studies.

Course Outcomes:

CO 1	Good understanding about the fundamental concept of materials structure
CO 2	Good hold on the fundamental knowledge of chemistry to seek solutions for complex problems, materials synthetic methods, and characterization techniques
CO 3	The course includes both basic and advanced training about nanomaterials
CO 4	To develop skills properties and reactivity of materials formulating a research work plan in a scientific manner.

Solid State Chemistry (20 Hours)

Crystal Structure: Crystalline and amorphous solids; crystal systems, point groups: methods of characterizing crystal structure - Powder x-ray diffraction, electron and neutron diffraction; types of close packing - hcp and ccp, packing efficiency, radius ratios; polyhedral description of solids; structure types -NaCl, ZnS, Na_2O, $CdCl_2$, wurtzite, nickel arsenide, CsCl, CdI_2, rutile and Cs_2O, perovskite ABO_3, K_2NiF_4, spinels.

Preparative methods: Solid state reaction, chemical precursor method, co-Precipitation, sol-gel, metathesis, self-propagating high temperature synthesis, ion exchange reactions, intercalation / deintercalation reactions; hydrothermal and template synthesis; High pressure synthesis

Methods of Single Crystal Growth: Solution growth; Melt Growth-Bridgeman, Czochralski, Kyropoulus, Verneuil; Chemical Vapour Transport; Fused Salt Electrolysis; Hydrothermal method; Flux Growth

Characterization: (25 Hours)

Thermal analysis: TGA, DTA, DSC

Electrical properties: Band theory of solids -metals and their properties; semiconductors - extrinsic and intrinsic, Hall effect; thermoelectric effects (Thomson, Peltier and Seebeck); insulators - dielectric, ferroelectric, pyroelectric and piezoelectric properties; ionic conductors.

Magnetic properties: Dia, para, ferro, ferri, and antiferro magnetic types; soft and hard magnetic materials; select magnetic materials such as spinels, garnets and perovskites, hexaferrites and lanthanide-transition metal compounds; magnetoresistance.

Optical properties: Luminescence of d- and f- block ions; structural probes; up and down conversion materials.

Superconductivity: Basics, discovery and high Tc materials.

Additional Topics: Amorphous materials, zeolites, fullerenes and nanocrystalline solids.

Recommended Books:

1. R. West, Solid State Chemistry and its Applications, John Wiley & Sons, 1984.
2. L. Smart and E. Moore, Solid State Chemistry - An Introduction, Chapman & Hall, 1992.
3. H. V. Keer, Principles of the Solid State, Wiley Eastern Limited, 1993.
4. K. Chakrabarty, Solid State Chemistry, New Age Publishers, 1996.

RIMT UNIVERSITY
MANDI GOBINDGARH, PUNJAB

Study Scheme & Syllabus

As per

Choice Based Credit System (CBCS)

For

Ph.D. Microbiology

Program Code: MBIO501

(Session 2021-22)

Department of LIFE SCIENCES

RIMT UNIVERSITY
MANDI GOBINDGARH, PUNJAB

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SECTION 1

Vision & Mission of the University

VISION

To become one of the most preferred learning places and a centre of excellence to promote and nurture future leaders who would facilitate the desired change in the society.

MISSION

- To impart teaching and learning through cutting-edge technologies supported by the world class infrastructure
- To empower and transform young minds into capable leaders and responsible citizens of India instilled with high ethical and moral values.

SECTION 2

Vision & Mission of the Department

VISION

The vision of life sciences encompasses a broad range of goals and aspirations related to the study and understanding of living organisms and their biological processes. Here are some key elements that contribute to the vision of life sciences:

1. Understanding life's complexity: Life sciences aim to unravel the intricate complexities of life, from the molecular and cellular level to the broader ecological and evolutionary scales. This involves investigating the structure, function, and interactions of living organisms to gain a comprehensive understanding of the principles that govern life.
2. Improving human health: Life sciences strive to enhance human health and well-being by advancing medical research, developing new therapies and treatments, and improving diagnostics. This includes studying the mechanisms of diseases, exploring novel drug targets, and developing personalized medicine approaches based on an individual's genetic makeup.
3. Exploring biodiversity and ecology: Life sciences seek to explore and preserve Earth's biodiversity, studying the diversity of species, their interactions, and the ecosystems they inhabit. Understanding ecosystems and their dynamics is crucial for conservation efforts, sustainable resource management, and addressing pressing environmental challenges, such as climate change.
4. Advancing agricultural and food sciences: Life sciences play a vital role in improving agricultural practices, crop yield, and food production. Research in this field focuses on developing sustainable and environmentally friendly farming methods, enhancing crop traits through genetic modification or breeding techniques, and ensuring food safety and security for an expanding global

population.

5. Uncovering fundamental biological processes: Life sciences aim to uncover the fundamental principles that govern life, ranging from basic biological processes like metabolism, growth, and reproduction to more complex phenomena such as development and aging. Understanding these processes can provide insights into the origins of life, as well as potential applications in biotechnology and synthetic biology
6. Integrating interdisciplinary approaches: Life sciences embrace interdisciplinary collaboration, bringing together various scientific disciplines such as biology, genetics, biochemistry, neuroscience, computational biology, and bioinformatics. By combining expertise from different fields, researchers can tackle complex problems and drive innovation in diverse areas, from drug discovery to bioengineering.
7. Promoting ethical considerations: Life sciences recognize the importance of ethical considerations in research and applications. This involves addressing ethical issues related to human subjects, animal welfare, genetic engineering, and the potential societal impact of scientific advancements. Ethical frameworks ensure responsible and sustainable practices within the life sciences community

Overall, the vision of life sciences encompasses a deep understanding of life's complexities, improving human health and well-being, preserving biodiversity, advancing agriculture, unraveling fundamental biological processes, promoting interdisciplinary collaboration, and upholding ethical standards. By pursuing these goals, life sciences contribute to our knowledge and pave the way for a healthier, more sustainable future.

