

**SANT GADGE BABA AMRAVATI UNIVERSITY,
AMRAVATI**



**THREE /FOUR-YEAR DEGREE OF BACHELOR OF
SCIENCE**

Bachelor of Science

SUBJECT: Statistics
FACULTY: SCIENCE AND TECHNOLOGY

**(Courses effective from Academic Year 2026-2027)
Under Uniform NEP 2020**

SYLLABUS

**Semester I and II
Semester III and IV
Semester V and VI**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI CURRICULUM AS PER NEP-2020
FACULTY OF SCIENCE AND TECHNOLOGY
Three Years Degree Course
SUBJECT Major: STATISTICS B.Sc. FIRST YEAR
SEMESTER-I

Programme Outcomes

- PO1 Disciplinary Knowledge: Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
- PO2 Critical Thinking and Problem solving: Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
- PO3 Social competence: Display the understanding, behavioral skills needed for successful social adaptation, working groups, exhibits thoughts and ideas effectively in writing and orally.
- PO4 Research-related skills and Scientific temper: Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research
- PO5 Personal and professional competence: Performing dependently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute inter personal relationships, self-motivation and adaptability skills and commit to professional ethics
- PO6 Effective Citizenship and Ethics: Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
- PO7 Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
- PO8 Self-directed and Life-long learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes: At the end of the program, students are able to

- PSO1 Understand the elementary techniques of data analysis such as, graphical and numerical.
- PSO2 Get the knowledge of different concepts, principles, methodologies and tools (skills) of Statistics.
- PSO3 Collect, represent graphically, analyze and interpret data /information by using appropriate Statistical tools.
- PSO4 Identify and solve a wide range of problems in real life /industry related to Statistics.
- PSO5 Apply various measures of central tendency and dispersion and hence enable them to infer about the nature and characteristics of a particular data set.
- PSO6 Understand the basic concepts of probability, Understand the concept of random variable, univariate probability distribution, expectation and moments of probability distribution.
- PSO7 Understand bivariate probability distributions and their applications in real life
- PSO8 Summarize, analyze and interpret data through various techniques learnt by manual calculations as well as by using MS-Excel.

B.Sc. First Year Semester I
Major / Minor - Statistics

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major / Minor-T	Theory-1	1320101	Descriptive Statistics	2	2	30

Course Objectives	1.To know the importance of Statistics in various field 2.To learn the basic statistical methods 3.To understand meaning of data and their types						
Course Outcomes	Students will be able to- 1. Identify the appropriate Scale of measurement for a particular characteristic under study. 2. Get the knowledge of various statistical organizations working in India. 3. Calculate and describe data through measures of central tendency and dispersion. 4. Interpret the utilization of measures of central tendency and dispersion to compare group results.						
Units	Contents						Workload Allotted
I	Meaning of statistics as science, its importance and limitations. Scope of Statistics: In the field of Industry, Biological Sciences, Medical Sciences, Agricultural Sciences, Management Sciences, Education and Psychology. Statistical Organizations in India and their functions: CSO, NSSO, IIPS, ISI.						8 hrs
II	Types of Data: Qualitative and Quantitative data, nominal and ordinal data, discrete and continuous data, frequency and non-frequency data. Primary and Secondary Data and its major sources. Types of Scales: Nominal, ordinal, ratio and interval. Classification: Rules of Classification and its types.						7 hrs
III	Frequency Distribution: Discrete and continuous frequency distribution, cumulative frequency distribution, ogive curves. Central Tendency: It's concept and its measures (A.M., weighted A.M., median, mode) with its merits and demerits. Properties of A.M., relation between mean, mode and median, Geometric Mean, Harmonic Mean, Partition values: Quartiles, deciles and percentiles						8 hrs
IV	Measures of dispersion: Range, Quartile deviation, mean deviation and its coefficients. Standard deviation, root mean square deviation, variance and various formulae for calculating variance, C.V. Moments: Raw moments and central moments with its relationship, effect of change of origin and scale on moments, Measures of Skewness and Kurtosis						7 hrs

References

- Brase C.H., Brase C.P (2016). Understandable Statistics, Concepts and Methods, 12th Edition, Cengage Learning.
- Freedman D., Pisani R., Purves R. (2007). Statistics, 4th Edition, W.W. Norton and Company.
- Freund J.E. (1977). Modern Elementary Statistics .4th Edition, Prentice Hall of India Private Limited, New Delhi.
- Goon A.M., Gupta, M.K .and Dasgupta, B. (1983). Fundamentals of Statistics, Vol.1. 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
- Gupta S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics. 8th Edition, Sultan Chand and Sons Publishers, New Delhi.
- Gupta S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, 3rd Edition, Sultan Chand and Sons Publishers, New Delhi.
- Heumann C., Schomaker, M., Shalabh (2016). Introduction to Statistics and Data Analysis. 1st Edition, Springer, Germany.
- V.S.Athawar, (2024) Advanced Statistics, First Edition ,Rest Publisher Ltd. India
- Moore D. S., Notz W. I., Fligner M. A. (2013). The Basic Practice of Statistics, 6th Edition, Ruth Baruth.
- Utts J.M., Heckard R. F. (2010). Mind On Statistics, 4th Edition, Richard Stratton Publisher.
- Zealure C. H. (1998). Fundamentals of Descriptive Statistics. 1st Edition, Routledge, U.K. (Taylor and Francis Group).

Vertical No.	Vertical Name	Type of Course	Course Code	Course Name	Credits	Work load Per week	Max Marks
a	Major / Minor-P	Lab	13201P1	Practicals based on 1320101	02	04	25

Course Outcomes	At the end of the course students are able to 1. Use various graphical and diagrammatic techniques to represent statistical data and interpret. 2. Prepare the frequency distribution and present it graphically. 3. Analyze data pertaining to discrete variables and to interpret the results. 4. Compute various measures of central tendency, dispersion.					
Contents:						Workload Allotted
1. Presentation of data by frequency table. 2. Calculation of arithmetic mean, median and mode for ungrouped frequency distributions. 3. Calculation of arithmetic mean, median and mode for grouped frequency distributions. 4. Calculations of partition values as quartiles deciles and percentiles for ungrouped data 5. Calculations of partition values as quartiles, deciles and percentiles for grouped data 6. Calculation of range, mean deviation and quartile deviation with its coefficients. 7. Calculation of standard deviation and coefficient of variation for grouped data. 8. Calculation of standard deviation and co efficient of variation for ungrouped data. 9. Problems on calculations of moments (up to third order) 10.Computation of covariance between two variables						4 hrs per week

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Workload Per week	Max Marks
c	GOEC-T	Theory-1	13201G1	Statistics in social and behavioral Sciences (Useful for competitive examination)	02	02	30

Course Objectives	The objective of this course is to understand basic knowledge of statistics that will be useful to apply in competitive Exams.					
Course Outcomes	At the end of the course, students are able to... 1. Identify the appropriate scale of measurement for a particular characteristic under study. 2. Represent data using appropriate diagram/graph. 3. Calculate and describe data through various frequency distribution 4. After completing of the course student are prepared for basic knowledge of competitive examination.					
Units	Contents					Workload Allotted
I	Meaning of statistics as science, its importance and limitations. Scope of Statistics: In the field of Industry, Biological Sciences, Medical Sciences, Agricultural Sciences, Management Sciences, Education and Psychology.					8 hrs
II	Statistical Organizations in India and their functions: CSO, NSSO, IIPS, ISI. Types of Data: Qualitative and Quantitative data, nominal and ordinal data, discrete and continuous data, frequency and non-Frequency data.					7 hrs
III	Primary and Secondary Data and its major sources, Time series data, cross sectional data, Classification: Rules of Classification and its types. Tabulation: Meaning of Tabulation & its types, construction of tables with one or more factors					8 hrs
IV	Frequency Distribution: Discrete and continuous frequency distribution, cumulative frequency distribution, Ogive curves. Central Tendency: It's concept and its measures (A.M., weighted A.M., median, mode, G.M., H.M.) with its merits and demerits.					7 hrs

References

1. Goon A.M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol.1. 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
2. Gupta S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics. 8th Edition, Sultan Chand and Sons Publishers, New Delhi.
3. Gupta S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, 3rd Edition, Sultan Chand and Sons Publishers, New Delhi.
4. Heumann C., Schomaker, M., Shalabh (2016). Introduction to Statistics and Data Analysis. 1st Edition, Springer, Germany.

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Workload Per week	Max Marks
c	GOEC-T	Theory-2	13201G2	Statistics for competitive examination	02	02	30

Course Objectives	The objective of this course is to make aware the students basic measures of central tendencies and dispersion and to understand basic concept of probability which will be useful for Staff Selection Commission Combined Graduate level examination					
Course Outcomes	At the end of the course students are able to 1. Calculate and describe data through measures of central tendency and dispersion. 2. Compute the variability between series through their measures. 3. Understand basic concept of probability 4. At the end of the course student will able to acquire basic knowledge of the staff selection commission combined graduate level exam.					
Units	Contents					Workload Allotted
I	Properties of A.M (only formula and numerical problems)., relation between mean, mode and median, relation between A.M., H.M., G.M. Partition values: Quartiles, deciles and percentiles. Simple numerical problems					8 hrs
II	Range, Quartile deviation, mean deviation and its coefficients. Standard deviation, root mean square deviation, variance and various formulae for calculating variance, C.V. Simple numerical problems					7 hrs
III	Permutation and combination theory, Binomial theorem. Algebra of Events. Simple problems. Concept of probability, Definitions of – Random experiment, Trial and Events, Exhaustive, Favourable, equally likely event, mutually exclusive event, independent event & complementary events. simple numerical problems					8 hrs
IV	Classical and Statistical Probability with its limits, simple numerical problems on probability, Sample space, discrete sample space. Axiomatic probability, simple theorems on probability with additive and multiplicative law of probability. Conditional probability, independence of events. Simple numerical problems.					7 hrs

References

1. Goon A.M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol.1. 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
2. Gupta S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics. 8th Edition, Sultan Chand and Sons Publishers, New Delhi.
3. Gupta S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, 3rd Edition, Sultan Chand and Sons Publishers, New Delhi.
4. Heumann C., Schomaker, M., Shalabh (2016). Introduction to Statistics and Data Analysis. 1st Edition, Springer, Germany.

Vertical No.	Vertical Name	Type of Course	Course Code	Course Name	Credits	Work load Per week	Max Marks
d	SEC-P	Lab	13201P2	Skilled Based Practical through MS-Excel	02	04	50

Course Objectives	1. To make the students familiar with MS-Excel and the formulae used in it. 2. To learn the calculations of basic characteristics of the data using excel.
Course Outcomes	At the end of the course students are able to 1. Calculate and describe data through measures of central tendency and dispersion. 2. Compute the variability between series through their measures. 3. Understand basic concept of probability 4. Interpret the utilization of measures of central tendency and dispersion to compare group results.
Contents: Advanced problems to be performed through MS Excel	
1. Calculation of arithmetic mean, median and mode for grouped and ungrouped frequency distributions. 2. Establish the relation between various measures through graphs 3. Calculations of partition values as quartiles, deciles and percentiles. 4. Calculation of range, mean deviation and quartile deviation with its coefficients. 5. Calculation of standard deviation and coefficient of variation for grouped and ungrouped data. 6. Problems on calculations of moments (up to third order) 7. Computation of Standard Deviation and coefficient of Variation.	Workload Allotted 4 hrs per week

References:

1. Frag Curtis (2013). Step by Step Microsoft Excel 2013, MSPress.
2. Frye Curtis D. (2007). Step by step Microsoft Office Excel 2007, Microsoft Press.
3. John Walkenbach (2013). 101 Excel 2013 Tips, Tricks and Times evers, Wiley.
4. Kumar Bittu (2013). Microsoft Office 2010, V & S Publishers.
5. Salkind Neil J. and Frey Bruce B. (2021). Statistics for people who (Think They) Hate Statistics, Using MS-Excel, Sage Publications.
6. Sanjay Saxena (2007). M S Office 2000 for everyone, Vikas Publishing House.

Major / Minor STATISTICS
B.Sc. FIRST YEAR
SEMESTER-II

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major/ Minor-T	Theory-2	1320201	Probability Theory	02	02	30

Course Objectives	1. The objective of the course is to understand the concept of probability. 2. Understand the concept of random variables in the real-life situation 3. The concepts of bivariate probability distributions with its applications in statistics can be easily understood.					
Course Outcomes	At the end of the course students are able to understand 1. Understand the basic concepts of random experiment, random variable, probability. 2. Use concept of probability in real life situations. 3. Compute probability of real-life events. 4. Identify the nature of data using moments. 5. Check the dependency of events using probability or conditional probability.					
Units	Contents					Workload Allotted
I	Principles of Counting, Permutation and combination theory, Algebra of Events, Concept of probability, Definitions of– Random experiment, Trial and Events, Types of events, Classical and Statistical Probability with its limitations, probability odds, simple numerical problems on probability. Sample space, discrete sample space, Continuous sample space Axiomatic probability, simple theorems on probability with additive and multiplicative law of probability. Conditional probability, independence of events: pairwise, mutual, total					8 hrs
II	Concept of random variable & its illustration by examples. Discrete and Continuous random variables. Probability distributions of a random variable, discrete and continuous distribution function, properties of distribution functions, simple numerical problems on probability distribution.					7 hrs
III	Mathematics expectations and its properties. Numerical problems on expectations. Expectation of discrete and continuous random variable, expectation of a linear combination of random variable, Addition and multiplication theorem of expectation variance of a random variable, covariance and its properties. Cumulant generating function, moment generating function, relation between CGF and MGF, properties of MGF Properties of CGF.					8 hrs
IV	Bivariate probability distributions (discrete and continuous), joint, marginal and conditional probability mass functions. Marginal distribution functions, joint density function, marginal and conditional density functions. Stochastic Independence, Numerical problems on bivariate, marginal and conditional functions.					7 hrs

References

1. Agarwal B.L. (2003). Programmed Statistics, 2nd edition, New Age International Publishers, New Delhi.
2. Brase C.H., Brase C.P (2016). Understandable Statistics, Concepts and Methods, 12th Edition, Cengage Learning.
3. Freedman D., Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
4. Gupta S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, 8th Edition, Sultan Chand and Sons Publishers, New Delhi.
5. V.S.Athawar, (2024) Advanced Statistics, First Edition, Rest Publisher Ltd. India
6. Hoel P. G. (1971). Introduction to Mathematical Statistics, John Wiley and Sons, New York.
7. Hogg R. V. and Craig R. G. (1989). Introduction to Mathematical Statistics, Mac Millan Publishing Co., New York.
8. Mayer P. (1972). Introductory Probability and Statistical Applications, Addison Wesley Publishing Co., London.
9. Mood A. M., Graybill, F. A. and Bose D. C. (1974). Introduction the Theory of Statistics, 3rd Edition, Mc Graw Hill Book Company.
10. Moore D. S., Notz W. I., Flinger M. A. (2013). The Basic Practice of Statistics, 6th Edition, Ruth Baruth.
11. Rao B L S Prakasa (2008). First Course in Probability and Statistics, New Age International Publishers, New Delhi
12. Rohatgi V. K. and Saleh, A. K. Md. E. (2015). An Introduction Probability and Statistics, John Wiley & Sons, Inc., Canada.
13. Ross S. (2002). A First Course in Probability, 6th Edition, Pearson Education, Inc. & Dorling Kindersley Publishing, Inc.
14. Utts J. M., Heckard R. F. (2010). Mind On Statistics, 4th Edition, Richard Stratton Publisher.
15. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
16. Goon A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol.1, 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
17. Gupta S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, 8th Edition, Sultan Chand and Sons Publishers, New Delhi.
18. Gupta S. P. (2014) Statistical Methods, 43rd Edition, Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.
19. Montgomery D. C, Peck, E. A., Vining, G. G. (2006). Introduction to Linear Regression Analysis, John Wiley and Sons
20. Moore D. S., Notz W. I., Fligner M. A. (2013). The Basic Practice of Statistics, 6th Edition, Ruth Baruth.

