

SANKALCHAND PATEL UNIVERSITY, VISNAGAR

Faculty of Science & Humanities



Structure, Teaching Scheme and Syllabus of

B. Sc. (Microbiology) Honours with Research

Sem-6 as per NEP-2020

Program Code: SC102

With effect from: 2023-24

Semester- 6

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Biostatistics
Course Code:	16-MIM304-3C
Pre-requisite Course:	

Course Objectives:

- To understand applications of biostatistics for data collection and Sampling
- To understand various tools and techniques for data-analysis.
- To apply the knowledge of biostatistics for various problem solving.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	Introduction to Biostatistics Introduction to Biostatistics: Definition of statistics and biostatistics, Development of biostatistics, Applications and role of biostatistics Sources and Presentation of Data: Types of data and Collection of data, Classification and tabulation, Diagram and Graph, Frequency distributions of data. Variables and its types. Sampling: Introduction and Definition, Types of population, Sample, sampling variation and Bias, Listing of population and sample size	15	33%
2	Tools and Techniques for data-analysis Measures of central Tendency: Mean, Median and Mode, Position of averages, Selection of the appropriate measure of central Tendency, Geometric mean and Harmonic mean. Partition values: Quartiles, Deciles and Percentile Measure of dispersion: Standard deviation and standard error	15	33%
3	Correlation and Regression Hypothesis testing Chi-Square Test: The formula for Chi-Square Test, Distribution of Chi-Square Test and degree of freedom, Application of Chi-Square Test Student t-test: Introduction, Student's t-Distribution, Application of t-Distribution Analysis of Variance (ANOVA): Principle of ANOVA, Partitioning of ANOVA, Comparison of pairs of Means, Assumption Underlying ANOVA, Application of ANOVA	15	34%

List of Experiments:

- Problems Solving using Mean
- Problems Solving using Median
- Problems Solving using Mode
- Problems Solving using Harmonic Mean
- Problems Solving using Geometric Mean

- Problems Solving using Standard Deviation
- Problems Solving using Hypothesis
- Problems Solving using Chi square test
- Problems Solving using t-Test
- Problems Solving using Anova

Textbooks:

- Biostatistics, by P N Aurora and PK Malhan Himalaya Publishing House
- Elements of Biostatistics by S Prasad, (2018) 3rd Ed. Rastogi Publication

Reference Books:

- Gurumani, N. An Introduction to Biostatistics. 2nd Edition. MJP Publishers, Chennai.
- Goon A.M. Gupta M.K. and Dasgupta B. (1985): Fundamental of Statistics Vol. I The World Press Private Ltd. Calcutta.
- Fundamentals of Biostatistics by Bernard Rosner (2011), 7th ed.

List of Open-Source Software/learning website:

- <http://digimat.in/nptel/courses/video/102101056/L01.html>
- <https://www.classcentral.com/course/swayam-introduction-to-biostatistics-7969>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Learn the basics of data collection and presentation.	1 Remember 2 Understand
CLO2	Basically, understand the factors responsible for sampling.	1 Remember 2 Understand, 3 Apply
CLO3	Apply the measure of central tendency in taking decisions	3Apply
CLO4	Analyze the data to reach a conclusion.	2 Understand, 3 Apply 4 Analyze
CLO5	Think critically about and applying various tool for data analysis	1 Remember 2 Understand, 3Apply 5 Evaluate
CLO6	The Student would be able to analyze various data statistically and /OR create a new process by applying the biostatistics tool.	3Apply,4 Analyse 5 Evaluate, 6 Create

Mapping of CLO s with POs & PSOs

Course Learning Outcome s	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	2					3					2					3		
CLO2		1			2		1			3		1			2			
CLO3			3					2					2			2		
CLO4		2					2					2						
CLO5					2					2					2			
CLO6	1					1					1					2		

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Microbial Bioprocesses
Course Code:	16-MIM305-3C
Pre-requisite Course:	Basics of Fermentation

Course Objectives:

- To understand Microbial processes and production
- To understand Fermentation processes
- To understand Biosensors
- To understand Fermentation economics

