॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड - ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with'B++' grade

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

Fax : (02462) 215572 | **Academic-1 (BOS) Section** | website: srtmun.ac.in

Phone: (02462)215542 | E-mail: bos@srtmun.ac.in

विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरणानुसार पदव्युत्तर स्तरावरील प्रथम वर्षाचे अभ्यासक्रम शैक्षणिक वर्ष २०२३–२४ पासून लागू करण्याबाबत..

प रि प त्र क

संदर्भ:– १. जा.क्र.शै–१/एनईपी२०२०/S&T/अक्र/२०२३–२४/१३० दिनांक ३०/०६/२०२३

२. जा.क्र.शै–१/एनईपी२०२०/S&T/अक्र/२०२३–२४/१३३ दिनांक ०७/०७/२०२३

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, संदर्भीय परिपत्रकान्वये दिनांक १६ जून २०२३ रोजी संपन्न झालेल्या मा. विद्यापरिषदेच्या बैठकीतील ऐनवेळचा विषय क्र. ०५/५६–२०२३ अन्वये मान्यता दिल्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरणानुसार अभ्यासक्रम शैक्षणिक वर्ष २०२३–२४ पासून लागू करण्यात आलेले आहेत. तथापी वरील संदर्भीय परिपत्रक १ व २ अन्वये प्रकाशित केलेल्या अभ्यासक्रमामध्ये अभ्यासमंडळानी किरकोळ दुरूस्ती करून अभ्यासक्रम सादर केले आहेत. त्यानुसार दुरूस्तीसह खालील अभ्यासक्रम लागू करण्यात येत आहेत.

1. M. Sc. Statistics I year (University Campus)
2. M. Sc. Statistics I year (Affiliated College)

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शैक्षणिक–१/परिपत्रक/एनईपीपीजी/S&T/
२०२३–२४/328

आपली विश्वासू

डॉ. सरिता यन्नावार
सहाय्यक.कुलसचिव

दिनांक : ०५.१०.२०२३.

प्रत माहिती व पुढील कार्यवाहीस्तव :

१) मा. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. प्राचार्य, सर्व संबधित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. यानां देवून कळविण्यात येते की, सदरील परिपत्रक विद्यापीठाच्या संकेतस्थळावर प्रसिध्द करण्यात यावे.

SWAMI RAMANAND TEERTH

MARATHWADA UNIVERSITY, NANDED - 431 606

(Structure and Syllabus of Two Years Multidisciplinary Master Degree Program with Multiple Entry and Exit Option)

(University Campus)

TWO YEARS MASTER DEGREE PROGRAMME IN SCIENCE

Subject: STATISTICS

Under the Faculty of
Science and Technology

Effective from Academic Year 2023 – 2024
(As per NEP-2020)

Forward by the Dean, Faculty of Science and Technology

From the Desk of the Dean:

To meet the challenge of ensuring excellence in Science and Technology education, the issue of quality needsto be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology of Swami Ramanand Marathwada University has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Science and Technology, Swami Ramanand Teerth Marathwada University, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes tobe clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Science and Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading systemis also introduced to ensure quality of education.

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Swami Ramanand Teerth Marathwada University has taken a lead in implementing the system through its affiliated Institutes and Faculty of Science and Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guestlectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of from the academic year 2014-2015 and subsequently this system will be carried forward for Second Year2015-2016 respectively.

Dr. L. M. Waghmare, Dean, Faculty of Science and Technology,
Dr. M. K. Patil, Associate Dean, Faculty of Science and Technology,
Swami Ramanand Teerth Marathwada University, Nanded

From Desk of Chairman, Board of Studies of the Subject STATISTICS

Preamble:

The education in India, in general is expanding manifolds. It is the challenge to ensure its quality to stakeholders to meet this challenge the issue of quality needs to be addressed and taken forward in systematic manner. For this we statistician tried to modify our subject curriculum according to National Education Policy (NEP) 2020 to explore future brightness of stakeholders.

M. A. / M. Sc. Statistics programme is of minimum 88 credits spread over four semesters. The programme emphasizes both theory and applications of statistics and is structured to provide knowledge and skills in depth necessary for the employability of students in industry, other organizations, as well as in academics. The program has some unique features such as independent projects, number of elective courses, extensive computer training of statistical computations including standard software packages such as MATLAB, MINITAB, R, Python, TORA and SPSS. The department has the academic autonomy and it has been utilized to add the new and need based elective courses. The independent project work is one of the important components of this program. In this syllabus core courses, electives and open electives are offered. The syllabus has been framed to have a good balance of theory, methods and applications of statistics. It is possible for the students to study basic courses from other disciplines such as economics, life sciences, computer science and mathematics in place of electives. This programme requires basic of data types, organization of data and tabulation of data, Graphical representation, data transformation, distribution theory, and sampling methodology.

A course with SSTAC, SSTAE, STATPC and STATOE indicates First letter S-Sci, next three letters STA-Major/DSE-Elective, fourth letter C-Core/E-Elective, x-Semester number, 'P' is for practical and last two numbers represent xx-paper no. SVC indicates. We'll follow this analogy for assigning CODE to the courses. OJT indicated for on job training respectively. A student can enroll for a practical course if the student has enrolled for the corresponding theory course (as indicated) in the same term.

I, as Chairman, Board of Studies in Statistics, Swami Ramanand Teerth Marathwada University, Nanded, happy to state here that we all members made a curriculum and finalized it. The Program Educational Objectives were finalized for postgraduate program in Statistics. I am thankful our Dean of Science and Technology Dr. L. M. Waghmare and Associate Dean Dr. M. K. Patil who has given this opportunity.

The Program Educational Objectives finalized for Postgraduate program in Statistics are listed below:

Program Educational Objectives (PEO):

M. A. / M. Sc. Statistics program has semester pattern and credit system with variable credits. The program consists of 88 credits. Credits of a course are specified against the title of the course. The learning objectives of this program are:

PEO1: Students should able to understand, implement and overcome problems through statistical techniques.

PEO2: To develop scientific view among students for better understanding and analytic ability the collected data for specific perspectives.

PEO3: Demonstrate graduate-level skills in communicating mathematics and statistics, orally and in writing.

PEO4: Students should able understand appropriate, relevant, fundamental and applied mathematical; and statistical methodologies and modern computational tools.

PEO5: The ability to bring together and flexibly apply knowledge to characterize, analyze and solve a wide range of problems an understanding of the balance between the complexity / accuracy of the mathematical / statistical models used and the timeliness of the delivery of the solution.

PEO6: Ability to contribute to professional work settings through effective participation in teams and organization of project tasks the ability to constructively engage with other team members and resolve

conflict.

PEO7: The ability to communicate effectively in terms of technical and non-technical material in a range forms to different audiences.

4. Program Outcomes (PO):

On successful completion of the program students will able to:

PO1: Have specialised knowledge and understanding of statistical theory at an advanced level which take into account recent advances in the subject.

PO2: Acquire the **s**trong foundation of statistical concepts which will benefit them to become good academicians.

PO3: Use acquired statistical methodologies and modelling techniques to address real-life problems.

PO4: Gain the knowledge of software which has the wide range of opportunities in the Quality control, Planning and development, IT sector, R&D in industries, Business, Government and private sector etc.

PO5: Qualify various National / State level competitive exams like ISS, DSO, CSIR-UGC NET, SLET, GATE, MPSC, UPSC, Banking etc.

5. Program Specific Outcomes (PSO):

On successful completion of the program students will able to:

PSO1: Understand, implement and develop statistical models.

PSO2: Handle and analyze small as well as large databases with computer skills.

PSO3: Describe complex statistical ideas to non-statisticians and to present the results of their analyses in written, oral forms and can make practical suggestions for improvement.

PSO4: Get wide range of statistical skills in problem-solving.

PSO5: The project work and presentation may enable to take prominent roles in a wide spectrum of employment and research.

Course Outcomes (for all courses):

The course outcomes are the statement that describes the knowledge & abilities developed in the student by the end of course (subject) teaching. The focus is on development of abilities rather than mere content. There are 4 course outcomes of all courses defined here. These are to be written in the specific terms and not in general.

In addition to Program Educational Objectives, for each course of postgraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I believe strongly that small step taken inright direction will definitely help in providing quality education to the stake holders.