Vertical No.	Vertical Name	Type of Course	Course Code	Course Name	Credits	Workload Per week	Max Marks
a	Major/ Minor-P	Practical-2	13202P1	Practical based on 1320201	02	04	25

Course Outcomes	At the end of the course students are able to 1. Use various types of probabilities 2. Prepare the probability distribution. 3. Analyze data pertaining to discrete variables and interpret the results. 4. Compute various probability distributions.					
Units	Contents					Workload Allotted
	1. Evaluation of simple probabilities 2. Evaluation of probabilities using addition theorem-1 3. Evaluation of probabilities using addition theorem- 2 4. Evaluation of probabilities using multiplication theorem-1 5. Evaluation of probabilities using multiplication theorem-2 6. Problems on conditional probability. 7. Determination of probability distribution of discrete random variables. 8. Determination of mathematical expectation and variance for discrete random variable 9. Determination of mathematical expectation and variance for continuous random variable 10. Computation of Marginal, Joint and conditional probability functions for discrete random variable 11. Computation of Marginal, Joint and conditional probability functions for continuous random variable					4 hrs per week

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Workload Per week	Max Marks
c	GOEC-T	Theory-1	13202G3	Business Analytics I (Useful for marketing strategies)	02	02	30

Course Objectives	1. This course is designed to understand the basic knowledge used in business analytics 2. Concepts used in measuring the relationship between two variables.					
Course Outcomes	At the end of syllabus, the student is able to do 1. Understand the concept of relationships between two variables. 2. Understand the concept used in the business analytics 3. Testing of association between two variables					
Units	Contents					Workload Allotted
I	Concept of correlation, scatter diagram and positive and negative correlation. Karl Pearson's coefficient of correlation, properties of correlation coefficient, coefficient of determination. Simple problems					8 hrs
II	Rank correlation– Spearman's rank correlation coefficient. Intra class Correlation coefficient. Simple problems based on Spearman rank correlation coefficient.					7 hrs
III	Index numbers: Introduction of Index Numbers, Definition and meaning, Problems in the construction of index numbers, Simple and weighted price index numbers, Lapeyre's price index numbers, Paasche's price index numbers, Consumer price index number					8 hrs
IV	Definition of attribute, notations, classes and class frequencies, order of class and class frequencies. Consistency of data, conditions for consistency of data, simple numerical problems. Independence of attributes, criteria for independence. Association of attributes, Yule's coefficient of association, coefficient of colligation, simple problems					7 hrs

References:

1. Brase C. H., Brase C.P (2016). Understandable Statistics, Concepts and Methods, 12th Edition, Cengage Learning.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
3. Goon A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol.1, 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
4. Gupta S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics ,8th Edition, Sultan Chand and Sons Publishers, New Delhi.
5. Gupta S. P. (2014) Statistical Methods, 43rd Edition, Sultan Chand and Sons, 23, Daryaganj, New Delhi.
6. V.S.Athawar, (2024) Advanced Statistics, First Edition ,Rest Publisher Ltd. India.

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Workload Per week	Max Marks
c	GOEC-T	Theory-1	13202G4	Business Analytics-II (Useful for marketing strategies and forecasting)	02	02	30

Course Objectives	This course is designed to familiar with the concept of structured and unstructured sample surveys. Also understanding the concept used in business analytics which will be useful for marketing strategies understanding of the student.					
Course Outcomes	At the end of this course, students are able to 1. Identify the most suited sampling method for an intended survey. 2. Understand the concept used in the projection of data. 3. Create structured and organized survey forms. 4. Acquiring the knowledge regarding market forecasting and strategies.					
Units	Contents					Workload Allotted
I	Questionnaire: Characteristics of a good questionnaire, Designing questionnaires for surveys (i.e. survey forms) Processing Survey Data, Types of questionnaires					8 hrs
II	Concept of Statistical Population, Concept of population surveys, sample surveys, scope of the surveys, limitations of survey. Concept of Sampling.					7 hrs
III	Design of sample surveys: Sample Design, sampling and non-sampling errors, sample survey VS Census Survey, Types of sampling Design: Non probability sampling, Probability sampling, Simple random Sampling with and without replacement (only concept)					8 hrs
IV	Time series analysis: Meaning of Time Series, Various components of a time series, Examples of time series in real life, Additive and Multiplicative methods for analysis of a time series, Methods of estimating trend: Freehand or Graphical method, Method of semi-averages, Method of moving averages					7 hrs

References:

1. Brase C. H., Brase C.P (2016). Understandable Statistics, Concepts and Methods, 12th Edition, Cengage Learning.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
3. Goon A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol.1, 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
4. Gupta S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics ,8th Edition, Sultan Chand and Sons Publishers, New Delhi.
5. Gupta S. P. (2014) Statistical Methods, 43rd Edition, Sultan Chand and Sons, 23, Daryaganj, New Delhi.
6. V.S. Athawar, (2024) Advanced Statistics, First Edition ,Rest Publisher Ltd. India

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Workload Per week	Max Marks
d	VSC-P	Lab	13202P2	Basic Analysis skill through MS Excel	02	04	50
Course Outcomes	At the end of the course student is able to do.... 1. Understanding with some fundamental concepts, which play a critical role in understanding and visualizing real world data. 2. Get familiar with the spread sheets of MS Excel 3. Understand the basic function of analytics through MS Excel						
Units	Contents					Workload Allotted	
	Following practicals to be performed through MS Excel 1. Problems on simple Correlation Coefficient. 2. Problems on Rank Correlation by Spearman's and Kendall's formulae. 3. Fitting of straight line 4. Fitting of second-degree parabola by least square method. 5. Fitting of exponential curve. 6. Problems on regression of two variables. 7. Testing association of attributes by all four methods. 8. Measurement of trend by semi average method 9. Measurement of trend by moving average method					4 hrs per week	

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Workload Per week	Max Marks
d	SEC-P	Lab	13202P3	Descriptive statistics Through R	02	04	50

Course Outcomes	At the end of the course student is able to do 1. Get acquainted with the concept of R software 2. Understanding various analysis skill through the use of R 3. Understanding fitting of discrete distributions	
Units	Contents	Workload Allotted
I	Introduction to R: Open-source software and its advantages, a Very brief history of R, installing R in computers, Different R environments (e.g. Posit, Anaconda etc.), Use of R as a calculator and built-in functions in R, Objects (variables) and their types (scalar, vector, matrix, List, Data Frame etc.) in R,	4 hrs per week
II	performing different mathematical operations using objects e.g. vectors, matrix etc., Control statement and loops in R. Installing and loading libraries, Functions in R and example of their use. Data cleaning techniques, using some mathematical topics using R. Data input in R environment for statistical analysis and examining different characteristics (dimension, variable names, missing values, no. of missing values, variables nature etc.) of the dataset.	
III	Constructing frequency table and finding descriptive statistics measures of a dataset. Graphical and diagrammatic Representation of Data: pie-chart, bar-plot, histogram, density plot, box-plot etc.	
IV	Coding examples for solving various mathematical problems like Finding Fibonacci sequence, factorial, Measures of Central Tendencies, Measures of dispersion.	

References:

1. Cotton, R., Learning R: A step-by-step function guide to data analysis. 1st edition. O'reilly Media Inc.
2. Pattnaik, M., Statistical Computing Using R Programming. 1st edition. Kalyani Publishing. New Delhi.
3. Gardener, M. (2017). Beginning R: The statistical programming language, Wiley.
4. Lawrence, M., & Verzani, J. (2016). Programming Graphical User Interfaces in R. CRC Press. (ebook)
5. R Software : https://onlinecourses.nptel.ac.in/noc25_ma99/preview
6. Analysing and Visualizing Big Data with R software, Editor Asha Jindal, Shailaja Prakashan, Kanpur

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
CURRICULUM AS PER NEP-2020
FACULTY OF SCIENCE AND TECHNOLOGY
Three Years Degree Course SUBJECT Major: STATISTICS
B.Sc. SECOND YEAR SEMESTER-III

Program outcomes:	
PO1	Disciplinary Knowledge: Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PO2	Critical Thinking and Problem solving: Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	Social competence: Display the understanding, behavioral skills needed for successful social adaptation, working groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	Research-related skills and Scientific temper: Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	Personal and professional competence: Performing dependently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute inter personal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO6	Effective Citizenship and Ethics: Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO7	Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO8	Self-directed and Life-long learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.
Program Specific Outcomes: At the end of the program, students are able to:	
PSO1	Understand the elementary techniques of data analysis such as, graphical and numerical.
PSO2	Get the knowledge of different concepts, principles, methodologies and tools (skills) of Statistics.
PSO3	Collect, represent graphically, analyze and interpret data /information by using appropriate Statistical tools.
PSO4	Identify and solve a wide range of problems in real life /industry related to Statistics.
PSO5	Apply various measures of central tendency and dispersion and hence enable them to infer about the nature and characteristics of a particular data set.
PSO6	Understand the basic concepts of probability.
PSO7	Understand the concept of random variable, univariate probability distribution, expectation and moments of probability distribution.
PSO8	Understand bivariate probability distributions and their applications.
PSO9	Summarize, analyze and interpret data through various techniques learnt by manual calculations as well as by using MS-Excel.

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Work load Per week	Max Marks
a	Major-T	Theory	1320301	Bivariate Data and vital statistics	2	2	30

Course Objectives	This course is design to have the analytical Skill in bivariate data. Again, the idea about attributes theory and fitting of various curves.						
Course Outcomes	Students will be able to- 1. Increase the analytical skill in bivariate data. 2. Get the knowledge correlation theory. 3. Develop the fitting concepts of various curves 4. Understand the association of attributes and their consistency by using various methods.						
Units	Contents					Workload Allotted	
I	Theory of Correlation: Types of Correlations, Scatter Diagram, Karl Pearson's Correlation Coefficient, Properties of correlation, Assumptions underlying Karl Parsons Correlation Coefficient, Rank Correlation Coefficient & its Limits.					8 hrs	
II	Theory of regression: Linear regression, Lines of Regression, Derivation of line of regression of Y on X. Regression Coefficients and their Properties. Fitting of Straight Line, Fitting of Second-degree Parabola, Fitting of Exponential Curve, and Numerical Example.					7 hrs	
III	Theory of Attributes: Introduction, Notations, basic terms, Consistency of data for two attributes and three attributes. Association of Attributes, Yule's coefficient of association, coefficient of colligation. Vital Statistics: Definition of vital statistics, vital events, methods of collection, measurement of mortality, standardized death rate: direct and indirect method.					8 hrs	
IV	Life table: Assumption, Description & main features, Relations between various elements, Construction, uses of life table of life table. Measurement of Fertility with merits and demerits, Measurement of Population Growth: Crude rate of natural increase, Gross and net reproduction rate (GRR & NRR) with its merits and demerits					7 hrs	

References:

1. Freedman D. Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
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7. Moore D. S., Notz W. I., Fligner M. A. (2013). The Basic Practice of Statistics, 6th Edition, Ruth Baruth.
8. V.S. Athawar, (2024) Advanced Statistics, First Edition, Rest Publisher Ltd. India.
8. Utts J. M., Heckard R. F. (2010). Mind On Statistics, 4th Edition, Richard Stratton Publisher.
9. Zealure C. H. (1998). Fundamentals of Descriptive Statistics. 1st Edition, Routledge, U. K. (Taylor and Francis Group).

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Work load Per week	Max Marks
a	Major-T	Theory	1320302	Discrete Probability Distributions	02	02	30

Course Objectives	This course is design to have the knowledge of discrete distributions and their conceptual analysis					
Course Outcomes	Students will be able to understand the concepts of discrete distributions and acquired the knowledge of determining various constants used in discrete distributions.					
Units	Contents					Workload Allotted
I	Bernoulli Distribution: Definition, mean, variance, MGF, CGF, Binomial distribution: Derivation of pmf, definition, mean and variance, expression for moments, Additive property, moment generating function, cumulant generating function, recurrence relation for probability.					8 hrs
II	Poisson Distribution: definition, pmf, mean and variance, expression for moments, Additive property, moment generating function, cumulant generating function, recurrence relation for probability. Poisson distribution is a Particular case Binomial distribution					7 hrs
III	Negative Binomial Distribution: definition, mean and variance, moments, m.g.f., c.g.f, deduction of moments of negative binomial distribution from those of binomial distribution, recurrence relation for probabilities of Negative binomial distribution.					8 hrs
IV	Hyper geometric: mean and variance, recurrence relation of probability distribution, numerical examples. Geometric distribution, mean and variance, m.g.f,					7hrs

References:

1. Freedman D. Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
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Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Work load Per week	Max Marks
a	Major-P	Lab	13203P1	Practical Based on 1320301 and 1320302	02	04	25

Practical List	Workload Allotted
1. To find Karl Pearson's of coefficient of correlations between two variables. 2. To find Rank Correlation 3. Fitting of straight line. 4. Fitting of Parabola 5. Fitting of Exponential Curve 6. Construction of Equation of regression line of Y on X 7. To find regression coefficients 8. To measure the association of attributes by various methods. 9. Fitting of binomial distribution. 10. Fitting of Poisson distribution. 11. Fitting of Negative binomial distribution. 12. Fitting of Hypergeometric distribution. 13. Practical on Measurement of Mortality, Fertility, Life table table.	4 Hrs per week

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Work load Per week	Max Marks
a	IKS-T	Theory	13203IKS	History of Statistics	2	2	30

Course Objectives	1. To understand the brief history of statistics 2. To know the importance of statistics in government organizations 3. To understand the basic knowledge of statistics which will be useful for the competitive examination 4. To improve the statistical reasoning of ability					
Course Outcomes	Students will be able to 1. Student will able to understand the brief history of statistics of India pre independence and after independence 2. Student improve their knowledge about application of statistics in different government organization 3. Student will able to understand the knowledge of Vedic mathematics 4. Statistical reasoning of student will get improved through the understanding.					
Units	Contents					Workload Allotted
I	Evolution of statistics in India: Importance of Statistics in ancient India, Brief history statistical system in ancient India, Statistical system in pre independence period, Statistical system after independence, Present statistical system in India, Central statistical Organization (CSO), National Sample Survey Organization, Indian Institute of Population Science, International Institute of Population Science					8 hrs
II	Statistics in Government Organizations: Use of Statistics in central and state government i.e. in five-year plan, agricultural development, health program, socio economic development of India, Industrial development, family welfare. Statistics in Indian Research Institute.					7 Hrs
III	Contributions of various Indian Statistician: C. R. Rao, V. S. Huzurbazar, D. Basu, J.K. Ghosh, K. Mardia, K. C. Sreedharan Pillai, P.K. Sen, P. C. Mahalanobis, P. V. Sukhatme, S. C. Shrikhande.					8 Hrs
IV	Statistical reasoning: Analytical evidence and empirical evidence, designing research, develop an understanding of data using graph in statistics, Statistical tools used in the scientific methods, Statistical reasoning process in data.					7 Hrs