School is committed to innovation and excellence in teaching and research and preparing the students to be successful in science-related careers that are essential for meeting global needs. School advances knowledge through multidisciplinary education and research in all streams of basic sciences viz; Microbiology, Botany and Zoology. The Ph.D. programmes are mainly focused on multi-disciplinary research based teaching with emphasis on dissertations. Each student is given perfect hands on training on current techniques in basic sciences.

RIMT UNIVERSITY
MANDI GOBINDGARH, PUNJAB

MISSION

To transform education through academic excellence in sciences, providing analytical and application oriented teaching, innovative and world class pedagogy, nurture professionals who, with their commitment and integrity, can make a difference in their respective profession and in turn transform the society.

Department of Life Sciences in School of Biosciences in RIMT University disseminating the knowledge in the field of Life Sciences through teaching & learning process. It offers various graduates, post graduate and doctorate courses in field of Microbiology. The Department is well equipped with teaching and research laboratories. For Life Science students, most of the opportunities are found in universities, research institutions and industries.

There are a large number of research institutions under the Council of scientific and industrial research. Students can opt the option of CSIR NET exam; it will give a great career scope in research. Life sciences students can go for various Pharmaceuticals by opting Masters with one of the clinical subject.

The knowledge of plant sciences is essential for development and management of forests, parks, waste lands etc. Few of the industries which can work with are: Forest Services, Biotechnology Firms, Food companies, Seed & Nursery companies, National Parks, Plant Resource Laboratories, Plant health inspection services, Arboretum, Chemical industries, Educational institutes, Biological supply houses. The field of Microbiology has immense scope, due to advancement of field of science and technology, and in many areas like medicine, pharmacy, dairy industry, clinical research, water industry, agriculture, chemical technology and nanotechnology. For higher studies also, students can go for various doctorate fellowships and Post doctorate fellowships for higher education in India and abroad as well.

SECTION 3

About the Program

Ph.D. Microbiology Program is three years to four year doctoral degree program that comprises Choice Based Credit System (CBCS) of foundational and advanced core courses with mandatory courses of research methodology and computer applications and The suggestive curriculum takes the Ph.D. Microbiology program to the next level in terms of implementing Outcome Based Education and to develop professionals who are knowledgeable in their domain of microbiology. This program was meant build students with prosperous and bright field exposure to society and themselves.

SECTION 4

Program Educational Objectives (PEOs), Program Outcomes (POs) and Program Specific Outcomes (PSOs)

PROGRAM EDUCATION OBJECTIVES

PEO1	To acquaint students with the literature and a broad understanding of scientific methods and techniques applicable to carry out research.
PEO2	Students will be equipped with demonstrable originality in the research with a practical understanding of research and interpretation of gained aspects knowledge in their field
PEO3	To develop an ability for generation of outcome based research methods and framing of the research in the form of publications
PE04	To develop various methodology and technologies in the societal favor based on their self-directional and originality in conservation hub.

PROGRAM OUTCOMES

PO 1	To inculcate significance of research problem and its implementation in various microbiological fields.
PO 2	To identify research problem and execute its progression aspects.
PO 3	To enhance the analytical skills of data using statistical measures, and software- SPSS, MS-EXCEL, etc.
PO 4	To apply communication skills in developing professional and ethical presentation of their work.
PO 5	To access and extract the desired information from the different scientific databases and resources
PO 6	To contribute to methods development that will enrich translational research.
PO 7	To commensurate and collaborate microbiology and computer application and emerge as digital microbiology
PO 8	To develop the skill in different fields of Microbiology especially the environment sustainability, entrepreneurship and become job providers, can excel in academics, consultancy, industry and pollution control boards, industry as well as policy makers.

PROGRAM SPECIFIC OUTCOMES

PSO 1	To bring parallel effect through combining theory and research other related disciplines to facilitate effective teaching and research.
PSO 2	To develop an understanding of various aspects of research fields.
PSO 3	To disseminate research and knowledge at recognized national and international level

NAME OF SCHOOL/DEPARTMENT: SCHOOL OF BIOSCIENCES/LIFE SCIENCES
PROGRAMME NAME: PH.D. MICROBIOLOGY
PROGRAMME CODE: MBIO-501
MAPPING OF PROGRAM SPECIFIC OUTCOMES (PSOs) WITH PROGRAM OUTCOMES (POs)

A broad relation between the program-specific outcomes and the program outcomes is given in the following table:

PROGRAM SPECIFIC OUTCOMES (PSOs)	**PROGRAM OUTCOMES**							
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
PSO 1	3	2	1	1	2	3	1	1
PSO 2	3	2	1	2	2	3	2	1
PSO 3	2	2	2	3	2	1	1	3

Contribution:

"1" Slight (Low) Correlation

"2" Moderate (Medium) Correlation

"3" Substantial (High) Correlation

"0" Indicates there is no Correlation.

RIMT UNIVERSITY
MANDI GOBINDGARH, PUNJAB

SCHEME OF STUDY
SUBJECT: MICROBIOLOGY
PROGRAM CODE: MBIO-501

Subject Code	Subject Name	(Contact Hours/ Week)			Credits	Evaluation Scheme					Exam Hours
		L	T	P		CWA	LWA	MTE	ETE	Total	
RMS 5011	Research Methodology & Statistical Techniques	5	0	0	5	16	-	24	60	100	3
CAR 502M	Computer Applications in Research	3	0	0	3	16	-	24	60	100	3
MRP 504M	Research Project/ Review of literature	0	0	4	2	-	-	-	-	100	Evaluation through presentation
RPE 503M	Research and Publication Ethics	2	0	0	2	16	-	24	60	100	3
MIC 503M	Recent trends in Microbiology	4	0	0	4	16	-	24	60	100	3
MIC 504M	Conceptual Microbiology , Instrumentation and Molecular biology	4	0	0	4	16	-	24	60	100	3
MIC 505M	Advances in Microbiology	4	0	0	4	16	-	24	60	100	3
		18	0	4	20	80		120	300	600	15

RIMT UNIVERSITY
MANDI GOBINDGARH, PUNJAB

COURSE NAME: RESEARCH METHODOLOGY & STATISTICAL TECHNIQUES
COURSE CODE: RMS 5011M
TIME: 3:00hrs
MAX MARKS: 100 (INTERNAL: 40; EXTERNAL: 60)

Learning Outcomes of the Course

The aim of the course is to provide participants with an introduction to research methods and report writing. Upon successful completion of the course, the students will be able to:

a) Develop an understanding about various kinds of research, objectives of doing research, research process, research design, and sampling.
b) Have a basic knowledge of qualitative research techniques.
c) Acquire an adequate knowledge of measurement and scaling techniques as well as the quantitative data analysis.
d) Get a basic awareness of data analysis and hypothesis testing procedures.