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	• Mushroom cultivation • Microbial processes in industry:-bioleaching and MEOR • Microbial processes in agriculture: bio insecticide and bio-fertilizer • Microbial production Bioplastic • Microbial production of biofuels	13	28%
2	• An overview of solid state fermentation, • Fermentation processes of Enzyme (Amylase, Protease) • Fermentation processes of alcohol, organic acids (Gluconic acid / Citric acid) • Fermentation processes of amino acids (Lysine), vitamins (Vit. B12) • Fermentation processes of antibiotics (penicillin, Streptomycin) • Fermentation processes of Microbial Biomass (SCP, SCO)	13	28%
3	• CONTROL PARAMETERS & ECONOMICS • Control systems manual and automatic, combined method, requirement for control, Recent trends in fermentation control • Biosensors: Principles and definition, characteristics of Ideal biosensors, Basic measuring procedure, Biochemical components of biosensors: Enzyme based biocatalyst sensors, Bioaffinity systems, Immunosensors • Application of Biosensors: Clinical laboratory, In vivo determination of metabolites, Environmental monitoring of toxic compound. • Fermentation economics: Fermentation economics for isolation , strain improvement, media design, sterilization , aeration and agitation and effluent treatments • Immobilization: Basic concept of immobilization in biotechnology, Principles and mechanism of Immobilization, Methods of Immobilization with examples	19	44%

List of Experiments:

1. Fermentative production of Amylase and determination of Amylase activity.
2. Typical fermentation of alcohol.
3. Typical fermentation of gluconic acid.
4. SCP production in laboratory.
5. Sterility testing of pharmaceutical products.
6. Immobilization of cells/enzyme.

Text books:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

Reference Books:

1. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
2. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education
3. Biotechnology –The Biological Principles, M.D.Trevaan ,S.Boffey,K H Goulding, P Stanbury
4. Mukhopadhyay, Process Biotechnology Fundamental. Viva book.
5. Shuler and Kargi, 1992. Bioprocess engineering, Prentice-Hall.
6. Bialy & Ollis.1986. Biochemical Eng. Fundaments. McGraw-Hill.
7. Schugerl. 1987. Bioreaction engineering, J/W.
8. Stanbury and Whitaker. Principles of fermentation technology.
9. Sikyta. Methods in Industrial microbiology. Ellis Hardwood Ltd.
10. Krysman. Product recovery in bioprocess technology.
11. T.K. Ghose. Bioprocess computation in biotechnology, Ellis Hardwood Ltd.
12. MurryJoh. 1997. Microorganisms and Biotechnology.
13. Demainefal. (ED) 1999. Manual of industrial Microbiology and Biotechnology. Asin Press.
14. Bioprocess Engineering Principles by Doran (D); Academic Press, 1998.
15. Cooney, A.E. Humphrey, Comprehensive Biotechnology : The principles and Regulation of
16. Biotechnology in Industry, Agriculture and Medicine. Vol.2, Pergamon Press, 1985.
17. Edition. Panima Publishing Company, New DelhiWiley JM, Sherwood LM AND Woolverton CJ (2013)
18. Prescott, Harley and Klein's Microbiology.9th Edition. McGraw Hill Higher education Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.

List of Open Source Software/learning website:

1. <https://www.youtube.com/watch?v=HNOcQKwW5ks>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	To describe and Microbial processes for sustainable development	1 Remember, 2 Understand
CLO2	To explain and discuss various Fermentation processes	1 Remember, 2 Understand 3 Apply, 4 Analyze
CLO3	To list types of Biosensors and understand its mechanism and structure, so the it will help to design	1 Remember, 2 Understand 3 Apply, 4 Analyze 5 Evaluate
CLO4	To be able discuss various methods of Immobilization and its commercial applications.	1 Remember, 2 Understand 3 Apply
CLO5	To understand and study the control parameters & economics control systems in fermentation.	1 Remember, 2 Understand 3 Apply
CLO6	To identify and understand Fermentation economics so as to evaluate and design cost effective processes	1 Remember, 2 Understand 3 Apply, 4 Analyze, 5 Evaluate 6 Create