References:

1. Ghosh, J. K., Delampady, M., & Samanta, T. (2006). An introduction to Bayesian analysis: Theory and methods. Springer.
2. International Institute for Population Sciences (IIPS). (2021). National Family Health Survey (NFHS-5), 2019–21: India. IIPS.
3. Mahalanobis, P. C. (1950). Why statistics? Sankhyā: The Indian Journal of Statistics, 10(3), 195–228.
4. Ministry of Statistics and Programme Implementation. (2022). Annual report 2021-22. Government of India.
5. Rao, C. R. (1973). Linear statistical inference and its applications (2nd ed.). John Wiley & Sons.
6. Sukhatme, P. V. (1954). Sampling theory of surveys with applications. Iowa State College Press.
7. Wild, C. J., & Pfannkuch, M. (1999). Statistical thinking in empirical enquiry. International Statistical Review, 67(3), 223–248.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Work load Per week	Max Marks
b	Minor-T	Theory	13203M1	Bivariate data and Discrete Distributions	2	2	30

Course Objectives	1. The objective of the course is to understand the concept of probability and its theoretical distribution 2. The concepts of bivariate probability distributions with its applications. 3. This course will also provide the knowledge of discrete distributions and their conceptual as well as practical analysis	
Course Outcomes	At the end of the course students are able to understand 1. Understand the basic concepts of random variable, probability and its distribution. 2. Use concept of probability in real life situations. 3. Compute probability of real-life events. 4. Identify the nature of data using moments. 5. Check the dependency of events using probability or conditional probability. 6. The applications of various discrete statistical distribution in real life and industry.	
Units	Contents	Workload Allotted
I	Theory of Correlation: Types of Correlations, Scatter Diagram, Karl Pearson's Correlation Coefficient, Properties of correlation, Rank Correlation Coefficient & its Limits. Theory of regression: Linear regression, Lines of Regression, Derivation of line of regression of Y on X. Regression Coefficients and their Properties.	8 hrs
II	Method of Least Square, Fitting of Straight Line, Fitting of Second-degree Parabola and Numerical Example. Theory of Attributes: basic terminologies, relation between class frequency, Consistency of data for two attributes. Association of Attributes: Yule's coefficient of association, coefficient of colligation.	7 Hrs
III	Discrete Distributions: Uniform distribution, Binomial distribution, Poisson distribution - definitions, mean, variance (with derivations), MGF, CGF, moments and properties (without derivations) Negative binomial distribution, geometric and hyper-geometric distribution – Definition, mean, variance, moments, mgf, cgf, simple numerical problems.	8 Hrs
IV	Discrete Distributions: Negative binomial distribution, Geometric distribution, hyper-geometric distribution- definitions, mean, variance (with derivations), MGF, CGF, moments and properties (without derivations), simple numerical problems.	7 Hrs

References:

1. Freedman D. Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
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Vertical No.	Vertical Name	Type of Corse	Course Code	Course Name	Credits	Workload Per week	Max Marks
b	Minor-P	Lab	13203M1P2	Practicals based on 13203M1	02	04	25

Practical List	Workload Allotted
1. Finding Karl Pearson's coefficient of correlation. 2. Problems on rank correlation. 3. problems on linear regression. 4. Problems on second-degree parabola. 5. Problems on association of attributes. 6. problems on binomial distribution (with fitting) 7. problems on Poisson distribution (with fitting) 8. problems on uniform, geometric and hyper-geometric distribution.	4 Hrs Per week.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
c	GOEC-T	Theory	13203G5	Application of Statistics in Finance	2	2	30

Course Objectives	This Course is design to aware the application of Statistics in Finance						
Course Outcomes	Students will able to understands 1. Survey Statistics and Case Study of Survey Statistics 2. To get the idea of data collection and preparation questionnaire 3. The concepts of finance in statistics 4. To understand various applications of Statistics in Finance.						
Units	Contents					WorkloadAllotted	
I	Survey Statistics: Definition of Sampling, Numerical and Categorical Data, Steps to conduct Survey with case study					8 hrs	
II	Data Collection: Definition of data, Primary data and secondary data and their sources, Preparation of questionnaire					7 Hrs	
III	Financial Statistics: Analysis of economics performance and trend, Definition of GDP growth, Inflation and Unemployment.					8 Hrs	
IV	Application of Statistics in Finance: Time series data to analysis the share market trend, correlation between economic indicators and financial market. regression analysis.					7 Hrs	

References:

1. Freedman D. Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
3. Gupta S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics. 8th Edition, Sultan Chand and Sons Publishers, New Delhi.
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Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
d	VSC-P	Lab	13203P3	Advanced Practicals based on Excel	02	04	25

Practical List	Work load Allotted
1. Preparation of frequency table using Excel 2. Finding descriptive characteristics of the data using excel 2. Fitting of binomial distribution in Excel 3. Fitting of Poisson distribution in Excel 4. Graphical Representation of Data using Excel. 5. Diagrammatic Representation of data using Excel	4 Hrs Per week.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
CURRICULUM AS PER NEP-2020
FACULTY OF SCIENCE AND TECHNOLOGY
Three Years Degree Course
Major SUBJECT: STATISTICS
B.Sc. II Semester- IV

Program outcomes:	
PO1	Disciplinary Knowledge: Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PO2	Critical Thinking and Problem solving: Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	Social competence: Display the understanding, behavioral skills needed for successful social adaptation, working groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	Research-related skills and Scientific temper: Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	Personal and professional competence: Performing dependently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute inter personal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO6	Effective Citizenship and Ethics: Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO7	Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO8	Self-directed and Life-long learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.
Program Specific Outcomes: At the end of the program, students are able to:	
PSO1	Understand the elementary techniques of data analysis such as, graphical and numerical.
PSO2	Get the knowledge of different concepts, principles, methodologies and tools (skills) of Statistics.
PSO3	Collect, represent graphically, analyze and interpret data /information by using appropriate Statistical tools.
PSO4	Identify and solve a wide range of problems in real life /industry related to Statistics.
PSO5	Apply various measures of central tendency and dispersion and hence enable them to infer about the nature and characteristics of a particular data set.
PSO6	Understand the basic concepts of probability.
PSO7	Understand the concept of random variable, univariate probability distribution, expectation and moments of probability distribution.
PSO8	Understand bivariate probability distributions and their applications.
PSO9	Summarize, analyze and interpret data through various techniques learnt by manual calculations as well as by using MS-Excel.

Major subject -Statistics
B.Sc. II Semester -IV

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major-T	Theory	1320401	Continuous Probability Distributions	02	02	30

Course Objectives	The objective of this course is to explain different concept of continuous distributions and the interrelations between them. The use of these distributions in real life					
Course Outcomes	At the end of the course student is able to do 1. Explain concept to discrete random variable and its probability distribution including expectation and moments. 2. Identify different discrete distributions such as Binomial, Poisson, their interrelations if any. 3. Apply standard discrete distributions to realistic situation.					
Units	Contents					Workload Allotted
I	Normal Distribution: pdf derivation, its definition, characteristics of normal distribution and normal curve mean, variance, median, mode, expression for raw moments and central moments & moment generating function, cumulant generating function. Simple numerical problems on mean and variance.					8 hrs
II	Standard normal distribution: mean, variance, moments, moment generating function, cumulant generating function Area property of Normal distribution, importance of normal distribution. Problems on area property. Fitting of Normal distribution. Central Limit theorems (only statements)					7 hrs
III	Continuous Uniform Distribution-its definition, mean variance, moments and moment generating function. Exponential Distribution -its definition, mean & variance moment generating function and cumulant generating function, moments using moment generating function and simple problems.					8 hrs
IV	Beta distribution of first kind its definition, mean and variance, Beta distribution of second kind its definition, mean and variance, one parameter gamma distributions, itsdefinition, mean, variance, two parameter gamma distributions, itsdefinition, mean, variance simple problems on finding mean and variance.					7 hrs

References-

1. Freedman D. Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
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10. Johnson, N. L., Kotz, S., & Balakrishnan, N. (1994). Continuous univariate distributions (2nd ed., Vol. 1). John Wiley & Sons.
11. Johnson, N. L., Kotz, S., & Balakrishnan, N. (1995). Continuous univariate distributions (2nd ed., Vol. 2). John Wiley & Sons.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major-T	Theory	1320402	Sampling Distributions and Large Sample Tests	02	02 hrs	30

Course Objectives	The objective of this course is to explain different concept sampling distributions and the interrelations between them. The use of these distributions in real life					
Course Outcomes	At the end of the course student is able to do 1. Explain concept of sampling probability distribution including expectation and moments. 2. Identify different sampling distributions such as Chi-Square, t, F, their interrelations if any. 3. Applications of these distributions to realistic situation.					
Units	Contents					Workload Allotted
I	Independence of sample mean and variance in random sampling from normal distribution (without derivation). Chi-square distribution: definition, derivation of p.d.f. Mean and Variance, MGF, CGF. Additive property of Chi-square variates. Conditions for the validity of Chi-square test, Assumptions of Chi-square. Chi-square test for population variance. Chi-square test for Goodness of fit. Chi-square test for Independence of Attributes. 2X2 contingency table and Yate's correction. Simple problems					8 hrs
II	Student's t-distribution: definition, derivation of its p.d.f. Importance of student's t-distribution and confidence limits for μ . Fisher's t-statistics, derivation of its distribution, limiting form of t-distribution, Mean, variance, median, Assumptions for t- test. t- tests for testing single mean, difference of means. difference of paired means, observed sample correlation coefficient.					7 hrs
III	Snedecor's F-statistics: definition, derivation of p.d.f., Assumptions, constants of F-distribution, mode and points of inflexion, relation between t and F, relation between F and Chi-square statistics, F-test for equality of population variance, F-test for equality of several means.					8 hrs
IV	Large sample tests: Test of significance for- single proportion, difference of proportion, single mean, difference of means, difference of standard deviations. Fisher's Z-distribution, MGF, Fisher's Z-transformation.					7 hrs

References-

1. Freedman D. Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
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10. Johnson, N. L., Kotz, S., & Balakrishnan, N. (1994). Continuous univariate distributions (2nd ed., Vol. 1). John Wiley & Sons.
11. Johnson, N. L., Kotz, S., & Balakrishnan, N. (1995). Continuous univariate distributions (2nd ed., Vol. 2). John Wiley & Sons.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major-P	Lab	13204P1	Practicals on 1320401 and 1320402	02	04 hrs	30

Course Objectives	The objective of this course is to perform the various practical problems. The applications of these distributions in real life situations in different field						
Course Outcomes	At the end of the course student is able to do.... 1.Explain concept of discrete random variable and its probability distribution including expectation and moments 2.Identify different discrete distributions such as Binomial, Poisson, their interrelations if any. 3.Apply standard discrete distributions to realistic situation.						
Contents- Practicals on 1320401 and 1320402						Workload Allotted	
1. Fitting of Normal Distribution. 2. Problems on Area property of normal distribution 3. Problems on exponential distribution 4. Problems on Uniform distribution 5. Chi-square test for goodness of fit. 6. Chi-square test for Independence of attributes. 7. Test of significance based on t-test for single mean 8. Test of significance based on t-test for difference of means 09. Test of significance based on F-test for population variances 10. Problems on unbiasedness of estimator. 11. Problems on Consistence estimator. 12.Practicals on large sample tests						4 hrs per week (2 practical each of 2hrs)	

References-

1. Freedman D. Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
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Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major-T	Theory	1320403	Theory of estimation and testing of hypothesis	02	02 hrs	30

Course Objectives	The objective of this course is to explain different concept of estimation of parameters, testing of hypothesis, sequential analysis and LRT as well as understand the applications in analysis of data, also, in real life					
Course Outcomes	At the end of the course student is able to do 1. use concepts of estimation and testing of hypothesis. 2. use various tests in different types of data.					
Units	Contents					Workload Allotted
I	Meaning of estimation, Point and Interval estimation, basic terminology, estimate of a parameter, Properties of estimator: Unbiasedness, Consistency, efficiency and sufficiency. Concept of bias and standard errors of estimate, standard errors of sample mean and proportion. Simple problems on properties of estimator.					8 hrs
II	Concept of Hypothesis: - Null and Alternative hypothesis. Types of Errors: Type-I and Type-II, critical region Level of significance, p-values, power of test, Optimum tests under different situations, most powerful test, uniformly most powerful test, Neyman-Pearson Lemma (statement).					7 hrs
III	Likelihood ratio test: properties of LRT, test for the-mean of normal population, equality of means of two normal populations, means of several normal populations, variance of two normal populations, equality of variance of two normal populations, variance of several normal populations					8 hrs
IV	Sequential analysis, Sequential probability ratio test (SPRT), operating characteristics function of SPRT, Average sample number (ASN)					7 hrs

References-

1. Freedman D. Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
3. Goon A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol.1. 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
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Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
b	Minor-T	Theory	13204M1	Continuous Probability Distributions and Testing of Hypothesis	02	02 hrs	30

Course Objectives	The objective of this course is to explain different aspects of official statistics and the way to understand the applied statistics and their applications in various field.					
Course Outcomes	At the end of the course student is able to do.... 1. Understand the official statistical methods 2. Understand vital statistics and collection of vital statistics data. 3. Get the knowledge of concepts of time series. 4. Understanding sampling methods in survey sampling.					
Units	Contents					Workload Allotted
I	Normal Distribution -pdf, definition, mean, variance, median, mode mgf, cgf, Area property, chief characteristics and importance of normal distribution, Simple numerical problems on mean and variance, area property.					8hrs
II	Continuous probability Distribution: Uniform, Exponential, gamma (two parameter), beta-I & II kind-definition, mean variance, moments, Applications and simple problems on finding mean and variance.					7hrs
III	Meaning of estimation, Point and Interval estimation & estimate of a parameter. Properties of estimator: - Unbiasedness, Consistency, efficiency and sufficiency (only definitions). Concept of bias & standard errors of estimate, standard errors of sample mean and proportion. Concept of statistics and its sampling distribution. Concept of Hypothesis: - Null and Alternative hypothesis. Types of Errors: - Type – I and Type – II, critical region Level of significance, p – values, power of test. Large sample tests, Simple problems					8hrs
IV	Chi-square distribution: Mean and Variance, Additive property. Conditions for the validity of χ^2 test, Assumptions of χ^2 . Chi-square tests for: population variance. Goodness of fit, test for Independence of Attributes. 2X 2 contingency table and Yate's correction.					7hrs

	Student's t-distribution: definition, derivation its p.d.f.. Assumptions for t- test. t- test for: single mean. difference of means, Paired t-test for difference of means. Snedecor's F-statistics: definition, F-test for equality of population variance.	
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References-

1. Freedman D. Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
3. Goon A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol.1. 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
4. Gupta S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics. 8th Edition, Sultan Chand and Sons Publishers, New Delhi.
5. Gupta S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, 3rd Edition, Sultan Chand and Sons Publishers, New Delhi.
6. Heumann C., Schomaker, M., Shalabh (2016). Introduction to Statistics and Data Analysis. 1st Edition, Springer, Germany.
7. Moore D. S., Notz W. I., Fligner M. A. (2013). The Basic Practice of Statistics, 6th Edition, Ruth Baruth.

