SRI SARADA COLLEGE FOR WOMEN
(AUTONOMOUS) SALEM – 16
Reaccredited with 'B++' Grade by
NAAC (Affiliated to Periyar University)

DEPARTMENT OF STATISTICS

OUTCOME BASED SYLLABUS
B.Sc. Statistics

(For the students in the academic year 2021 – 24)

SRI SARADA COLLEGE FOR WOMEN (AUTONOMOUS), SALEM – 16
B.Sc. STATISTICS
COURSE STRUCTURE UNDER CBCS

(2021-24)   I SEMESTER

Part	Course	Course Title	Code	Hrs./ Week	Credits
I	Tamil/Hindi/Sanskrit	Tamil /Hindi/ Sanskrit Paper- I	21ULTC1/ 21ULHC1/ 21ULSC1	6	3
II	English	Communicative English -I	22ULEC1	6	3
III	Core Course – I	Descriptive Statistics	21USTC1	4	4
III	Core Course – II	Correlation and Regression Analysis	21USTC2	4	4
III	Allied Course – I	Mathematics – I	21USTAC1	5	5
IV	Skill Based – I	Data analysis using Excel	21USTSQC1	2	2
III	Core Practical	Core Practical – I (extended to II Semester)	21USTQC1	2	-
V	Extension Activity	Group Project Based on Extension Activities	21UEXAC	1	1
		Total		**30**	**22**
VI		Articulation and idea fixation skills Physical Fitness Practice – 35 Hours per semester Certificate Course in Statistical Methods – 100 hours per year			

II SEMESTER

Part	Course	Course Title	Code	Hrs./ Week	Credits
I	Tamil/Hindi/Sanskrit	Tamil /Hindi/ Sanskrit Paper- II	21ULTC2/ 21ULHC2/ 21ULSC2	6	3
II	English	Communicative English -II	21ULEC2	6	3
III	Core Course – III	Introduction to Probability theory	21USTC3	4	4
III	Core Course – IV	Distribution Theory	21USTC4	4	4
III	Allied Course – I	Mathematics – II	21USTAC2	5	5
IV	Skill Based – II	Data analysis using SPSS	21USTSQC2	2	2
III	Core Practical	Core Practical – I (extended from I Semester)	21USTQC1	1	2
IV	Environmental Studies	Environmental Studies	21UEVSC1	2	1
IV	Group Project for Environmental Studies		21UEVSPC	-	1
Total				**30**	**25**
VI		Articulation and Idea Fixation Skills – 1 Extra Credit Physical Fitness Practice – 35 hours per Semester – 1 Extra Credit Certificate Course in Yoga – 30 hours – 1 Extra Credit Certificate Course in Statistical Methods - 100 hours per year - 2 Extra Credits Extra credits are given for extra skills and courses qualified in MOOC/NPTEL			

(2021- 24 Batch) SEMESTER– III

S.No.	Title of Paper	Code	Hours per week	Credits
1.	Tamil - III	21ULTC3	6	3
2.	Communicative English -III	21ULEC3	6	3
3.	Core- V: Introduction to Real Analysis and Linear Algebra	21USTC5	4	4
4.	Core- VI: Sampling Theory	21USTC6	4	4
5.	Allied: 'C' Programming	21USTAC3	5	5
6.	Skill Based – III: Demographic Methods	21USTSC3	2	2
7.	Core Practical – II (extended to IVth Semester)	21USTQC2	1	-
8.	Non – Major Elective: Survey Methodology	21USTNEC1	2	2

- Articulation and idea fixation skills – 6 Hours per semester (out of college hours – I credit extra)
- Life Skills Promotion – 2 Hours per semester (out of college hours- 1 credit extra)
- Physical Fitness Practice – 35 Hours per semester (out of college hours - 1 credit extra)

TOTAL   30   23+3*

SEMESTER– IV

S.No.	Title of Paper	Code	Hours per week	Credits
1.	Tamil - IV	21ULTC3	6	3
2.	Communicative English -IV	21ULEC3	6	3
3.	Core-VII: Applied Statistics	21USTC7	4	4
4.	Major Elective – I: Numerical Analysis	21USTEC1	4	4
5.	Allied: Practical - 'C' Programming	21USTAQC1	5	5
6.	Skill Based – IV : Data analysis using R	21USTSQC4	2	2
7	Core Practical – II (extended from IIIrd Semester)	21USTQC2	1	2
8.	Non – Major Elective – II: Business Statistics	21USTNEC2	2	2

- Articulation and idea fixation skills – 6 Hours per semester (out of college hours – I credit extra)
- Life Skills Promotion – 2 Hours per semester (out of college hours- 1 credit extra)
- Physical Fitness Practice – 35 Hours per semester (out of college hours - 1 credit extra)

TOTAL   30   25+3*

(2021-24 Batch)
SEMESTER – V

S.No.	Title of Paper	Code	Hours per week	Credits
1.	Core – VIII: Theory of Estimation	21USTC8	6	4
2.	Core –IX : Design of Experiments	21USTC9	6	4
3.	Core – X : Operation Research - I	21USTC10	6	4
4.	Major Elective – II : Stochastic Processes	21USTEC2	5	5
5.	Core Practical : Core Practical – III	21USTQC3		
6.	Non – Major Skill Based Subject – I		2	2
7.	Value Education (extended to Semester – VI)		1	

- Articulation and idea fixation skills – 6 Hours per semester (out of college hours – I credit extra)
- Life Skills Promotion – 2 Hours per semester (out of college hours- 1 credit extra)
- Physical Fitness Practice – 35 Hours per semester (out of college hours - 1 credit extra)

TOTAL   30   25+3[*]

SEMESTER – VI

S.No.	Title of Paper	Code	Hours per week	Credits
1.	Core – XI: Testing of Hypothesis	21USTC11	6	4
2.	Core –XII : Statistical Quality Control	21USTC12	6	4
3.	Core – XI : Operation Research- II	21USTC13	6	4
4.	Major Elective – III: Actuarial Statistics	21USTEC3	5	5
5.	Core Practical- IV : Core Practical- IV	21USTQC4	4	3
6.	Non – Major Skill Based Subject – I		2	2
7.	Value Education (extended from Semester – V)		1	2

- Articulation and idea fixation skills – 6 Hours per semester (out of college hours – I credit extra)
- Life Skills Promotion – 2 Hours per semester (out of college hours- 1 credit extra)
- Physical Fitness Practice – 35 Hours per semester (out of college hours - 1 credit extra)

TOTAL   30   25+3[*]

PAPER HANDLED FOR OTHER DEPARTMENTS

1. *ALLIED FOR II B.Sc. COMPUTER SCIENCE*

III Semester	Code	Hours/week	Credits
Statistical Methods – I	21UCSAC3	5	5

IV Semester			
Statistical Methods – II	21UCSAC4	5	5

2. *NON – MAJOR ELECTIVES FOR II B. A. / B.Sc. / B.Com.*

III Semester			
NME – I : Survey Methodology	21USTNEC1	2	2

IV Semester			
NME – II : Business Statistics	21USTNEC2	2	2

DEPARTMENT OF STATISTICS

Programme Title: B.Sc. Statistics

Programme Educational Objectives:

➢ To provide a degree for students to acquire high ability to combine and relate Statistics with other domains

➢ To prepare the students to become leaders in their associated organisations with managing capabilities.

Programme Outcomes:
On successful completion of the programme, the students will be able to

PO Number	PO Statement
1	Acquire the basic knowledge to continue and complete an advanced degree.
2	Prepare for lifelong learning and successful careers using their mathematical and statistical skills.
3	Apply their knowledge to retrieve, analyze and assimilate information.
4	Afford the opportunity to pursue studies in a discipline other than Statistics.
5	Develop oral and written communication skills that allow them to present the information effectively.

Course Title   : DESCRIPTIVE STATISTICS
Course Code   : 21USTC1
Hours/Week   : 4 hrs   Semester   I

Credit   : 4   Batch   : 2021- 2024

Course Objective:

The course aims to introduce the basic concepts in statistics and presentation of data.

Syllabus

Unit – I: **No. of Hours : 12 hrs**

Definition, scope and limitations of statistics – statistical survey – types of data – methods of collection –framing a questionnaire.

Unit – II: **No. of Hours : 12 hrs**

Frequency distribution – Classification & Tabulation of data – Characteristics – Graphs and diagrams – Bar diagram, Histogram and Pie diagram.

Unit – III: **No. of Hours : 12 hrs**

Measures of Central tendency – Arithmetic mean , Geometric mean, Harmonic mean, median and mode – Inter relationship between AM, GM and HM – Quantiles – Quartiles, Deciles and Percentiles.