DEATLIED SYLLABUS

Unit-I

Introduction to Research Methodology: Meaning, nature, and scope; types of research, Methods of research, Methodologies of research, Research hypothesis, Types of hypothesis, Formulation of hypothesis, Parameters and variables in Research, Research Design, Types of Research Design, Applications of Research Design, Sampling Techniques, Sampling procedures and design, Data collection, Types of data.

Unit-II

Sampling: Principal, Methods (Probability and Non Probability) Characteristics. Sampling Distribution and Errors Data Collection Sources (Primary and Secondary Technique: Observation, Interview. Schedules and Questionnaire.

Unit-III

Measures of Central Tendency. Calculation of Arithmetic Mean Median and mode in case of individual discrete and continuous series, merit and demerits. Dispersion, Meaning Significance and types. Calculation of Mean Deviation and Standard Deviation in case of individual. Discrete and continuous series. Merit and Demerits of Mean and Standard Deviation Lorenz Curve. Co-efficient of variations (CV).

Unit-IV

Correlation Definition. Types, Correlation and Causation, Methods of Correlation, Karl Pearson co-efficient of correlation. Co-efficient of correlation and probable error. Regression analysis, types of regression analysis. Difference between correlation and regression. Regression lines. Regression equations. (Y or X) and (X or Y). Tests of

significance for large samples and small samples, student's t-distribution. properties, and t- distributions and the t-levels applications of the t-distribution chi-square test and goodness of fit. F-test and Z test analysis of variance, Non-Parametric test The Mann-Whitney test, Krushal Wallias test, SPSS, uses and its applications. Analysis of Qualitative Data Techniques such as scaling methods.

Recommended books:

1. Fisher, R.A, statistical methods for research workers, Oliver and Boyd Itd, London UK
2. Gupta, S.P. statistical methods. Sultan Chand and sons, Educational publishers, New Delhi 3. Allen, R.G.D. statistical for Economies (Hutchinson)
4. Blair, Morris M. Elementary statistics (Henry Holt and Co.)
5. CR, Kothari, research methodology, 6. Smith and Smith, business and economic statistics. South Western publishing co.eare

RIMT UNIVERSITY
MANDI GOBINDGARH, PUNJAB

COURSE NAME: COMPUTER APPLICATIONS IN RESEARCH
COURSE CODE: CAR 502M
TIME:3:00 HOURS
MAX MARKS: 100 (INTERNAL: 40; EXTERNAL: 60)

Course Outcomes: After the completion of course-work, the candidates will able to:

- Present the graphical representations of data
- Make use of applications of MS Office
- Learn the functional units and classify types of computers, how they process information and how individual computers interact with other computing systems and devices

DEATLIED SYLLABUS

Unit-I

Computer Fundamentals: Data and Information, Characteristics of Computers, Various fields of application of Computers, Input-output Devices (Hardware, Software, Human ware and Firmware). Advantages and Limitations of Computer, Block Diagram of Computer. Function of Different Units of Computer. Classification of Computers. Types of Software, Application software and system software. Introduction to Operating System.

Unit-II

Word Processor: Various aids useful for thesis writing, adding references to documents, citing @citation in text, macros, hyperlinks, mail-merge etc: Power Point Presentations: PowerPoint, Features of MS PowerPoint Clipping. Design layouts, hyperlinks. tables. insertion of multi- media files. Slide Animation. Slide Shows. Formatting etc. Case study MS-Excel: Introduction to Electronic Spreadsheets. Feature of MS-Excel. Entering Data. Entering Series. Editing Data. Cell Referencing, ranges, Formulae. Functions, Auto Sum. Copying Formula, Formatting Data. Creating Charts, Statistical functions. Sorting Data. Filtering etc.

Unit-III

Internet and applications of IT: Program Vs Software, Software Engineering, SDLC, DBMS, Data Models, DFD, Specification Tool: SMARTDRAW. Case Study on DFD.

Unit-IV

Latest trends in Computing: Cloud computing, Data mining, Data Warehousing, Object Oriented Relational Database Management, Object Oriented Relational Database Management System, Distributed databases Concept. Three tier Client/ Server Architecture, Digital Image Processing, etc.

Recommended books:

1. Pardeep K. Sinha, Priti Sinha, Computer Fundamentals, BPB Publications.
2. Rajaraman, V., Fundamental of Computers. Prentice Hall India, New Delhi
3. R. S. Salaria, Fundamentals of Computers. Salaria Publishing House

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RIMT UNIVERSITY
MANDI GOBINDGARH, PUNJAB

COURSE NAME: MINI RESEARCH PROJECT/ REVIEW OF LITERATURE
SUBJECT CODE: MRP504M
MAX MARKS: 100 INTERNAL: 100

The candidates will be required to do literature survey covering review of Ph.D. thesis and/or review research papers of reputed journals related to the research field. It is expected that about 2 to 3 thesis and 40 to 15 research papers will be reviewed by the candidates and will finally present the seminar. The candidates will submit 3-4 topics out of which one topic will be approved by a committee at the departmental level

The candidates will be required to make presentation for the end term examination before a committee and shall be evaluated on the basis of file and presentation

RIMT UNIVERSITY
MANDI GOBINDGARH, PUNJAB

COURSE NAME: RESEARCH AND PUBLICATION ETHICS
SUBJECT CODE: RPE503M
TIME: 3:00 hrs
MAX MARKS: 100 (INTERNAL: 40; EXTERNAL: 60)

Learning Outcomes of the course: Student will be able to learn about

1. Basics of philosophy of science and ethics, research integrity, publication ethics
2. Hands-on-sessions are designed to identify research misconduct and predatory publications.
3. Indexing and citation databases, open access publications, research metrics (citations, h-index. Impact Factor, etc.)
4. Plagiarism tools, Pedagogy: Class room teaching, guest lectures, group discussions, and practical sessions.