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	2	2		2			2				2				1			1
CLO2			2					2	2			1	2			2		
CLO3	2	2		3		3	2			1	2				2		2	
CLO4			2		3								2			3		
CLO5	2						1		1					2			2	
CLO6		3				3		1		2		1						3

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Industrial Microbiology
Course Code:	16-MIM306-3C
Pre-requisite Course:	Basics of Fermentation

Course Objectives:

- To understand fermentation process and strain improvement
- To understand medium formulations for industry
- To understand Design of fermenter
- To understand downstream processing

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	Introduction to fermentation and strain improvement • Concept of Fermentation, Range of fermentation processes, component parts of fermentation process. • Growth kinetics: Batch, fed-batch and continuous culture (chemostat and turbidostat) • Isolation, Enrichment & screening (Primary & Secondary) of Industrial Important Microorganisms. • Preservation techniques • Strain Improvement: Induced mutants for primary and secondary metabolites, Application of r-DNA technology for strain improvement.	13	28%
2	Concept of fermentation media and inoculum development • Medium formulations for industry and types (crude and synthetic) of fermentation media Raw materials used in fermentation media and criteria for selection, Batch and Continuous sterilization, Del factor, Sterilization of Media & Air • Inoculum Development: Typical Inoculum Development program, Inocula development for Bacteria, Yeast and Fungal processes. • Scale-Up	13	28%
3	Design of fermenter • Design of fermentor: Basic function of typical fermenter • Design of ideal STR and various auxiliary parts (aeration, agitation and body construction) • Aseptic operations and Containments • Types of fermenters: Tower, Cylinroconical, Air lift, Acetator-Cavitator, Bioreactors for animal cell cultures Downstream processing. • Removal of Solid & Microbial Cells and other solid Matter, Foam separation, Precipitation, Filtration and Centrifugation, Cell disruption . • Concentration of extracted product: Liquid-Liquid extraction, Distillation, • Purification products: Chromatography, Membrane processes and ultra	19	44%

	filtration • Drying & Crystallization • Quality Assurance-Bioassay • Drying & Crystallization • Quality Assurance-Bioassay		
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List of Experiments:

1. Primary screening of Amylase producer
2. Primary screening of Organic acid producers
3. Primary screening of Protease producer
4. Primary screening of Antibiotic producers, i) crowded plate method, ii) Wilkin's method.
5. Bioassay of Penicillin using *Bacillus subtilis*
6. Model making of Fermentor with its parts/ Downstream Processing (group activity)

Text books:

1. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
2. Stanbury and Whitaker. Principles of fermentation technology.

Reference Books:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
1. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education
2. Biotechnology –The Biological Principles, M.D.Trevaan , S.Boffey, K H Goulding, P Stanbury Mukhopadhyay, Process Biotechnology Fundamental. Viva book.
3. Shuler and Kargi, 1992. Bioprocess engineering, Prentice-Hall.
4. Bialy & Ollis.1986. Biochemical Eng. Fundaments. McGraw-Hill.
5. Schugerl. 1987. Bioreaction engineering, J/W.
6. Sikyta. Methods in Industrial microbiology. Ellis Hardwood Ltd.
7. Krysman. Product recovery in bioprocess technology.
8. T.K. Ghose. Bioprocess computation in biotechnology, Ellis Hardwood Ltd.
9. MurryJoh. 1997. Microorganisms and Biotechnology.
10. Demainefal. (ED) 1999. Manual of industrial Microbiology and Biotechnology. Asin Press.
11. Bioprocess Engineering Principles by Doran (D); Academic Press, 1998.
12. Cooney, A.E. Humphrey, Comprehensive Biotechnology : The principles and Regulation of Biotechnology in Industry, Agriculture and Medicine. Vol.2, Pergamon Press, 1985. Edition. Panima Publishing Company, New DelhiWilley JM, Sherwood LM AND Woolverton CJ (2013)
13. Prescott, Harley and Klein's Microbiology.9th Edition. McGraw Hill Higher education

List of Open Source Software/learning website:

1. <https://www.youtube.com/watch?v=PLpfVLg5f08>
2. https://www.youtube.com/watch?v=hav_yLrgFqs

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Understanding the concept of fermentation ,enlist various Range of fermentation and Parts of fermenter .	1 Remember 2 Understand
CLO2	Discuss growth of microbes and the control of biosynthetic pathway.	1 Remember 2 Understand 3 Apply
CLO3	Discuss various design of fermenter , Overview of downstream processing in which students will have knowledge of purification of microbial products.	1 Remember 2 Understand 3 Apply
CLO4	Describe and compare various methods of Isolation, Enrichment, screening& preservation techniques of Industrial Important Microorganisms. Strain Improvement	1 Remember 2 Understand 3 Apply 4 Analyze
CLO5	Discuss types of media and ingredients used in production media its advantages and disadvantages for medium formulations, for industry ,	1 Remember 2 Understand 3 Apply 4 Analyze 5 Evaluate 6 Create
CLO6	Evaluate and compare different methods of sterilization, inoculums development processes and Scale-Up	1 Remember 2 Understand 3 Apply 4 Analyze 5 Evaluate 6 Create

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	2	2		2			2				2				1			
CLO2			2		3			2	2			1	2			2		1
CLO3		2				1	2			1	2				2		2	
CLO4	1		2					1				2	2			3		
CLO5	2	2		1			1		1					2			2	
CLO6						3		1		2		1						3

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Disorders of Immune System
Course Code:	16-BIE304-3C
Pre-requisite Course:	Basics of Microbiology

Course Objectives:

- The course is designed to acquire basic knowledge of hypersensitivity and autoimmunity.
- This will enable the student to understand basics of autoimmune diseases.
- This course is designed to enable students in understanding the basics and applications immune systems, cancer and organ transplantation.

Teaching and Examination Scheme:

Teaching Scheme(Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	-	25	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	• Hypersensitivity: Immediate and delayed hypersensitivity • Autoimmunity: Immunotolerance and autoantigens - Organ Specific Autoimmune Diseases: Grave's disease and Pernicious anemia - Systemic Autoimmune Diseases : Multiple sclerosis and Rheumatoid arthritis	15	34%
2	• Immunodeficiency diseases: Congenital/Primary and Acquired/Secondary • Immune Response to infectious Diseases: Viral Infections, Bacterial Infections, Protozoan Infections, Helminth Infection	15	33%
	• Tumor Immunity: Oncogenes and Cancer Induction. Cancer Immunotherapy. • Transplantation Immunity: Host Vs graft, Graft Vs host Reaction, Immuno Suppression, organ transplantations	15	33%

List of Experiments:

1. Analyse the underlying mechanisms and clinical implications of hypersensitivity reactions.
2. Explain the principles of immunotolerance and the role of autoantigens in autoimmune responses.
3. Investigate the causes, symptoms, and treatment strategies for various immunodeficiency conditions.
4. Evaluate the principles and applications of cancer immunotherapy.
5. Learn the mechanisms and applications of immunosuppression in organ transplantation.
6. Visit to AIDS and /Or Cancer Research Centre.

Textbooks:

1. Kuby's Immunology: R.A.Goldsby, T.J.Kindt and B.A.Osborne

Reference Books:

1. Atlas, R.M. (1997) Principles of Microbiology. (2nd ed.). Win. C Brown Publishers. Dubuque.
2. Prescott, L.M., Harley, J.P., Klein. DA., (2002) Microbiology (5th ed) McGraw Hill. International ed.
3. Tortora, G.J., Funke, B.R., Case, C.L. (2001) Microbiology: An Introduction. (7th ed). Benjamin Cummings N.Y.
4. Essential Immunology: Ivan Roitt
5. Immunology: I.Roitt, Brostoff, Mole
6. Introductory Immunology: How Davies
7. Immunology Introductory Text Book Shetty Nandini.

