Resolution number: AC/II(22-23).3.RPS1

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

RUIA COLLEGE
Explore • Experience • Excel

Syllabus for

Program: M.Sc. in Bioanalytical Sciences

(Post-graduate Syllabus)

Program Code: RPSBAS

(As per the guidelines of National Education Policy 2020-Academic year 2023-24)

(Choice based Credit System)

Graduate Attributes

S. P. Mandali's Ramnarain Ruia Autonomous College has adopted the Outcome Based Education model to make its science graduates globally competent and capable of advancing in their careers. The Bachelors Program in Science also encourages students to reflect on the broader purpose of their education.

GA	GA Description **A student completing Bachelor's/Master's Degree in Science program will be able to:**
GA 1	Demonstrate in depth understanding in the relevant science discipline. Recall, explain, extrapolate and organize conceptual scientific knowledge for execution and application and also to evaluate its relevance.
GA 2	Critically evaluate, analyze and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
GA 3	Access, evaluate, understand and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation.
GA 4	Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research work in appropriate scientific language.
GA 5	Demonstrate initiative, competence and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups.
GA 6	Use an objective, unbiased and non-manipulative approach in collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance.
GA 7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills and lead a team for planning and execution of a task.
GA 8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM OUTCOMES

PO	Description **A student completing Master's Degree in Science program in the subject of Bioanalytical Sciences will be able to:**
PO 1	Gain high quality science education in a vibrant academic ambience with the faculty of distinguished teachers and scientists.
PO 2	Take up the challenge of doing quality research and teaching and also contribute to industrial production and R & D in the fields of Bioanalysis, Bioinformatics and Nutraceutical Sciences.
PO 3	Amalgamate classical analytical chemical techniques with modern genomic and proteomic technologies of manufacturing and analysis to better characterize the products useful as medicines as well as nutraceuticals.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	Course Type	CREDITS
M.Sc. II	III	RPSBAS301	Molecular Biology and OMICS	-	4
		RPSBAS302	Modern Analytical Instrumentation	-	4
		RPSBAS303	Bioanalytical Techniques	-	4
		RPSBASP301	Practicals on RPSBAS301	-	2
		RPSBASP302	Practicals on RPSBAS302	-	2
		RPSBASP303	Practicals on RPSBAS303	-	2
		RPSBASP304	Internship/Research Project	-	6
M.Sc. II	IV	RPSBAS401	Clinical Research Industry	-	4
		RPSBAS402	Pharmaceutical Method Development and Validation	-	4
		RPSBASE403	Biopharmaceuticals & Biosimilars	-	4
		RPSBASE404	Xenobiotic Analysis		
		RPSBASP401	Practicals on RPSBAS401	-	2
		RPSBASP402	Practicals on RPSBAS402	-	2

		RPSBASEP403	Practicals on RPSBASE403	-	2
		RPSBASEP404	Practicals on RPSBASE404		
		RPSBASP405	Internship/Research Project	-	6

Course Code: RPSBAS301

Course Title: Molecular Biology and OMICS (Core Course)
Academic year 2023-24

COURSE OUTCOMES

COURSE OUTCOME	DESCRIPTION
CO 1	Explain the applications of PCR techniques
CO 2	Elaborate on the techniques involved in genome studies and also understand the significance of pharmacogenomic studies
CO 3	Explain the techniques involved in transcriptome studies
CO 4	Perform techniques involved in protein purification
CO 5	Hands-on different methodologies used for proteomic and metabolomic studies

DETAILED SYLLABUS

Paper Code	Semester III- Paper I	Credits/ Hours
RPSBAS301	**Molecular Biology and OMICS**	**4/60**
301.1: PCR and Recombinant DNA technology		
1. Types of PCR: Conventional Qualitative PCR, Hot start PCR, Colony PCR, Nested PCR, Realtime PCR, Reverse transcriptase PCR, Touchdown PCR, Mulitplex PCR, Assembly PCR, Methylation specific PCR, LAMP assay 2. PCR instrumentation: Principle of thermal cycler 3. PCR standardization 4. Applications of PCR: PCR-RFLP, AFLP, RAPD, Diagnostics 5. Basics of recombinant DNA technology.		**15**
301.2: Genomics		
1. Introduction to genomics and its types. 2. Genome sequencing techniques- Sanger sequencing, Maxim Gilbert Sequencing, Next generation sequencing techniques (Illumina sequencing, 454 pyrosequencing, etc), Overview of whole genome sequencing 3. Types of SNPs and techniques to identify them (suitable examples of techniques based on restriction digestion, microarray, DNA conformation, and DNA sequencing). 4. Identification for SNPs for diseases- Haplotypes, Linkage disequilibrium, Genome wide association 5. Pharmacogenomics-. Correlation of SNPs with variations of ADME. (With suitable examples such as CYP gene variations), Variations in ethnic groups and races. 6. Introduction to epigenomics		**15**