Unit – IV: **No. of Hours : 12 hrs**

Measures of dispersion (absolute and relative) – Range, Quartile deviation, mean deviation, standard deviation and coefficient of variation – Interrelationship between QD, MD and SD.

Unit – V: **No. of Hours : 12 hrs**

Moments – raw moments, central moments – Measures of Skewness – Karl Pearson's coefficient of skewness – Bowley's coefficient of skewness – Measures of Kurtosis.

Books for Study:

R.S.N. Pillai & Bagavathi: Statistics.

S.P.Gupta: Statistical Methods**.**

Books for Reference:

D.C. Sancheti & V.K. Kapoor: Statistics.

Web Resources:

https://www.fd.cvut.cz/department/k611/PEDAGOG/THO_A/A_soubory/statistics_firstfive.pdf
http://www.mypolyuweb.hk/machanck/lectnotes/c1_des.pdf

Course Outcomes (CO):

On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**know** the basic concepts in sample surveys and data.	K1
2.	**illustrate** the knowledge of framing Questionnaire.	K2
3.	**calculate** the various descriptive measures.	K3
4.	organize, present and **analyse** the collected data.	K4
5.	**visualise** the distribution of data and interpret accordingly.	K5

Mapping of CO with PO & PSO:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	L	M	L	M		S	M	L		L	L	M
CO2	L		M	M	M	L	L	M		L	M	
CO3	L	S	L		M	M			M	S	M	L
CO4	M		S	M	M	L		M	S		M	S
CO5	L		M	L	L	M	S	M	S	L	S	S

L – Low; M – Medium; S - Strong

Course Title : CORRELATION & REGRESSION ANALYSIS
Course Code : 21USTC2
Hours/Week : 4 hrs   **Semester**   **II**
Credit : 4   **Batch**   : 2021- 2024

Course Objective:
   The course aims to study the linear and average relationship between two and more than two variables.

Syllabus

Unit – I :   **No. of Hours : 12 hrs**
Curve fitting – Principle of Least squares – Fitting of first degree and second degree polynomial – Power curve & Exponential curve – Simple problems.

Unit – II :   No. of Hours : 12 hrs
Correlation: Definition – Types of Correlation – Methods of studying Correlation – Scatter Diagram method – Karl Pearson's coefficient and Spearman's Rank correlation coefficient – Coefficient of concurrent deviation – Correlation for grouped bivariate data – Mathematical properties and interpretation of the coefficient of correlation.

Unit – III :   **No. of Hours : 12 hrs**
Regression – Definition, uses and its significance – Difference between correlation and regression – Regression equation of Y on X and X on Y – Regression equation for a grouped bivariate data – Mathematical properties of Regression coefficients.

Unit – IV :   **No. of Hours : 12 hrs**
Plane of Regression – Yule's notation – Derivation (only for three variables) – Properties of Residuals – Variance of the residual – Partial & Multiple correlation – Definition with example – Derivation – Simple problems.

Unit – V: **No. of Hours : 12 hrs**
Case Study based on Correla

Books for Study:
R.S.N. Pillai & Mrs. Bagavathi: Statistics(Unit II & II).
S.C. Gupta & V.K. Kapoor: Fundamentals of Mathematical Statistics(Unit I, IV & V)

Books for Reference:
D.C. Sancheti & V.K. Kapoor: Statistics.

Web Resources :
https://www.studocu.com/en/document/washington-state-university/statistical-methods-in-research-i/lecture-notes-lecture-14-correlation-and-regression/776404/view
http://www.personal.kent.edu/~mshanker/personal/Classes/f06/ch13_F06.pdf

Course Outcomes (CO) :

On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**recall** the distribution and fitting of the data.	K1
2.	**describe** the relationship and the direction of association between two variable	K2
3.	**analyse** and predict the future outcomes.	K4
4.	**differentiate** correlation and regression.	K5
5.	**extend** the acquired knowledge to find relationship between more than two variables.	K6

Mapping of CO with PO & PSO :

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M	L	M	M	L	L	L	M		L		M
CO2	L		S	M	L	M	M	S	M	M	S	
CO3	M	L	S	S	M	S	S	M	L	S	M	S
CO4	M	S	M	M	L	L		S		L	S	L
CO5	L	L	M	L		M	M	S	L	M	M	S

L – Low; M – Medium; S - Strong

Course Title : SKILL BASED- I: DATA ANALYSIS USING EXCEL
Course Code : 21USTSC1
Hours/Week : 2 hrs   Semester   I
Credit : 2   Batch : 2021- 2024

Course Objective:
     The course aims to provide data handling experience using MS- Excel

Syllabus

MS- EXCEL:

1. Diagrammatic representation.
2. Measures of central tendency
3. Measures of dispersion.
4. Moments, Skewness and Kurtosis.
5. Histogram and Box plot
6. Karl Pearson's correlation – Rank correlation.
7. Multiple and partial correlation
8. construction of regression lines

Course Outcomes (CO):
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	be **familiar** with presentation of Statistical output in MS – Excel software.	K1
2.	**understand** the basic working of MS – Excel .	K1
3.	enter, **organize** and save data in suitable way.	K3
4.	**conduct** descriptive and basic inferential statistics in software.	K4
5.	**create** and edit graphical displays of data.	K5

Mapping of CO with PO & PSO:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	L	M	S	L		M	M	L	S	L	M	S
CO2	M	M	S	L	L	L	L	S	S	M	M	M
CO3	L	L	M	M		L	L	S	S	L	S	
CO4	M	M	S	M	M	S	L	S	S	M	M	S
CO5	L	L	S	M	L			M	M			

L – Low; M – Medium; S - Strong

Course Title   : **PROBABILITY THEORY**
Course Code   : **21USTC3**
Hours/Week   : **4 hrs**   **Semester**   **II**

Credit   : **4**   **Batch**   : **2021- 2024**

Course Objective:
        To demonstrate the concepts of probability and the uses of probability theory in day-to-day life.

Syllabus

Unit – I :   **No. of Hours : 12 hrs**
Random experiment – Trial – Sample point – Sample space, Event – Types of Events – Definition of probability – Mathematical, Statistical and Axiomatic approach – Addition theorem – Conditional probability – Multiplication theorem – Baye's Theorem – Simple problems.

Unit – II :   **No. of Hours : 12 hrs**
Concepts of random variable – Discrete random variable, Continuous random variable, Probability mass function, distribution function – Properties of Distribution function – Independence of random events and random variables – Pairwise independence and mutual independence – Simple problems. .

Unit – III :   **No. of Hours : 12 hrs**
Mathematical expectation random variables – Properties of mathematical expectation – Moments – Raw moments, central moments – Measures of location and dispersion of random variables – Chebyshev inequality and its application – Simple problems.

Unit – IV :   **No. of Hours : 12 hrs**
Moment generating function of a random variable – Properties and its uses – Cumulants – Characteristic functions – Properties of characteristic function – Simple examples – Inversion theorem(Statement only) – Weak law of large numbers – Simple problems.

Unit – V: **No. of Hours : 12 hrs**
Bivariate distribution – Distribution function of bivariate random variable and its properties – Probability mass and density function – Marginal and Conditional distributions – Conditional expectation – Covariance and correlation – Simple problems.

Books for Study:
R.S.N. Pillai & Bagavathi: Statistics.

Books for Reference:
Murray R. Spiegel : Probability and Statistics. (Schaum's Outline Series)
Walpole, R. H. Myres, S.L. Myres & K.Ye: Probability and Statistics.

Web Resources :
http://nptel.ac.in/downloads/111101004/
http://www.math.ucsd.edu/~bdriver/280_06-07/Lecture_Notes/N16_2p.pdf

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**understand** the axiomatic formulation of modern probability theory and random variables.	K2
2.	**illustrate** probability models and function of random Variables	K2
3.	**evaluate** and **apply** moments, characteristic functions and random phenomenon.	K3 , K4
4.	**derive** the probability distributions relevant to functions of random variables	K4
5.	**convert** real-world problems into probability models.	K6

Mapping of CO with PO & PSO:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M	M	L		M	M	L	M		M	M	L
CO2	L		M	M	L	L	M	L	L	S	M	
CO3	L	M	M	M	S	S	L	M	M	M	L	L
CO4	M	L	M	M	L	L	M	L	L	L	M	S
CO5	S	M	S	M	S	L	S	S	M	M	S	M

L – Low; M – Medium; S – Strong

Course Title   : DISTRIBUTION THEORY
Course Code   : 21USTC4
Hours/Week   : 4 hrs   **Semester**   : II

Credit   : 4   **Batch**   : 2021- 2024

Course Objective:
     To illustrate the concepts of probability distributions and their applications to problems in diversified fields.