UNIT–I

Philosophy and Ethics: Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgements and reactions. Scientific Conduct: Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication, and plagiarism (FFP). (10 hrs)

UNIT–II

Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data.
Publication Ethics: Publication ethics: definition, introduction and importance. Best practices/standards setting initiatives and guidelines: COPE, WAME, etc, Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types. Violation of publication ethics, authorship and contributorship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals (15 hrs)

UNIT–III

Open access publishing: Open access publications and initiatives. SHERPA/ROMEO online resource to check publisher copyright & self-archiving policies. Software tool to identify predatory publications developed by SPPU. Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. (10 hrs.)

UNIT–IV

Publication Misconduct: Group Discussions, Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad, Software tools. Use of plagiarism software like Turnitin, Urkund and other open source software tools.

Databases And Research Metrics: Databases, Indexing databases, Citation databases: Web of Science, Scopus, etc.,Research Metrics, Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score, Metrics: h-index, g index, i10 index, altmetrics. (15 hrs.)

References Books:

Bird, A. (2006). Philosophy of Science. Routledge.
Macintyre, Alasdair (1967) A Short History of Ethics. London.
P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:9789387480865
- National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
Resnik, D. B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm
Beall, J. (2012). Predatory publishers are corrupting open access, Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a
Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance(2019). ISBN:978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics Book.pdf

RIMT UNIVERSITY
MANDI GOBINDGARH, PUNJAB

(CORE ELECTIVE SUBJECT-I)
COURSE NAME: RECENT TRENDS IN MICROBIOLOGY
COURSE CODE: MIC 503M
TIME: 3:00 HOURS
MAX MARKS: 100 (INTERNAL: 40; EXTERNAL: 60)

Course Outcomes: After the completion of course-work, the candidates will able to:

- Develop the insight to technological advancements in microbiology
- Understand the factors of microbiology at living systems interface (human, plants and animals).
- Understand the concept and importance of various aspects in microbiology
- Understand the behavioral aspects of microorganisms.

UNIT–I

Introduction: Microbial world, Prokaryotic and eukaryotic microbes.
Cell organization: Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms
Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls; Archaebacteria,
Staining: Gram's, negative and acid fast staining mechanisms, Effect of antibiotics and enzymes on the cell wall.
Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.

UNIT–II

Recent advances in bacterial metabolism, stress and survival of bacteria: Prokaryotic responses to environmental stress, heat shock and molecular chaperones, oxidative stress. hydrostatic stress, osmotic shock, cross responses to stress factors, use of proteomics and genomics to understand physiology under stress conditions.

UNIT–III

Soil Microbiology: Microbial groups in soil, Role of microbes in soil fertility and crop production, Microflora in Rhizosphere and Phyllosphere, their Importance, Microorganisms in agriculture, Biofertilizers its Importance, Biopesticides and its Advantages Innovative aspects in the application bacteria in biotechnology, probiotic microorganisms, Biofuel.

UNIT–IV

Immunological and biochemical methods for identification of microorganisms. Electron microscopy and its applications in Microbiological sciences. Chromatographic techniques for the separation and purification of metabolites and MS for structure elucidation. Metagenomic approaches for isolation of novel biocatalysts genes, novel pathways Flow cytometry and flow

cell sorting techniques, peptide mass fingerprinting, DNA microarray- basic components, organization, working components and analysis, FISH-MAR.

Reference Books:

1. Molecular microbial Ecology 2005 Ed Orborn, AM, Smith CJ Tylor and Francis
2. Kuby-Immunology: T. J. Kindt. R. A. Goldsby and B. A. Osborne; W. H. Freeman
3. Janeway's Immunology: K. Murphy. P. Travers and M. Walpon: Garland Sciences
4. Immunology: Ivan Rott, J. Brostoff and D Male: Mosby
5. Essential immunology: Ivan Roitt: Oxford: Blackwell
6. Principles of Genetic Manipulation - Old & Primrose

RIMT UNIVERSITY
MANDI GOBINDGARH, PUNJAB

(CORE ELECTIVE SUBJECT-II)

COURSE NAME: COCEPTUAL MICROBIOLOGY, INTRUMENTATION & MOLECULAR BIOLOGY
TIME: 3:00 HOURS
SUBJECT CODE: MIC506M
MAX MARKS: 100 (INTERNAL: 40; EXTERNAL: 60)

Learning outcome of course:

1. Orient the students with the basics of Microbiology and its associated subjects.
2. The students will be able to understand the diversified aspects of microbes and their applications.
3. The students will be able to understand advanced instrumentation.
4. The students will be able to understand molecular techniques.

Unit-I

Fundamentals, History and Evolution of Microbiology: Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny, and current classification of bacteria. Microbial Diversity: Distribution and Characterization of Prokaryotic and Eukaryotic Cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa, and Unique features of viruses.
Prokaryotic cell organization: Cell shape, size, and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae, and pilli, Lipo-polysaccahride (LPS) Spheroblast, and L-forms.
Cell wall: Composition and detailed structure of gram-positive and gram negative cell walls, Archaebacteria, Biologics against cell wall, Staining techniques.
Cell membrane: Structure, function and chemical composition of bacterial and archaeal cell.