301.3: Transcriptomics	
1. Introduction to transcriptome, structure of eukaryotic m-RNA, exons, introns, splice variants. Types of non-coding RNAs 2. cDNA libraries and Expressed Sequence Tags (ESTs) 3. Techniques of gene expression analysis (Northern blot, in-situ hybridization, qRT-PCR, microarrays, RNA-seq, etc), Overview whole transcriptome sequencing 4. Transcriptomics biomarkers- mRNA and non-coding RNAs as biomarkers with suitable examples.	**15**
301.4: Proteomics and Metabolomics	
1. Protein extraction, separation, purification and identification 2. Types of Proteomics with suitable examples–, Functional Proteomics, Structural Proteomics, Post-translational modifications, Protein-Protein interaction, Protein expression profiling, Proteome mining, Human Proteome Project 3. Protein fingerprinting techniques, De Novo sequencing of protein 4. Advanced techniques in proteomics: Co-immunoprecipitation, Yeast 2hybrid, Label free and label -based methods for protein quantification 5. Introduction to Peptidomics 6. Metabolomics- Lipidomics, Glycomics	**15**
RPSBASP301	
1. Plant DNA extraction and analysis using suitable method 2. Amplification of DNA by PCR 3. Separation of proteins using SDS-PAGE: plasma protein profiling, plant protein profiling 4. Protein extraction, purification and quantitation from any biological source 5. RT-PCR (demo) 6. Metabolic profiling using HPTLC	**1/30**

References:

1. iGenetics A molecular Approach: Russell
2. Lehninger's Principle of Biochemistry : David Nelson, Michael Cox : Springer
3. Principles of Gene Manipulation and Genomics: Sandy B. Primrose, Richard Twyman
4. Genomics: Concepts and Applications: Caleb Elliot
5. Genomics and Proteomics- Functional and Computational Aspects: Sándor Suhai
6. Principles of Proteomics: Richard Twyman
7. Metabolomics: A Powerful Tool in Systems Biology
8. Omics in Clinical Practice- Genomics, Pharmacogenomics, Proteomics, and Transcriptomics in Clinical Research: Yu Liu

Course Code: RPSBAS302

Course Title: Modern Analytical Instrumentation (Core Course)
Academic year 2023-24

COURSE OUTCOMES

COURSE OUTCOME	DESCRIPTION
CO 1	Apply the different thermal analytical techniques with special emphasis on Bioanalysis.
CO 2	Describe different analytical techniques like XRD-XRF
CO 3	Explain the applications of Chiral chromatography

DETAILED SYLLABUS

Paper Code	Semester III- Paper II	Credits/ Hours
RPSBAS302	**Modern Analytical Instrumentation**	**4/60**
302.1: Thermal Analysis		
1. Principles of Thermal Analysis 2. Instrumentation Requirements 3. Sample preparation, Experimental conditions, Techniques in Thermal Analysis 4. Applications of Thermal Analysis 5. Thermal analysis of Bhasma preparations (Case studies e.g. Praval bhasma, Lohabhasma)		**15**
302.2: XRD and XRF		
1. Theory of XRD and XRF 2. Crystal structure of solids and concept of crystallography 3. Bragg's law of diffraction 4. Instrumentation of powdered XRD 5. Application in the determination of polymorphs in pharmaceutical compounds 6. Percent crystallinity, Single crystal XRD 7. Determination of the 3D structure 8. Wavelength dispersive (WD) and energy dispersive (ED) XRF 9. Instrumentation of WD and (ED)XRF 10. Applications of XRF for elemental analysis		**15**
302.3: Chiral Chromatography		
1. Concept of chirality 2. Types of Chiral Chromatographic techniques (Direct and Indirect Chiral HPLC). 3. Principle of chiral separation using chiral liquid chromatography. 4. Chiral HPLC-Instrumentation 5. Classes and types of Chiral Stationary Phases (CSPs) – brush type, helical polymer		**15**