Syllabus

Unit – I :   **No. of Hours : 12 hrs**
Bernoulli distribution : Definition only - Binomial distribution : Definition - Physical conditions for binomial distribution - Mean and variance - M.G.F. - Moments using M.G.F. - Additive property - Recurrence formulae for probabilities and moments - Fitting of binomial distribution - Simple problems.

Unit – II :   **No. of Hours : 12 hrs**
Poisson distribution : Definition - Conditions for binomial distribution to tend to Poisson distribution - Mean and variance - M.G.F. - Recurrence relation for probabilities and moments - Fitting of Poisson distribution - Simple problems - Exponential distribution : Definition - M.G.F. - Mean and variance using M.G.F. - Rectangular distribution : Definition - Mean and variance - M.G.F.

Unit – III :   **No. of Hours : 12 hrs**
Univariate normal distribution : Definition - M.G.F. - Additive property - Recurrence relation for the moments - Moments - p.d.f. and M.G.F. of a standard normal variate - Chief characteristics - Fitting of normal distribution by the area method - Simple problems.

Unit – IV :   **No. of Hours : 12hrs**
Gamma distribution : Definition - M.G.F. - Additive property - Mean and variance using M.G.F. - Beta distribution of first kind: Definition - Mean and variance - Beta distribution of second kind : Definition - Mean and variance - Definitions of Cauchy and standard Cauchy distributions.

Unit – V: **No. of Hours : 12 hrs**
Chi-square distribution: Definition of chi-square statistic - Derivation of the p.d.f. - M.G.F. - Additive property - t-distribution : Definition of Student's t- Derivation of the p.d.f. - F distribution: Definition of F-statistic - Derivation of the p.d.f. -Relation between t and F distributions -Relation between F and chi-square distributions.

Books for Study:
S.C. Gupta & V.K. Kapoor : Fundamentals of Mathematical Statistics.

Books for Reference:
R.V. Hogg, Craig & A.T. Craig: Introduction to Mathematical Statistics.
A.M. Mood, P.A. Graybill & D.C. Boes: Introduction to the theory of Statistics.
Wilks. S.S. : Mathematical Statistics.

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**recall** the basic properties of probability theory	K1
2.	**perform** calculations relating to probability distributions for discrete and continuous random Variables	K3
3.	**evaluate** and **interpret** various properties of both discrete and continuous distributions (i.e) mean, variance, M.G.F. etc.	K3
4.	**apply** distributions theory in real-life problems	K4
5.	**develop** complex mathematical reasoning	K6

Mapping of CO with PO & PSO:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	L		M	M	L	M	M	S	L	L	M	
CO2	M	M	M	L	L	M	L	M	M	L		M
CO3	M	L	M	M	S	S		M		M	L	S
CO4	M	M	S	M	L	M	L	M	L	L	M	M
CO5	S	S	M	M	L	S	M		M	S	M	S

L – Low; M – Medium; S - Strong

Course Title   : **SKILL BASED – II: Data analysis using SPSS**
Course Code   : **21USTSC2**
Hours/Week   : **2 hrs**   **Semester**   **II**

Credit   : **2**   **Batch**   : **2021- 2024**

Course Objective:
   The course aims to provide data handling experience using SPSS.

Syllabus

SPSS

1.   Ungrouped frequency data
2.   Data validation – Transform, Sorting, Select case.
3.   Importing data from Excel.
4.   Diagrammatic representation.
5.   Measures of Central tendency & dispersion.
6.   Karl Pearson's correlation – Rank correlation
7.   Simple linear regression.
8.   Fitting of Distribution

Books for Study:

Stephen A**.** Sweet, and Karen Grace-Martin (2012): Data Analysis with SPSS: A First Course in Applied Statistics, Pearson, 4th Edition.

Web Resources :
   https://www.slideshare.net/davidmbwiga1990/spss-lecture-notes
   https://stats.idre.ucla.edu/spss/seminars/notes/

Course Outcomes (CO) :
 On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	be **familiar** with presentation of Statistical output in SPSS software.	**K1**
2.	**understand** the basic working of SPSS .	**K1**
3.	enter, **organize** and save data in suitable way.	**K3**
4.	**conduct** descriptive and basic inferential statistics in software.	**K4**
5.	**create** and edit graphical displays of data.	**K5**

Mapping of CO with PO & PSO:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M	M	L		M	M	L	M		M	M	L
CO2	L		M	M	L	L	M	L	L	S	M	
CO3	L	M	M	M	S	S	L	M	M	M	L	L
CO4	M	L	M	M	L	L	M	L	L	L	M	S
CO5	S	M	S	M	S	L	S	S	M	M	S	M

L – Low; M – Medium; S - Strong

Course Title	: CORE PRACTICAL – I		
Course Code	: 21USTSQC1		
Hours/Week	: 3 hrs	Semester	: II
Credit	: 2	Batch	: 2021- 2024

Course Objective:
   To develop the skills in applying statistical tools in real life data.

Syllabus

DESCRIPTIVE STATISTICS:

1.   Construction of Univariate and Bivariate frequency tables.
2.   Diagrammatic and Graphical representation of data.
3.   Computation of Measures of Central tendency.
4.   Computation of Measures of Dispersion.
5.   Measures of Skewness and Kurtosis.

CORRELATION AND REGRESSION

6.   Computation of Simple correlation.
7.   Computation of Regression Coefficients.
8.   Construction of simple regression lines.

DISTRIBUTION THEORY

9.   Fitting of discrete distributions – Binomial, Poisson.
10. Fitting of Continuous distribution.

Books for Study:

S.C. Gupta & V.K. Kapoor : Fundamentals of Applied Statistics.
S.C. Gupta & V.K. Kapoor : Fundamentals of Mathematical Statistics.

Course Outcomes (CO) :
 On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1. **construct** the frequency table.		K2
2. **draw** the diagram and graph based on the data.		K3
3. **analyse** the central tendency dispersion of the data.		K4
4. **understand** the differences between variables.		K4
5. **form** the regression equations.		K6

Mapping of CO with PO & PSO:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	L	L	S	L	M	L	L	M		M	L	L
CO2		L	M	L				M		S	M	M
CO3	L	M	S	L	L		L	L		S	L	
CO4	L	L	M	L	L	L	L	S		L	M	L
CO5	L		M		L	M	L	M		L	M	L

L – Low; M – Medium; S - Strong

Course Title	: Introduction to Real Analysis and Linear Algebra		
Course Code	: 21USTC5		
Hours/Week	: 4 hrs	Semester	: III
Credit	: 2	Batch	: 2021- 2024

Credits: 4

Course Objective:

The course aims to introduce the basic concepts in real analysis and linear algebra

Syllabus

Unit – I : (Pg. no.:43-59)   **No. of Hours : 12hrs**

Real numbers – order axioms – ordered field – Field axioms – least upper bound – greatest lower bound – Simple problems.

Unit – II : (Pg. no.: 92-105)   **No. of Hours : 12 hrs**

Sequences – Bounded and unbounded sequences – Convergent, divergent and oscillatory sequences – limit of a sequence – Monotonic sequence – Simple problems.

Unit – III : (Pg. no.:139-170 & 197-216)   **No. of Hours : 12 hrs**

Functions – Limit of a function – Continuity of a function – properties – Derivatives of a function – Rolle's theorem – Mean value theorem.

Unit – IV : (Pg. no.:35-59)   **No. of Hours : 12hrs**

Vector space – linear combination of vectors – Linear dependence and Linear independence – Basis and dimension.

Unit – V:(Pg. no.:129-151)   **No. of Hours : 12 hrs**

Linear transformation – Properties – Range of linear transformation – Rank and Nullity of linear transformation..

Books for Study:

Bali. N.P. , golden Math Series Analysis (1984), Lakshmi Publication. (Unit – I to Unit - III)

Gupta . P. P.,& Sharma. S.K. , Linear Algebra (1982), S.Chand& Company (Unit – IV to Unit – V)

Books for Reference:

Vasishta. A. R. (2005), Matices, Krishna PrakashanMandir, New Delhi.

Kumeresan (2005) , Linear Algebra Geometric approach, Prentice Hall of India Pvt. Ltd.,

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**Understand** the basic concepts of Real number system	**K1**
2.	**Understand** the axioms and theorems on sequences.	**K1**
3.	**Solve** the limits for the function.	**K3**
4.	**Recall** the concepts of vector space.	**K4**
5.	**Evaluate** different concepts of linear Transformation	**K6**

Mapping of COs with POs:

CO	PO					PSO						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1	L		M	M	L	M	M	S	L	L	M	
CO2	M	M	M	L	L	M	L	M	M	L		M
CO3	M	L	M	M	S	S		M		M	L	S
CO4	M	M	S	M	L	M	L	M	L	L	M	M
CO5	S	S	M	M	L	S	M		M	S	M	S

L – Low; M – Medium; S - Strong

Course Title	: SAMPLING THEORY		
Course Code	: 21USTC6		
Hours/Week	: 4 hrs	Semester	: III
Credit	: 4	Batch	: 2021- 2024

Course Objective:

The course aims to equip students with different sampling techniques which are useful in conducting sample surveys.