Unit-II

Growth and cultivation of microorganisms: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria, Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. Nutritional categories of micro-organisms.
Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways.
Bacterial Reproduction: Asexual methods of reproduction, logarithmic representation of bacterial populations, Transformation, Transduction, Conjugation, Endospores and sporulation in bacteria.

Unit-III

Experimental Analysis of metabolism: Goals of the study**,** Levels of organization at which metabolism is studied, Metabolic probes. Use of radioisotopes in biochemistry,

Pulse labeling, Assay and study of radio respirometry to differentiate EMP & ED, Use of biochemical mutants, Sequential induction

Maintenance and control of Microorganisms: Methods of isolation, Purification and preservation. Control of microorganisms by physical, chemical and chemotherapeutic Agents Water Microbiology: Bacterial pollutants of water, coliforms and non-coliforms. Sewage composition and its disposal.

Identification and characterization: Characterization of DNA, RNA, plasmids. Agarose gel electrophoresis, ethidium bromide staining. Southern, Northern, Western Blotting, RAPD, RFLP, DGGE, TGGE, PCR.

Unit-IV

Instrumentation: Microscopy, HPLC, HPTLC, GC-MS, FTIR, SEM/TEM, NMR, AAS.

Enzyme assay: enzyme activity and specific activity determination. Cell disintegration and extraction techniques, separation of proteins by fractionation (ammonium sulphate, organic solvents). Ion exchange chromatography, molecular sieve chromatography, affinity chromatography, paper chromatography, thin layer chromatography, ultra filtration, Ultracentrifugation. Gel electrophoresis, isoelectric focusing and immunoelectrophoresis, capillary electrophoresis, pulse field electrophoresis.

Reference Books:

1. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004) Microbiology. 5th edition Tata McGraw Hill.
2. Cappucino J and Sherman N. (2013). Microbiology: A Laboratory Manual. 10th edition. Pearson Education Limited
3. Methods of Protein and Nucleic acid Research, Osterman Vol I – III
4. Centrifugation D. Rickwood
5. Practical Biochemistry, V th edition, Keith Wilson and Walker.
6. Tortora GJ, Funke BR and Case CL. (2016). Microbiology: An Introduction. 12th edition. Pearson Education
7. Tools in Biochemistry David Cooper

RIMT UNIVERSITY
MANDI GOBINDGARH, PUNJAB

(CORE ELECTIVE SUBJECT-III)

COURSE NAME: ADVANCES IN MICROBIOLOGY
COURSE CODE: MIC505M
TIME: 3:00 HOURS
MAX MARKS: 100 (INTERNAL: 40; EXTERNAL: 60)

Learning outcome of course:

1. Orient the students with the basics of Microbiology and its associated subjects.
2. The students will be able to understand the diversified aspects of microbes and their applications.
3. The students will be able to understand advanced instrumentation.
4. The students will be able to understand molecular techniques.

Unit-I

Microscopy: Analysis of Biological samples using microscopic techniques. Visualization of cells and subcellular components – Light , Fluorescent and Electron microscopy. Living cells- Phase contrast and confocal microscopy. FISH & GISH

Molecular Biology Techniques: Nucleic acid purification - isolation of DNA and plasmids (Plant & animal cells). Amplification of DNA by PCR (simple, nested, Multiplex). Gene expression studies- RT –PCR, Micro array. Cloning – types(TA cloning), Blue –white screening. Role of RFLP, AFLP and RAPD in Biology.

Unit-II

Bioinformatics: Biological databases (NCBI, EBI, JDBD), Sequence analysis (Multiple sequence analysis Local &Global). Algorithms fused for Nucleic acid and protein analysis

Immune system: Types of immunity, Mediators of immunity, Staining and microscopy. Isolation and identification of causal organism, Growth mediums specific to isolate or differentiate various pathogenic bacteria, Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes, Adjuvants, Structure, Types and Functions of antibodies, Immunologic tests like ELISA, immunofluorescence, Agglutination based tests, Complement fixation and western blotting.

Unit-III

Identification and characterization: Characterization of DNA, RNA, plasmids. Agarose gel electrophoresis, ethidium bromide staining. Southern, Northern, Western Blotting, RAPD, RFLP, DGGE, TGGE, PCR.

Fermentation : Recent developments on production of primary and secondary metabolites; Microbial production of health care products, Treatment of biological wastes, microbial inoculants and enzymes for waste treatment; Yeast technology – classification, genetics, strain improvement for brewing, baking and distilleries and topics of current interest in fermentations, Probiotics.

Unit-IV

Instrumentation: Microscopy, HPLC, HPTLC, GC-MS, FTIR, SEM/TEM, NMR, AAS.
Enzyme assay: enzyme activity and specific activity determination. Cell disintegration and extraction techniques, separation of proteins by fractionation (ammonium sulphate, organic solvents). Ion exchange chromatography, molecular sieve chromatography, affinity chromatography, paper chromatography, thin layer chromatography, ultra filtration, Ultracentrifugation. Gel electrophoresis, isoelectric focusing and immunoelectrophoresis, capillary electrophoresis, pulse field electrophoresis.

Reference Books:

1. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004) Microbiology. 5th edition Tata McGraw Hill.
2. Cappucino J and Sherman N. (2013). Microbiology: A Laboratory Manual. 10th edition. Pearson Education Limited
3. Methods of Protein and Nucleic acid Research, Osterman Vol I – III
4. Centrifugation D. Rickwood
5. Practical Biochemistry, V th edition, Keith Wilson and Walker.
6. Tortora GJ, Funke BR and Case CL. (2016). Microbiology: An Introduction. 12th edition. Pearson Education
7. Tools in Biochemistry David Cooper
8. Molecular Cloning : A laboratory manual J Sambrook & EF Fritsch Cold Spring Harbor Laboratorypress
9. Bioinformatics Sequence and Genome Analysis by David W Mount

RIMT UNIVERSITY

MANDI GOBINDGARH, PUNJAB

RIMT
UNIVERSITY

Study Scheme & Syllabus

For

Ph.D. (2021)

Department of Education

RIMT UNIVERSITY

MANDI GOBINDGARH, PUNJAB

VISION

To become one of the most preferred learning places and a centre of excellence to promote and nurture future leaders who would facilitate the desired change in the society.