Dr. B. L. Bable
Chairman, Board of Studies of the Statistics

Swami Ramanand Teerth Marathwada University, Nanded

Details of the Board of Studies Members in the subject STATISTICS under the faculty of Science & Technology of S.R.T.M. University, Nanded

Sr No	Name of the Member	Designation	Address	Contact No.
1	Dr. B. L. Bable	Chairman	DSMs College of Arts, Commerce and Science, Parbhani	9420817528
2	Dr. A. A. Muley	Member	School of Mathematical Sciences, SRTMUN	7276114558
3	Dr. S. V. Kawale	Member	Dr. B. A. M. Uni., Chhatrapati Sambhajinagar	9421303727
4	Dr. V.S. Jadhav	Member	Sanjeevanee College,Chapoli	9604421675
5	Dr. M. R. Fegade	Member	Digambarrao Bindu College, Bhokar	9922675834

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science & Technology

Credit Framework for Two Year PG Program

Subject: Statistics

Year & Level 1	Sem. 2	Major Subject (DSC) 3	Major Subject (DSE) 4	RM 5	OJT / FP 6	Research Project 7	Practicals 8	Credits 9	Total Credits 10
1	1	SSTAC401 (4 Cr) SSTAC402 (4 Cr) SSTAC403 (4 Cr)	SSTAE401 (4 Cr) SSTAE402 (4 Cr) SSTAE403 (4 Cr) *(Select Any one Above / From Same School)*	SVECR 401 *Research Methodology* (3 Cr)	--	--	SSTAP401 (3Cr)	22	44
	2	SSTAC451 (4 Cr) SSTAC452 (4 Cr) SSTAC453 (4 Cr)	SSTAE451 (4 Cr) SSTAE452 (4 Cr) SSTAE453 (4 Cr) *(Select Any one Above / From Same School)*	---	SSTAO451 (3 Cr)	--	SSTAP451 (3Cr)	22	
Exit option: Exit Option with PG Diploma *(after 2024-25)*									
2	3	SSTAC501 (4 Cr) SSTAC502 (4 Cr) SSTAC503 (4 Cr)	SSTAE501 (4 Cr) SSTAE502 (4 Cr) SSTAE503 (4 Cr) SSTAE504 (4 Cr) SSTAE505 (4 Cr) *(Select Any one Above / From Same School)*	--		Research Project SSTAR551 (4Cr)	SSTAP501 (2 Cr)	22	44
	4	SSTAC551 (4 Cr) SSTAC552 (4 Cr)	SSTAE551 (4 Cr) SSTAE552 (4 Cr) SSTAE553 (4 Cr) SSTAE554 (4 Cr) *(Select Any one Above / From Same School)*	SVECP 551 Publication Ethics (2 Cr)		Research Project SSTAR552 (6 Cr)	SSTAP551 (2Cr)	22	
Total Credits		**44**	**16**	**05**	**03**	**10**	**10**	**88**	

M. Sc. First Year Semester I *(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SSTAC401**	Real Analysis and Linear Algebra	04	--	**04**	04	--
	SSTAC402	Probability and Distribution Theory	04	--	**04**	04	--
	SSTAC403	Sampling Methods	04	--	**04**	04	--
Elective (DSE) (Any one from same Department/ School)	**SSTAE401**	Statistical Computing	04	--	**04**	04	--
	SSTAE402	Econometrics					
	SSTAE403	Computer Graphics					
	SSTAE404	NPTEL/SWAYAM MOOCs					
Research Methodology	**SVECR401**	Research Methodology	03	--	**03**	03	--
STA Practical	**SSTAP401**	Practical-I	--	03	**03**	--	06
Total Credits			**19**	**03**	**22**	**19**	**06**

M. Sc. First Year Semester I *(Level 6.0)*

Examination Scheme

[20% Continuous Assessment (***CA***) and 80% End Semester Assessment (***ESA***)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SSTAC401**	Real Analysis and Linear Algebra	20	20	20	80	--	--	100
	SSTAC402	Probability and Distribution Theory	20	20	20	80	--	--	100
	SSTAC403	Sampling Methods	20	20	20	80	--	--	100
Elective (DSE) (Any one from same Department/ School)	**SSTAE401**	Statistical Computing	20	20	20	80	--	--	100
	SSTAE402	Econometrics							
	SSTAE403	Computer Graphics							
	SSTAE404	NPTEL/SWAYAM MOOCs							
Research Methodology	**SVECR401**	Research Methodology	15	15	15	60	--	--	75
DSE Practical	**SSTAP401**	Practical-I	--	--	--	--	15	60	75

M. Sc. First Year Semester II *(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SSTAC451**	Regression Analysis	04	--	**04**	04	--
	SSTAC452	Statistical Inference	04	--	**04**	04	--
	SSTAC453	Stochastic Processes	04	--	**04**	04	--
Elective (DSE) (Any one from same Department/ School)	**SSTAE451**	Statistical Methods in Finance	04	--	**04**	04	--
	SSTAE452	Categorical Data Analysis					
	SSTAE453	Calculus					
	SSTAE454	NPTEL/SWAYAM MOOCs					
On Job Training	**SSTAO451**	ON Job Training	03	--	**03**	03	--
STA Practical	**SSTAP451**	Practical-II	--	03	**03**	--	06
Total Credits			**19**	**03**	**22**	**19**	**06**

M. Sc. First Year Semester II *(Level 6.0)*

Examination Scheme

[20% Continuous Assessment (***CA***) and 80% End Semester Assessment (***ESA***)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SSTAC451**	Regression Analysis	20	20	20	80	--	--	100
	SSTAC452	Statistical Inference	20	20	20	80	--	--	100
	SSTAC453	Stochastic Processes	20	20	20	80	--	--	100
Elective (DSE) (Any one from same Department/ School)	**SSTAE451**	Calculus	20	20	20	80	--	--	100
	SSTAE452	Categorical Data Analysis							
	SSTAE453	Statistical Methods in Finance							
	SSTAE454	NPTEL/SWAYAM MOOCs							
On Job Training	**SSTAO451**	ON Job Training	15	15	15	60	--	--	75
DSE Practical	**SSTAP451**	Practical-II	--	--	--	--	15	60	75

M. Sc. Second Year Semester III *(Level 6.5)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SSTAC501**	Design and Analysis of Experiments	04	--	**04**	04	--
	SSTAC502	Applied Multivariate Analysis	04	--	**04**	04	--
	SSTAC503	Machine Learning	04	--	**04**	04	--
Elective (DSE) (Any one from same Department/ School)	**SSTAE501**	Time Series Analysis	04	--	**04**	04	--
	SSTAE502	Industrial Statistics					
	SSTAE503	Decision Theory					
	SSTAE504	Mathematical Biology					
	SSTAE505	Statistical Methods in Epidemiology and Ecology					
	SSTAE506	NPTEL/SWAYAM MOOCs					
Research Project	**SSTAR551**	Research Project	04	--	**04**	04	
STA Practical	**SSTAP501**	Practical III	--	02	**02**	--	04
Total Credits			**20**	**02**	**22**	**20**	**04**

M. Sc. Second Year Semester III *(Level 6.5)*

Examination Scheme

[20% Continuous Assessment (***CA***) and 80% End Semester Assessment (***ESA***)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SSTAC501**	Design and Analysis of Experiments	20	20	20	80	--	--	100
	SSTAC502	Applied Multivariate Analysis	20	20	20	80	--	--	100
	SSTAC503	Machine Learning	20	20	20	80	--	--	100
Elective (DSE) (Any one from same Department/ School)	**SSTAE501**	Time Series Analysis	20	20	20	80	--	--	100
	SSTAE502	Industrial Statistics							
	SSTAE503	Decision Theory							
	SSTAE504	Mathematical Biology							
	SSTAE505	Statistical Methods in Epidemiology and Ecology							
	SSTAE506	NPTEL/SWAYAM MOOCs							
Research Methodology	**SVECR501**	Research Project	--	--	--	--	--	--	100
STA Practical	**SSTAP501**	Practical - III Clinical Trials	--	--	--	--	10	40	50

M. Sc. Second Year Semester IV *(Level 6.5)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SSTAC551**	Asymptotic Inference	04	--	**04**	04	--
	SSTAC552	Reliability and Survival Analysis	04	--	**04**	04	--
Elective (DSE) (Any one from same Department/ School)	**SSTAE551**	Operational Research	04	--	**04**	04	--
	SSTAE552	Clinical Trials					
	SSTAE553	Statistical techniques in Microarray Data Analysis					
	SSTAE554	Directional Data Analysis					
Publication Ethics	**SVECP551**	Publication Ethics	02	--	**02**	02	--
Research Project	**SSTAR552**	Research Project	06	--	**06**	06	--
STA Practical	**SSTAP551**	Practical - IV	--	02	**02**	--	04
Total Credits			**20**	**02**	**22**	**20**	**04**

M. Sc. Second Year Semester IV *(Level 6.5)*

Examination Scheme

[20% Continuous Assessment (***CA***) and 80% End Semester Assessment (***ESA***)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SSTAC551**	Asymptotic Inference	20	20	20	80	--	--	100
	SSTAC552	Reliability and Survival Analysis	20	20	20	80	--	--	100
Elective (DSE) (Any one from same Department/ School)	**SSTAE551**	Operations Research	20	20	20	80	--	--	100
	SSTAE552	Clinical Trials							
	SSTAE553	Statistical techniques in Microarray Data Analysis							
	SSTAE554	Directional Data Analysis							
Publication Ethics	**SVECP551**	Publication Ethics	10	10	10	40	--	--	50
Research Project	**SSTAR552**	Research Project	--	--	--	--	--	--	150
STA Practical	**SSTAP551**	Practical -IV	--	--	--	--	10	40	50

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr.