Syllabus

Unit – I :   **No. of Hours : 15 hrs**
Concept of sampling and population: Need for sampling – Design, Organization and execution of sample survey – Principle steps in sample surveys – preparation of Questionnaire and schedules – Pilot survey – Sampling and Non- Sampling Errors – Limitation of sampling.

Unit – II :   **No. of Hours : 15 hrs**
Methods of Sampling – Probability and Non- Probability Sampling – Limitation and advantages of Probability Sampling – Judgement Sampling – Quota Sampling – Convenience sampling – Merits and Demerits. .

Unit – III :   **No. of Hours : 15 hrs**
Simple random sampling: Definition – Methods of selecting a S.R.S. – Unbiased estimator of population mean and population mean square (in SRSWOR) – Variance of sample mean of SRSWOR – Comparison of SRSWOR with SRSWR – Merits and Limitation of S.R.S .

Unit – IV :   **No. of Hours : 15 hrs**
Stratified Random Sampling: Definition – Advantages – Unbiased estimator of population mean – Variance of the stratified mean – Proportional and optimum allocations of sample sizes – variance of sample mean under proportional and optimum allocation – Comparison of proportional allocation and Neyman's allocation with S.R.S.

Unit – V: **No. of Hours : 15 hrs**
Systematic sampling: Definition – i^{th} systematic sample – Variance of the mean of systematic sample using the mean square $_wS^2$- Comparison of systematic sampling with S.R.S.– Proving the result $\text{var}(\bar{y}_{st}) \leq \text{var}(\bar{y}_{sys}) \leq \text{var}(\bar{y}_n)_R$ when the population consists of a linear trend – Merits and Demerits of systematic sampling – NSSO, CSO and its functions.

Books for Study:
S.C. Gupta & V.K. Kapoor : Fundamentals of Applied Statistics.

Books for Reference:
Cochran W. G. : Sampling Techniques.
Des Raj: Sampling Theory

Web Resources:
http://nptel.ac.in/downloads/111104073/
http://home.iitk.ac.in/~shalab/course1.htm

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**understand** the principles and theory of probability sampling.	**K1 & K2**
2.	**understand** the concepts of bias and sampling variability and strategies for removing them.	**K1&K2**
3.	**analyse** data from surveys using various sampling plans .	**K4**
4.	**access** the appropriateness of sampling plans	**K4**
5.	**evaluate** the different methodology to estimate population parameters for sampling plans.	**K5**

Mapping of COs with POs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M		L	M	L	L	S		L	L	M	
CO2	L			S	L	M	M			M		
CO3		S	M			S	S	S			S	S
CO4				S		S		S		S	L	
CO5	M	M	S		S		S		S	S		S

L – Low; M – Medium; S – Strong

Course Title   **: SKILL BASED –III: DEMOGRAPHIC METHODS**

Course Code   **: 21USTSC1**

Hours/Week   **: 2 hrs**   **Semester**   **III**

Credit   **: 2**   **Batch**   **: 2021- 2024**

Course Objective:

The course aims to study the applications of Statistics in the field of Health statistics.

Syllabus

Unit – I :(Pg. no.:9.2-9.5)   **No. of Hours : 6 hrs**

Demography – definition, sources of demographic data – Population Census – Demography surveys – Registration method: vital registration – Population register and other administrative records, registrat

Unit – II :(Pg. no.:9.6-9.13)   **No. of Hours : 7 hrs**

Measurement of mortality: Crude death rate – Specific death rate – Age specific death rate – Infant mortality rate – Standardized death rate – Direct method of standardization – Indirect method of standardization – Simple problems.

Unit – III :(Pg. no.:9.44-9.48)   **No. of Hours : 6 hrs**

Measure of fertility: Crude birth rate – General fertility rate – Specific fertility rate – Age specific fertility rate – Total fertility rate – Simple problems..

Unit – IV :(Pg. no.:9.51-9.62)   **No. of Hours : 5 hrs**

Gross reproduction rate – Net reproduction rate – Simple problems.

Unit – V:(Pg. no.:9.15-9.28)   **No. of Hours : 6 hrs**

Life tables – Uses of life tables – Curate expectation of life and complete expectation of life – Central mortality – Description of a life table – Construction of a life table – Simple problems .

Books for Study:

S.C. Gupta & V.K. Kapoor : Fundamentals of Applied Statistics.

Books for Reference:

D. C. Sancheti & V.K.Kapoor: Statistics

S.P. Gupta: Statistical Methods.

Course Outcomes (CO) :
 On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	be **familiar** with the source of vital statistics.	K1 & K2
2.	**calculate** basic measures to evaluate vital statistics.	K3
3.	**determine** fertility and mortality rates.	K4
4.	**derive** information from the life tables.	K5
5.	**construct** life tables.	K6

Mapping of COs with POs :

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M	L	S		S	L						L
CO2		M	M	L	L	M		S		L	S	M
CO3	M	S	S	M	S	L	S	M		L	S	
CO4	S	S	S	S		M	S		S			S
CO5	S	S	M		M	L		M		M		S

 L – Low; M – Medium; S - Strong

Course Title   : APPLIED STATISTICS
Course Code   : 21USTSC7
Hours/Week   : 4 hrs   Semester   : IV
Credit   : 4   Batch   : 2021- 2024

Course Objective:
    To learn application of Statistics in the economic field where Statistics plays significant *role.*
Note: Questions only on the topics mentioned.
UNIT- I(Pg. no.:2.2-2.32)   **No. of Hours :12hrs**
    Concept of time series – Components of time series – Additive and multiplicative models of time series- resolving the components of time series – Trend – Methods of measuring trend – Method of least squares(Straight line and parabola) – Semi-average method – Method of moving averages – Simple problems.
UNIT- II(Pg. no.:2.41-2.57& 2.67-2.70)   **No. of Hours :12hrs**
    Seasonal variation – Methods of measuring seasonal variation – Simple average method – Ratio-to-trend method – Ratio –to-moving method- Link relative method- Cyclical variation- Measurement of cyclical variation- Random Component- Variate difference method- Simple problems.
UNIT- III (Pg. no.:3.2-3.16)   **No. of Hours :12hrs**
    Index numbers – Definition and importance – problems involved in the construction of index numbers – Types of index numbers – Simple aggregate method – Weighted aggregate method (Laspeyre's, Paasche's, Marshall-Edgeworth's and Dorbish-Bowley's index numbers)- Average of price relatives method- Simple problems.
UNIT- IV(Pg. no.: 3.17-3.59)   **No. of Hours :12hrs**
    Optimum tests of index numbers- Unit test – Time reversal test- Factor reversal test- Circular test- Wholesale price index number- Chain base index number- Conversion of fixed base index number into chain index number and vice versa- Uses of index numbers.
UNIT- V (Pg. no.: 3.17-3.59)3.29-3.60   **No. of Hours : 12hrs**
    Cost of living index numbers –Main steps in the construction of cost of living index numbers – Methods of constructing cost of living index numbers – Aggregate expenditure method- Family budget method – Simple problems – Index number of industrial production – Splicing and Base shifting – Deflating – Uses of cost of living index numbers – Limitations of index numbers.

Books for Study:
    Gupta S.C. and Kapoor V.K.: Fundamentals of Applied Statistics

Books for Reference:
    Goon A.M., Gupta M.K. and Das Gupta B. : Fundamentals of statistics, Volume II
    Gupta S.P.: Statistical Methods

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	be **familiar** with the concepts of time series	K1
2.	**forecast** the trends and seasonal variations	K4
3.	**Understand** the concepts of index numbers	K1
4.	**solve** various problems on index numbers	K5
5.	**Apply** the concepts of time series and index numbers in real life situation	K3

Mapping of COs with POs :

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M	L	S		S	L						L
CO2		M	M	L	L	M		S		L	S	M
CO3	M	S	S	M	S	L	S	M		L	S	
CO4	S	S	S	S		M	S		S			S
CO5	S	S	M		M	L		M		M		S

L – Low; M – Medium; S - Strong

Course Title	**: MAJOR ELECTIVE I: NUMERICAL ANALYSIS**
Course Code	**: 21USTEC1**

Hours/Week	**: 4 hrs**	**Semester**	**IV**
Credit	**: 4**	**Batch**	**: 2021- 2024**

Course Objective:

The course aims to gain knowledge in Numerical Methods and develop skills for solving different kinds of numerical problems in Science, Engineering and Technology.