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Workload Per week	Max Marks
b	Minor-P	Lab	13204M1P2	Practicals based on 13204M1	02	04 hrs	30

Course Objectives	The objective of this course is to explain different aspects of official statistics and the way to understand the applied statistics and their applications in various field.						
Units	Contents- List of Practicals on Minor M4					Workload Allotted	
	1. practical on Normal Distribution 2. practical on Area property of normal distribution. 3. practical on exponential distribution. 4. practical on type-I and type-II error. 5. practical on Chi-square tests. 6. practical on t-tests 7. practical on F-test 8. practicals on large sample tests					4 hrs per week (2 practicals each of 2hrs)	

References-

1. Freedman D. Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
3. Goon A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol.1. 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
4. Gupta S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics. 8th Edition, Sultan Chand and Sons Publishers, New Delhi.
5. Gupta S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, 3rd Edition, Sultan Chand and Sons Publishers, New Delhi.
6. Heumann C., Schomaker, M., Shalabh (2016). Introduction to Statistics and Data Analysis. 1st Edition, Springer, Germany.
7. Moore D. S., Notz W. I., Fligner M. A. (2013). The Basic Practice of Statistics, 6th Edition, Ruth Baruth.

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Workload Per week	Max Marks
c	GOEC-T	Theory	13204G6	Financial Statistics	02	02 hrs	30

Course Objectives	The objective of this course is to understand the various Financial and Industrial Statistical concepts. The applications are in real life situations in Financial Statistics.						
Course Outcomes	At the end of the course student is able to do 1. Students can understand and interpret various types of data. 2. To understand, identify and apply appropriate graphical method. 3. To understand the role of importance of statistical methods in banking and financial decision. 4. To analyze the time series analysis and forecasting technique. 5. To understand the role of statistics industrial in processes and quality control.						
Units	Contents					Workload Allotted	
I	Data Analysis with Charts: Simple bar Charts, line diagram, multiple bar diagram, subdivided bar diagram and pie diagram					8 hrs	
II	Data Analysis with graphs: Visual representation of Histogram and frequency polygon, Scatter plot, box plot.					7 hrs	
III	Statistics in Banking: Information of Financial health and operation of bank, RBI and its working, Non-performing Assets, liability and Assets.					8hrs	
IV	Industrial Statistics: Statistical quality control and its applications, Application of Statistics in various industries.					7 hrs	

References-

1. Freedman D. Pisani R., Purves R. (2007). Statistics, 4th Edition, W. W. Norton and Company.
2. Freund J. E. (1977). Modern Elementary Statistics. 4th Edition, Prentice Hall of India Private Limited, New Delhi.
3. Goon A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol.1. 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
4. Gupta S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics. 8th Edition, Sultan Chand and Sons Publishers, New Delhi.
5. Gupta S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, 3rd Edition, Sultan Chand and Sons Publishers, New Delhi.
6. Heumann C., Schomaker, M., Shalabh (2016). Introduction to Statistics and Data Analysis. 1st Edition, Springer, Germany.
7. Moore D. S., Notz W. I., Fligner M. A. (2013). The Basic Practice of Statistics, 6th Edition, Ruth Baruth.

Vertical No.	Vertical Name	Type of Course	Course Code	Course name	Credits	Workload Per week	Max Marks
d	VSC-P	Lab	13204P3	Practicals on Vocational using MS-Excel	02	04 hrs	30

Units	Contents- Practicals on Vocational using MS-Excel	Workload Allotted
	Following practical's to be perform using MS Excel 1. Fitting of Normal Distribution. 2. Problems on Area property of normal distribution-1 3. Problems on Area property of normal distribution-2 4. Problems on exponential distribution 5. Problems on Uniform distribution 6. Chi-square test for goodness of fit. 7. Chi-square test for Independence of attributes. 8. Test of significance based on t-test for single mean 9. Test of significance based on t-test for difference of means 10. Test of significance based on F-test for population variances 11. Problems on unbiasedness of estimator. 12. Problems on Consistence estimator.	4 hrs per week (2 practicals each of 2hrs)

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI CURRICULUM AS PER NEP-2020
FACULTY OF SCIENCE AND TECHNOLOGY
Three Years Degree Course SUBJECT Major: STATISTICS
B.Sc. THIRD YEAR SEMESTER-V

Program outcomes

PO1 Disciplinary Knowledge: Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.

PO2 Critical Thinking and Problem solving: Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.

PO3 Social Competence: Display the understanding, behavioral skills needed for successful social adaptation, working groups, exhibits thoughts and ideas effectively in writing and orally.

PO4 Research-related skills and Scientific temper: Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.

PO5 Personal and Professional Competence: Performing dependently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute inter personal relationships, self motivation and adaptability skills and commit to professional ethics.

PO6 Effective Citizenship and Ethics: Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.

PO7 Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO8 Self-directed and Life-long learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Program Specific Outcomes:

At the end of the program, students are able to:

1. Understand the elementary techniques of data analysis such as, graphical and numerical.
2. Get the knowledge of different concepts, principles, methodologies and tools (skills) of Statistics.
3. Collect, represent graphically, analyze and interpret data/information by using appropriate Statistical tools.
4. Identify and solve a wide range of problems in real life/industry related to Statistics.
5. Apply various measures of central tendency and dispersion and hence enable them to infer about the nature and characteristics of a particular data set.
6. Understand the basic concepts of probability.
7. Understand the concept of random variable, univariate probability distribution, expectation and moments of probability distribution.
8. Understand bivariate probability distributions and their applications in real life.
9. Summarize, analyze and interpret data through various techniques learnt by manual calculations as well as by using MS-Excel.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Work load Per week	Max Marks
a	Major-T	Theory-I	1320501	Sample Survey design & Research Methodology	02	02	30

Course Objectives	This course is design to have the idea about the Sampling and their various design. and applying Statistical Knowledge in research.					
Course Outcomes	Students will be able to- 5. Increase the analytical skill in Sampling. 6. Get the knowledge Sample Survey. 7. Enhance the skill regarding Sampling. 8. Understand the Statistical knowledge applied in Research.					
Units	Contents					Workload Allotted
I	Sample Survey Design: Introduction to Sampling, Definition; Population, Sample, Estimator, Parameters, Statistics, Sampling Distribution, Standard Error, Major steps in sample survey, Types of Sampling, Sampling and Non-Sampling Errors, Random Sampling, Simple Random Sampling (SRS) with and without replacement: Mean and Variance					8 hrs
II	Stratified Random Sampling: Introduction, Mean and Variance, Proportional Allocations and Neyman Allocations and their Variances, Comparison various allocations with SRS					7 hrs
III	Systematic Sampling: Introduction, Mean and Variance, Comparison of variance with linear trend. Cluster Sampling: Introduction, Mean and Variance					8 hrs
IV	Research Methodology: Introduction, Meaning of Research, Objective of Research, Types of Research, Research problem, Necessity of defining the problem, Meaning of Research Design, Need for Research design, Different Research design, Basic principles of Research design.					7 hrs

Books

1. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
2. Kothari, C. R. (2004). Research methodology: Methods and techniques (2nd ed.). New Age International Publishers.
3. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Applied Statistics. 3rd Edition, Sultan Chand and Sons, New Delhi
4. A. M. Goon, M. K. Gupta and B. Das Gupta (1971) Fundamentals of Statistics,” The World Press Pvt. Ltd., Kolkata.
5. Murthy M. N. (1967): Sampling Theory and Methods, Statistical Pub. Soc., Calcutta
6. Sampath S. (2000): Sampling Theory and Methods, Narosa Publishing House.
7. Cochran, W. G. (1977). Sampling techniques (3rd ed.). John Wiley & Sons
8. Des Raj (2000): Sample Survey Theory, Narosa Publishing House.
9. Singh D., Chaudhary F. S.: Theory and Analysis of Sample Survey Designs.
10. Primal Mukhopadhyay: Theory and Methods of Survey Sampling, Prentice Hall.
11. Sukhatme P. V. and Sukhatme B. V. Sampling Theory of Surveys with Applications.
12. Kish, L. (1965). Survey sampling. John Wiley & Sons
13. Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). Sage Publications.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course Name	Credits	Workload Per week	Max Marks
a	Major-T	Theory-II	1320502	ANOVA and Non-Parametric Methods	02	02	30
Course Objectives		This course is design to have knowledge of non parametric methods and also analysis of variance.					
Course Outcomes		1.Students will be able to understand the concepts of Non parametric methods and various test. 2. Study of Analysis of variance in fixed effect model. 3. To acquire the analytical skill in two-way classification with multiple observation.					
Units		Contents				Workload Allotted	
I		Non-parametric Methods; Introduction, Run test, Median test, Sign Test, Advantages and disadvantages of Non-parametric over Parametric methods				8hrs	
II		One-Way Classification: Introductions, Assumptions and complete analysis of one-way classification. Least square estimates of various effects. Expectation of sum of squares.				7hrs	
III		Two Way Classification: Introduction, Assumptions for ANOVA test and complete analysis of two-way classification with one observation per cell. Least square estimates of various effects. Expectation of sum of squares.				8hrs	
IV		Two-way classification with Multiple observations: Complete analysis of two-way classified data with m-observations per cell-fixed effect model. Least square estimates of various effects. Expectation of sum of squares.				7hrs	

Books

1. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
2. Kothari, C. R. (2004). Research methodology: Methods and techniques (2nd ed.). New Age International Publishers.
3. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Applied Statistics. 3rd Edition, Sultan Chand and Sons, New Delhi
4. A. M. Goon, M. K. Gupta and B. Das Gupta (1971) Fundamentals of Statistics,” The World Press Pvt. Ltd., Kolkata.
5. Keppel, G., & Wickens, T. D. (2004). Design and analysis: A researcher's handbook (4th ed.). Pearson.
6. Montgomery, D.C. (2017) Design and Analysis of Experiments Arisona, State University. Ninth Edition, John Wiley & Sons, New York,
7. Fisher, R. A. (1925). Statistical Methods for Research Workers. Oliver & Boyd
8. Conover, W. J. (1999). Practical Nonparametric Statistics (3rd ed.). John Wiley & Sons.
9. Hollander, M., Wolfe, D. A., & Chicken, E. (2013). Nonparametric Statistical Methods (3rd ed.). John Wiley & Sons.
10. Gibbons, J. D., & Chakraborti, S. (2020). Nonparametric Statistical Inference (6th ed.). Chapman & Hall/CRC. [Available on CRC Press]
11. Lehmann, E. L., & D'Abrera, H. J. M. (2006). Nonparametrics: Statistical Methods Based on Ranks. Springer.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course Name	Credits	Workload Per week	Max Marks
a	Major-T	Theory-III	1320503	Design of Experiments	02	02	30
Course Objectives		This course is design to provide knowledge of design of experiment used in Agricultural methods, research design, socioeconomic study.					
Course Outcomes		1.Students will be able to layout their own design. 2. Students will be able to apply the knowledge of design in Agricultural experimentation, clinical trials and research design.					
Units		Contents				Workload Allotted	
I		Design of Experiment: Introduction, Important terms and definitions, Principle of design of experiment. Complete Statistical Analysis of completely randomized design, least square estimates of effect. Advantages and disadvantages of CRD				8hrs	
II		Randomized Block Design (RBD): Definitions, particular layout of RBD, linear model of RBD, mathematical analysis of RBD, least square estimate. Null Hypothesis and ANOVA table, efficiency of RBD over CRD. Advantages and disadvantages of RBD				7hrs	
III		Latin Square Design (LSD): Definitions, particular layout of LSD, linear model, mathematical analysis of LSD, least square estimate. Null Hypothesis and ANOVA table, Advantages and disadvantages of LSD.				8hrs	
IV		Factorial Experiment: Concept of Factorial Experiment, Advantages of factorial experiment. 2^2 and 2^3 Factorial experiment. (Concept, null hypothesis and ANOVA table. Yates method for computing factorial effects.				7hrs	

Books:-

1. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
2. Kothari, C. R. (2004). Research methodology: Methods and techniques (2nd ed.). New Age International Publishers.
3. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Applied Statistics. 3rd Edition, Sultan Chand and Sons, New Delhi
4. A. M. Goon, M. K. Gupta and B. Das Gupta (1971) Fundamentals of Statistics,” The World Press Pvt. Ltd., Kolkata.
5. Keppel, G., & Wickens, T. D. (2004). Design and analysis: A researcher's handbook (4th ed.). Pearson.
6. Montgomery, D.C. (2017) Design and Analysis of Experiments Arisona, State University. Ninth Edition, John Wiley & Sons, New York,
7. Fisher, R. A. (1925). Statistical Methods for Research Workers. Oliver & Boyd
8. Box, G. E. P., Hunter, J. S., & Hunter, W. G. (2005). Statistics for experimenters: Design, innovation, and discovery (2nd ed.). Wiley.
9. Dean, A. M., & Voss, D. (1999). Design and analysis of experiments. Springer.
10. Field, A., & Hole, G. (2002). How to design and report experiments. SAGE Publications.
11. Fisher, R. A. (1935). The design of experiments. Oliver & Boyd.
12. Montgomery, D. C. (2017). Design and analysis of experiments (9th ed.). Wiley.
13. Morris, M. (2011). Design of experiments: An introduction based on linear models. Chapman & Hall/CRC.
14. Wu, C. F. J., & Hamada, M. S. (2021). Experiments: Planning, analysis, and optimization (2nd ed.). Wiley.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major-P	Lab	13205P1	Practicals on 132501,502,503	02	04	25
Course Objectives		1. Understand the basic concepts, terminology, and principles of Design of Experiments. 2. Learn the structure, assumptions, statistical analysis, and interpretation of Completely Randomized Design (CRD). 3. Understand the layout, linear model, ANOVA, and efficiency of Randomized Block Design (RBD). 4. Study the construction, analysis, and applications of Latin Square Design (LSD). 5. Apply suitable experimental designs for agricultural, industrial, and scientific data analysis.					
Course Outcomes		1. Explain the basic concepts, terminology, and principles of experimental design including randomization, replication, and local control. 2. Analyze experimental data using Completely Randomized Design (CRD) and interpret ANOVA tables and least square estimates. 3. Construct and analyze Randomized Block Design (RBD), test hypotheses, and compare the efficiency of RBD over CRD. 4. Apply Latin Square Design (LSD) for experiments involving two-way control of variation and perform its statistical analysis. 5. Select appropriate experimental designs for practical problems and interpret statistical results effectively.					
Contents- List of Practicals on 132501,502,503							Work load Allotted
1. Drawing of random sample under SRSWOR from a given 2. population and estimation of the mean and total and the standard error of the estimator. 3. Drawing of random sample under SRSWR from a given population and estimation of the mean and total and the standard error of the estimator. 4. Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWR. 5. Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWOR. 6. Estimation of the mean, total and the standard error of the estimator under stratified random sampling. 7. Exercise on Proportional allocation of samples. 8. Exercise on Neyman allocation of samples. 9. Problems on Systematic sampling. 10. ANOVA for one-way and two-way classified data. 11. Analysis of CRD, RBD and LSD. 12. Analysis of 2^2 factorial experiment using RBD layout. 13. Analysis of 2^3 factorial experiment using RBD layout.							4 hrs per week (2 practicals each of 2hrs)