type, cavity type, protein based, macrocyclic glycopeptide based; materials used for preparing them and their chemistry, mobile phases used in Chiral HPLC. 6. Special type of detectors used in Chiral HPLC. 7. Applications of chiral HPLC in analysis of pharmaceuticals, pesticides and natural products.	
302.4: CD-ORD	
1. Molecular dissymmetry and chiroptical properties, nature of light – linearly and circularly polarised light 2. Circular Dichroism, CD Spectroscopy instrumentation and its application in analysis of proteins and nucleic acids. 3. Optical Rotary Dispersion, Circular birefringence and cotton effect 4. ORD Spectroscopy and its instrumentation. 5. Types of ORD curves and their applications. 6. Octant Rule and α –halo ketone rule with their applications. 7. Differences between CD and ORD.	**15**
RPSBASP302	
1. RFLP analysis 2. Purification of a compound using preparative HPTLC/HPLC. 3. Simultaneous analysis of Iron by colorimetry and AAS 4. IR analysis of bhasma sample 5. HPTLC analysis of a drug from plasma.	**1/30**

References:

1. Stereochemistry of Organic Compounds by D.Nasipuri
2. Chiral Analysis: Advances in Spectroscopy, Chromatography and Emerging Methods by Daniel W. Armstrong. (2nd edition)
3. Fundamentals of Analytical Chemistry by D.A Skoog, D.M. West, F.J. Holler. 4. Principles of instrumental analysis: Douglas a. Skoog
5. ORD and CD in Chemistry and Biochemistry: Pierre Crabbe
6. Chiral Chromatography: Beesley& Scott

Course Code: RPSBAS303
Course Title: Bioanalytical Techniques (Core Course)
Academic year 2023-24

COURSE OUTCOMES

COURSE OUTCOME	DESCRIPTION
CO 1	Explain the importance of hyphenated techniques.
CO 2	Analyse and interpret mass spectrometric data for identification and quantification of analytes.
CO 3	Interpret spectral data of IR, NMR and LC-MS for structural elucidation of analytes.

DETAILED SYLLABUS

Paper Code	Semester III- Paper III	Credits/ Hours
RPSBAS303	**Bioanalytical Techniques**	**4/60**
303.1: Introduction to Mass Spectrometry(MS)		
1. Evolution of MS 2. Importance of MS as a detector 3. Interfaces used in LC-MS & GC-MS 4. Sample preparations of MS 5. Components of Mass Spectrometer: a) Inlets b) Ion sources- GC-MS: EI,CI; LC-MS: ESI,API(APCI & APPI), FI,FD,FAB,TSP, MALDI c) Analyzers- QP,TOF, Ion trap, Magnetic sector, Hybrid analyzers d) Detectors 6. Importance of vacuum in MS system 7. Sample preparation for MS		**15**
303.2: Advances of Mass Spectroscopy		
1. Introduction to MS/MS (tandem MS) 2. GC/MS and GC/MS/MS 3. LC/MS and LC/MS/MS 4. Scan events in Triple Quadrupole and other tandem systems and hybrid Systems 5. Introduction to ICP-MS and its industrial applications. 6. Introduction to advances in the field of mass spectroscopy e.g. Headspace Gas chromatography, Thin Layer Chromatography-Mass Spectroscopy		**15**
303.3: NMR and its applications in Bioanalysis		
1. Basic Phenomenon of Nuclear Magnetic Resonance(NMR) Spectroscopy: Nuclear spin transition, magnetic dipole 2. Chemical Shielding		**15**