Syllabus

Unit – I : (No derivation)   **No. of Hours : 15 hrs**

Defining the operators E, Δ and ∇ - Difference Table – Newton's forward interpolation formula for equal intervals – Newton's backward interpolation formula for equal intervals – Simple problems.

Unit – II : (No derivation)   **No. of Hours : 15 hrs**

Divided difference – Newton's divided difference formula – Lagrange's divided difference formula – Lagrange's formula of interpolation – Simple problems.

Unit – III : (No derivation)   **No. of Hours : 15 hrs**

Central difference formulae of interpolation – Gauss forward, Gauss backward, Stirling's and Bessel's formulae – Simple problems.

Unit – IV : (No derivation)   **No. of Hours : 15 hrs**

Numerical differentiation – Newton's forward, backward, Stirling's, Newton's divided difference formulae – Simple problems.

Unit – V: (No derivation)   **No. of Hours : 15 hrs**

Numerical integration – Trapezoidal rule – Weddle's rule – Simpson's 1/3rd and 3/8th rules – Simple problems.

Books for Study:

Balasubramanian P. & Ohers: Numerical Mathematics Vol. I & II.

Kandasamy, Thilagavathy and Gunavathy: Numerical Methods.

Books for Reference:

R.Gupta: Numerical Analysis.

S.S. Sastry: Introductory Methods of Numerical Analysis.

H.C. Sexena: Finite Differences and Numerical Analysis.

Web Resources :

https://www.math.ust.hk/~machas/numerical-methods.pdf

https://pfortuny.net/uniovi/numerical_methods/notes.pdf

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**aware** of using numerical methods in modern scientific computing.	K2
2.	**apply** numerical methods to obtain appropriate solution to mathematical problem.	K3
3.	**analyse** and **evaluate** the accuracy of common numerical methods.	K4
4.	**derive** numerical methods for various operator such as interpolation, differentiation, integration, etc.	K6

Mapping of COs with POs :

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	S	L		L	S				L	M		
CO2		S	M	M		L	L					M
CO3		M	S	S	L			M				
CO4	L		S	S	L			M		S	L	M

L – Low; M – Medium; S – Strong

Course Title : SKILL BASED IV: DATA ANALYSIS USING R
Course Code : 21USTSQC3
Hours/Week : 2 hrs   **Semester**   IV
Credit : 2   **Batch**   : 2021- 2024

Course Objective:

The course aims to provide data handling experience using R.

Syllabus

1. Data validation – Transform, Sorting, Select case.
2. Importing data from Excel.
3. Diagrammatic representation.
4. Measures of Central tendency & dispersion.
5. Karl Pearson's correlation – Rank correlation
6. Simple linear regression.
7. Fitting of Distribution

Books for Study:

Sandip Rakshit (2017), R Programming for Beginners, McGraw Hill Education; First edition

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	be **familiar** with presentation of Statistical output in R Programming.	K1
2.	**understand** the basic working of R	K1
3.	enter, **organize** and save data in suitable way.	K3
4.	**conduct** descriptive and basic inferential statistics.	K4
5.	**create** and edit graphical displays of data.	K5

Mapping of COs with POs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	S	S	L			L		M	S			
CO2		S	M	L					S	M	M	
CO3	L	S	S	L		L	S	M	S			S
CO4		S	S		M	M	S	S		S	S	S
CO5	M	S	S					S		M		S

L – Low; M – Medium; S - Strong

Course Title	: THEORY OF ESTIMATION		
Course Code	: 21USTC8		
Hours/Week	: 6 hrs	Semester	: V
Credit	: 4	Batch	: 2021- 2024

Course Objective:

This course deals with fundamental concepts and techniques of statistical inference like estimation.

Syllabus

Unit – I :   **No. of Hours : 18 hrs**

Point Estimation – Distinction between Estimator and Estimate – Properties of Estimators – Concept of Unbiasedness, consistency, Efficiency and Sufficiency – Statement of Neyman-Pearson Factorization theorem – Simple applications.

Unit – II :   **No. of Hours : 18 hrs**

Minimum Variance Unbiased Estimator (MVUE) – Uniqueness property of MVUE – Proof – Lower bound for variance of estimator – Regularity conditions – Cramar-Rao inequality – Statement and proof – Simple problems – Asymptotic efficiency

Unit-III

Sufficient statistic and its properties- concept of complete sufficient statistics- simple illustrations-Minimum Variance Bound Estimator (MVBE) - Concept of Blackwellisation-Statement and proof of Rao-Blackwell theorem.

Unit-IV

Methods of estimation- Maximum likelihood estimator (MLE) and their properties-Simple problems on MLE-Method of moments-Simple illustrations-Methods of minimum chi-square and modified minimum chi-square.

Unit-V

Interval estimation- Distinction between point estimation and interval estimation-Confidence interval and confidence limits-General procedure of obtaining confidence limits-Construction of confidence intervals for parameters of Binomial, Poisson and Normal distribution- Simple problems.

Books for study

Gupta S.C. & V.K.Kapoor   : Fundamental of Mathematical Statistics.
J.N.Kapur &H.C. Saxena : Mathematical Statistics.
B.L.Agarwal : Programmed Statistics.

Books for reference

A.M.Mood, P.A. Graybill & D.c.Boes : Introduction to the theory of Statistics.
H.C. Saxena and P.U. Surendran   : Statistical Inference.
S.S. Wilks: Mathematical Statistics.

Course Outcomes (CO) :

On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	have **knowledge** about fundamental principles of statistical inference	**K1**
2.	**Explain** the notion of parametric model on point estimation	**K2**
3.	**demonstrate** computational skills to implement various statistical inferential approaches.	**K2**
4.	**explore** different methods of estimating the parameters	**K4**
5.	**construct** point and interval estimators.	**K6**

Mapping of COs with POs & PSOs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	S	S	L		M	S	M	M		M	S	M
CO2	M	L			M	M	L			L	M	
CO3	S			L		M			M			
CO4	L		M		M	L			M		M	S
CO5		L		M			M		M				M

L – Low; M – Medium; S - Strong

Course Title	: DESIGN OF EXPERIMENTS		
Course Code	: 21USTC9		
Hours/Week	: 6 hrs	**Semester**	V
Credit	: 4	**Batch**	: 2021- 2024

Course Objective:

The course aims to enhance the theoretical as well as practical skills about the various designing concepts in field experiments.

Syllabus

Unit – I :   **No. of Hours : 18 hrs**

Analysis of variance: One-way and two-way classification (without interaction) – Uniformity trials – Determination of shape and size of plots and blocks – Fundamental principles of design: bioReplication, Randomization and Local control techniques.

Unit – II :   **No. of Hours : 18 hrs**

C.R.D.-Definition, advantages , disadvantages and Statistical Analysis of C.R.D.- R.B.D.-Definition , advantages, disadvantages and its Statistical Analysis .

Unit – III :   **No. of Hours : 18 hrs**

Missing plot technique for R.B.D (one and two missing values)-Latin Square Design (LSD) - Definition, Standard Latin Square, Advantages, Disadvantages and its Statistical analysis- Missing plot technique- Estimation of missing value in LSD.

Unit – IV :   **No. of Hours : 18 hrs**

Factorial Experiments: Concept of main effects and interactions $p \times q$, $2^2, 2^3$ and 2^n Factorial Experiment and their statistical analysis.

Unit – V: **No. of Hours : 18 hrs**

Principles of confounding and Partial Confounding in 2^3 Factorial Experimentand their statistical analysis- Split- plot Design and Balanced Incomplete Block Design (Concept only).

Books for Study:
S.C. Gupta & V.K. Kapoor : Fundamentals of Applied Statistics.
M.N.Das and N.C.: Design and Analysis of Experiments (Unit- V)

Books for Reference:
Goon Gupta and Das Gupta: Fundamentals of Statistics.
D.D.vJoshi: Linear Estimation and Design of Experiments.

Web Resources :
https://faculty.franklin.uga.edu/dhall/sites/faculty.franklin.uga.edu.dhall/files/STAT8200-Fall13-lec1.pdf
http://nptel.ac.in/downloads/111104075

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	critically **review** the concepts of experimental designs	**K1**
2.	**understand** the issues and principles of design of experiments	**K2**
3.	**recognize** appropriate design to be followed	**K3**
4.	**analyse** the data collected based on the designing principle used and its underlying assumptions.	**K4**
5.	**interpret** statistical results from an experiment and report them in non- technical language	**K5**

Mapping of COs with POs & PSOs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	S	M		S	M	M	M					M
CO2	S	L	M	M		S	M			L	M	S
CO3	M	S			M	S		L		S	L	M
CO4	L	M	L	L		M	L	M	M			
CO5	L				S	M	M	S	M			

L – Low; M – Medium; S - Strong

Course Title : OPERATIONS RESEARCH -I
Course Code : 21USTC10
Hours/Week : 5 hrs   **Semester**   V
Credit : 4   **Batch**   : 2021- 2024

Course Objective:

      This course introduces you to the fundamentals of Operations Research Models including linear programming and applications.