Vide G.R. No. NEP-2022 /CR No. 09/VISHI-3 /शिकाना dated April 20, 2023, the Directive, covering the Credit distribution structure for Four Year UG Honours/ Honours with Research Degree Programme with Multiple Entry and Exit options, was issued. In continuation of Section 8 of this GR- 'Design of PG / Master's Programmes', the illustrative Table depicting the Credit Distribution for Two Year PG Programme with one Exit Option/ One Year PG Programme is as given below:

(a) With effect from Academic Year 2023-24, Two years Master's Degree Program will be revamped as per the Illustrative Credit Distribution given in the above Table.
(b) Credits offered per Semester will be a Minimum of 20 and a Maximum of 22. While minimum credits are mandatory as per National Credit Framework, the Universities can evolve the mechanism for providing Semester/ Level wise credit attainment flexibility within the broad framework.
(c) Under the One-year PG Diploma program, and two-year master's Degree program, the students must complete on-the-job training/internship of 03 credits during summer break, after completion of the second semester of the first year in the respective Major Subject.
(d) The 3 Credits Research Methodology Component is mandatory in the First Year.
(e) Since the Master's Programme is based on DSC Specialization, the PG curricular framework will not include Minor Subject. Electives selected in the PG program may be Relevant to OR Supportive of the Major Subject chosen.
(f) The students will have to undertake a research project of 4 credits in Semester III and a research project of 6 credits in Semester IV in the second year of the two-year master's degree program. This is also applicable to the students admitted to one year PG program after completion of four year UG Program.
(g) Colleges already having permission and recognition for the PG degree programme along with UG degree programme in the same Major shall be automatically allowed to continue PG degree programme in the same Major without undergoing any additional procedures. Similarly, the colleges with approved PG programme and Ph.D. Research Centre in the same Major shall be automatically allowed to continue PG and Ph. D. Degree programme without undergoing any additional procedures.
(h) The exit option at the end of one year of the Master's degree program will commence from AY 2024-25. Students who have joined a two-year Master's degree program may opt for exit at the end of the first year and earn a PG Diploma.
(i) The PG Diploma may be awarded to a student provided they have earned the requisite credits in one year including on-the-job training of 03 credits during summer break, after completion of the second semester of the first year in the respective Major Subject.
(j) The one-year Master's Degree Program will begin with effect from Academic Year 2027-28.
(k) Re-entry to complete the PG degree, after taking the exit option, will be permissible up to 05 years from the date of admission to the PG program.

Detailed Semester-wise syllabus:

M.Sc. Statistics First semester

	Course Code	Course Name	Credits Assigned		
			Theory	Practical	Total
Major	**SSTAC401**	Real Analysis and Linear Algebra	04	--	**04**
	SSTAC402	Probability and Distribution Theory	04	--	**04**
	SSTAC403	Sampling Methods	04	--	**04**
Elective (DSE) (Any one from same Department/ School)	**SSTAE401**	Statistical Computing	04	--	**04**
	SSTAE401	Econometrics			
	SSTAE401	Computer Graphics			
	SSTAE404	NPTEL/SWAYAM MOOCs	04	--	**04**
Research Methodology	**SVECR401**	Research Methodology	03	--	**03**
STA Practical	**SSTAP401**	Practical-I	--	03	**03**
Total Credits			**19**	**03**	**22**

SSTAC401 REAL ANALYSIS AND LINEAR ALGEBRA

(Maximum no. of periods 60)

Course pre-requisite:

1. This course requires basics of vector and matrix algebra.

Course objectives:

- The aim of the course is to introduce fundamental concept of real analysis.
- To learn the basic ideas of linear algebra and techniques.

Course outcomes: After completion of the course students will able to:

- **CO1:** Apply fundamentals of Real analysis like supremum and infimum.
- **CO2:** Understand Sequences, series and their convergence problems.
- **CO3:** Learn Vector spaces, linear transformations and their applications
- **CO4:** Calculate eigen values and eigen vectors and apply them to find minimal polynomial and diagonalization problems.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Set and functions, finite and infinite sets, countability	
	1.2	supremum and infimum of sets , Archimedean property, Density of Rational numbers in R	
	1.3	Sequences and their limits, Monotone sequences, Subsequences, Bolzano -Weierstrass theorem(Statement only),	
	1.4	Limit superior, limit inferior, The Cauchy Criterion,	
2.0			**15**
	2.1	Series of real numbers, convergence of series, tests for convergence of series, absolute convergence,	
	2.2	Limits of functions, Cluster point,	
	2.3	Continuity and uniform continuity of functions	
	2.4	The derivative, The mean value theorem, taylors theorem	
3.0			**15**
	3.1	Vector spaces, subspaces, span of a set, linear dependence, independence, Dimension and Basis	
	3.2	Linear Transformation, Range and kernel of a linear map, Rank and Nullity,	
	3.3	Inverse of linear transformation, Rank Nullity theorem Linear map associated to matrix, matrix associated with linear map	
	3.4	Inner product spaces, orthogonality, orthonormal basis, Gram Schmidt orthogonalization process	
4.0			
	4.1	Eigen values and Eigen vectors Algebraic and geometric multiplicity	**15**
	4.2	Cayley Hamilton theorem, Minimal polynomial.	
	4.3	Echelon form, Diagonalisation, Jordan canonical form,	
	4.4	Classification of quadratic forms, rank and signature	
		Total	**60**

Text books:

1. Bartle and Sherbert (2015) Introduction to Real Analysis , 4th ed.Wiley.
2. Krishnamurthy, Mainra and Arora (1938) An introduction to Linear Algebra, East- west press pvt. Ltd. New Delhi.
3. Hoffman and Kunze (2018) Linear Algebra, Prentice Hall India.

Reference Books:

1. Courant R. And John F.(1965) Introduction to Calculas and Analysis, Wiley.
2. Miller K.S.(1957)Advanced Real Calculas, Harper, New York.
3. Rudin ,Walter(1976) Principles of Mathematical Analysis,McGraw Hill.
4. Malik S.C.and Savita Arora , Mathematical Analysis, New Age International (p)Ltd.
5. Ramchandra Rao and Bhimasankaram (2000) Linear Algebra, 2nd edition, Hindustan book agency (India)
6. S. K. Mapa (2003) Higher algebra Abstract and Linear, 10th ed., SARAT Book distributors, Calcutta.
7. Friedberg, Insel, Spence (2015) Linear Algebra, 4th edition, Prentice Hall India.

SSTAC402 PROBABILITY AND DISTRIBUTION THEORY

(Maximum no of periods: 60)

Course pre-requisite:

1. Basics of measure theory, real analysis, random variable, generating functions, distribution function.
2. Random experiment and its sample space, events, random variables: discrete and continuous random variables, P.d.f., P.m.f., c.d.f. of random variables, M.g.f., p.g.f. c.g.f., characteristic function of random variables, Moments.

Course objectives:

- To understand the uncertain occurrence situations with logical manner.
- To present the general theory of statistical distributions as well as the standard distributions found in statistical practice
- To train students with essential tools for statistical analyses at the post graduate level. Fostering understanding through real-world statistical applications.

Course Outcomes: After completion of the practical students will able to:

- **CO1:** Understand basics of sets in probability and laws of convergence.
- **CO2:** Understand inequalities and laws of large numbers.
- **CO3:** Get familiar with mixtures of distributions and their properties.
- **CO4:** Apply compound, Truncated, mixture and non-central probability distributions to solve problems.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0			**15**
	1.1	Classes of Sets, Fields and Sigma-Fields, Sigma- Field Generated by a Class of Subsets. Borel Sigma Field. Probability Measure on a Sigma-Field, Probability Space, Continuity of a Probability Measure	
	1.2	Random Variable, Borel Function, indicator function, algebra of random variables, Limits of Random Variables.	
	1.3	Distribution function of a random variable, Expectation of a random variable	
	1.4	Monotone convergence theorem, Fatou's Lemma, Lebesgue Dominated convergence theorem.	
2.0			**15**
	2.1	Inequalities: C_r-inequality, Holder's inequality (without proof), Minkowski(without proof), Basic inequality, Markov and Chebyshev's inequality, independence of random variables.	
	2.2	Almost sure Convergence, Convergence in Probability, Convergence in rth Mean, Convergence in Distribution, Borel-Cantelli Lemma	
	2.3	Weak Law of Large Numbers: Chebyshev's and Kinctchine's WLLN. Strong law of large numbers (without proof)	
	2.4	Levy Continuity Theorem(Statement only), Central Limit Theorem.	
3.0			**15**
	3.1	Review of basic distribution theory, Joint , marginal and conditional pmf and pdf of discrete and continuous distributions	
	3.2	Bivariate normal distribution, important properties and applications	
	3.3	Functions of random variables and their distributions using Jacobean of transformation	
	3.4	Mixture of discrete and continuous distributions, their properties	
4.0			**15**
	4.1	Compound distributions- Nayman Type A distributions, Polya-Eggenberger distribution, inverse Polya-Eggenberger distribution	
	4.2	Truncated distributions of discrete and continuous distributions	
	4.3	Non-central Chi-square, t and F-distributions and their properties	
	4.4	Order statistics: distribution of r-th order statistics, joint distribution of rth and sth order statistics ($r < s$) and their functions	
		Total	**60**

Text books:

1. Bhat B. R. (2000) Modern Probability Theory, New age international.
2. Hogg R.V. and Craig A.T.(1978) Introduction to Mathematical Statistics, 5th Ed. Pearson's Education.
3. Rohatgi V.K. and Ehsanes Saleh A.K.MD. (2003) An Introduction to probability theory and Mathematical Statistics, Wiley Eastern ,2nd Ed.
4. Kartick Chandra Bhuyan (2010) Probability Distribution Theory and Statistical Inference, New Central Book Agency.
5. Mukhopadhay P. (1996) Mathematical Statistics, New central book agency, Calcutta.