List of Open-Source Software/learning website:

<https://www.youtube.com/watch?v=HNOcQKwW5ks>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Students will gain an understanding of hypersensitivity and autoimmunity.	1 Remember 2 Understand
CLO2	Identify and categorize various types of autoimmune diseases.	1 Remember 2 Understand
CLO3	Understand the mechanisms and implications of immunodeficiency diseases.	2 Understand 3 Apply
CLO4	Learn foundational techniques to diagnose and interpret autoimmune diseases.	1 Remember 2 Understand 3 Apply
CLO5	Explore immune responses to infectious diseases and tumor immunity.	1 Remember 2 Understand 4 Analyze 5 Evaluate
CLO6	Acquire fundamental knowledge and apply it to comprehend autoimmune disorders.	6 Create

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	2	1	2	1	3	2	1	2	1	1	3	2	2	2	1	2		
CLO2	3	1	3	1	1	2	1	2	2	1	1	1	2	1	2	2		
CLO3	2	1	2	2	1	3	2	1	1	2	2	1	2	2	1	1		
CLO4	2	2	2	2	1	1	1	2	1	2	3	2	3	1	3	2		
CLO5	2	1	1	1	3	3	1	1	2	1	2	1	2	3	2	1		
CLO6	1	2	1	1	3	1	1	2	1	2	1	2	1	1	2	1		

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Data Analysis for Biologists
Course Code:	16-BIE304-3O
Pre-requisite Course:	

Course Objectives:

- Understand and apply key concepts of probability, statistics, and linear algebra using R for biological data analysis.
- Develop skills in data visualization, regression, clustering, and classification techniques using R.
- Analyze and interpret complex biological datasets through advanced methods like PCA and t-SNE.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	Probability and Statistics Fundamentals of probability and statistical concepts Probability rules Discrete and continuous probability distributions Descriptive statistics using R Statistical moments: variance and covariance Introduction to statistical tests Linear Algebra Basics of vectors and vector operations Matrix operations, including determinant and inverse Eigenvalues and eigenvectors Solving linear systems Singular Value Decomposition (SVD) Linear algebra applications using R R Programming Introduction to R environment Performing algebraic and logical operations Reading from and writing to data files Descriptive statistics using R Statistical tests in R: t-test and ANOVA Linear algebra computations in R	15	34%

2	Data visualization Histogram & Box plot Heatmap and Volcano plot Network visualization Data visualization using ggplot2 – I Data visualization using ggplot2 - II Correlation and regression Correlations Linear regression – I Linear regression – II Linear regression using R Multiple linear regression Multiple linear regression using R Clustering and classification, Correlation and regression Nonlinear regression Nonlinear regression using R Clustering and classification Logistic regression Logistic regression using R Distance measures for clustering	15	33%
3	Clustering and classification k-means clustering k-means clustering using R Hierarchical clustering Hierarchical clustering using R Decision tree classifier Support vector machines Analysis of higher-dimensional data Higher-dimensional data in biology Principal component analysis Principal component analysis using R Statistics using R ,À Descriptive Statistics t-SNE using R Linear Algebra using R	15	33%

List of Experiments:

Practical Steps for Data Analysis in Biology:

1. Define the Research Question: Clearly state the biological question you want to answer with your data.
2. Data Collection and Preparation: Gather and organize the data, ensuring it's compatible with your chosen software.
3. Exploratory Data Analysis: Examine the data to understand its structure, identify trends, and spot outliers.
4. Statistical Analysis: Choose appropriate statistical methods (e.g., ANOVA, chi-square tests, regression) to analyze the data.
5. Interpretation and Conclusion: Interpret the results in the context of your research question and draw conclusions.
6. Data Visualization: Create graphs and visualizations to effectively communicate your findings.

Reference Books:

- Whitlock, Michael C.; Schluter, Dolph. The Analysis of Biological Data (2nd edition).Freeman, W. H. & Company, 2014.
- Yang, Zheng R.; Machine Learning Approaches to Bioinformatics. World Scientific, 2010.