Syllabus

Unit – I :   **No. of Hours : 18 hrs**
      Origin - Nature of OR- Decision making- Models in OR- Phase of OR - Uses and Limitations of OR- LPP- Definition, Mathematical formulation of LPP- Graphical Method.

Unit – II :   **No. of Hours : 18 hrs**
      General LPP- Canonical form & Standard form of LPP- Slack, Surplus & Artificial variable- Maximization- Minimization- Simplex method- Big-M method- Two phase method.

Unit – III :   **No. of Hours : 18 hrs**
Duality in LPP- Formulation of Dual LPP- Primal- Dual relationship- Solving LPP using Dual concepts- Dual simplex method.

Unit – IV :   **No. of Hours : 18 hrs**
Transportation problem- Balanced, Unbalanced T.P. - Initial basic feasible solution- North West Corner Rule- Row minima- Column minima- Matrix minima (LCM) - Vogel's approximation method- Optimum solution- MODI method.

Unit – V: **No. of Hours : 18 hrs**
Assignment problem- Introduction- Balanced-Unbalanced- Maximization- Minimization- Hungarian method

Books for Study:
V. Sundaresan, K.S. Ganapathy and K.Ganesan: Resource Management Techniques.

Books for Reference:
Kanti Swarup, P.K. Gupta and Man Mohan: Operations Research.
V.K. Kapoor: Operations Research.

Web Resources :
http://www.cs.toronto.edu/~stacho/public/IEOR4004-notes1.pdf
http://nptel.ac.in/courses/112106134/14

Course Outcomes (CO) :

On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**define** and **formulate** linear programming problems	**K1 & K3**
2.	**solve** linear programming problems using optimization methods.	**K3**
3.	**Solve** specialized programming problems like transportation and assignment problems.	**K3**
4.	**identify** best techniques to solve specific problems.	**K5**
5.	**develop** general understanding of operational research approach in decision making.	**K6**

Mapping of COs with POs & PSOs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M		M		M	S				S		M
CO2		M	M	M	M	S		M	M	L	M	M
CO3	M			L		M		L	M		S	M
CO4	L	L	L	M	M	L				M	L	
CO5	L		M			M	M			S		S

L – Low; M – Medium; S - Strong

Course Title	: MAJOR ELECTIVE II: STOCHASTIC PROCESSES		
Course Code	: 21USTEC2		
Hours/Week	: 6 hrs	Semester	: V
Credit	: 4	Batch	: 2021- 2024

Course Objective:

To analyze the stochastic models and utilities

Syllabus

Unit – I: No. of Hours : 15 hrs

Stochastic processes – Definition - Classification of Stochastic processes – Examples of Stochastic processes.

Unit – II: No. of Hours : 15 hrs

Markov Chains – Definition and examples – Higher transition probabilities – Chapman – Kolmogorov equation – Classification states.

Unit – III: No. of Hours : 15 hrs

Poisson process – Poisson process and related distributions – Birth and death process.

Unit – IV: No. of Hours : 15 hrs

Branching Process – Properties of generating functions of branching process.

Unit – V: No. of Hours : 15 hrs

Stationary process like – Moving average – Autoregressive – Autoregressive moving average processes.

Books for Study:
Medhi, J. : Stochastic Processes

Books for Reference:
    Karlin, S. And Taylor, H.M. : A First Course in Stochastic Processes
    Ross, S.M. : Stochastic Processes

Web Resources :
https://people.richland.edu/james/lecture/m113/

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**understand** basic concepts of Stochastic processes.	**K1**
2.	**implement** and **apply** appropriate stochastic models.	**K3**
3.	**calculate** transition probability matrix.	**K3**
4.	**communicate** stochastic models clearly, in verbal form, using appropriate statistical terminology.	**K4**

Mapping of COs with POs & PSOs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	S	S			M	S				M	S	
CO2	M	L	S		M	M	M	S	M	L	M	M
CO3	S		M	L		M	L	S	M	S		
CO4	L		M		M	L		M			S	S

L – Low; M – Medium; S - Strong

Course Title	: TESTING OF HYPOTHESIS		
Course Code	: 21USTC11		
Hours/Week	: 6 hrs	**Semester**	VI
Credit	: 4	**Batch**	: 2021- 2024

Course Objective:

The course aims to enable students to gain insight in statistical inference using different methods of testing hypothesis.

Syllabus

Unit – I :   **No. of Hours : 18 hrs**

Statistical Hypothesis- Simple, Composite, null and alternative hypothesis- Critical Regions-Types of errors- Level of Significance-Size and Power of the test-Most Powerful(MP) and Uniformly most powerful test(UMP) -Neyman-Pearson Lemma- Simple Problems.

Unit – II :   **No. of Hours : 18 hrs**

Sampling distribution of a statistic and its standard error-General procedure for testing of hypothesis-Test of Significance for large sample-Single proportion, Difference of proportions, Single mean, Difference of means Difference of standard deviation-Practical Problems.

Unit – III :   **No. of Hours : 18 hrs**

Small sample tests based on Student's t-Assumptions and Applications of Student's t test- General procedure for testing single mean, Difference of means and Paired t test- F- test for equality of two population variances- Practical problems.

Unit – IV :   **No. of Hours : 18 hrs**

Chi-square test Statistic-Applications-To test the goodness of fit, To test the independence of attributes (r x s contingency table) - Practical problems.

Unit – V: **No. of Hours : 18 hrs**

Non-Parametric test- definition- advantages and disadvantages-Run test , Median test, Sign test-Mann –Whitney-Wilcoxon U test - Practical problems.

Books for Study:
S.C. Gupta & V.K. Kapoor : Fundamentals of Mathematical Statistics.

Books for Reference:
R.V. Hogg, Craig & A.T. Craig: Introduction to Mathematical Statistics.
V.K. Rohatgi: An Introduction to Probability theory and Mathematical Analysis.

Web Resources:
http://www.stat.colostate.edu/~vollmer/stat307pdfs/LN7a_2017.pdf
http://nptel.ac.in/courses/103106120/LectureNotes/Lec6_1.pdf

Course Outcomes (CO) :
 On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**demonstrate** their understanding of mathematics in statistical inference	K1
2.	**check** the validity of each testing methods.	K3
3.	**associate** with the estimate to draw inference.	K4
4.	**derive** the distributional results needed for statistical inference	K5

Mapping of COs with POs & PSOs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M			L		S						M
CO2		L	M		M			L	L	L	M	
CO3	M	M	L				M	M		M	M	
CO4	L		M	M	M	L				M		L

 L – Low; M – Medium; S - Strong

Course Title :STATISTICAL QUAITY CONTROL
Course Code : 21USTC12
Hours/Week : 6 hrs   **Semester**   : VI

Credit : 4   **Batch**   : 2021- 2024

Course Objective:

  The course aims to educate students on the concepts of Statistical Quality Control with their applications in industries.

Syllabus

Unit – I :   No. of Hours : 18 hrs
Statistical Quality Control – Need in industry and uses – Chance and assignable causes of variation – Definitions of process control and product control – theory of control charts – Specification and tolerance limits – Comparison of specification and tolerance limits – Modified control limits.

Unit – II :   No. of Hours : 18 hrs

Control charts for variables: $\bar{X}$ and R charts – Construction and operation of $\bar{X}$ and R charts –

Criteria for detecting lack of control in : $\bar{X}$ and R charts –· Control charts for attributes: p, np, c and u charts, their construction and analysis ·

Unit – III :   No. of Hours : 18 hrs
Acceptance sampling by attributes: Producer's risk and consumer's risk – Concept of AQL, LTPD – Rectifying Inspection plan, AOQ, AOQL, OC curve (Concept only) – Single sampling plan – its OC, ASN and ATI curves (derivation not included).

Unit – IV :   No. of Hours : 18 hrs
Double sampling plans for attributes – its OC, ASN and ATI curves (derivations not included) – Comparison of single and double sampling plans.

Unit – V: No. of Hours : 18 hrs
Sequential sampling plans for attributes – Expression for the OC and ASN of SPRT (derivation not included) – Continuous sampling plans for CSP-1, CSP-2 and CSP-3.