Note: Student should select either Major-Elective T1 and its Practical or Major-Elective T2 and its Practical.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major ElectiveT1	Theory-1	13205E1	Basic Queuing Theory	02	02	30
Course Objectives		This course is design to have the idea about the advanced operations research. and applying Statistical Knowledge in research.					
Course Outcomes		Students will be able to- 1. Increase the analytical skill in optimization. 2. Get the knowledge modeling. 3. Enhance the skill regarding fitting of optimization models 4. Understand the Statistical knowledge applied in Research.					
Units		Contents					Workload Allotted
I		Basic elements of the queuing theory, Role of Poisson and exponential distribution. Pure Birth Models and Pure Death Models, Queuing with Combined Arrivals and departures. Generalized Poisson model					8 hrs
II		Specialized Poisson queues- (M/M/1): (GD/ ∞/∞), (M/M/1): (GD/ N/ ∞), The details of above models with respect to expected number of customers and waiting time. some examples					7 hrs
III		(M/M/c): (GD/ ∞/∞), (M/M/c): (GD/ N/ ∞), The details of above models with respect to expected number of customers and waiting time. some examples					8 hrs
IV		Non-Poisson queues, queues with priorities for service, Tandem Queues, Two station series models with zero queue capacity					7 hrs

Books:

1. Hillier, F. S., & Lieberman, G. J. (2021). Introduction to operations research (11th ed.). McGraw-Hill Education.
2. Taha, H. A. (2023). Operations research: An introduction (11th ed.). Pearson.
3. Winston, W. L. (2004). Operations research: Applications and algorithms (4th ed.). Brooks/Cole.
4. Bazaraa, M. S., Sherali, H. D., & Shetty, C. M. (2006). Nonlinear programming: Theory and algorithms (3rd ed.). John Wiley & Sons.
5. Bertsimas, D., & Tsitsiklis, J. N. (1997). Introduction to linear optimization. Athena Scientific.
6. Boyd, S., & Vandenberghe, L. (2004). Convex optimization. Cambridge University Press.
7. Ahuja, R. K., Magnanti, T. L., & Orlin, J. B. (1993). Network flows: Theory, algorithms, and applications. Prentice Hall.
8. Williams, H. P. (2013). Model building in mathematical programming (5th ed.). John Wiley & Sons.
9. Operation Research by Kanti Swarup , P.K.Gupta and Man Mohan
10. Fundamental of Operation Research By Tulsian P.C and Tulsian Bharat.
11. Introduction to Operation Research by Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu
12. Introductory Operations Research: Theory and Application by H.S.Kasana and K.D.Kumar

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major ElectiveP1	Lab	13205E1P2	Practicals Based on 13205E1	02	04	25
Course Objectives		To apply the various methods in different field					
Course Outcomes		Students will be able to understand and apply the methods in real life field.					
Contents- List of Practicals							Work load Allotted
1. To obtain the Cumulative Probabilities for Pure Birth Model 2. To obtain the Cumulative Probabilities for Pure Death Model 3. To obtain the expected waiting time for (M/M/1):(GD/ ∞/∞), 4. To obtain expected waiting time for (M/M/1): (GD/ N/∞), 5. To obtain expected waiting time for (M/M/c): (GD/ N/∞), 6. Obtain expected waiting time for (M/M/c): (GD/ N/∞),							4 hrs per week (2 practical's each of 2hrs)

Vertical No.	Vertical Name	Type of Corse	Course Code	Course Name	Credits	Workload Per week	Max Marks
A	Major ElectiveT2	Theory 2	13205E2	Stochastic Processes	02	02	30
Course Objectives		This course is design to have knowledge of Stochastic Processes					
Course Outcomes		1.Students will be able to understand the concepts of Stochastic Processes 2. To Study of Stochastic Processes model and its applications in various field. 3. To acquire the analytical skill in Stochastic Processes modeling.					
Units		Contents				Workload Allotted	
I		Introduction to Stochastic processes, its specifications, stationary processes. Markov Chain its definitions, Transition probabilities, classification of trials and chains, determination of higher transition probabilities. examples.				8hrs	
II		Stability of Markov Chain, Graph Theoretic approach, examples. Markov chain with denumerable number of states. examples, Reducible chains. Numerical Problems				7hrs	
III		Statistical Inference for Markov chain, Markov chain with continuous state space, examples. Non-homogeneous chains. Examples on Markov chains				8hrs	
IV		Markov Process with discrete state space, Poisson process, definition, related distributions, Birth and death process, examples.				7hrs	

Books

1. Stochastic Processes by J. Medhi New age international publishers
2. Gallager, Robert G. Discrete Stochastic Processes. Springer US, 1996
3. J, Sobel Matthew, ed. Stochastic models in operations research. Dover Pub., 2004
4. Shanthikumar, J. G. Applied Probability and Stochastic Processes. Springer US, 1999.
5. J, Lieberman Gerald, and Hillier Frederick S, eds. Introduction to stochastic models in operations research. McGraw-Hill, 1990.
6. Hentenryck, Pascal Van. Online stochastic combinatorial optimization. MIT Press, 2009.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major ElectiveP2	Lab	13205E2P3	Practicals Based on 13205E2	02	04	25
Course Objectives	To apply the various methods in different field						
Course Outcomes	Students will be able to understand and apply the methods in real life field.						
Contents- List of Practicals						Work load Allotted	
1. To obtain the Transition Probabilities 2. To obtain the prepare the Transition Probability Matrix. 3. To obtain the solution of steady state Markov chain. 4. To obtain order of the Markov Chain. 5. To obtain Higher Transition Probabilities 6. Obtain solution of Two State Markov Chain.						4 hrs per week (2 practicals each of 2hrs)	

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
b	Minor-T	Theory	13205M1	Applied Statistics and Non-parametric tests	02	02	30

Course Objectives	1. The objective of the course is to understand the concept of probability and its theoretical distribution 2. The concepts of bivariate probability distributions with its applications. 3. This course will also provide the knowledge of discrete distributions and their conceptual as well as practical analysis					
Course Outcomes	At the end of the course students are able to understand 1. Understand the basic concepts of random variable, probability and its distribution. 2. Use concept of probability in real life situations. 3. Compute probability of real-life events. 4. Identify the nature of data using moments. 5. Check the dependency of events using probability or conditional probability. 6. The applications of various discrete statistical distribution in real life and industry.					
Unit	Contents					Workload Allotted
I	Sample Survey Design: Introduction to Sampling, Definition; Population, Sample, Estimator, Parameters, Statistics, Sampling Distribution, Standard Error, Major steps in sample survey, Types of Sampling, Sampling and Non-Sampling Errors, Random Sampling, Simple Random Sampling (SRS) with and without replacement: Mean and Variance, Stratified Random Sampling: Introduction, Mean and Variance, Proportional Allocations and Neyman Allocations and their Variances					8 hrs
II	Non-parametric Methods; Introduction, Run test, Median test, Sign Test, Advantages and disadvantages of Non-parametric over Parametric methods, ANOVA: One-Way Classification, Two Way Classification.					7 hrs
III	Design of Experiment: Introduction, Important terms and definitions, Principle of design of experiment. Complete Statistical Analysis of completely randomized design, least square estimates of effect. Advantages and disadvantages of CRD, Randomized Block Design (RBD): Definitions, particular layout of RBD, linear model of RBD, least square estimate. Null Hypothesis and ANOVA table, efficiency of RBD over CRD. Advantages and disadvantages of RBD					8 hrs
IV	Latin Square Design (LSD): Definitions, particular layout of LSD, linear model, east square estimate. Null Hypothesis and ANOVA table, Advantages and disadvantages of LSD. Factorial Experiment: Concept of Factorial Experiment, Advantages of factorial experiment. 2^2 Factorial experiment. (Concept, null hypothesis and ANOVA table. Yates method for computing factorial effects.					7 hrs

Books

1. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
2. Kothari, C. R. (2004). Research methodology: Methods and techniques (2nd ed.). New Age International Publishers.
3. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Applied Statistics. 3rd Edition, Sultan Chand and Sons, New Delhi

4. A. M. Goon, M. K. Gupta and B. Das Gupta (1971) Fundamentals of Statistics,” The World Press Pvt. Ltd., Kolkata.
5. Keppel, G., & Wickens, T. D. (2004). Design and analysis: A researcher's handbook (4th ed.). Pearson.
6. Montgomery, D.C. (2017) Design and Analysis of Experiments Arisona, State University. Ninth Edition, John Wiley & Sons, New York,
7. Daniel, W. W., & Cross, C. L. (2013). Biostatistics: A foundation for analysis in the health sciences (10th ed.). John Wiley & Sons.
8. Johnson, R. A., & Bhattacharyya, G. K. (2014). Statistics: Principles and methods (7th ed.). John Wiley & Sons.
9. Triola, M. F. (2017). Elementary statistics (13th ed.). Pearson.
10. Johnson, N. L., Kotz, S., & Balakrishnan, N. (1994). Continuous univariate distributions (2nd ed., Vol. 1). John Wiley & Sons.
11. Johnson, N. L., Kotz, S., & Balakrishnan, N. (1995). Continuous univariate distributions (2nd ed., Vol. 2). John Wiley & Sons.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
b	Minor-P	Lab	13205M1P4	Practical based on 13205M1	02	04	25

Contents	Workload
1. Practical on SRSWR, SRSWOR 2. Practical on Stratified sampling. 3. Practical on non-parametric tests, ANOVA-One way, two-way 4. Practical on ANOVA-One way, two-way 5. Practical on CRD 6. Practical on RBD. 7. Practical on LSD 8. Practical on Factorial experiments	4 hrs per week (2 practical's each of 2hrs)

Books

1. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
2. Kothari, C. R. (2004). Research methodology: Methods and techniques (2nd ed.). New Age International Publishers.
3. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Applied Statistics. 3rd Edition, Sultan Chand and Sons, New Delhi
4. A. M. Goon, M. K. Gupta and B. Das Gupta (1971) Fundamentals of Statistics,” The World Press Pvt. Ltd., Kolkata.
5. Keppel, G., & Wickens, T. D. (2004). Design and analysis: A researcher's handbook (4th ed.). Pearson.
6. Montgomery, D.C. (2017) Design and Analysis of Experiments Arisona, State University. Ninth Edition, John Wiley & Sons, New York,

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
d	VSC-P	Lab	13205P5	Practical on Python Programming	02	04	50
Course Objectives		1. To equip students to be able to use python programming. 2. To provide comprehensive knowledge of python for basic data Analysis.					
Course Outcomes		1. To demonstrate significant experience with python program development environment. 2. Implement data handling and visualization and able to analyze the data					
Units	Contents: Practical on Python Programming					Workload Allotted	
I	Basics of Python Spyder (Tool): Introduction to spyder, setting working directory, creating and saving a script file, file execution, clearing console, removing variables from environment, clearing environment, commenting script files, variable creation, arithmetic and logical operators, data types and associated operations.					4 hrs per week (2 practical's each of 2hrs)	
II	Sequence data types and associated operations: Strings, lists, arrays, tuples, dictionary, sets, Range, NumPy, ndarray.						
III	Pandas data frame and data frame related operations on Toyota Corolla dataset: Reading files, exploratory data analysis, Data preparation and pre-processing. Data visualization on Toyoto Corolla dataset using matplotlib and seaborn libraries: Scatter plot, line plot, bar plot, histogram, box plot, pair plot. Control structures using Toyoto Corolla dataset: if-else family, for loop, for loop with if break, while loop. Functions.						
IV	Files & I/O: File objects – Built in Functions – Methods – Built in Attributes – Standard files – Command line arguments – File System – File Execution – Storage Modules. Exception Handling: Exception - Exception Handling - Except clause – Try- Finally clause - User Defined Exceptions.						

Books:

1. Suresh Kumar Mukhiya and Usman Ahmed: Hands-On Exploratory Data Analysis with Python: Perform EDA techniques to understand, summarize, and investigate your data Additional
2. Gardener, M. (2017). Beginning R: The statistical programming language, Wiley.
3. Lawrence, M., & Verzani, J. (2016). Programming Graphical User Interfaces in R. CRC Press. (ebook)
4. Paul Barry (2016): Head-First Python, 2nd edition, O'Reilly
5. Avinash Navlani, Armando Fandango, Ivan Idris (2021) Python Data Analysis: Perform data collection, data processing, wrangling, visualization, and model building using Python.
6. Mastering python for data science – Samir Madhavan

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
d	SEC-P	Lab	13205P6	Basic Data Analysis using R Software	02	04	50

Course Objectives	1. Understand the fundamentals of R Programming for statistical computing and data analysis. 2. Develop programming skills in R for data handling, computation, and visualization. 3. Learn techniques of Data Analysis using libraries and tools. 4. Apply data preprocessing, exploratory data analysis, and visualization methods to real-world datasets. 5. Understand the concepts and applications of Business Analytics for solving business problems. 6. Develop practical and analytical skills involving data collection, analysis, interpretation, and presentation.	
Course Outcomes	1. Understand the fundamentals of R Programming for statistical computing and data analysis. 2. Develop programming skills in R for data handling, computation, and visualization. 3. Learn techniques of Data Analysis using R libraries and tools. 4. Apply data preprocessing, exploratory data analysis, and visualization methods to real-world datasets. 5. Understand the concepts and applications of Business Analytics for solving business problems. 6. Develop practical and analytical skills involving data collection, analysis, interpretation, and presentation.	
Contents: Basic Data Analysis using R Software-Practicals on following topics		Workload Allotted
I	Probability and probability distributions, generating random numbers, fitting probability distribution, statistical tests using R.	4 hrs per week (2 practical’s each of 2hrs)
II	Time Series: Simple moving average, weighted moving average Exponential smoothing, and Forecasting Techniques using time series, Accuracy of measurements: Mean Absolute Percentage Error (MAPE), Root Mean Square Error (RMSE)	
III	Simple Random Sampling-With Replacement and Without replacement, Stratified Random Sampling with various allocations	
IV	ANOVA: one-way, two-way (one and multiple observations), Design of Experiments: CRD, RBD, LSD	

Text Books

- 1.Cotton, R., Learning R: A step-by-step function guide to data analysis. 1st edition. O'reilly Media Inc.
2. Pattnaik, M., Statistical Computing Using R Programming. 1st edition. Kalyani Publishing. New Delhi.
- 3.Gardener, M. (2017). Beginning R: The statistical programming language, Wiley.
- 4.Lawrence, M., & Verzani, J. (2016). Programming Graphical User Interfaces in R. CRC Press. (ebook)
- 5R Software : https://onlinecourses.nptel.ac.in/noc25_ma99/preview**
- 6Analysing and Visualizing Big Data with R software, Editor Asha Jindal, Shailaja Prakashan, Kanpur
- 7.V.S.Athawar, (2024) Advanced Statistics, First Edition ,Rest Publisher Ltd. India