MISSION

- To impart teaching and learning through cutting-edge technologies supported by the world class infrastructure
- To empower and transform young minds into capable leaders and responsible citizens of India instilled with high ethical and moral values.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities.

DEPARTMENT OF PHYSICS

VISION

To build a foundation for Excellence and encourage the development of the institution as premier institution by igniting and promoting enthusiasm, interest and passion, in the study of physics, in professional courses, as a part of curriculum.

MISSION

- To awaken the young minds and discover their talents both in theory and practical physics through dedication to teach, commitment towards students and the responsibility towards the department.
- To support the development activities of the university and make the department vibrant.
- To demonstrate a high level of competence in the study of applied physics.
- To develop strategy in the deptt. for continuous improvement.
- Department of Physics achieves its mission by trying to evenly represent the underlying sub- disciplines of physics in research and teaching, but also to promote new areas of research, with an emphasis on interdisciplinary and applied research.

ABOUT THE PROGRAM

The program will develop the candidate's independent and reflective knowledge and skills for his/her own research and others as well as the role of research in a broader context. A candidate will achieve the following course outcomes in terms of knowledge, skills, and general competencies, after completing the Ph.D. program.

SCHOOL OF BASIC APPLIED AND BIOSCIENCES

DEPARTMENT OF PHYSICS

PROGRAM EDUCATION OBJECTIVES

PEO1	Apply the laws of physics in classical mechanics, quantum mechanics, electrodynamics, and statistical mechanics at a level commensurate with current standards in physics.
PEO2	Students will be equipped with skills to undertake research work.
PEO3	To develop an understanding of the basic framework of the research process and publications
PE04	To Demonstrate mastery of advanced physics within their chosen subfield. For theorists, demonstrate breadth of knowledge outside their chosen subfield as well.

Program Outcomes for Ph.D. in Physics

PO 1	Understanding different research methods, Equipping scholars with relevant tools and techniques, Data collection and analysis by using statistical measures, use of conceptual understanding in practical research work, and writing a research report.
PO 2	To identify and critically evaluate research and publication of ethical issues within the area of physics.
PO 3	Enhance the analytical and interpretation skills of data, Scholars are well trained in using statistical measures, and software- SPSS; MS EXCEL, etc.
PO 4	Conduct primary research literature searches in their chosen subfield.
PO 5	Apply critical, analytical, and communication skills in developing professional presentations and writing.
PO 6	To access and extract the desired information from the different scientific databases and resources.
PO 7	Apply theoretical and/or experimental tools, as appropriate, to make progress in expanding the frontiers of physics knowledge.
PO 8	Students will be acquainted with the statistical techniques in research.

PROGRAM SPECIFIC OUTCOME

PSO 1	Communicate effectively the results of their research to professionals within their subfield, and within the broader physics community, through both oral presentation and written work.
PSO 2	To develop an understanding and appreciation for the various kinds of research as well as their aspects.
PSO 3	Complete an original, creative project that demonstrably advances knowledge within their subfield.

Program: Ph.D. Course Work

Subject: Physics

Program Code: PHY 501

Subject Code	Subject Name	(Hours Per Week)				
		L	T	P	S	Credits
RMS 5011	Research Methodology & Statistical Techniques	**5**	**0**	**0**	**-**	**5**
RMNS 5012	Research Methodology & Non-Statistical Techniques	**5**	**0**	**0**	**-**	**5**
RME 5013	Research Methodology Techniques (English)	**5**	**0**	**0**	**-**	**5**
CAR 502M	Computer Applications in Research	**3**	**0**	**0**	**-**	**3**
PHY 5 037	Theoretical Physics	**5**	**0**	**0**	**-**	**5**

PHY 5 038	Experimental Physics					
RPE 503 M	Research Publications & Ethics	**2**	**0**	**0**	**-**	**2**
MRP 504 M	Research Project/ Literature Review	**2**	**0**	**0**	**-**	**2**
		27	**0**	**0**	**-**	**27**

RIMT UNIVERSITY

Course Name: Research Methodology& Statistical Techniques

Course Code: RMS 5011

Course Objectives

a) To familiarize participants with the basics of research and the research process.
b) To enable the participants in conducting research work and formulating a research synopsis and report.
c) To impart knowledge for enabling students to develop data analytics skills and meaningful interpretation of the data sets to solve the business/Research problem.

Learning Outcomes of the Course

The aim of the course is to provide participants with an introduction to research methods and report writing. Upon successful completion of the course, the students will be able to:

a) Develop an understanding about various kinds of research, objectives of doing research, research process, research design, and sampling.
b) Have a basic knowledge of qualitative research techniques.
c) Acquire an adequate knowledge of measurement and scaling techniques as well as the quantitative data analysis.
d) Get a basic awareness of data analysisand hypothesis testing procedures.

Unit-I

Introduction to Research Methodology: Meaning, nature, and scope; types of research, andresearch process.*Problem Definition:*Research problem; the necessity of defining the problem; techniquesinvolved in defining a problem; review of literature and identification of research gaps.

Research Design: Meaning of research design; need for research design; features of a good design; important concepts relating to research design; and different research designs.

Sampling Design: Census and sample survey; steps in sampling design; criteria of selecting a sampling; characteristics of a good sample design; different types of sample designs; and random sampling design.

Unit-II

Measurement and Scaling Techniques: Sources of error in measurement; tests of sound measurement; and important scaling techniques.

Data Collection: Collection of primary data; observation method; interview method; a collection of data through questionnaires; collection of data through schedules; latest advances in methods of data collection; collection of secondary data; the case study method.