3. Chararacteristic 1H, 13C and 15N chemical shifts 4. Factors affecting chemical shifts 5. Chemical shift dispersion and multi-dimensional NMR 6. Applications in Bioanalysis	
303.4: Structural Elucidation by FTIR, MS and NMR	
1. FTIR as a preliminary tool in structural elucidation 2. Role of GCMS, GCMS/MS spectra in structural elucidation 3. Role of LCMS, LCMS/MS spectra in structural elucidation 4. Resonance assignment in NMR spectra	**15**
RPSBASP303	
1. HPLC analysis of modern drug from plasma 2. LC/MS quantitation of a modern drug (e.g. Diclofenac Sodium, Ezetimibe etc.) 3. GC/MS separation of plant essential oil 4. Mass Fingerprinting of peptides using a suitable sample 5. IR analysis of a purified compound 6. Structural elucidation of a compound on the basis of its FTIR, NMR and MS outputs.	**1/30**

REFERENCES:

1. Principles of Instrumental Analysis - Skoog, Holler, Crouch
2. Modern Practices in Gas-Chromatography- Robert L. Grob, Eugene F. Barry
3. Radioactive Tracer Techniques by George Keene Schweitzer
4. Handbook of Analytical Techniques, Vol I & II- Wiley Publications

Core Course: RPSBAS304
Course Title: Internship/Research Project
Academic year 2023-24

COURSE OUTCOMES

COURSE OUTCOME	DESCRIPTION
CO 1	Comprehend the functionality and working setup and norms of Industry.
CO 2	Industrial training will impart all types of professional qualities in students along with enhancing their skills in the Industrial research.
CO 3	Familiarize students with current research trends and job roles in the Pharmaceutical and allied industries.

DETAILED SYLLABUS

Paper Code	Semester III- Paper III	Credits/ Hours
RPSBAS304	**Internship/Research Project**	**120**

Industrial Training, and/or research project

1. Students are required to complete an Industrial training/ Research project for duration of 8-12 weeks.

2. Students are required to submit a report of the Industrial training/ Research project in the format provided by the college/department.

3. A certificate of successful completion of the training provided by the Company/research institute should be attached in the submitted report.

Course Code: RPSBAS401

Course Title: Clinical Research Industry (Core Course)
Academic year 2023-24

COURSE OUTCOMES

COURSE OUTCOME	DESCRIPTION
CO 1	Give an account of the various aspects of clinical research.
CO 2	Evaluate the case report format involved in BA/BE study.
CO 3	Give an account of Therapeutic Drug Monitoring and its Pharmacoeconomics.
CO 4	Highlight the role and significance of Pharmacovigilance along with its process.
CO 5	Calculate different Pharmacokinetic parameters and solve Bioavailability & Bioequivalence problems.
CO 6	Apply HPLC in therapeutic drug monitoring.

DETAILED SYLLABUS

Paper Code	Semester IV- Paper I	Credits/ Hours
RPSBAS401	**Clinical Research Industry**	**4/60**
401.1: Design and Conduct of Clinical Study		
1. Clinical Trial Designs: Types 2. Preparing for clinical study 3. Study Initiation , Monitoring, Study closeouts 4. Overview of clinical audits 5. Regulatory compliance 6. Preparation and submission of clinical dossier		**15**
401.2: Bioavailability and Bioequivalence		
1. Concept of BA and BE 2. Parameters to evaluate BA and BE of a drug 3. Factors that influence BA and BE of a drug 4. Evaluating BA and BE of a drug 5. Estimating BA and BE parameters of a drug 6. Design of a BA and BE study 7. Conduct of a BA and BE study 8. Data record and evaluation in BA and BE study 9. Reporting a BA study 10. Regulatory requirements of BA and BE		**15**
401.3: Clinical Data Management		

1. Introduction to CDM 2. Collection, Cleaning, and Management of subject data 3. Tools for CDM 4. Regulations, Guidelines, and Standards in CDM 5. The CDM Process 6. Review and finalization of study documents 7. Database designing, Data Collection 8. CRF tracking 9. Data entry & Validation, Medical Coding 10. Roles and Responsibilities in CDM	**15**
401.4: Pharmacovigilance and Therapeutic Drug Monitoring	
Pharmacovigilance (10 L) 1. Introduction to Pharmacovigilance 2. Significance and need for Pharmacovigilance 3. Indian scenario and the role of regulatory in Pharmacovigilance 4. Pharmacovigilance and safe use of medicines (with case studies) **Therapeutic Drug Monitoring (05 L)** 1. Purpose of therapeutic drug monitoring 2. Bioanalytical techniques in TDM 3. Analytical and practical issues of TDM 4. Pharmaco-economics of TDM	**15**
RPSBASP401	
1. Calculation of AUC and bioequivalence from the given data (2 expts.) 2. Calculation of different Pharmacokinetic parameters like Ka, Ke, t 1/2, C max, Tmax and AUC from the given blood data. 3. Study of sample forms, checklists and logs of a clinical study 4. Evaluation of a BA/BE Report 5. Introduction to registry resources such as ct.gov 6. Introduction to medical writing	**1/30**