Program:				Semester:	V	
Course:	Foundation of Artificial Intelligence			Code:		
Teaching Scheme				Evaluation Scheme		
Level	Lecture	Hours	Credit	Internal	External	Total
5.5	2	2	2	20	30	50
Methods of Internal Assessment: 15 Marks to Class Tests, / Assignments / Vivavoce / Presentation & 5 Marks to Attendance						
Course Objectives: To introduce AI concepts in a simple, real-life way with focus on understanding applications, ethics, and future opportunities.						
Course Outcomes: After completion of the course, the students will be able to:						
CO	Course Outcomes				BT Level	
CO-1	Explain the basic concepts, history, and types of AI with real-life examples.				L1– Knowledge, L2 – Understanding	
CO-2	Describe AI structures and architectures using simple real-world analogies.				L2– Understanding, L3– Application	
CO-3	Identify and analyze applications of AI in the area of arts, commerce, humanities, and daily life.				L3– Application, L4– Analysis	
CO-4	Evaluate ethical, social issues and predict future opportunities of AI in their own fields.				L4 – Analysis, L5– Evaluation	

Unit1: Introduction to Artificial Intelligence (8Hours)

Definition of AI: What is Intelligence? Natural vs. Artificial, Simple definition of AI; History & Evolution of AI: From early computers to modern AI; Types of AI: Narrow AI vs. General AI vs. Super AI; AI in Everyday Life: Google Maps, E-commerce suggestions, Chatbots, Social Media feeds; Key Components: Data, Algorithms, Computing Power

Unit2: AI Structures, Architectures & Techniques (7Hours)

Basic Structure of an AI System; AI Architectures (Simplified): Rule Based System, Machine Learning, Neural Networks; Key Concepts: Knowledge Representation (using symbols, facts), Search & Problem Solving (maze example, finding shortest route), Natural Language Understanding (Google Translate, chatbots)

Unit3: Applications of AI in Society (7 Hours)

AI in Different Fields: Education (Personalized learning apps, plagiarism checkers), Healthcare (Disease prediction, medical chatbots), Commerce (Fraud detection in banking, stock market predictions, customer support), Daily Life (Smart home devices, language translation, travel assistants); AI & Decision Making: Hiring, Loan Approval, Court Decisions; Advantages of AI, Limitations of AI

Unit4: Ethical, Social & Future Aspects of AI (8Hours)

Ethical Concerns in AI: Privacy issues (CCTV, online data), Bias & Fairness (AI preferring certain groups), Job Displacement (automation replacing humans); Responsible AI: Transparency, Accountability, Human oversight; Future Trends in AI: Self-driving cars, AI in governance, creative industries; AI and You (Career Perspective): Opportunities in Digital Marketing, Content

Creation, Business Analytics, HR Tech, Creative Industries (non-programming roles)

Textbook:

Melanie Mitchell – Artificial Intelligence: A Guide for Thinking

Humans Reference Books:

1. Boden, Margaret A., Artificial Intelligence: A Very Short Introduction
2. Elaine Rich – Artificial Intelligence (3rd Edition)
3. Godbole, Achyut, Artificial Intelligence, Bookganga Publication.
4. Kulkarni, Dr Anand, Artificial Intelligence chya watevar, Sakal Media Pvt. Ltd.
5. Stuart Russell – Human Compatible (2019)
6. Thorpe, Josh, AI for Students: Creative Hacks for Academic Success, Promptly Books

B.Sc. THIRD YEAR SEMESTER-VI

Vertical No.	Vertical Name	Type of Corse	Course Code	Course Name	Credits	Workload Per week	Max Marks
a	Major-T	Theory-I	1320601	Operations Research-I	02	02	30
Course Objectives		This Syllabus is design to get the detail knowledge of operation research and its various method to obtained optimum solution.					
Course Outcomes		1. Introductory part of operation research which studies to find optimum solution to the problems. 2. Details study of graphical methods to find the optimum solution 3. Optimum solution is studied by simplex method. 4. Detail study of transportation problem and the various method to find the optimum transportation cost.					
Units		Contents					Workload Allotted
I		Introduction of Operation Research, Convex Sets, Concave Sets, GLPP, Formulation of LPP, Graphical Method of LPP- Construction, Solution					8 hrs
II		Standard Form of LPP. Canonical form of LPP, Slack Variable, Surplus variable, Dual Problem of LPP, Numerical Problems					7 hrs
III		Simplex Method of LPP its construction and solution, Numerical Problems, artificial variable technique (only concept).					8 hrs
IV		Transportation Problem: Mathematical formulation, loops in Transportation problem, Methods to obtain initial basic feasible solution: N-W-C-Rule, Row Minima Method, Column minima method, Matrix Minima Method, Vogel's Approximation method.					7 hrs

Books

1. Hillier, F. S., & Lieberman, G. J. (2021). Introduction to operations research (11th ed.). McGraw-Hill Education.
2. Taha, H. A. (2023). Operations research: An introduction (11th ed.). Pearson.
3. Winston, W. L. (2004). Operations research: Applications and algorithms (4th ed.). Brooks/Cole.
4. Bazaraa, M. S., Sherali, H. D., & Shetty, C. M. (2006). Nonlinear programming: Theory and algorithms (3rd ed.). John Wiley & Sons.
5. Bertsimas, D., & Tsitsiklis, J. N. (1997). Introduction to linear optimization. Athena Scientific.
6. Boyd, S., & Vandenberghe, L. (2004). Convex optimization. Cambridge University Press.
7. Ahuja, R. K., Magnanti, T. L., & Orlin, J. B. (1993). Network flows: Theory, algorithms, and applications. Prentice Hall.
8. Williams, H. P. (2013). Model building in mathematical programming (5th ed.). John Wiley & Sons.
9. Operation Research by Kanti Swarup , P.K.Gupta and Man Mohan

10. Fundamental of Operation Research By Tulsian P.C and Tulsian Bharat.

11. Introduction to Operation Research by Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu

12. Introductory Operations Research: Theory and Application by H.S.Kasana and K.D.Kumar

Vertical No.	Vertical Name	Type of Corse	Course Code	Course Name	Credits	Workload Per week	Max Marks
a	Major-T	Theory-2	1320602	Operations Research-II	02	02	30
Course Objectives		This course is design to develop skills in minimizing cost or time (or maximizing profit) analytical thinking for situations involving competition and workflow optimization.					
Course Outcomes		1.Understand the concept of assignment models and their applications in real-life decision-making. 2. Compare assignment with transportation and linear programming models for better resource utilization. 3. Understand the importance of job sequencing in manufacturing and service systems. 4. Understand the fundamental concepts of competitive decision-making under conflict situations					
Units		Contents					Workload Allotted
I		Assignment Problem: Definition and example of a A.P., mathematical formulation of a A.P. Solution of assignment problem- Complete Enumeration Method, Hungarian assignment algorithm, Travelling Salesman Problem					8 hrs
II		Sequencing problem: Introduction, Concept, Sequencing problem with n jobs and 2 machines, Sequencing problem with n jobs and 3 machines.					7 hrs
III		Game theory: Two persons zero sum game, Maximin- Minimax principal, mixed strategies, saddle point, Games without saddle point. Dominance properties. Graphical solution of $2 \times n$ and $m \times 2$ Games.					8 hrs
IV		Research Methodology II: Methods of data collection, Collection of Primary data, secondary data, Observation method Interview method, Collection of data through questionnaires, Collection of data through schedules, difference between questionnaire and schedule.					7 hrs

Books

1. Hillier, F. S., & Lieberman, G. J. (2021). Introduction to operations research (11th ed.). McGraw-Hill Education.

2. Taha, H. A. (2023). Operations research: An introduction (11th ed.). Pearson.

3. Winston, W. L. (2004). Operations research: Applications and algorithms (4th ed.). Brooks/Cole.

4. Bazaraa, M. S., Sherali, H. D., & Shetty, C. M. (2006). Nonlinear programming: Theory and algorithms (3rd ed.). John Wiley & Sons.

5. Bertsimas, D., & Tsitsiklis, J. N. (1997). Introduction to linear optimization. Athena Scientific.

6. Boyd, S., & Vandenberghe, L. (2004). Convex optimization. Cambridge University Press.

7. Ahuja, R. K., Magnanti, T. L., & Orlin, J. B. (1993). Network flows: Theory, algorithms, and applications. Prentice Hall.

8. Williams, H. P. (2013). Model building in mathematical programming (5th ed.). John Wiley & Sons.

9. Operation Research by Kanti Swarup , P.K.Gupta and Man Mohan

10. Fundamental of Operation Research By Tulsian P.C and Tulsian Bharat.

11. Introduction to Operation Research by Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu

12. Introductory Operations Research: Theory and Application by H.S.Kasana and K.D.Kumar

13. Research methodology by C R Kothari. New age international publishers.

Vertical No.	Vertical Name	Type of Course	Course Code	Course Name	Credits	Workload Per week	Max Marks
a	Major	Theory 3	1320603	Industrial Statistics	02	02	30
Course Objectives	This course is design understand the importance of SQC in production and to understand the concept of acceptance sampling and demand function.						
Course Outcomes	1.Understand the concept of quality and the role of statistics in quality improvement. 2.Apply acceptance sampling techniques to real-life business/industrial problems 3.Explain the components of time series – trend, seasonal, cyclical, and irregular variations. 4.Use time series models for forecasting business and economic data. 5.Explain the law of demand and the factors influencing demand.						
Units	Contents						Workload Allotted
I	SQC-I: Importance of statistical methods in industrial research and practice. Determination of tolerance limits. General theory of control charts, causes of variation in quality, control limits, summary of out-of-control criteria. Control charts for variables - X bar and R Chart.						8 hrs
II	SQC II: Control charts for attributes-np charts, p-chart and c chart. Problem of lot acceptance, stipulation of good and bad lots, producer's risk and consumer's risk. Single sampling plans and their OC functions.						7 hrs
III	Time Series: Introduction, definitions, Method of measuring Secular trend, Simple Average Method, Semi-average Method, trend values, Measurement of seasonal variation, Measurement of Cyclic variation, Measurement of irregular variation, Ratio to trend method, Ratio to moving average method. Least square moving average method Advantages and Disadvantages.						8 hrs
IV	Demand Analysis: Theory of consumer behavior. Utility functions. Indifference curves. Cardinal approach, Ordinal approach, Partial elasticities of demand. Income distribution Pareto Curve.						7 hrs

Books

1. Operation Research by Kanti Swaroop, P. K. Gupta and Man Mohan
2. Fundamental of Operation Research by Tulsian P.C and Tulsian Bharat.
3. Introduction to Operation Research by Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu
4. Introductory Operations Research: Theory and Application by H. S. Kasana and K. D. Kumar.
5. Fundamental of applied Statistics by Gupta and Kapoor. Sultan chand and Sons publishers
6. Fundamental of Statistics by S C Gupta and Kapoor. Sultan chand and Son's publishers
7. Goon A. N. Gupta M. K., Das Gupta B. (1986): Fundamentals of Statistics, Vol.II World Calcutta.
8. S. C. Gupta, V. K. Kapoor: Fundamentals of Applied Statistics, Sultan Chand and sons.
9. Time Series for Data Science: Analysis and Forecasting by Wayne A. Woodward (Author), Bivin Philip Sadler (Author), Stephen Robertson (Author)
10. V.S.Athawar, (2024) Advanced Statistics, First Edition ,Rest Publisher Ltd. India

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major-P	Lab	13206P1	Practicals Based 1320601, 602, 603	02	04	25
Course Objectives	1. Understand the basic concepts, models, and applications of Operations Research in decision-making and resource optimization. 2. Develop knowledge of mathematical techniques used in Operations Research such as linear programming, transportation, assignment, and sequencing problems. 3. Understand the concepts and methods of Demand Analysis and their applications in forecasting and business planning. 4. Learn methods for analyzing and interpreting Time Series Analysis data including trend, seasonal, cyclical, and irregular variations. 5. Apply statistical and analytical techniques for forecasting, optimization, and managerial decision-making. 6. Develop problem-solving and analytical skills for practical applications in business, economics, and industry.						
Course Outcomes	After successful completion of the course, students will be able to: 1. Explain the basic concepts, scope, and applications of Operations Research in real-life decision-making problems. 2. Formulate and solve optimization problems using Operations Research techniques such as linear programming, transportation, and assignment models. 3. Analyze demand patterns and apply demand forecasting methods for business and economic decisions. 4. Interpret and analyze time series data by identifying trend, seasonal, cyclical, and irregular components. 5. Apply statistical tools and forecasting techniques for prediction and planning purposes. 6. Develop analytical and quantitative skills for solving practical problems in management, economics, and industrial applications.						
Contents: Practical Based 1320601, 602, 603							Work load Allotted
1. Solving LPP by graphical method 2. Solution of LPP by simplex method 3. Transportation Problem 4. Assignment problem 5. Construction of index numbers and consumer price index numbers, consistency of index numbers 6. Time Series-1: Measurement of trend 7. Time Series-2: Measurement of seasonal variation 8. Drawing of control charts for mean and range 9. Drawing of control charts for mean and standard deviation 10. Problems on Drawing of np-chart, p-chart and C-charts 11. Drawing OC curves for single sampling plan							4 hrs per week (2 practicals each of 2hrs)

Note: Student should select either Major-Elective T1 and its Practical or Major-Elective T2 and its Practical.

Vertical No.	Vertical Name	Type of Course	Course Code	Course Name	Credits	Workload Per week	Max Marks
a	Major Elective T1	Theory-I	13206E1	Advanced Operations Research-I	02	02	30
Course Objectives		This Syllabus is design to get the detail knowledge of advanced operation research and its various method to obtained optimum solution.					
Course Outcomes		1.Introductory part of operation research which studies to find optimum solution to the problems. 2.Optimum solution to be studied by various Queuing Models 3. Detail applications of Queueing models to various field.					
Units		Contents					Workload Allotted
I		Integer Linear Programming Problem: Introduction, definition and applications in capital Budgeting and fixed charged problem. Job Shop Scheduling Problem.					8 hrs
II		Solution methods of integer programming problem, Branch and Bound Algorithm, Cutting Plane algorithm with examples. Zero one Integer problem, additive algorithm. Examples.					7 hrs
III		Dynamic programming: Introduction, definition, DP model with Recursive equations using principle of optimality. Capital Budgeting example and its solution					8 hrs
IV		Backward Recursive Equation method, examples. Cargo Loading Problem with example. Reliability problem with additive decomposition, example. Forward Backward recursive equation.					7 hrs

Books

1. Hillier, F. S., & Lieberman, G. J. (2021). Introduction to operations research (11th ed.). McGraw-Hill Education.
2. Taha, H. A. (2023). Operations research: An introduction (11th ed.). Pearson.
3. Winston, W. L. (2004). Operations research: Applications and algorithms (4th ed.). Brooks/Cole.
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8. Williams, H. P. (2013). Model building in mathematical programming (5th ed.). John Wiley & Sons.
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10. Fundamental of Operation Research By Tulsian P.C and Tulsian Bharat.
11. Introduction to Operation Research by Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu
12. Introductory Operations Research: Theory and Application by H.S.Kasana and K.D.Kumar

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major ElectiveP1	Lab	13206E1 P2	Practicals Based on 13206E1	02	04	25
Course Objectives		To apply the various methods in different field					
Course Outcomes		Students will be able to understand and apply the methods in real life field.					
Contents- Practicals Based on 13206E1						Work load Allotted	
1. To formulate Integer Linear Programming Problem. 2. To obtain the feasible integer solution by simple rounding method, 3. To obtain the solution of ILP by Branch and Bound algorithm. 4. To obtain solution of ILP by fractional algorithm. 5. To obtain solution of DP by recursive method. 6. Obtain solution of DP by backward recursive method.						4 hrs per week (2 practical's each of 2hrs)	