Data Analysis-I: *Descriptive Statistics Analysis* covering measures of central tendency, dispersion and asymmetry; measures of relationship using regression, correlation, and association (in case of attributes). *Inference Statistics Analysis covering* sampling theory, concept of standard error, and the problem of estimation of a sample size.

Unit-III

Data Analysis-II: Testing of hypotheses covering basic concepts, procedure for hypothesis testing, tests of hypotheses, tests of significance for large samples and small samples, students t-distribution, properties, and t-distributions and the t-levels applications of the t-distribution, chi-square test and goodness of fit, F-test and Z test, analysis of variance, non-parametric test, The Mann – Whitney test, Krushal-Wallias test. *Multivariate Regression Analysis:* econometric model formulation, estimation, testing and interpretation.

Unit-IV

Research Tools: *MS-Excel,* covering broad structure, features, data /file handling, formulae /functions and brief review of utilities of the package. *Statistical/Econometric Package* covering structure of package, data and file handling utilities and analysis utilities of the package.

Interpretation and Report Writing: Technique of Interpretation: Different Steps in Writing Report.

Recommended books:

1. Kothari, C.R., *Research Methodology: Methods and Techniques*, New Age International Publishers, New Delhi, 2010.
2. Garrett Henery E., *Statistics in Psychology and Education*, Longmans, Green, And Co., 1958.
3. Fisher, R.A., *Statistical Methods for Research Workers*, Springer-Verlag New York, Inc. 1992.
4. Gupta, S.P, *Statistical Methods*, Sultan Chand &Sons, New Delhi, 2019.

5. Allen, R.G.D., *Statistics for Economists*. London (Hutchinson), 1949.
6. Blair, Morris M. *Elementary Statistics*, Henry Holt and Co., 1944
7. Smith and Smith, *Business and Economic Statistics*, South Western publishing co., 1996.

Ph.D. Course Work

Course Name: Computer Applications in Research

Course Code: CAR 502M

Course Outcomes: After the completion of course-work, the candidates will able to:

- Present the graphical representations of data
- Make use of applications of MS Office
- Learn the functional units and classify types of computers, how they process information and how individual computers interact with other computing systems and devices

Sr. No	Contents
Unit I	**Computer Fundamentals:** Data and Information, Characteristics of Computers, Various fields of application of Computers, Input-output Devices (Hardware, Software, Human ware and Firmware), Advantages and Limitations of Computer, Block Diagram of Computer, Function of Different Units of Computer, Classification of Computers. Types of Software, Application software and system software. Introduction to Operating System.
Unit II	**Word Processor:** Various aids useful for thesis writing, adding references to documents, citing a citation in text, macros, hyperlinks, mail-merge etc. **Power Point Presentations:** PowerPoint, Features of MS PowerPoint Clipping, Design

	layouts, hyperlinks, tables, insertion of multi-media files, Slide Animation, Slide Shows, Formatting etc. Case study.**MS-Excel:** Introduction to Electronic Spreadsheets, Feature of MS-Excel, Entering Data, Entering Series, Editing Data, Cell Referencing, ranges, Formulae, Functions, Auto Sum, Copying Formula, Formatting Data, Creating Charts, Statistical functions, Sorting Data, Filtering etc.
Unit III	**Internet and applications of IT:** Program Vs Software, Software Engineering, SDLC, DBMS, Data Models, DFD, Specification Tool: SMARTDRAW. Case Study on DFD.
Unit IV	**Latest trends in Computing:** Cloud computing, Data mining, Data Warehousing, Object Oriented Relational Database Management, Object Oriented Relational Database Management System, Distributed databases Concept, Three tier Client/ Server Architecture, Digital Image Processing, etc.

Recommended books:

1. Pardeep K. Sinha, Priti Sinha, Computer Fundamentals, BPB Publications.
2. Rajaraman, V., Fundamental of Computers. Prentice Hall India, New Delhi.
3. R. S. Salaria, Fundamentals of Computers, Salaria Publishing House

Ph.D. Course Work

Course Name: Theoretical Physics

Course Code: PHY 5 037

Objectives

- To convey the scholars some of the concepts of higher levels of physics;
- To prepare them for research in advanced physical fields.

Learning Outcome:

After attending the course the scholars will have some of the advanced concepts of quantum mechanics, condensed matter physics, statistical mechanics, general theory of relativity, high energy physics and nonlinear optics, likely to be useful in forefront areas of research.

UNIT-I: Quantum Mechanics: Schrödinger Picture, Time independent perturbation theory: Theory and an example; Scattering theory: Quantum theory, Partial wave analysis (one example), Born Approximation and its validity (One example); Path integral formulation: propagator, Schrödinger wave equation from path integral, eg: free particles; Introduction to second quantization; Quantum field theory: quantization of scalar field and Dirac field.

UNIT-II: Condensed Matter Physics: Electronic Structure Calculation: Hartree-Fock Theory, Introduction to Density Functional Theory; Correlated Electron States: Mott Transition, Hubbard Model, Magnetic impurities and Kondo Model; Quantum Hall effect: Integer and fractional Hall Effect, Magnetism: Mean-field approximation for Heisenberg Hamiltonian model for Ferromagnetism.

UNIT-III: Statistical Mechanics: Landau theory for phase transitions. Ising model: transfer matrix method; Onsager solution of 2-dimensional Ising model. Non-equilibrium Statistical Mechanics: Response function and susceptibility; fluctuation-

dissipation theorem; irreversibility and the master equation; Fokker-Planck and diffusion equations.

UNIT-IV: High Energy Physics: Introduction to relativistic kinematics, Introduction of four forces and interactions, Feynman diagrams Basics of quantum electrodynamics: Glashow-SalamWeinberg model, Standard Model Physics.

Text Books:

1. Introduction of Quantum Mechanics; David J. Griffiths; Pearson Education; 2010.
2. Introduction to Condensed Matter Physics; F. Duan, J. Guojun; World Scientific; 2007.
3. Statistical Mechanics: R. K. Pathria; Elsevier; 2002.
4. Introduction to Elementary Particles; David J. Griffiths; Wiley; 2008.
5. Introduction to High Energy Physics, Donald Perkins; Cambridge University Press; 2000.