Books for Study:
S.C. Gupta & V.K. Kapoor : Fundamentals of Applied Statistics.
R.C. Gupta: Statistical Quality Control

Books for Reference:
Douglas. C. Montgomery: Statistical Quality Control
M. Mahajan: Statistical Quality Control

Web Resources:
http://homepages.stmartin.edu/fac_staff/dstout/MEM650/lecture_notes.htm

https://www.wiley.com/college/sc/reid/chap6.pdf

Course Outcomes (CO) :

 On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**understand** the philosophy and basic concepts of quality improvement.	K2
2.	**demonstrate** use of methods of statistical process control.	K2
3.	**design**, use and **interpret** different control charts.	K3 & K5
4.	**face** the real challenges in industries.	K5

Mapping of COs with POs & PSOs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M	M	M			M					M	M
CO2	L	L	L	M	L	S	M	M		L		M
CO3	M			L	M	L	L	L	M	M	L	L
CO4			L	L	M	M			L	L		

 L – Low; M – Medium; S - Strong

Course Title   : **OPERATIONS RESEARCH-II**
Course Code   : **21USTC13**
Hours/Week   : **6 hrs**   **Semester**   **VI**

Credit   : **5**   **Batch**   : **2021- 2024**

Course Objective:

The course aims to provide the basic tools of Operations research in solving the management problems using mathematical approach for decision making.

Syllabus

Unit – I :   **No. of Hours : 18 hrs**
Sequencing problem- Problems with n-jobs on two machines- problems with n-jobs on three machines- problems with n-jobs on m–machines- simple problems

Unit – II :   **No. of Hours : 18 hrs**
Game Theory- Introduction- Two person zero sum game: - Maximin- Minimax principle- Game's with saddle point and without saddle point- Dominance property- Graphical solutions of $2 \times n$ and $m \times 2$ Games- simple problems.

Unit – III :   **No. of Hours : 18 hrs**
Network analysis- Basic Concepts- Constraints in Network- Construction of network- Critical path method (CPM) - Program Evaluation Review Technique (PERT) – simple problems.

Unit – IV :   **No. of Hours : 18 hrs**
Replacement problem- Replacement of items that deteriorate with time- Replacement of items whose maintenance cost increases with time & the value of money remains same during the period and the value of money also changes with time- selection of best machine amongst two- simple problems.

Unit – V: **No. of Hours : 18 hrs**
Decision theory- Introduction-Types of Decision Making Environment- Decision Making under uncertainty- Maximin criterion- Minimax criterion- Laplace criterion-Hurwitz criterion- Decision Making under risk-EMV-EOL-EVPI-Decision Tree Analysis (Concepts only) - simple problems.

Books for Study:
V. Sundaresan, K.S. Ganapathy and K.Ganesan: Resource Management Techniques.
V.K. Kapoor: Operations Research.

Books for Reference:
Goel B. S. and Mittal S. K.: Operations Research.
Kanti Swarup, P.K. Gupta and Man Mohan: Operations Research.

Course Outcomes (CO) :
 On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**propose** the best strategy using decision making methods under uncertainty and game theory.	K1
2.	**formulate** and **solve** problems in the form of networks and graphs.	K2 & K3
3.	**solve** problems logically, critically, analytically and creatively.	K3
4.	**use** CPM and PERT techniques to plan, schedule and control project activities.	K4
5.	**report** and **interpret** findings in scientific and concise manner.	K5

Mapping of COs with POs & PSOs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1		M	M	M	S	M				M	M	
CO2	L	L		M		L		M			L	S
CO3			L		M	M		M		S	L	M
CO4	M		M	L	L	S	S		M	M		
CO5	M	M				M			L			M

L – Low; M – Medium; S - Strong

Course Title   : MAJOR ELECTIVE III: ACTUARIAL STATISTICS
Course Code   : 21USTC11
Hours/Week   : 5 hrs   Semester   : VI

Credit   :4   Batch   : 2021- 2024

Course Objective:
The course aims to understand the applications of compound interest, annuity certain, premium calculations and the construction of life tables.
Syllabus

Unit – I :   **No. of Hours : 15 hrs**
        Simple interest, compound interest, nominal and effective rate of interest – Simple problems.

Unit – II :   **No. of Hours : 15 hrs**
Present value and accumulated value of a single payment with fixed interest rate or varying rate of interest during certain period –Varying payments during certain period with fixed or varying rate of interest – Simple problems.

Unit – III :   **No. of Hours : 15 hrs**
Annuities and its types – Present and accumulated value of an immediate annuity and with different period value of an annuity due and with deferment period – Simple problems.

Unit – IV :   **No. of Hours : 15 hrs**
Redemption of loan – sinking fund – Lender 's sinking fund – Simple problems – Probabilities of survival and death – $p_x, q_x, {}_np_x, {}_{|m}q_x {}_{m|}q_x$ and ${}_{m|n}q_x$ – Simple problems.

Unit – V: **No. of Hours : 15 hrs**
Principle of life assurance – premium and its types (single, annual, yearly, half-yearly, quarterly) – Four basic types of assurance – Temporary, Whole life, Endowment and Pure Endowment.

Books for Study:
Mathematical Basis of Life Assurance – published by Insurance Institute of India, Bombay.
Applied Statistics by S.C. Gupta and V.K. Kapoor (for Unit-III)

Web Resources :
http://www.stats.ox.ac.uk/~winkel/o13.pdf
Course Outcomes (CO) :
 On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**recognize** the important role of statistical principles and their application in actuarial sciences.	K1
2.	**analyse** and interpret actuarial and statistical information	K4
3.	**justify** and **communicate** the necessary skills for	K4

dealing with organization teams and policy issues.

4. critically engage with and **evaluate** actuarial and **K5** statistical problems.

5. **develop** insight in insurance and financial markets.   **K6**

Mapping of COs with POs & PSOs:

CO	PO					PSO						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1	S		S	M	M	M		M		M	S	M
CO2	M	L				L				L		
CO3		M	M	L	L	M					L	
CO4	L			L		M		M	L			S
CO5	L	M	M		M	M	M	M		M	M		M

L – Low; M – Medium; S - Strong

Course Title : **CORE PRACTICAL IV**
Course Code : **21USTQC4**
Hours/Week : **4 hrs** **Semester** : **VI**

Credit : **4** **Batch** : **2021- 2024**

Course Objective:
   The course aims to demonstrate the concepts of statistical inference and Statistical Quality Control with simple problems.
Syllabus

TESTING OF HYPOTHESIS

- t-test for single mean, two means (independent and dependent samples) and correlation coefficient.
- F-test for variance.
- Chi-square test of homogeneity, goodness of fit and independence of attributes.

INDUSTRIAL STATISTICS

- Control charts for variables: $\bar{X}$ and R charts.
- Control charts for attributes: p , np and c charts.

DESIGN OF EXPERIMENTS
- Analysis of CRD, RBD & LSD.
- Missing plot techniques in RBD & LSD.
- Analysis of 2^2, 2^3 factorial experiments with and without confounding.

Books for Study:

R.C. Gupta: Statistical Quality Control
S.C. Gupta & V.K. Kapoor : Fundamentals of Mathematical Statistics

Books for Reference:
V.K. Rohatgi: An Introduction to Probability theory and Mathematical Analysis.
Douglas. C. Montgomery: Statistical Quality Control

Web Resources :
http://www.stat.colostate.edu/~vollmer/stat307pdfs/LN7a_2017.pdf
https://www.wiley.com/college/sc/reid/chap6.pdf

Course Outcomes (CO) :

On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**understand** the concepts of testing of hypothesis and statistics used in industries.	K1
2.	**design**, use and **interpret** different control charts.	K3 & K5
3.	**check** the validity of each testing methods.	K4
4.	**associate** with the estimate to draw inference.	K5
5.	**face** the real challenges in industries.	K5

Mapping of COs with POs & PSOs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M			L		S						M
CO2		L	M		M			L	L	L	M	
CO3	M	M	L				M	M		M	M	
CO4	L		M	M	M	L				M		L
CO5		L	M		M			L	L	L	M	

L – Low; M – Medium; S - Strong

Course Title   **: ALLIED: STATISTICAL METHODS – I**
Course Code   **: 21UCSAC3**
Hours/Week   **: 5 hrs**   **Semester**   **III**

Credit   **: 5**   **Batch**   **: 2021-2024**

Course Objective:

The course aims to gain knowledge in basic Statistical Methods and their applications.

Syllabus

Unit – I :   **No. of Hours : 15hrs**
Definition of Statistics – Uses and limitations of Statistics – Measures of Central tendancy: Criteria of a good average – Mean, Median and Mode – Merits and Demerits – Simple problems.

Unit – II :   **No. of Hours : 15 hrs**
Measures of Dispersion: Criteria of a good measures of dispersion – Range – Quartile deviation – Standard deviation – Coefficient of Variation – Simple problems .