Reference Books:

1. Ash Robert (1972) Real analysis and probability, Academic press.
2. Billingsley P. P. (1986) probability and measure, Wiley.

3. Biswas S. (2002) Topic in Statistical Methodology, New Age International, New Delhi
4. Cramer H.(1946)Mathematical Methods of Statistics, Princeton.
5. Das KK and Bhattacharjee (2008) A treatise on Statistical inference and distributions, Asian Books, New Delhi.
6. Dudewicz E.J.and Mishra S.N.(1988)Modern Mathematical Statistics, Wiley & Sons.
7. Freund JE (1998) Mathematical statistics, Prentice hall of India, New Delhi
8. G De Barra(2013) Measure Theory and Integration Second Edition New Age International Private Limited
9. Goon A M., Gupta M K. and Dasgupta B. (2016) Fundamental of Statistics Vol I, Word press
10. Hogg R.V. and Tanis E.(2002)An Probability and Statistical Inference, 6th Ed. Pearsons Education.
11. Johnson S.and Kotz (1972) Distributions in Statistics, Vol. I, II and III, Houghton and Miffin.
12. Krishnamoorthy K. (2015) Handboook of Statistical distributions with applications, 2Ed., CRC Press.
13. Mukhopadhay P. (2002) Theory of Probability, New central book agency, Calcutta.
14. Pitman J.(1993) Probability, Narosa Publishing House.
15. Rao C.R.(2002)Linear Statistical Inference and its Applications, 2nd Ed., Wiley Eastern
16. RohatgiV. K. (1984) An introduction to probability theory and Mathematical Statistics, Wiley Eastern
17. Vardhan S. R. S. (2000) Probability Theory, New York University.
18. Wilks SS (2007) Mathematical Statistics, Buck Press.

SSTAC403 SAMPLING METHODS

(Maximum no. of periods = 60)

Course pre-requisite:

1. This paper requires basic of data types, organization of data, tabulation of data etc.

Course objectives:

- To learn scientific view to conduct the survey in proper way to collect the data about specific perspective.
- To Learn variety of probability and non-probability sampling methods for selecting a sample from a population.

Course outcomes: After completion of the course students will able to:

- **CO1:** Understand the basic principles underlying survey design and random sampling.
- **CO2:** Apply the different sampling methods for designing and selecting a sample from a population.
- **CO3:** Implement Ratio and Regression estimation in real life problems. unequal probability sampling designs viz. PPSWR, PPSWOR including Lahiri's method and Murthy's estimator for survey.
- **CO4:** Apply resampling techniques, and Bootstrap and Jackknife methods.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Concept of population and sample, need for sampling, Census and sample surveys, basic concepts in sampling and designing of large-scale survey design,	
	1.2	Sampling scheme and sampling strategy.	
	1.3	Sampling and Non-sampling errors, Response and non-response errors.	
	1.4	Basic methods of sample selection: SRSWR, SRSWOR.	
2.0			**15**
	2.1	Stratified sampling: Formation of strata and number of strata, Allocation problems and estimation problems, cost and variance analysis. Systematic sampling and related results on estimation of population total, mean and proportion.	
	2.2	Circular Systematic sampling, Cluster sampling, Estimator of population mean and its properties.	
	2.3	Single stage, Multistage: Two-stage sampling. Double sampling.	
3.0			**15**
	3.1	Ratio and Regression estimators and their properties and MSEs. Unbiased and almost Unbiased ratio type estimators.	
	3.2	Probability proportional to size with replacement: Heansen-Horwitz and Desraj estimators for a general sample size, Lahiri's method and Murthy's estimator for a sample of size, Midzuno sampling design. Probability proportional to size without replacement	
	3.3	Inclusion probability proportional to size sampling: Sampford's scheme, Midzuno-Sen strategy, Rao-Hartley-Cocharn strategy, Classes of linear estimators	
4.0			
	4.1	Resampling techniques: Monte Carlo method	**15**
	4.2	Bootstrap and Jackknife methods	
	4.3	Introduction of Non-sampling errors, Types of non-sampling errors	
		Total	

Text books:

1. Latpate R., Kshirsagar J., Gupa V. K. and Chandra G. (2021) Advanced Sampling Methods, Springer.
2. Chaudhari A. And Mukerjee R. (1988) Randomized Response: Theory and Techniques, New York, Marcel Dekker Inc.
3. Cochran W.G.(1984) Sampling Techniques, Wiley.
4. Des Raj and Chandok(1999)Sample Survey Theory, Narosa.
5. Sukhatme P.V., Sukhatme B.V. and Ashok C.(1984)Sampling Theory of Surveys with Applications, Iowa state University Press and IARS.

Reference Books:

1. Singh D. and Chaudhary F. S. (1986) Theory and Analysis of Sample Survey Designs, New Age International Publishers.
2. Mukhopadhay P.(2002) Theory and Methods of Sample Survey, Chpman and Hall
3. Murthy M. N.(1977) Sampling Theory and Methods, Statistical Pub. Society, Calcutta.
4. Rao P.S.R.S.(2000)Sampling Methodologies and Applications, Chapman and Hall/ CRC
5. Govindrajalu Z. (1999)Elements of sampling theory and methods, Prentice Hall

SSTAE401 STATISTICAL COMPUTING

(Maximum no of periods: 60)

Course pre-requisite:

1. Basics of descriptive statistics, probability distributions, statistical inference and basic of computer fundamentals etc.

Course objectives:

- To familiar and to develop learning mindsets to analyze statistical data through R software.
- To learn basic syntax, coding and vocabulary to aid in data analysis.

Course outcomes: After completion of the course students will able to:

- **CO1:** Get familiar with R software and learn basics of R with descriptive statistics. Compute probabilities and fitting of probability distribution with R environment.
- **CO2:** Explore small and large data-sets to create testable hypotheses and identify appropriate statistical tests. Perform correlation, regression analysis and appropriate statistical tests for real life situations using R.
- **CO3:** Familiarize with python interface and Python libraries.
- **CO4:** Apply Python libraries viz., Numpy, Pandas to perform basic data operations.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Introduction: History of R programming, starting and ending R, Data types, Getting help in R, R use as calculator. Descriptive Statistics: Diagrammatic representation of data. Measures of central tendency	
	1.2	Measures of dispersion, measures of skewness and kurtosis	
	1.3	Probability problems on finding basic probabilities.	
	1.4	Probability distributions: some special discrete and continuous probability distributions. Probabilities and inverse for various distributions, sketching graphs for various distributions	
2.0			**15**
	2.1	Statistical inference: Sampling distribution of sample means, Estimation of parameters, Hypothesis testing, Goodness of fit tests.	

	2.2	Correlation, inference procedure for correlation coefficient, Bivariate correlation, Multiple correlations	
	2.3	Linear regression and its inference procedure, Simple optimization method	
3.0			
	3.1	Introduction to Python, Data types, Essential Python Libraries: NumPy, pandas, matplotlib,IPython and Jupyter, SciPy, scikit-learn, statsmodels	**15**
	3.2	Installation, Setup and Packages, Python 2 and Python 3, Basic functions, importing exporting data. Python Language Basics, IPython, and Jupyter Notebooks	
	3.3	Built-in Data Structures, Functions, and Files	
4.0			
	4.1	NumPy Basics: Arrays and Vectorized Computation, Introduction to pandas Data Structures,	**15**
	4.2	Data Loading, Storage, and File Formats, Data Cleaning and Preparation	
	4.3	Data Wrangling: Join, Combine, and Reshape	
	4.4	Plotting and Visualization, Data Aggregation and Group Operations	
		Total	**60**

Text books:

1. Purohit S. G., Gore S. D. and Deshmukh S. K. (2010) Statistics using R, Narosa.
2. Peter Dalgaard (2008) Introductory Statistics with R, Springer.
3. M. D. Ugarte, A. F. Militino, A. T. Arnholt (2008) Probability and Statistics with R, CRC Press.
4. Wes McKinney (2018) Python for Data Analysis, 2nd Ed. William McKinney
5. Introduction to Python for Econometrics, Statistics and Data Analysis 4th Edition Kevin Sheppard University of Oxford.