Ph.D. Course Work

Course Name: Experimental Physics

Course Code: PHY 5 038

Course Objectives:

• To teach scholars some of the basic concepts of experimental methods of physics in research;

• To prepare them for research in advanced fields of experimental physics. Learning Outcome

Learning Outcomes: After attending the course the scholars will have some of the fundamental and higher level concepts of Experimental physics likely to be useful especially in forefront areas of experimental research.

UNIT-I: Vacuum Generation and Measurement Techniques: 1 Introduction to vacuum, gas law; Rotary vane pump, Turbomolecular pump, Cryo pump; Pirani gauge, Penning gauge.

UNIT-II: Fundamentals of Synthesis and Fabrication of Materials: Classification of powders; Synthesis of powders: Sol-gel, Hydrothermal, Combustion techniques; Synthesis of thin films: Spincoating, Dip coating, Thermal and electron beam evaporation, Pulsed laser deposition; General concept of lithography, Photolithography, Electron beam lithography; Clean room.

UNIT-III: Introduction to Basic Measurements and Characterization Techniques: Study of Crystal Structure: X-ray diffraction (XRD), Transmission Electron diffraction (TED),

Microscopic Techniques: Scanning Electron Microscope, Transmission Electron Microscope, Scanning Probe Microscopes.

Spectroscopic Techniques: UV-Vis, Fluorescence, IR and FTIR, Photo-Acoustic, Laser Induced Breakdown, Raman, Twyman-Green interferometer as a special case of Michelson Interferometer for testing of optical components, Lateral shearing interferometers and its applications such as testing.

UNIT-IV: Accelerator and Fusion Techniques: Pelletron, Linear accelerator, Cyclotron, Synchrotron, Tokamac; Applications in High energy physics, Materials science and Particle therapy, Low Temperature Methods: Temperature measurement and control; Cryostats and cooling methods.

TEXT BOOKS:

1. Handbook of Vacuum Science and Technology; Hoffman, Singh and Thomas; Academic Press, 1998.

2. Nanostructures and Nanomaterials - Synthesis, Properties and Applications; Guozhong Cao, World Scientific, 2004

3. Thin Film Phenomena; Chopra; McGraw-Hill; 1969

4. Principles of Fluorescence Spectroscopy; J. R. Lakowicz, Third Ed., Springer, 2006.

5. Fundamentals of Molecular Spectroscopy; C. N. Banwell and E. M. McCash, 4th Ed., McGraw, 2016.

6. Plasma Physics and Controlled Nuclear Fusion, K. Miyamoto, Springer, 2005

7. Experimental Techniques for Low-Temperature Measurements: Cryostat Design, Material Properties, and Superconductor Critical-Current Testing; Jack W. Ekin, Oxford,

Ph.D. Course Work
Course Name: Research Publications & Ethics

Course Code: RPE503M

Course Outcomes: After completion of the course, the scholars will be able to:

- To understand the philosophy of science and ethics, research integrity and publication ethics
- To identify research misconduct and predatory publications.
- To understand indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.)
- To understand the usage of plagiarism tools.

THEORY:

- **RPE 01: PHILOSOPHY AND ETHICS (3 hrs.)**

    1. Introduction to philosophy: definition, nature and scope, concept, branches
    2. Ethics: definition, moral philosophy, nature of moral judgments and reactions

- **RPE 02: SCIENTIFIC CONDUCT (5 hrs.)**

    1. Ethics with respect to Science and Research
    2. Intellectual honesty and research integrity
    3. Scientific Misconducts: Falsification, Fabrication and Plagiarism (FFP)

4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

- **RPE 03: PUBLICATION ETHICS (7 hrs.)**

1. Publication ethics: definition, introduction and importance
2. Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

PRACTICE:

- **RPE 04: OPEN ACCESS PUBLISHING (4 hrs.)**

1. Open access publications and initiatives
2. SHERPA/ ROMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

- **RPE 05: PUBLICATION MISCONDUCT (4 hrs.)**

A. Group Discussions (2 hrs.)
   1. Subject specific ethical issues, FFP, authorship
   2. Conflicts of interest
   3. Complaints and appeals: examples and fraud from India and abroad

B. Software tools (2 hrs.)
   Use of plagiarism software like Turnitin, Urkund and other open source software tools

- **RPE 06: DATA BASES AND RESEARCH METRICS (7 hrs.)**

A. Databases (4 hrs.)

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics (3 hrs.)
1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, C ite Score
2. Metrics: h-index, g-index, i10index, altmetrics

SUGGESTED READINGS:

- The Ethics of Teaching and Scientific Research By Miro Todorovich; Paul Kurtz; Sidney Hook.
- Research Ethics: A Psychological Approach By Barbara H. Stanley; Joan E. Sieber; Gary B. Melton
- Research Methods in Applied Settings: An Integrated Approach to Design and Analysis By Jeffrey A. Gliner; George A. Morgan Lawrence Erlbaum Associates, 2000
- Ethics and Values in Industrial-Organizational Psychology By Joel LefkowitzLawrence Erlbaum Associates, 2003.
- Robin Levin Penslar, Research Ethics: Cases and Materials, Indiana University Press
- Chowdhary, N., & Hussain, S. (2021). Handbook of Research and Publication Ethics. Bharti Publications: New Delhi

Ph.D. Course Work

Course Name: Research Project/ Review of Literature

Course Code: MRP 504M

Max Marks: 100

Internal: 100

The candidates will be required to do literature survey covering review of Ph.D theses and/or review research papers of reputed journals related to the research field. It is expected that about 2 to 3 theses and 10 to 15 research papers will be reviewed by the candidates and will finally present the seminar. The candidates will submit 3-4 topics out of which one topic will be approved by a committee at the departmental level.

The candidates will be required to make a presentation for the end term examination before a committee and shall be evaluated on the basis of file and presentation.