Vertical No.	Vertical Name	Type of Corse	Course Code	Course Name	Credits	Workload Per week	Max Marks
a	Major ElectiveT2	Theory-II	13206E2	Advanced Operations Research-II	02	02	30
Course Objectives	This course is design to develop skills in minimizing cost or time (or maximizing profit) analytical thinking for situations involving competition and workflow optimization.						
Course Outcomes	1.Understand the concept of CPM and PERT models and their applications in real-life decision-making. 2. To understand the concept of inventory models 3. Understand the importance of inventory models in various field 4. Understand the fundamental concepts of competitive decision-making under conflict situations						
Units	Contents						Workload Allotted
I	Introduction to PERT and CPM, Basic Differences Between PERT and CPM, Significance of Using PERT/CPM, Phases of Project Management, PERT/CPM Network Components and Precedence Relationships, Rules for AOA Network Construction, Errors and Dummies in Network, Critical Path Analysis, Forward Pass Method (For Earliest Event Time), Backward Pass Method (For Latest Allowable Event Time), Float (Slack) of an Activity and Event, Critical Path, Project Scheduling with Uncertain Activity Times, Estimation of Project Completion Time.						8 hrs
II	Inventory Models-I Deterministic Inventory Control Models: Introduction, The Meaning of Inventory Control, Functional Role of Inventory, Reasons for Carrying Scheme I to VI Inventory, Factors Involved in Inventory Problem Analysis, Inventory Cost Components, Demand for Inventory Items, Replenishment Lead Time, Planning Period, Inventory Model Building, Steps of Inventory Model Building, Replenishment Order Size Decisions and Concept of EOQ, Classification of EOQ Models, Single Item Inventory Control Models without Shortages, Single Item Inventory Control Models with Shortages, Multi-Item Inventory Models with Constraints, Single Item Inventory Control Models with Quantity Discounts.						7 hrs
III	Inventory Model-II Inventory Control Models with Uncertain Demand, Reorder Level with Constant Demand, Service Level, Additional Stocks, Information Systems for Inventory Control, The Q-System with Uncertain Demand, The Q-system with Uncertain Demand and Lead Time, Application of Q-System: Two-Bin System, The P-System with Uncertain Demand, Comparison Between Q-system and P-System						8 hrs
IV	Decision Theory: Introduction, Steps of Decision-Making Process, Types of Decision-Making Environments, Decision-Making Under Uncertainty, Optimism (Maximax or Minimin) Criterion, Pessimism (Maximin or Minimax) Criterion, Equal Probabilities (Laplace) Criterion, Coefficient of Optimism (Hurwicz) Criterion, Regret (Savage) Criterion, Decision-Making Under Risk, Expected Monetary Value (EMV), Expected Opportunity Loss (EOL), Expected Value of Perfect Information (EVPI), Decision Trees Analysis						7 hrs

Books

1. Hillier, F. S., & Lieberman, G. J. (2021). Introduction to operations research (11th ed.). McGraw-Hill Education.

2. Taha, H. A. (2023). Operations research: An introduction (11th ed.). Pearson.
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12. Introductory Operations Research: Theory and Application by H.S.Kasana and K.D.Kumar

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
a	Major ElectiveP2	Lab	13206E2P3	Practicals Based on 13206E2	02	04	25
Course Objectives		To apply the various methods in different field					
Course Outcomes		Students will be able to understand and apply the methods in real life field.					
Contents- List of Practicals						Workload Allotted	
1. To construct the Arrow Diagram for various activities. 2. To obtain Critical path Diagram 3. To obtain the earliest Start Time and Latest Completion Time 4. To obtain the probabilities using PERT. 5. To obtain the Economic Order Quantity. 6. Obtain Economic Lot Size and Reorder Point 7. To obtain the Total Cost Per Cycle. 8. To obtain the Buffer Stock when daily demand is normal and Lead time is given. 9. Problems on Decision making with various criterions 10. Problems on decision making with uncertainty.						4 hrs per week (2 practical's each of 2hrs)	

Books

1. Hillier, F. S., & Lieberman, G. J. (2021). Introduction to operations research (11th ed.). McGraw-Hill Education.
2. Taha, H. A. (2023). Operations research: An introduction (11th ed.). Pearson.
3. Winston, W. L. (2004). Operations research: Applications and algorithms (4th ed.). Brooks/Cole.
4. Bazaraa, M. S., Sherali, H. D., & Shetty, C. M. (2006). Nonlinear programming: Theory and algorithms (3rd ed.). John Wiley & Sons.
5. Bertsimas, D., & Tsitsiklis, J. N. (1997). Introduction to linear optimization. Athena Scientific.
6. Boyd, S., & Vandenberghe, L. (2004). Convex optimization. Cambridge University Press.
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11. Introduction to Operation Research by Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu
12. Introductory Operations Research: Theory and Application by H.S.Kasana and K.D.Kumar

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
b	Minor-T	Theory-6	13206M1	Operations Research and Industrial Statistics	02	02	30

Course Objectives	1. To explain different concept of operations research and their applications in real life	
Course Outcomes	At the end of the course students are able to understand 1. Understand the basic concepts of LPP, TP, AP, SP, 2. Apply Industrial statistics in various situations.	
Unit	Contents	Workload Allotted
I	Introduction of Operation Research, GLPP, Formulation of LPP, Graphical Method of LPP- Construction, Solution Standard Form of LPP. Canonical form of LPP, Slack Variable, Surplus variable, Dual Problem of LPP, Simplex Method of LPP its construction and solution, Numerical Problems.	8 hrs
II	Transportation Problem: Definition, Mathematical formulation, Methods to obtain initial basic feasible solution: N-W-C-Rule, Row Minima Method, Column minima method, Matrix Minima Method, Vogel's Approximation method. Assignment Problem: Definition Solution of assignment problem, Hungarian assignment algorithm	7 hrs
III	Sequencing problem: Introduction, Concept, Sequencing problem with n jobs and 2 machines, SQC-I: Importance of statistical methods in industrial research and practice. Determination of tolerance limits. General theory of control charts, causes of variation in quality, control limits, summary of out-of-control criteria. Control charts for variables - X bar and R Chart.	8 hrs
IV	SQC II: Control charts for attributes-np charts, p-chart and c chart. Problem of lot acceptance, stipulation of good and bad lots, producer's risk and consumer's risk. Single sampling plans and their OC functions.	7 hrs

Books

- Hillier, F. S., & Lieberman, G. J. (2021). Introduction to operations research (11th ed.). McGraw-Hill Education.
- Taha, H. A. (2023). Operations research: An introduction (11th ed.). Pearson.
- Winston, W. L. (2004). Operations research: Applications and algorithms (4th ed.). Brooks/Cole.
- Bazaraa, M. S., Sherali, H. D., & Shetty, C. M. (2006). Nonlinear programming: Theory and algorithms (3rd ed.). John Wiley & Sons.
- Bertsimas, D., & Tsitsiklis, J. N. (1997). Introduction to linear optimization. Athena Scientific.
- Boyd, S., & Vandenberghe, L. (2004). Convex optimization. Cambridge University Press.
- Ahuja, R. K., Magnanti, T. L., & Orlin, J. B. (1993). Network flows: Theory, algorithms, and applications. Prentice Hall.
- Williams, H. P. (2013). Model building in mathematical programming (5th ed.). John Wiley & Sons.
- Operation Research by Kanti Swarup, P.K.Gupta and Man Mohan
- Fundamental of Operation Research By Tulsian P.C and Tulsian Bharat.
- Introduction to Operation Research by Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu
- Introductory Operations Research: Theory and Application by H.S.Kasana and K.D.Kumar
- Research methodology by C R Kothari. New age international publishers.
- Fundamental of applied Statistics by Gupta and Kapoor. Sultan chand and Sons publishers
- Research methodology by C R Kothari. New age international publishers.
- Fundamental of Statistics by S C Gupta and Kapoor. Sultan chand and Sons publishers
- Goon A.N.Gupta M.K.,Das Gupta B.(1986):Fundamentals of Statistics, Vol.II World Calcutta.
- S.C.Gupta,V.K.Kapoor:Fundamentals of Applied Statistics, Sultan Chand and sons.

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
b	Minor-P	Lab	13206M1P4	Practical Based on 13206M1	02	04	30
Contents: Practical Based on 13206M1					Workload Allotted		
1. practical on LPP 2. practical on transportation problem. 3. practical on assignment problem. 4. practical on sequencing problem. 5. practical on X bar and R charts. 6. practical on control charts for attributes					4 hrs per week (2 practicals each of 2hrs)		

Vertical No.	Vertical Name	Type of Corse	Course Code	Course name	Credits	Workload Per week	Max Marks
d	VSC-P	Lab	13206P5	Practicals on Big Data Analysis Using R	02	04	50
Course Objectives		1. Understand the basic concepts of big data 2. To understand the concepts of applied statistics 3. Analysis of Variance and Design of experiments 4. Understand the concepts of sampling, financial functions, Time Series etc. 5. to learn the procedure of solving LPP, TP, AP using R software 6. To learn factor analysis, discriminant analysis, logistic regression, multiple correlation etc.					
Course Outcomes		After successful completion of the course, students will be able to: 1. Apply R programming concepts for analyzing Big Data. 2. Compute and interpret descriptive measures. 3. Analyze and interpret the output obtained after the analysis of data. 4. Evaluate relationships between variables and predict the values for future events. 6. Use R software for Big-data analysis for the real-world datasets.					
Units		Contents: Practicals on Big Data Analysis Using R					Work load Allotted
I		Theory of Estimation: Point Estimation and Interval Estimation, Non-parametric tests: Sign test, Wilcoxon Signed rank test, Two or more sample tests: Mann-Whitney Test, Kruskal-Wallis rank sum test.					4 hrs per week (2 practical's each of 2hrs)
II		Multiple Regression: Imputation of missing values, predictive modeling, multicollinearity, VIF, GVIF, Homoscedasticity, normality of residuals, linearity between response and predictors, Logistic Regression.					
III		Factor Analysis, Discriminant Analysis, Linear Programming Problems, Transportation Problem, Assignment Problem.					
IV		Financial Functions: Effective Annual Rate, present value for single sum, present value for ordinary annuity, present value for annuity due, Present value of perpetuity, Future value, loan payment calculations, rate of return.					

Text Book

1. Pattnaik, M., Statistical Computing Using R Programming. 1st edition. Kalyani Publishing. New Delhi.
2. Gardener, M. (2017). Beginning R: The statistical programming language, Wiley.
3. Cotton, R., Learning R: A step-by-step function guide to data analysis. 1st edition. O'reilly Media Inc.
4. Pattnaik, M., Statistical Computing Using R Programming. 1st edition. Kalyani Publishing. New Delhi.
5. Gardener, M. (2017). Beginning R: The statistical programming language, Wiley.
6. Lawrence, M., & Verzani, J. (2016). Programming Graphical User Interfaces in R. CRC Press. (ebook)
7. **R Software:** https://onlinecourses.nptel.ac.in/noc25_ma99/preview
8. Analyzing and Visualizing Big Data with R software, Editor Asha Jindal, Shailaja Prakashan, Kanpur

External Assessment for practical (Major/Minor Lab)

- | | |
|---------------------------|-----------|
| • Practical Exam | :20 marks |
| • Viva-Voce | :05 marks |
| • Total | :25 marks |
| • Duration of Examination | :02 Hrs. |

Internal Assessment for practical (Major/Minor Lab)

- | | |
|---|-----------|
| • Internal Assessment based on CAT (MCQ based) | :20 marks |
| • Record Book | :05 marks |
| • Total | :25 marks |
-

Internal Assessment for OE

- | | |
|--|-----------|
| • Internal Assessment based on CAT (Theory based) | :20 marks |
| • End Semester Examination | :30 marks |
| • Total | :50 marks |
| • Duration of End Semester Examination | :02 Hrs. |

Internal Assessment for practical (SEC/VSC Lab)

- | | |
|---|-----------|
| • Internal Assessment based on CAT (MCQ based) | :20 Marks |
| • Record Book | :10 Marks |
| • End Semester Examination (Skill Based Practical) | :20 Marks |
| • Total | :50 Marks |
| • Duration of End Semester Examination | :02Hrs. |

Note: The External Assessment of theory courses will be conducted in accordance with the guidelines issued by the SGBA University.

Internal Assessment for Theory/Practical/Laboratory:

All the internal assessments should be conducted on the basis of Continuous Assessment Tests (CAT). Continuous Assessment Tests (CAT): For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under

i. Three CAT each of 10 Marks (Theory) and 10 Marks (Practical).

- First on completion of 25% Syllabus of the course or on completion of 25 teaching days
- Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
- Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.

iii. Total Performance in CAT (i.e.40 %) shall be based on the best two out of three in CAT examinations

iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as MCQ class test, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI



THREE-YEAR UNDERGRADUATE PROGRAMME

Bachelor of Science (B.Sc.)

Subject: STATISTICS

FACULTY: SCIENCE AND TECHNOLOGY

(Courses effective from Academic Year 2026-2027 Under Uniform NEP 2020)

Scheme of Teaching-Learning-Evaluation, Credit Distribution, Workload Calculation and Examination

Credit Distribution

Three/Four-year UG Degree Programme (Level 4.5 to 5.5)

Vertical	Vertical Type	I	II		III	IV	V	VI	Total Credits	Grand Total
	(i) Three-year UG Degree Programme (Level 4.5.to 5.5)									
A	Major DSC (60–64) (Minimum 50% of Total Credits)	4	4	Major	6	8	8	8	38	48
				IKS	2				2	
		0	0	Elective	0	0	4	4	8	
B	Minor (from same faculty of DSC) (18–24)	4	4		4	4	4	4	24	24
C	Generic/Open Elective (OE) (Faculty-wise basket other than Major/Minor faculty) (10–12)	4	4		2	2	0	0	12	12
D(i)	Vocational Skill Courses (VSC) corresponding to Major/Minor (8–10)	0	2		2	2	2	2	10	16
D(ii)	Skill Enhancement Courses (SEC)	2	2		0	0	2	0	6	
E(i)	Ability Enhancement Courses (AEC) (English + Modern Indian Language)	1+1	1+1		1+1	1+1	0	0	8	14
E(ii)	Indian Knowledge System (IKS) 2 Generic	2	0		0	0	0	0	2	
E(iii)	Value Education Courses (VEC) (Understanding India, EVS, Digital & Technological Solution) 4	2	2		0	0	0	0	4	
F(i)	Internship / Apprenticeship corresponding to Major (OJT)	0	0		0	0	0	4	4	18
F(ii)	Field Projects / Community Engagement & Service (CEP) corresponding to Major	0	0		2	2	2	0	6	
F(iii)	Co-curricular Courses (CC) (health & wellness, yoga education, sports, fitness, cultural activities, NSS/ NCC & Fine/ Applied/ Visual/ Performing Arts 8	2	2		2	2	0	0	8	
	Total Credits per Semester	22	22		22	22	22	22	132	132