Reference Books:

1. Normal Maltoff (2009) The art of R programming.
2. W. John Braun, John Braun, Duncan James Murdoch (2007) First Course in Statistical Programming with R, Cambridge University Press.
3. Michael J. Crawley (2007) The R Book, John Wiley and Sons.
4. Ossama Embarak (2018) Data Analysis and Visualization Using Python, Apress.

SSTAE402 **ECONOMETRICS**

(Maximum no. of periods 60)

Course pre-requisite:

This course requires basic knowledge of linear regression models.

Course objectives:

- To study about classical linear regression model and their estimation.
- To study multicollinearity and heteroscedasticity.
- To discuss about Autocorrelation, different orders of Autocorrelation and their estimation procedures.
- To explain different lag models and their estimate procedures and simultaneous linear equations model and their different methods and estimation.

Course outcomes: After completion of the course students will able to:

- **CO1:** Core concepts and techniques in econometrics, with a special focus on the classical linear regression model.
- **CO2:** Heteroscedasticity and multicollinearity and their estimation procedures.
- Students understood about different lag models and simultaneous linear equations model with their estimation methods.
- **CO3:** Understand autocorrelation, sources, consequences, remedies, and their parameter estimation.
- **CO4:** Understand the assumptions upon which different lag and econometric models and their implications.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Quick review of inference in classical linear regression model; Estimation and tests of significance of linear and compound growth rates	
	1.2	Incremental analysis; Testing the function form of regression	
	1.3	choosing between linear and log-linear regression models; Likelihood Ratio	
	1.4	Wald and Lagrange Multiplier tests	
2.0			**15**
	2.1	Multicollinearity; Sources, consequences and detection of Multicollinearity,	
	2.2	FarrarGlauber test; remedial measures; Heteroscedasticity: Sources and consequences;	
	2.3	Tests for Heteroscedasticity; Glejser's test, Goldfield-Quandt test and Breusch-Pagan-Godfrey test;	
	2.4	Estimation of parameters under Heteroscedasticity;	
3.0			**15**
	3.1	Autocorrelation; sources and consequences;	
	3.2	first order autoregressive scheme; tests for autocorrelation	

		Durbin-Watson test;	
	3.3	Remedies; Estimation of parameters under Autocorrelation;	
	3.4	Stochastic Regressors; Errors in variables linear model, IV and ML methods of estimation.	
4.0			
	4.1	Finite distributed lag models; Almon's Polynomial approach; Infinite distributed lag models;	**15**
	4.2	Geometric lag model; Koyck's approach; IV method;	
	4.3	simultaneous linear equations models; Problem of identification;	
	4.4	Indirect least squares, LIML, Two stage least squares; three stage least squares and FIML estimation methods.	
		Total	**60**

Text books:

1. Apte PG (1980): Text book of Econometrics. Tata McGraw Hill.
2. Carmer, J.S. (1971): Empirical Econometrics, North Holland 3. Gujarathi, D (1979): Basic Econometrics, McGraw Hill.
3. Gujarathi, D. (1979): Basic Econometrics, Mc Graw hill.
4. Koutsoyiannis A. (2001) Theory of Econometrics, Palgrave Macmillan; 2nd edition

Reference Books:

1. Intrilligator, M.D (1980): Econometric Models, Techniques and Applications, Prentice Hall.
2. Johnston, J. (1984): Econometric methods. Third edition, McGraw Hill.
3. Judge, C.G., Griffths, and Hill, R.C. et al (1985): Theory and Practice of Econometrics, John Wiley.
4. Klein, L.R. (1962): An introduction to Econometrics, Prentice Hall India.
5. Malinvaud, E (1966): Statistical methods of Econometrics, North Holland.
6. Theil, H. (1982): Introduction to the theory and practice of Econometrics, John Wiley.
7. Virendera K. Srivastava, David E.A. Giles (1987): Semingly unrelatd regresson eqations models, CRC Press.
8. Walters, A. (1970): An introduction to Econometrics, McMillan & Co.
9. Wetherill, G.B. (1986): Regression analysis with applications, Chapman Hall.

SSTAE403 # COMPUTER GRAPHICS

(Maximum no of periods: 60)

Course pre-requisite:

1. Basics of hardware and software of computer, MS- word, MS-paint.

Course objectives:

- To learn basic concepts used in computer graphics.
- To implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling, clipping, fundamentals of animation, virtual reality and its related technologies.
- To understand a typical graphics pipeline and to design an application.

Course outcomes: After completion of the course students will able to:

- **CO1:** Understand input and output devices of computer.
- **CO2:** Understand how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition.
- **CO3:** Visualize the colors in computer graphics.
- **CO4:** Able to plot curve functions. Comprehend and analyze the fundamentals of animation, virtual reality, underlying technologies, principles, and applications.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Introduction: a) Input/output devices: Keyboard, Mouse, Trackball, Joysticks, Data Glove, Digitizers, Light pen, Touch panels, Image scanners, Printers and plotters.	
	1.2	b) Logical Input Devices: Locator, Stroke, String, Valuator, Choice and Pick.	
	1.3	c) Video Display Devices: Refresh Cathode-Ray Tubes, Raster-Scan Displays, Random-Scan Displays, Colour CRT Monitors, Direct-View Storage Tubes, Flat Panel Displays	
	1.4	d) Raster-Scan Systems: Video Controller, Raster-Scan Display Processor, Random-Scan Systems.	
2.0			**15**
	2.1	Output Primitives: a) Line, Circle, Ellipse and Curve generation algorithm, b) Polygon filling algorithm,	
	2.2	c) Windowing and clipping: Window to Viewport transformation, line clipping and polygon clipping	
	2.3	B) 2D and 3D transformations: a) 2D basic transformation, other transformation, composite transformation, matrix representation and homogeneous transformation	
	2.4	b) 3D concepts: Display models, parallel and perspective projections, c) 3D basic transformation, other transformation & composite transformation.	
3.0			**15**

	3.1	Colours in computer graphics: Chromatic and achromatic light, properties of light, colour lookup tables,	
		Colour models : XYZ, RGB, CMY, HSV, HLS, B) Curve generation: a) Bezier curve, properties of Bezier curve, Cubic Bezier Curve	
	3.2	b) B-Spline curves : i)Uniform, Periodic B Spline, ii) Cubic, periodic B-spline, iii) Open, uniform B- Spline iv)Non-uniform B-spline	
	3.3	c) Beta-Spline: Beta spline continuity conditions, cubic periodic beta spline, matrix Representation, d) Introduction to fractal (Koch and Hilberts curve).	
4.0			
	4.1	Illumination model and shading methods: a) Basic illumination models : Ambient light, diffuse reflection, specular reflection and its Phong model, shadows and transparency, ray tracing, displaying continuous tone images, halftone pattern and Dithering techniques, aliasing and antialiasing b)Phong rendering methods: Constant intensity shading, Gouroud shading, Phong and Fast Phong shading	**15**
	4.2	B) Visible surface detection methods :Classification of visible surface detection algorithm, Back-face detection, depth-buffer method, A-buffer method and Painter's algorithm	
	4.3	C) Design and implementation of Application s/w :Study of advance software platform viz. 3-D studio max, Animator Pro,	
	4.4	Introduction to OPEN GL, comparison with the facilities provided by conventional IDEs viz. CC++, Visual computing environment.	
		Total	**60**

Text books:

1. Rogers, D. F., & Adams, J. A. (1989). Mathematical elements for computer graphics. McGraw-Hill, Inc..
2. Foley, J. D., Van Dam, A., Feiner, S. K., Hughes, J. F., & Phillips, R. L. (1994). Introduction to computer graphics (Vol. 55). Reading: Addison-Wesley.
3. Hill, F. S., & Kelley, S. M. (2007). Computer graphics: using OpenGL. Upper Saddle River: Pearson Prentice Hall.

Reference Books:

1. Hearn, D., Baker, M. P., & Baker, M. P. (2004). Computer graphics with OpenGL (Vol. 3). Upper Saddle River, NJ: Pearson Prentice Hall.
2. Stevens, R. T., & Watkins, C. (1991). Advanced graphics programming in C and C++.
3. Rogers, D. F. (1986). Procedural elements for computer graphics. McGraw-Hill, Inc.
4. Harrington, S. (1987). Computer graphics: a programming approach. McGraw-Hill, Inc.

SSTAE404 **NPTEL/SWAYAM MOOCs**

SVECR401 RESEARCH METHODOLOGY

(Maximum no. of periods 45)

Course pre-requisite: Any Science Graduate

Course objectives:

To develop the research aptitude among the researchers.