REFERENCES:

1. Principles of Good Clinical Practice: McGraw, George, Shearn, Hall and Thomas
2. Good Clinical Practice Standard Operating Procedures for Clinical Researchers: Graeme Scott, Josef Kolman, Paul Meng
3. Clinical Trials Audit Preparation: A Guide for Good Clinical Practice (GCP) Inspections: Vera Mihajlovic-Madzarevic
4. Design & Analysis of Bioavailability & Bioequivalence studies: Shein-Chung Chow & Jen Pei Liu
5. Biopharmaceutics Applications in Drug Development: Rajesh Krishna & Lawrence Yu
6. Bioavailability and Bioequivalance in Pharmaceutical technology: T. K. Pal, P. K. Ganesan
7. Therapeutic Drug Monitoring: Newer Drugs and Biomarkers: Amitava Dasgupta
8. Therapeutic Drug Monitoring and Toxicology by Liquid Chromatography: Wong

Course Code: RPSBAS402

Course Title: Pharmaceutical Method Development and Validation (Core Course)

Academic year 2023-24

COURSE OUTCOMES

COURSE OUTCOME	DESCRIPTION
CO 1	Perform method development and validation using analytical instruments.
CO 2	Comprehend the additional issues of endogenous substances and biomarkers in Bioanalytical Method Development.
CO 3	Perform method validation using sophisticated analytical instruments like HPLC or GC.
CO 4	Apply mass spectrometry for qualitative and quantitative analysis of data
CO 5	Interpret the Mass Spectra.
CO 6	Interpret spectral data of LC-MS for structural elucidation of analyte

DETAILED SYLLABUS

Paper Code	Semester IV- Paper II	Credits/ Hours
RPSBAS402	**Pharmaceutical Method Development and Validation**	**4/60**
402.1: Analytical Method Development (AMD) and Analytical Method Validation (AMV)		
1. Concept of method development and validation 2. System suitability, Parameters for Method Validation 3. Use of Reference standards 4. Regulatory requirements of validation		**15**
402.2: Bioanalytical Method Development (BMD) and Bioanalytical Method Validation (BMV)		
Bioanalytical Method Development (BMD) (07 L) 1. Strategies for Method development 2. Difference between AMD and BAMD, AMV and BAMV. 3. Regulatory requirements of validation 4. Intra and inter lab – Validation 5. IQ, OQ and PQ of analytical instruments **Bioanalytical Method Validation (BMV) (08L)** 1. Pre- study Validation. 2. Selectivity, Accuracy, Precision, Recovery, Calibration Curve, Sensitivity, Reproducibility, Stability Incurred sample re-analysis (ISR). 3. Documentation and Additional issues like Endogenous substances & Biomarkers etc. 4. In-Study Validation.		**15**

402.3: Method Development and Validation in HPTLC, GC and GCMS	
1. Method Development and Validation in HPTLC: Approach, Methodology and trouble shooting (with suitable examples) 2. Method Development and Validation in GC and GCMS: Approach, Methodology and trouble shooting (with suitable examples)	**15**
402.4: Method Development and Validation in HPLC, LC-MS	
1. Method Development and Validation in HPLC: Approach, Methodology and trouble shooting (with suitable examples) 2. Method Development and Validation in LC-MS: Approach, Methodology and trouble shooting (with suitable examples)	**15**
RPSBASP402	
1. GC analysis of herbal raw material & ASU formulations 2. Study of Installation Qualification, Operational Qualification, Performance Qualification of any one analytical instrument. 3. Analytical Method Validation (any one example) 4. Interpretation of GCMS spectra 5. Interpretation of LCMS spectra	**1/30**

REFERENCES:

1. Principles of Instrumental Analysis, Author: Skoog, Holler, Crouch
2. Method Validation in Pharmaceutical Analysis, Edited by: Ermer&Nethercote 3. Analytical chemistry by open learning- Mass spectrometry
4. Analytical Method Development And Validation: Swartz and Krull
5. Validation of Analytical Methods, Methodology and Statistics : Shrivastava and Saxena
6. Bioanalytical Method Validation: Waghulkar, Deshpande & Rathod

Course Code: RPSBAS405

Course Title: Internship/Research Project

Academic year 2023-24

COURSE OUTCOMES

COURSE OUTCOME	DESCRIPTION
CO 1	Formulate hypothesis, carry out literature survey, test hypothesis by designing experiments, and interpret results
CO 2	State the importance of proper documentation
CO 3	Develop Research Presentation skills

DETAILED SYLLABUS

Paper Code	Semester IV- Paper V	Credits/ Hours
RPSBAS405	**Internship/Research Project**	**6/120**

Industrial Training, and/or research project

1. Students should submit the detailed report regarding of the above-mentioned course.
2. Students should consult the teacher mentor allotted by the department and HOD for taking up modules from the course.
3. After getting approval from the mentor/HOD, student should provide the weekly update to the mentor over email.
4. For internal component students are required to present the learning outcome(s) of the module twice in a semester and submit necessary assignments given by the mentor.

Research Project

1. Students are expected to identify a research problem relevant to the subject 2. The topic of research should be interdisciplinary, and should involve statistical analysis.
3. Thorough literature review should be carried out by the students. 4. A project Proposal should be submitted by student and should get approval from mentor(s) allotted by the department.
5. Students should report and update the allotted mentor regarding the project work. 6. Students are expected to support detailed report of the project work such as Laboratory notebooks.
7. Final hardbound report as well as the soft copy report of the project work should be prepared by the student as per the guidelines/ format provided by the institution & should submit the same to the department before the examination**.**
8. Student is expected to prepare a PowerPoint presentation and present the same at the time of Practical examination and should face Viva voce based on the project work.

Research Review:

1. Students should identify a topic for literature review
2. They should review at least 15 research articles for the review topic
3. Review article should be a detailed, comprehensive summary of the research articles in student's own words.

4. Final hardbound report as well as the soft copy report of the review article should be prepared by the student as per the guidelines/ format provided by the institution & should submit the same to the department before the examination
5. Student is expected to prepare a PowerPoint presentation and present the same at the time of Practical examination and should face Viva voce based on review article.

Research based on Survey/Case study

1. Students should identify a topic for survey/case study
2. They should prepare an outline for data collection that can include questionnaire/interviews/referencing and present the same. Data collection can be done online, if required.
3. They should gather data for survey/case study in a stipulated time and keep record of the same.
4. After data, collection, students should analyze the data using appropriate statistical tests and write final conclusion of the study.
5. Final hardbound report as well as the soft copy of the survey/case study report should be prepared by the student as per the guidelines/ format provided by the institution & should submit the same to the department before the examination
6. Student is expected to prepare a PowerPoint presentation and present the same at the time of Practical examination and should face Viva voce based on survey/case study article.

Modality of Assessment

Sem III & IV

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1.	Internal Examination	20
2.	Assignment/Group Discussion/Presentation/Class Activity	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

1. Duration - These examinations shall be of **2.5 Hrs** duration.
2. Theory question paper pattern:

Paper Pattern (except RPSBASP304):

Question	Options	Marks	Questions Based on
Q.1 Short answer questions (4 Marks each)	3 out of 4	12	Unit I
Q.2 Short Answer questions (4 Marks each)	3 out of 4	12	Unit II
Q.3 Short Answer questions (4 Marks each)	3 out of 4	12	Unit III
Q.4 Short Answer questions (4 Marks each)	3 out of 4	12	Unit IV
Q.5 Objective/short answer questions (3 Marks each)	4 out of 6	12	Combination of all units
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	
Journal	10
Experimental tasks/Attendance	10
Small project/Class assignment/Presentation/Activity/Viva	20
Total	**40**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	**Paper**
Required Experiments Performed with appropriate principle, approach, Observations, Result, Demonstration of skills, Conclusion and Viva.	**60**
Total	**60**