(ii) Four-year UG Degree programme (Level 6.0) Honors Degree in Major or Minor					
A. Honors Degree in Major or Minor					
	Vertical Type		Semester VII	Semester VIII	
	Major (Offered at Three-year UG Programme)	Mandatory	12-14(2*4+2*2 or 3*4+2)	12-14(2*4+2*2 or 3*4+2)	28
		Elective	4	4	8
	Research Methodology (RM)		4	0	4
	On the Job Training (OJT)		0	4	4
	Total		22	22	44
	Cumulative		(132+44) 176		
(ii) Four-year UG Degree Programme (Level 6.0)					
B. Honors with Research Degree in Major or Minor					
	Major (Offered at Three-year UG Programme)		Semester VII	Semester VIII	
		Mandatory	8-10 (2*4+2 or 2*4)	8-10 (2*4+2 or 2*4)	20
		Elective	4	4	8
	Research Methodology (RM)		4	0	4
	Research Project (RP)		4	8	12
	Total		22	22	44
	Cumulative		(132+44) 176		

Sant Gadge Baba Amravati University, Amravati

Teaching and Learning Scheme for the Degree of Bachelor of Science

FACULTY: SCIENCE AND TECHNOLOGY

TLE Scheme for FIRST YEAR: SEMESTER – I (Statistics) (Level 4.5)

(As per uniform NEP Scheme)

The Vertical	Type of Course	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal		Max. Marks	Min. Marks
						Max. Marks	Min. Marks	Max. Marks	Min. Marks		
Major / Minor	Theory	1320101	Descriptive Statistics	2	2	30	9	20	6	50	20
	Lab/Practical	13201P1	Practical based on 1320101	2	4	25	10	25	10	50	20
Minor / Major	Theory	-	-	2	2	30	9	20	6	50	20
	Lab/Practical	-	-	2	4	25	10	25	10	50	20
GOEC	Theory	13201G1	Statistics in Social and behavioural Science (Useful for Competitive Examination)	2	2	30	9	20	6	50	20
GOEC	Theory	13201G2	Statistics for Competitive Examination	2	2	30	9	20	6	50	20
VSC	-	-	-	-	-	-	-	50	20	50	20
SEC	Lab/Practical	13201P2	Skilled Based Practical	2	4	-	-	50	20	50	20

			through MS-Excel								
AEC - English	Theory		Refer University basket	1	1						
AEC – MIL	Theory		Refer University basket	1	1						
IKS- Generic	Theory		Refer University basket	2	2						
VEC	Theory		Refer University basket	2	2						
CC	Outdoor		Separate SOP will be released	2	4						
TOTAL				22	30						

TLE Scheme for FIRST YEAR: SEMESTER – II (Level 4.5)

The Vertical	Type of the Course	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal		Max. Marks	Min. Marks
						Max. Marks	Min. Marks	Max. Marks	Min. Marks		
Major / Minor	Theory	1320201	Probability Theory	2	2	30	9	20	6	50	20
	Lab/Practical	13202P1	Practical Based on 1320201	2	4	25	10	25	10	50	20
Major / Minor	Theory		-	2	2	30	9	20	6	50	20
	Lab/Practical		-	2	4	25	10	25	10	50	20
GOEC	Theory	13202G3	Business Analytics I (Useful for marketing Strategies)	2	2	30	9	20	6	50	20
GOEC	Theory	13202G4	Business Analytics II (useful for marketing Strategies and forecasting)	2	2	30	9	20	6	50	20
VSC	Lab/Practical	13202P2	Basic analysis skill through MS Excel	2	4	-	-	50	20	50	20
SEC	Lab/Practical	13202P3	Descriptive Statistics through R	2	4	-	-	50	20	50	20
AEC - English			Refer University basket	1	1	-	-	50	20	50	20
AEC – MIL			Refer University basket	1	1	-	-	50	20	50	20
VEC			Refer University basket	2	2						

CC			Separate SOP will be released	2	4						
TOTAL				22	32						

*** Important:**

- VSC Should be Complementary to Major/Minor
- SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

TLE Scheme for SECOND YEAR: SEMESTER – III (Level 5.0)

The Vertical	Type of the Course	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal		Max. Marks	Min. Marks
						Max. Marks	Min. Marks	Max. Marks	Min. Marks		
Major	Major-T	1320301	Bivariate Data and vital statistics	2	2	30	9	20	6	50	20
Major	Major-T	1320302	Discrete Probability Distribution	2	2	30	9	20	6	50	20
Major	Major-P	13203P1	Practical Based on 1320301 and 1320302	2	4	25	10	25	10	50	20
Major	IKS-T	13203IKS	History of Statistics	2	2	30	9	20	6	50	20
Minor	Minor-T	13203M1	Bivariate data and Discrete Distributions	2	2	30	9	20	6	50	20
Minor	Minor-P	13203M1P2	Practical Based on 13203M1	2	4	25	10	25	10	50	20
GOEC	GOEC-T	13203G5	Application of Statistics in Finance	2	2	30	9	20	6	50	20
VSC	VSC-P	13203P3	Advanced Practical Based on Excel	2	4	-	-	50	20	50	20
FP/CES	FP/CES	13203F1	Statistics lab (FP/CEP in Statistics)	2	4	-	-	50	20	50	20
CC	CC		Separate SOP shall be consulted from university website	2	4	-	-	50	20	50	20

Important: *VSC Should be Complementary to Major Faculty/Discipline of the Major/Minor

** SEC has to be selected from the Basket Provided by University, from the same

TLE Scheme for SECOND YEAR: SEMESTER – IV (Level 5.0)

The Vertical	Type of the Course	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal		Max. Marks	Min. Marks
						Max. Marks	Min. Marks	Max. Marks	Min. Marks		
Major	Major-T	1320401	Continuous Probability Distributions	2	2	30	9	20	6	50	20
Major	Major-T	1320402	Sampling Distributions and Large Sample Tests	2	2	30	9	20	6	50	20
Major	Major-T*	1320403	Theory of estimation and testing of hypothesis	2	2	30	9	20	6	50	20
Major	Major-P	13204P1	Practical based on 1320401 and 1320402	2	4	25	10	25	10	50	20
Minor	Minor-T	13204M1	Continuous Probability Distributions and Testing of Hypothesis	2	2	30	9	20	6	50	20
Minor	Minor-P	13204M1P2	Practical based on 13204M1	2	4	25	10	25	10	50	20
GOEC	GOEC-T	13204G6	Financial Statistics	2	2	30	9	20	6	50	20
VSC	VSC-P	13204P3	Practical Vocational using MS -Excel	2	4	-	-	50	20	50	20
SEC	SEC-P [#]	13204P12	Skill Enhancement course (Discontinued from session 2025-26)	2	4	-	-	50	20	50	20
FP/CES	FP/CES	13204F1	Statistics Lab (FP/CEP in Statistics)	2	4	-	-	50	20	50	20
CC	CC		Separate SOP shall be consulted from university website	2	4	-	-	50	20	50	20

* To be implemented w.e.f. academic session 2026-27# - Only applicable up to academic session 2025-26

Important: VSC Should be Complementary to Major and SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

TLE Scheme for THIRD YEAR: SEMESTER – V(Level 5.5)

The Vertical	Type of the Course	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Pract (Total) Marks	
						External		Internal			
						Max.	Min.	Max.	Min.	Max.	Min.
Major	Major-T	1320501	Sample Survey design & Research Methodology	2	2	30	9	20	6	50	20
Major	Major-T	1320502	ANOVA and Non-Parametric Methods	2	2	30	9	20	6	50	20
Major	Major-T	1320503	Design of Experiments	2	2	30	9	20	6	50	20
Major	Major-P	13205P1	Practical Based on 1320501,502,503	2	4	25	10	25	10	50	20
Major	Major-Elective T1	13205E1	Basic Queuing Theory	2	2	30	9	20	6	50	20
Major	Major-Elective P1	13205E1P2	Practical Based on 13205E1	2	4	25	10	25	10	50	20
OR											
Major	Major-Elective T2	13205E2	Stochastic Processes	2	2	30	9	20	6	50	20
Major	Major-Elective P2	13205E2P3	Practical Based on 13205E2	2	4	25	10	25	10	50	20
OR											
Major	Major-Elective T3			2	2	30	9	20	6	50	20
Major	Major-Elective P3			2	4	25	10	25	10	50	20
OR											
Major	Major-Elective T4			2	2	30	9	20	6	50	20
Major	Major-Elective P4			2	4	25	10	25	10	50	20
Minor	Minor-T	13205M1	Applied Statistics and Non-parametric tests	2	2	30	9	20	6	50	20

Minor	Minor-P	13205M1P4	Practical based on 13205M1	2	4	25	10	25	10	50	20
VSC	VSC-P	13205P5	Practical on Python Programming	2	4	-	-	50	20	50	20
SEC	SEC-P1	13205P6	Basic Data Analysis using R Software	2	4	-	-	50	20	50	20
OR											
SEC	SEC-P2			2	4	-	-	50	20	50	20
OR											
SEC	SEC-P3			2	4	-	-	50	20	50	20
OR											
	SEC-P4			2	4	-	-	50	20	50	20
FP/CEP	FP/CEP	13205F1	Statistics Lab (FP/CEP in Statistics)	2	4	-	-	50	20	50	20
Non Credit	Non Credit		Foundation of Artificial Intelligence	NC	2			30+20	9+6	50	20

Important:

- **VSC Should be Complementary to Major**
- **SEC must be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor**
- As per Sant Gadge Baba Amravati University, Amravati Extra-Ordinary Notification No. No. 241/2025 Dated 24/12/2025 “Foundation of Artificial Intelligence” is the Mandatory **Non-Credit Course** compulsory course for all the UG students in fifth semester of all undergraduate programs of all faculties in Sant Gadge Baba Amravati University, Amravati to earn their degree
- NC is Non-Credit Course
- Students must select **Any One** of the Major-Elective Courses (T1 to T4) with respective Practical Course in Semester V and **same shall be continued** for Semester VI
- Students must select **Any One** of the SEC-P (P1 to P4) Course in Semester V.

TLE Scheme for THIRD YEAR: SEMESTER – VI (Level 5.5)

The Vertical	Type of the Course	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Pract (Total) Marks	
						External		Internal			
						Max.	Min.	Max.	Min.	Max.	Min.
Major	Major-T	1320601	Operations Research-I	2	2	30	9	20	6	50	20
Major	Major-T	1320602	Operations Research-II	2	2	30	9	20	6	50	20
Major	Major-T	1320603	Industrial Statistics	2	2	30	9	20	6	50	20
Major	Major-P	13206P1	Practical Based on 1320601,602,603	2	4	25	10	25	10	50	20
Major	Major-Elective T1	13206E1	Advanced Operations Research-I	2	2	30	9	20	6	50	20
Major	Major-Elective P1	13206E1P2	Practical Based on 13206E1	2	4	25	10	25	10	50	20
OR											
Major	Major-Elective T2	13206E2	Advanced Operations Research-II	2	2	30	9	20	6	50	20
Major	Major-Elective P2	13206E2P3	Practicals Based on 13206E2	2	4	25	10	25	10	50	20
OR											
Major	Major-Elective T3			2	2	30	9	20	6	50	20
Major	Major-Elective P3			2	4	25	10	25	10	50	20
OR											
Major	Major-Elective T4			2	2	30	9	20	6	50	20
Major	Major-Elective P4			2	4	25	10	25	10	50	20
Minor	Minor-T	13206M1	Operations Research and Industrial Statistics	2	2	30	9	20	6	50	20
Minor	Minor-P	13206M1P4	Practical Based on 13206M1	2	2	30	9	20	6	50	20
VSC	VSC-P	13206P5	Practicals on Big Data Analysis Using R	2	4	-	-	50	20	50	20
OJT	Intern/Apprenticeship	13206IA	Statistics Lab (Internship/ Apprenticeship)	4	8	-	-	50	20	50	20

Important: VSC Should be Complementary to Major has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

SWAYAM/NPTEL Courses under NEP 2020

Sr. No.	Course Title	Course Code*	Duration (in Weeks)	Credits*	Institution	Agency	Enrollment Ends	Link to Enroll
1	Introduction to Probability and Statistics		4	1	IIT Madras	Swayam, NPTEL		Read more at: https://www.careers360.com/university/indian-institute-of-technology-madras/introduction-probability-and-statistics-certification-course
2	Non-Parametric Statistical Inference...		4	1	IIT Delhi	Swayam, NPTEL		Read more at: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org
3	Statistical Inference		8	2		Swayam, NPTEL		Read more at: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org
4	Descriptive Statistics with R Software		8	2		Swayam, NPTEL		Read more at: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org
5	Handling Large Scale Unit Level Data Using STATA		8	2		Swayam, NPTEL		Read more at: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org
6	Biostatistics and Design of Experiments		8	2		Swayam, NPTEL		Read more at: https://www.careers360.com/university/indian-institute-of-technology-madras/biostatistics-and-design-of-experiments-certification-course
7	Engineering Statistics		12	3		Swayam, NPTEL		Read more at: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org

								org
8	Probability and Statistics		12	3		Swayam, NPTEL		Readmoreat: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org
9	Introduction to Stochastic Processes		12	3		Swayam, NPTEL		Readmoreat: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org
10	Probability and Probability Distributions		12	3		Swayam, NPTEL		Read more at: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org
11	Applied Time-Series Analysis		12	3		Swayam, NPTEL		Read more at: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org
12	Business Statistics		12	3		Swayam, NPTEL		Read more at: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org
13	Research Methodology and Statistical Analysis		16	4		Swayam, NPTEL		Readmoreat: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org
14	Foundations of Mathematical Statistics		13	3		Swayam, NPTEL		Readmoreat: https://www.careers360.com/courses-certifications/swayam-statistics-courses-brp-org

* Course codes may vary according to the year and session of enrollment

** Credits will be awarded as per provisions of the SWAYAM/NPTEL at the time of actual enrollment.

Instructions for Enrollment in SWAYAM/NPTEL Courses under NEP 2020

All students of **B.Sc. with Statistics as Major or Minor** of all semesters are encouraged to enroll in suitable SWAYAM/NPTEL online courses to enhance their academic knowledge, practical skills, and employability.

General Instructions

1. Students may choose any course of their interest listed in table above for specific semester.
2. Before enrollment, students must ensure that they have an active Academic Bank of Credits (ABC) ID. The same ABC ID should be used while registering for the selected SWAYAM/NPTEL course so that earned credits can be deposited in the Academic Bank of Credits.
3. Students should carefully read the course details including duration, eligibility, syllabus, examination schedule, and credit structure before enrolling.
4. Merely enrolling in a course does not make a student eligible for academic credits. Students must:
Complete the course requirements, Appear for the proctored examination, and Successfully pass the examination as per the norms prescribed by SWAYAM/NPTEL.
5. Credits will be awarded only after successful completion and certification of the course by the concerned agency.
6. Every student must submit the details of the enrolled course to the Department of Statistics immediately after registration.
7. Submission of enrollment details to the Department is mandatory to facilitate record maintenance and compliance with University requirements regarding credit transfer and academic documentation.
8. Students are advised to preserve all course-related documents, including Enrollment confirmation, Course progress records, Examination registration receipt, Score card, Final certificate.
9. Students shall be responsible for timely registration for the examination, payment of examination fees (if applicable), and completion of all course requirements within the stipulated period.
10. The Department of shall not be responsible for missed deadlines, incomplete registrations, examination non-appearance, or failure to satisfy the certification requirements of the concerned SWAYAM/NPTEL course.
11. After successful completion of the course, students must submit a copy of the course certificate and score card to the Department of Statistics for further processing and reporting to the University.