To develop the most appropriate methodology for his/her research.

To make them familiar with different research methods and techniques.

Course outcomes: After completion of the course, students should be able to:

- Understand the meaning and importance of research.
- Understand the concept of research design and survey methodology.
- Collection of data, processing of data and descriptive measures of data.
- Inferential analysis of data with hypothesis testing and multivariate techniques

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Research Methodology**	**10**
	1.1	Meaning of research, Objectives of research, Types of research	
	1.2	Research approaches, Significance of research, Research methods versus methodology, Research and scientific methods.	
	1.3	Research processes, Criteria for good research.	
	1.4	Research problem, Selecting the problem, Necessity of defining the problem, Techniques involved in defining a problem.	
2.0		**Research Design and Sample Surveys**	**12**
	2.1	Meaning and need for research design, features of a good design.	
	2.2	Important concepts relating to research design: Dependent and independent variables, Extraneous variables, Control, Research hypothesis, Experimental and non-experimental hypothesis –Testing research, Experimental and control group	
	2.3	Different research designs: Research design in case of exploratory research studies, Research design in case of hypothesis- testing research studies, basic principles of experimental designs,Important Experimental Designs	
	2.4	Sampling Design, steps in sample design, criteria of selecting a sampling procedure, characteristics of a good sample design, different types of sample design	
3.0		**Data Collection and Data Processing**	**12**
	3.1	Measurements in Research, Measurement Scales, Sources of errors in measurement	
	3.2	Collection of primary data: Observation Method, Interview Method, through questionnaires, through schedules, difference between questionnaire and schedule	
	3.3	Collection of secondary data, Selection of appropriate methods for data collection, Case study method	
	3.4	Data processing, processing operations: editing, coding, classification, tabulation, graphical representation, types of analysis, Statistics in research, Dispersion and Asymmetry, Measures of Relationship	

4.0		**Testing of Hypothesis and Chi-Square Test**	
	4.1	Basic Concepts Concerning Testing of Hypotheses, Procedure and Flow diagram for Hypothesis Testing, Measuring the Power of a Hypothesis Test, Tests of Hypotheses , Hypothesis Testing of Correlation Coefficients and Limitations of the Tests of Hypotheses	**11**
	4.2	Chi-Square Test: Chi-Square Test for Comparing Variance, Chi-square as a Non-parametric Test, Conditions for the Application of Chi-Square Test, Steps Involved in Applying Chi-square Test, Important Characteristics of Chi-Square Test and caution in using Chi-Square test. Relationship between Spearman's r's and Kendall's, Characteristics of Distribution-free or Non-parametric Tests	
		Total	**45**

Text book:

1. C. R. Kothari, Research Methodology – Methods and Techniques, (Second Revised Edition), New Age International Publications

Reference Books:

1. Michael Alley, The Craft of Scientific Writing (3rd Edition), Springer, New York,1996
2. Philip Reubens (General editor), Science and Technical Writing – A Manual of Style (2nd Edition), Routledge, New York, 200

M.Sc. Statistics Second semester

	Course Code	Course Name	Credits Assigned		
			Theory	Practical	Total
Major	**SSTAC451**	Regression Analysis	04	--	**04**
	SSTAC452	Statistical Inference	04	--	**04**
	SSTAC453	Stochastic Processes	04	--	**04**
Elective (DSE) (Any one from same Department/ School)	**SSTAE451**	Statistical Methods in Finance	04	--	**04**
	SSTAE452	Categorical Data Analysis			
	SSTAE453	Calculus			
	SSTAE454	NPTEL/SWAYAM MOOCs			
On Job Training	**SSTAO451**	ON Job Training	03	--	**03**
STA Practical	**SSTAP451**	Practical-V	--	03	**03**
Total Credits			**19**	**03**	**22**

SSTAC451 **REGRESSION ANALYSES**

(Maximum no. of periods: 60)

- **Course pre-requisite:**

Basics of data types, correlation, distribution of the data, and theory of estimation**.**

Course objectives:

- To develop a deeper understanding of the linear and non-linear regression model and its limitations.
- To learn how to develop regression model and apply for the specific perspective data appropriate manner.

Course outcomes: After completion of the course students will able to:

- **CO1:** Apply simple linear regression model to real life examples.
- **CO2:** Understand multiple linear regression models with applications and concept of Multicollinearity.
- **CO3:** Understand variable transformation and variable selection process.
- **CO4:** Apply Non-linear regression implementation. Apply Logistic regression and autocorrelation models and its implementation in real life situation.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			
	1.1	Simple linear regression model, assumptions, least square (LS) estimation of parameters,	**15**
	1.2	Hypothesis testing on slope and intercept	
	1.3	Interval estimation in simple linear regression, prediction,	
	1.4	Coefficient of determination, regression through origin, estimation by MLE, random regressor case.	
2.0			
	2.1	Multiple linear regression: least square estimation, error and estimation spaces, variance and covariance of LS estimators, properties of LS estimators.	**15**
	2.2	Testing of hypothesis for one and more than one linear parametric functions, confidence intervals	
	2.3	Hidden exploration, standardized regression coefficient, Multicollinearity: Source, effect, diagnostics, consequences, detection and remedies. Ridge regression.	
	2.4	Model adequacy checking, residual analysis, PRESS Statistic, detection and treatment of outliers, Lack of fit model.	
3.0			
	3.1	Variance stabilization Transformation, Transformations: Linearize model, Analytical method: Box-Cox power Transformation. Generalized weighted least sequence.	**15**
	3.2	Residual and residual diagnostics	
	3.3	Variable selection and model building: Mallows Cp Statistics	
	3.4	Computational techniques for variable selection: forward, backward and step-wise.	
4.0			
	4.1	Robust regression: M-estimators, properties. Non-linear regression models. Least square estimation, Transformation to linear model.	**15**
	4.2	Parameter estimation in non-linear system and its statistical inference.	
	4.3	Generalized linear models: Logistic regression: Logistic transform, ML estimation, tests of hypothesis, Wald test, LR test	
	4.4	Autocorrelation consequences, Durbin Watson test, estimation of parameters in autocorrelation.	
		Total	**60**

Text books:

1. Montgomery D.C., Peck, E.A. and Vining G.G.(2003). Introduction to Linear Regression Analysis,3rd Ed. Wiley.
2. Draper N.R. and Smith, H (1998) applied Regression analysis, 3rd ed. Wiley.
3. Weisberg S. (1985) Applied Linear Regression, Wiley.

Reference Books:

1. Joshi D.D. (1987) Linear Estimation and design and analysis of experiments, Wiley Eastern.
2. Giri N (1986) Analysis of variance, South Asia Publishers.
3. Cook R.D. And Weisberg S. (1982) Residual and influence in Regression, Chapman and Hall.
4. Rao. C.R. (2002) Linear Statistical Inference and its Applications, 2nd Ed. Wiley.
5. Ratkowsky, D. A.(1983) Nonlinear regression modeling, Marcel Dekker.

6. Kutner, Neter, Nachtsheim and Wasserman (2003) Applied Linear Regression, 4th Ed., McGraw-Hill.

SSTAC452 STATISTICAL INFERENCE

(Maximum no of periods: 60)

Course pre-requisite:

- Basics of descriptive statistics, probability distribution.
- Basics of data types, distribution of data, statistical inference etc.

Course objectives:

- To derive suitable point estimators of the parameters of the distribution of a random variable and give a measure of their precision.
- To learn computational skills to implement various statistical inferential approaches.
- To learn the development of null and alternative hypotheses.
- To learn types of errors, non-parametric tests.
- To perform Test of Hypothesis as well as obtain MP, UMP tests.