- Moses, Alan; Statistical Modeling and Machine Learning for Molecular Biology. Chapman and Hall/CRC, 2016.
- Hartvigsen, Gregg. A Primer in Biological Data Analysis and Visualization Using R, (1st Edition). Columbia University Press, 2014.
- Stewart, James; Day, Troy; Biocalculus: Calculus for Life Sciences. Cengage Learning, 2015
- James, Gareth, et al. An introduction to statistical learning with application in R. Vol. 112. New York: springer, 2013. First edition can be downloaded from the website <https://www.statlearning.com/>

List of Open-Source Software/learning website:

https://onlinecourses.nptel.ac.in/noc21_bt14/preview

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Learn and explain fundamental concepts of probability, statistics, and linear algebra, and apply them using R programming.	1 Remember 2 Understand 3 Apply
CLO2	Perform descriptive statistical analysis and hypothesis testing (t-test, ANOVA) using R.	3 Apply 4 Analyze
CLO3	Develop and interpret various data visualizations including histograms, box plots, heatmaps, and network graphs in R.	3 Apply 4 Analyze
CLO4	Conduct correlation and regression analyses (linear, multiple, nonlinear, logistic) using R and interpret results.	3 Apply 4 Analyze
CLO5	Implement clustering and classification techniques such as k-means, hierarchical clustering, decision trees, and SVM.	3 Apply 4 Analyze
CLO6	Analyze and interpret high-dimensional biological data using advanced techniques such as PCA and t-SNE in R.	4 Analyze 5 Evaluate

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	3	3	1		1					2								
CLO2	3	3	2		2					2								
CLO3	3	3	2		3					2								
CLO4	3	3	1		3	1				2								
CLO5	3	3	1		2	1				2								
CLO6	3	3	3		3	1				2								

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Advanced English
Course Code:	16-AEC301-3C
Pre-requisite Course:	Basics English Grammar and Composition up to T.Y. B.Sc.

Course Objectives:

- To inculcate human values among the students through poems and prose.
- To create an interest in literature and to develop language skills.
- The students will become familiar with formal vocabulary that is common in academic texts.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
2	--	--	2	25	25	--	--	50

Subject Contents:

Unit	Content	Lectures	Weightage
1	VOCABULARY&GRAMMARLINK Review of Confusing Words, Simple- Compound and Complex Sentences.	9	30
2	SPEAKING Group Discussion Group discussion as a part of selection process, group behavior & leadership Potential, Tips for Effective group discussion. Group Discussion (GD) Topics on Current Affairs The New Education Policy (NEP): Challenges in Implementation, India's Space Missions: From Chandrayaan to Gaganyaan, India's Role in G20 Leadership: Achievements and Challenges	6	20
3	READING&WRITING Writing Portion Essay Writing: Electric Vehicles: The Future of Transportation, The Role of Artificial Intelligence in Shaping the Future, Impact of Western Culture on Indian Youth, How Technology is Transforming Education Unseen Passages/Comprehension Texts from journals, newspapers, research articles, and essays.	6	20
4	TEXT Catalyst-Lesson 6 to 10	9	30

Text Books:

- Catalyst-Text Book, 2020
- Easy to learn English grammar by Dr. Jayesh Patel, 2021

Reference Books:

- Very Useful Verbs book (Enka Publication)2021
- Contemporary English Grammar Structure & Composition,2020
- Murphy R. Intermediate English Grammar(New Delhi: Cambridge University)2019

List of Open Source Software/learning website:

- englishpage.com
- epaper.timesofindia.com
- epaperindianexpress.com
- <https://www.youtube.com/watch?v=QdAgyD4xhY>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Describe how public speaking can be used to advocate or create change	1 Remember
CLO2	Explain the goals and benefits of public speaking	2 Understand
CLO3	Use parallel structures correctly and effectively.	3 Apply
CLO4	Identify strategies for researching and supporting a speech	4 Analyze
CLO5	Recognize when to use visual aids	3 Apply
CLO6	Describe how public speaking can be used to advocate or create change	6 Create

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1				3		1		2			1				1			
CLO2			2	3	2	1	2			2	1	2						
CLO3			1	2				2	1						2			
CLO4							1				1							
CLO5					1		1			2		1			1			
CLO6			1															

3: High, 2: Medium, 1: Low