Unit – III :   **No. of Hours : 15 hrs**
Skewness – Types of skewness – Karl Pearson's and Bowley's coefficients of skewness –Simple problems – Definition of kurtosis – Fitting of linear and Quadratic equations..

Unit – IV :   **No. of Hours : 15 hrs**
Correlation: Types of correlation – Scatter diagram – Karl Pearson's correlation coefficient for ungrouped data – Spearman's rank correlation coefficient – Simple problems.

Unit – V: **No. of Hours : 15 hrs**
Regression analysis: Uses of regression analysis – Regression coefficients – Regression equations for ungrouped data- Simple problems.

Books for Study:
R.S. N. Pillai & V. Bagavathi: Statistics.

Books for Reference:
D. N. Elhance, Veena Elhance & B.M. Aggarwal: Fundamentals of Statistics
S.P. Gupta: Statistical Methods.
DC. Sanchetti & V. K .Kapoor: Fundamentals of Statistics..

Web Resources :

https://www.fd.cvut.cz/department/k611/PEDAGOG/THO_A/A_soubory/statistics_firstfive.pdf

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**understand** the basic statistical methodologies	K2
2.	**apply** a range of statistical techniques based on theory and concepts.	K3
3.	**relate** statistics to real life problems.	K3
4.	**communicate** meaningfully and productively with others.	K4
5.	**fit** a linear model and show how much it is related	K5

Mapping of COs with POs & PSOs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	L	M	L	M		S	M	L		L	L	M
CO2	L		M	M	M	L	L	M		L	M	
CO3	L	S	L		M	M			M	S	M	L
CO4	M		S	M	M	L		M	S		M	S
CO5	L		M	L	L	M	S	M	S	L	S	S

L – Low; M – Medium; S - Strong

Course Title	: ALLIED: STATISTICAL METHODS – II		
Course Code	: 21UCSAC4		
Hours/Week	: 5 hrs	Semester	IV
Credit	: 5	Batch	: 2021-2024

Course Objective:

The course aims to learn about the common methods of sampling, testing of statistical hypothesis and analysis of variance.

Syllabus

Unit – I :   **No. of Hours : 15 hrs**

Sampling: Definitions of population and sample – Census method – Merits of Sampling – Methods of Sampling: Simple random sampling – Stratified random sampling – Systematic sampling – Cluster sampling – Judgement sampling – Quota sampling – Convenience sampling.

Unit – II :   **No. of Hours : 15 hrs**

Null and alternative hypotheses – Type I and Type II errors – Critical region and acceptance region – Level of Significance – One –tailed and two-tailed tests – Sampling distribution and standard error – Procedure of testing of hypothesis – Large sample tests for single proportion, difference of two proportions, single mean and difference of two means – Simple problems.

Unit – III :   **No. of Hours : 15 hrs**

Assumptions in t-test – t-tests for single mean and difference of two means – Paired t- test and t-test for correlation coefficient – Simple problems. .

Unit – IV :   **No. of Hours : 15 hrs**

Contingency Table – 2x2 contingency table – Conditions for the validity of Chi-square test – Chi-square tests of homogeneity and independence of two attributes – Simple problems.

Unit – V: **No. of Hours : 15 hrs**

Analysis of Variance – Definition and uses – ANOVA for one-way classification – ANOVA for two-way classification – Simple problems.

Books for Study:

S. P. Gupta: Elementary Statistical Methods.

Books for Reference:

S.C. Gupta and V.K. Kapoor: Fundamentals of Applied Statistics.
S.C. Gupta and V.K. Kapoor: Fundamentals of Mathematical Statistics..

Web Resources :

https://www.fd.cvut.cz/department/k611/PEDAGOG/THO_A/A_soubory/statistics_firstfive.pdf

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**recall** different statistical methodologies.	K1
2.	**test** and **estimate** the parameters.	K3
3.	**examine** suitable statistical tools.	K4
4.	**conclude** with well-defined inference.	K5
5.	**integrate** theoretical concepts with real life problems.	K6

Mapping of COs with POs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M		L	M	L	L	S		L	L	M	
CO2	L			S	L	M	M			M		
CO3		S	M			S	S	S			S	S
CO4				S		S		S		S	L	
CO5	M	M	S		S		S		S	S		S

L – Low; M – Medium; S - Strong

Course Title : NME – I : SURVEY METHODLOGY
Course Code : 21USTNEC1
Hours/Week : 2 hrs   **Semester** : III

Credit : 2   **Batch** : 2021-2024

Course Objective:
    The course aims to illustrate the various methodologies in statistics.
Syllabus

Unit – I :   **No. of Hours : 6 hrs**
Definition of Statistics – Statistical survey –Planning a statistical survey – Executing a Statistical survey.

Unit – II: **No. of Hours : 6 hrs**
Census method and sampling – Methods of sampling: Simple random sampling – Stratified random sampling – Systematic sampling – Judgement sampling – Quota sampling – Convenience sampling. (Concepts only)

Unit – III :   **No. of Hours : 6 hrs**
Collection of Data: Primary and secondary data – Collection of primary data – Sources of secondary data – Framing a questionnaire.

Unit – IV: **No. of Hours : 6 hrs**
 Classification – Definition – Objectives, Rules and Types of Classification – Tabulation – Definition – Objectives, Rules and Types of Tabulation – Problems based on Tabulation.

Unit – V: **No. of Hours : 6 hrs**

Simple bar diagram – Multiple bar diagram – Subdivided bar diagram – Pie diagram – Histogram – Time series graph.

Books for Study:
 R.S.N. Pillai & Bagavathi: Statistics.

Books for Reference:
B. L. Agarwal: Programmed Statistics.

Web Resources:
http://www.mypolyuweb.hk/machanck/lectnotes/c1_des.pdf

Course Outcomes (CO) :
On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**know** the basic concepts in sample surveys and data.	**K1**
2.	**obtain** the knowledge of framing Questionnaire.	**K2**
3.	**organize**, manage and **present** the collected data .	**K3**
4.	**explore** the data in forms of tables, diagrams and graphs.	**K4**
5.	**visualise** the data collected and interpret.	**K5**

Mapping of COs with POs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	M		L	M	L	L	S		L	L	M	
CO2	L			S	L	M	M			M		
CO3		S	M			S	S	S			S	S
CO4				S		S		S		S	L	
CO5	M	M	S		S		S		S	S		S

L – Low; M – Medium; S - Strong

Course Title	: NME – II: BUSINESS STATISTICS		
Course Code	: 21USTNEC2		
Hours/Week	: 2 hrs	Semester	IV
Credit	: 2	Batch	: 2021-2024

Course Objective:

To learn statistical techniques for business data analysis.

Note: Derivations are not included Questions – Only on the topics mentioned.

Unit – I   **No of hours: 6 hrs**

Measures of Central tendency – Definition and its characteristics – Mean, Median, Mode-Simple problems.

Unit – II   **No of hours: 6 hrs**

Measures of Dispersion – Definition and its properties – Range, Quartile deviation, Standard deviation and Co-efficient of variation- Simple problems.

Unit – III   **No of hours: 6 hrs**

Correlation – Definition , its types and uses co-efficient of correlation for ungrouped data only – Rank correlation co-efficient (No repeated ranks) – Simple problems- Regression- Definition its types and uses – Simple problems.

Unit – IV   **No of hours: 6 hrs**

Time series – Definition and its uses – Components of Time series – Measurement of Trend by fitting a straight line and by the methods of moving average – Measurement of Seasonal variation by simple average method – Simple problems.

Unit – V   **No of hours: 6 hrs**

Index Number: Definition and its uses – classification of index number – problems involved in the construction of index numbers – Laspeyre's, Paasche's and Fisher's Index Number – Simple problems- Cost of living index numbers (concept only).

BOOKS FOR STUDY

R.S.N. Pillai and Bagavatti: Statistics

P.R. Vital   :Business Statistics

BOOKS FOR REFERENCE

B.L.Agarwal : Programmed Statistics.

Course Outcomes (CO) :
 On completion of the course, students should be able to

CO Number	CO Statement	Knowledge Level
1.	**apply** various statistical techniques related to business	K1
2.	**identify** the business data and present it precisely	K2
3.	**organize** and **summarize** the business data using descriptive statistics	K3
4.	**predict** the relevant relationship between business variables	K5

Mapping of COs with POs & PSOs:

CO	PO					PSO						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	L	M	L	M		S	M	L		L	L	M
CO2	L		M	M	M	L	L	M		L	M	
CO3	L	S	L		M	M			M	S	M	L
CO4	M		S	M	M	L		M	S		M	S
CO5	L		M	L	L	M	L	M	S	L	M	L

L – Low; M – Medium; S - Strong