Course outcomes: After completion of the course students will able to:

- **CO1:** Understand basics of a parametric models, point and interval estimation of the parameters of those models. Understand the concept of sufficiency, exponential and pitman families, MVUE, MVBUE.
- **CO2:** Understand the concept of UMVUE and Bayesian estimation.
- **CO3:** Formulate null and alternative hypotheses and apply small, large sample and non-parametric tests in real life problems. Compute probabilities of types of error, MP tests and MLR property.
- **CO3:** Understand UMP and UMPU test with their applications.
- **CO4:** Obtain asymptotic confidence interval of a parameter and its relation with testing of hypothesis problem.

oduleNo.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Introduction of Parametric models, Point estimation, Interval estimation, Joint distribution of a sample and sampling distribution of a statistic. Likelihood function for discrete and continuous models. Method of estimation: MLE, Methods of moments. Method of minimum Chi-square, methods modified minimum Chi-square, Least square methods	
	1.2	Sufficiency, Sufficient Statistic, Neyman Factorizability criterion. Invariance property of sufficiency under one-one transformation of sample space. Likelihood equivalence, Minimal sufficient Statistic	
	1.3	Exponential families and Pitman families. Fisher information for one and several parameters models Ancillary Statistic, Basu's theorem	
	1.4	Unbiasedness, Minimum Variance Unbiased Estimator, Cramer-Rao lower bound, Cramer-Rao inequality and its applications, Minimum Variance Bound Unbiased Estimator, Uniformly Minimum Variance Bound Unbiased Estimator (UMVUE)	

2.0			
	2.1	Rao-Blackwell theorem, Completeness and Lehmann-Scheffe theorem	**15**
	2.2	Necessary and sufficient condition for UMVUE	
	2.3	Introduction to Bayesian estimation, prior and posterior distribution, loss function	
	2.4	Principle of minimum expected posterior loss, quadratic & other common loss functions, Conjugate family of prior distribution & its examples	
3.0			
	3.1	Simple and Composite hypotheses, Types of errors, size and power of the test. Power function of a test. Randomized and non-randomized tests.	**15**
	3.2	Most powerful (MP) and Uniformly Most powerful (UMP) test	
	3.3	Neyman-Pearson Lemma and its applications.	
	3.4	Generalized Neyman Pearson Lemma. Monotone likelihood ratio (MLR) property.	
4.0			
	4.1	Existence of UMP tests for one and two sided alternatives, their existence and non-existence.	**15**
	4.2	Unbiased test, UMPU tests and their existence in the case of exponential families (Statements only), Similar tests, test with Neyman structure, locally most powerful tests.	
	4.3	Problem of confidence intervals, relation with testing of hypotheses problem	
	4.4	Uniformly Most Accurate (UMA) and Uniformly Most Accurate Unbiased (UMAU) confidence intervals, shortest expected length confidence intervals. Likelihood ratio test	
		Total	**60**

Text books:

1. Kale B.K. (1999) A First course on Parametric Inference, Narosa.
2. Casella G. & Beregar R.L.(2002) Statistical Inference, 2nd edition, Duxbury Advanced series.
3. M K Srivastava, A H Khan, N Srivastava (2014) Statistical Inference :Theory of Estimation 1st ed. Phi learning; 1st edition
4. Srivastava , Manoj Kumar (2009) Statistical Inference: Testing of Hypotheses, Prentice Hall India Learning Private Limited.
5. Rajagopalan (2012) Statistical Inference, Prentice Hall India Learning Private Limited.
6. Kartick Chandra Bhuyan (2010) Probability Distribution Theory and Statistical Inference, New Central Book Agency.

Reference Books:

1. Dudewicz E.J. & Mishra S.N.(1988): Modern Mathematical Statistics, Wiley Series
2. Ferguson T.S (1996): A course on large sample Theory, Chapman and Hall.
3. Ferguson T.S. (1967): Mathematical Statistics: A decision Theoretical Approach. Academic Press.
4. Lehman E.L. (1986) Testing of statistical hypotheses, John Wiley.
5. Lehman E.L. (1987): Theory of Testing of Hypotheses. Student Edition.
6. Lehman E.L. (1988) Theory of point estimation, John Wiley.
7. Rao C. R.(1973) Linear Statistical Inference & its Applications, 2nd Ed., Wiley.
8. Rohatgi V.K.(2001): Introduction to Probability and Mathematical Statistics, Wiley Eastern Ltd. New Delhi.
9. Zacks S. (1971) Theory of Statistical Inference John Wiley and Sons, New York.

SSTAC453 **STOCHASTIC PROCESSES**

(Maximum no. of periods = 60)

- **Course pre-requisite:**

This paper requires basics of exploratory data analysis, data types, basic probability etc.

Course objectives:

- To learn and to understand stochastic processes predictive approach.
- To develop an ability to analyze and apply some basic stochastic processes for solving real life situations.

Course outcomes: After completion of the course students will able to:

- **CO1:** Understand the stochastic processes, Markov chains, Transition probability matrix and various types of states, Random walk, and Gambler ruins problem.
- **CO2:** Understand and apply Poisson process and its real life situations.
- **CO3:** Formulate and solve problems which involve setting up stochastic models.
- **CO4:** Understand renewal theory and branching processes and its real life applications.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Introduction to stochastic Processes (SP's), Classification of SP's according to State space & time domain. Markov chain, countable state Markov chain, construction and calculation of n-step transition probability matrix & its limit.	
	1.2	Conditional probability, unconditional probability with initial distribution, Chapman-Kolmogorov equation	
	1.3	Classification of states, criteria for various states, First time passage time distribution, stability of Markov chain, Ergodic theorem. Limiting Probabilities and Stationary distribution.	
	1.4	Random walk & gambler's ruin problem, absorbing and reflecting barriers, Probability of eventual absorption, expected duration of game Markov chain with continuous state space, examples of various stochastic processes.	
2.0			**15**
	2.1	Poisson process, properties of Poisson process and related distributions	
	2.2	Discrete state space & continuous time Markov chain, pure birth, pure death, Birth and death process.	
	2.3	Limiting probabilities of Birth and death process.	
3.0			**15**
	3.1	Brownian motion/Wiener process, Kolmorgorov equations	
	3.2	first passage time problem in Wiener process, continuous state space	
	3.3	Wiener process as a limit of random walk	
	3.4	differential equation of Wiener process	
4.0			
	4.1	Martingles, Renewal and delayed renewal processes, related theorems, key renewal theorem (without proof) and its application,	**15**

	4.2	Generating functions and its properties. Probability of extinction, Galton-Watson Binaymi Branching process.	
	4.3	Simulation of branching process Probability of ultimate extinction. Continuous time Markov branching process	
	4.4	Distribution of population size and association results. Basic elements of Queuing model. Steady state probabilities and various average characteristics for the models: M/M/1, M/M/1 with balking, M/M/c and M/G/1.	
		Total	**60**

Text books:

1. Bhat, B. R. (2000) Stochastic Models: Analysis and Applications, New Age International, India.
2. Medhi, J. (1994) Stochastic Processes, Wiley Eastern.
3. Ross, S. (2005) Introduction to Probability Models, 6th Ed. Academic Press.

Reference Books:

1. Adke, S. R. and Manjunath, S.M. (1984) An Introduction to finite Markov Processes, Wiley Eastern.
2. Cinlar E.(1975) Introduction to Stochastic Process, Prentice Hall.
3. Feller, W.(1968) Introduction to Probability and its Applications, (Vol.1) Wiley Eastern.
4. Harris, T.E. (1963). The Theory of Branching Processes, (Springer-Verlag).
5. Hoel, P.G., Port, S. C. and Stone, C. J. (1972) Introduction to Stochastic Processes, Houghton Miffin & Co.
6. Jagers, P. (1974) Branching Processes with Biological Applications, Wiley.
7. Karlin & Taylor, A. (1975) First Course in Stochastic Process, (Vol.1) Academic Press.
8. Parzen E. (1962) Stochastic Process, Holden-Pay.
9. Srinivas and Mehta (1976) Stochastic Processes, Tata McGraw Hill, New Delhi.
10. Taylor and Karlin (1984) An Introduction to Stochastic Modeling, Academic Press

SSTAE451 STATISTICAL METHODS IN FINANCE

(Maximum no of periods: 60)

Course pre-requisite:

- **Prerequisites:** Basics of stochastic processes**.**

Course objectives:

- To learn and develop an analytic approach to deal with financial data.

Course outcomes: After completion of the course students will able to:

- **CO1:** Understand the concept of returns, efficient market hypothesis and compounding.
- **CO2:** Understand the concept of one risky and two risky assets, portfolio theory.
- **CO3:** Apply the concept capital asset pricing model.
- **CO4:** Understand option pricing, Value at risk, the concept of re-sampling.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			
	1.1	Introduction and behaviour of Returns,	**15**
	1.2	Origins of Random Walk Hypothesis,	
	1.3	Efficient Market Hypothesis (EMH).	
	1.4	Discrete and Continuous compounding.	
2.0			
	2.1	Trading Off Expected Return and Risk,	**15**
	2.2	One Risky Asset and Two Risky Assets. Combining Two Risky Assets with a Risk-Free Asset	
	2.3	. Risk-Efficient Portfolios with N Risky Assets.	
3.0			
	3.1	Introduction to Capital Asset Pricing Model(CAPM). Capital Market Line(CML).	**15**
	3.2	Betas and the Security Market Line, Security Characteristic Line.	
	3.3	Estimation of Beta and Testing CAPM.	
4.0			
	4.1	Introduction of Option Pricing, Call Options.	**15**
	4.2	The law of One Price. Time value of Money and Present Value, Pricing Calls. Martingales. Introduction of Fixed Income Securities	
	4.3	Zero-Coupon Bonds, Yield to Maturity, Term Structure	
	4.4	Introduction of Resampling, Resampling and efficient Portfolios. Need for Risk Management, Value-At-Risk(VaR) with one asset, VaR for a Portfolio Assets.	
		Total	**60**

Text Books:

1. David Ruppert (2004) Statistics and Finance –An Introduction, Springer Texts in Statistics.

Reference Books:

1. Erik Lindström, Henrik Madsen, Jan Nygaard Nielsen(2018) Statistics for Finance, Chapman & Hall/CRC Texts in Statistical Science, 1st Edition.
2. Hand (1998): Statistics in Finance John Wiley & Sons Inc.
3. ST Rachev (2010): Probability and Statistics for Finance, John Wiley & Sons Inc.

SSTAE452 CATEGORICAL DATA ANALYSIS

(Maximum no of periods: 60)

- **Course pre-requisite:**
  1. This paper requires basic of data types, organization of data, tabulation of data etc.

Course objectives:

- To study distributions for categorical data.
- To describe and make statistical inference for contingency tables.
- To learn different models for categorical data such as Generalized Linear, logit, logistic, log linear and matched pair models.

Course outcomes: After completion of the course students will able to:

- **CO1:** Visualize categorical data, compute measures of association and structural models for discrete data.
- **CO2:** Fit logistic models and Poisson models to data set.
- **CO3:** Check model assumptions and analyze residuals and goodness-of-fit, Conduct inference for model parameters.
- **CO4:** Understand path and structural equation modeling.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Visualizing Categorical data, Measures of association,	
	1.2	Structural models for discrete data in two or more dimensions.	
	1.3	Estimation in complete tables.	
	1.4	Goodness of fit, choice of a model	
2.0			**15**
	2.1	Generalized Linear Model for discrete data,	
	2.2	Components of a Generalized Linear Model, for Binary Data, for Count Data	
	2.3	Statistical Inference and Model Checking	
	2.4	Fitting Generalized Linear Models	
3.0			**15**
	3.1	Logistic regression models, Inference for Logistic Regression,	
	3.2	Logistic Regression with Categorical Predictors	
	3.3	Summarizing Effects in Logistic Regression, Odds-ratio.	
4.0			
	4.1	Product multinomial to model sampling from multiple populations. Elements of inference for cross classification tables. Chi-square approximation for various goodness-of-fit statistics, Models for nominal and ordinal response.	**15**
	4.2	Multicategory Logit Models, for Nominal Responses, for Ordinal Responses, Paired-Category Ordinal Logits, Tests of Conditional Independence	
	4.3	Loglinear Models for Contingency Tables: Loglinear Models for Two-Way and Three-Way Tables	
	4.4	Inference for Loglinear Models, The Loglinear–Logistic Connection, Independence Graphs and Collapsibility, Modeling Ordinal Associations	
		Total	**60**

Text books:

1. Agresti, An Introduction to Categorical Data Analysis Wiley 2007
2. Bilder and Loughlin, Analysis of Categorical data with R, Chapman and Hall/CRC 2014

Reference Books:

1. Kateri, Contingency Table Analysis, Springer 2014
2. Dobson and Barnett: An Introduction to Generalized Linear Models, Chapman & Hall/CRC 2008
3. Hosmer, Lemeshow and Sturdivant, Applied Logistic Regression, Wiley 2013

SSTAE453 CALCULUS

(Maximum no. of periods: 60)

Course pre-requisite:

1. This paper requires basics of real analysis.

Course objectives:

1. To compute and analyze limits, derivatives, and integrals functions.
2. To recognize the appropriate tools of calculus to solve applied problems.

Course outcomes: After completion of the course students will able to:

CO1: Understand the type of variable and useful in the development of the function.
CO2: Verify the value of the limit of a function at a point using the definition of the limit.
CO3: Understand the consequences of the Intermediate value theorem for continuous function.
CO4: Know the chain rule and use it to find derivatives of composite functions and obtain expression for higher order derivatives of a function using the rule of differentiation and able to solve integrals and evaluation of multiple integrals with numerical problems.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Derivatives: Introduction, Definition of derivative, Derivatives and continuity, Algebra of derivatives,	
	1.2	The chain rule, One-sided derivatives and infinite derivatives,	
	1.3	Functions with nonzero derivatives,	
	1.4	Zero derivatives and local extrema.	
2.0			**15**
	2.1	Rolle's theorem, The Mean-Value Theorem for derivatives, Intermediate-Value theorem for derivatives	
	2.2	Taylor's formula with remainder, Partial derivatives, The directional derivative, Directional derivatives and continuity	
	2.3	The total derivative, The total derivative expressed in terms of partial derivatives.	

3.0			
	3.1	The matrix of a linear function, The Jacobian matraix, The chain rule, The Mean-Value Theorem for differentiable functions,.	**15**
	3.2	A sufficient conditions for differentiability, A sufficient condition for equality of mixed partial derivatives, Functions with nonzero Jacobian derterminant	
4.0			
	4.1	The inverse function theorem(statement only), The implicit function theorem(statement only), Extrema of real-valued functions of one variable,	**15**
	4.2	Extremum of real-valued functions of several variables, Extremum problems with side conditions, Line integrals, Line integrals independent path,	
	4.3	Double integrals, Triple integrals.	
		Total	**60**

Text Book:

1. Apostol Tom. M.-Mathematical Analysis: A modern approach to Advanced calculus.(Addison-Wesley)
2. Kreyszig,E. Advanced Engineering Mathematics, Wiley Eastern.

Reference Books:

1. Courant R. And John F.(1965) Introduction to Calculus and Analysis, Wiley.
2. Miller K.S.(1957)Advanced Real Calculus, Harper, New York.
3. Rudin ,Walter(1976) Principles of Mathematical Analysis, McGraw Hill.

SSTAE454 NPTEL/SWAYAM MOOCs

SSTAO451 ON JOB TRAINING (OJT)

(45 Hours)

Course pre-requisite: Basics of data collection, tabulation and analysis of data.

Course objectives:

- It aims to provide necessary practical knowledge and hands-on experience in the application of Statistical tools to solve real-world problems.

Course Outcomes: After completion of the practical students will able to:

- **CO1:** Apply various statistical tools to different societal problems.
- **CO2:** Analyze the real-world data using Statistical techniques and get expertise on use of Statistical tools and software.
- **CO3:** Interpret the results and its output to the end user.
- **CO4:** Explore himself / herself in competitive corporate environment.

In this course, there should be a supervisor from the organization/Institute from which the OJT is being done apart from the internal supervisor. The completion certificate as well as the activity report should be signed by both supervisors.

The objectives of OJT in Statistics are as follows:

1. In the 3-4 weeks of internship with a minimum of 15/21 days (6/5 hours per day) working along with an activity report / conduct a field survey with the analysis and report with an equal amount of work/ any other similar activity. An equivalent amount of work which has to be done in other Government/ Semi-government/ Private Institutions/ Organizations/ Industries, where they can explore their statistical knowledge under the guidance of Faculty/ researchers or Scientists.

OR

The Department may conduct necessary lectures/ training program/ workshops/ seminars as a part of OJT.

2. A student is expected to spend not less than 90 working hours for On Job Training and related activities.
3. Students are expected to gain the practical knowledge under the mentoring of personnel available therein.
4. OJT will be carried out in summer vacation after the students complete their first semester examination.
5. Students need to provide the confirmation letter from the organization or the Institute where they have joined for it.
6. Continuous evaluation of the students' performance in the OJT will be carried out with the assistance of the personnel of training institution/organization where the training is being given.
7. The proof of completion certificate / field report should be submitted duly issued and signed by the concerned training organization.

Evaluation: Students' performance will be evaluated for 75 marks (03 credits) splitted in two parts:

Internal Evaluations: 15 marks based on the certificate of assessment issued by organization, where the student completed his/ her On Job Training.

External/ End Semester Evaluation: 60 marks, out of which 40 marks will be for submitted report of OJT and 20 marks for oral presentation/viva-voce examination.

Practical Courses

The practical based on the core courses will be taken accordingly.

Semester I: SSTAP401 (3 Credit)

Semester II: SSTAP451 (3 Credit)

Semester III: SSTAP501 (2 Credit)

Semester IV: SSTAP551 (2 Credit)

Guidelines for Course Assessment:

A. Continuous Assessment (CA) (20% of the Maximum Marks):

This will form 20% of the Maximum Marks and will be carried out throughout the semester. It may be done by conducting **Two Tests** (Test I on 40% curriculum) and **Test II** (remaining 40% syllabus). Average of the marks scored by a student in these two tests of the theory paper will make his **CA** score (col. 6).

B. End Semester Assessment (80% of the Maximum Marks):

1. **ESA Question paper will consists of 6 questions, each of 20 marks.**
2. **Students are required to solve a total of 4 Questions.**
3. **Question No.1 will be compulsory and shall be based on entire syllabus.**
4. Students need to solve **ANY THREE** of the remaining Five Questions (Q.2 to Q.6) and shall be based on entire syllabus.
5. Practical examination will be based on End semester examination.

Note: **Number of lectures required to cover syllabus of a course depends on the number of credits assigned to a particular course. One credit of theory corresponds to 15 Hours lecturing and for practical course one credit corresponds to 30 Hours. For example, for a course of two credits 30 lectures of one hour duration are assigned, while that for a three credit course 45lectures.**

%%%%%