MAR ATHANASIUS COLLEGE (AUTONOMOUS)
KOTHAMANGALAM, KERALA - 686666

College with Potential for Excellence
NAAC Accredited 'A⁺' Grade Institution

Email: mac@macollege.inwww.macollege.in

CURRICULUM AND SYLLABI FOR

B.VOC PROGRAMME
IN
DATA ANALYTICS AND MACHINE LEARNING
REGULATION, SCHEME AND SYLLABUS

(Under Credit & Semester System)
(2020 ADMISSION ONWARDS)

Contents

Board of Studies Members in Statistics

SL NO	NAME	OFFICIAL ADDRESS
	CHAIRPERSON	
1	SUDHA V	Assistant Professor and Head Department of Statistics Mar Athanasius College, Kothamangalam
	MEMBERS	
2	Dr. NIDHI P RAMESH	Assistant Professor Department of Statistics Mar Athanasius College, Kothamangalam
	EXPERTS (2)	
3	Dr. RANI SEBASTIAN	Assistant Professor Department of Statistics St Thomas College, Thrissur
4	Dr. G. RAJESH	Associate Professor Department of Statistics Cochin University of Science & Technology Kalamassery, Kochi.
	UNIVERSITY NOMINEE	
5	Dr. JAMES KURIEN	Associate Professor and Head. Department of Statistics Maharajas College, Ernakulam
	MEMBER FROM INDUSTRY	
6	Dr. D. DHANURAJ	Chairman Centre for Public Policy Research, Kochi
	MERITORIOUS ALUMNUS	
7	Dr. ABDUL SATHAR E. I.	Professor, Department of Statistics Kerala University, Kariavattom
	SPECIAL INVITEES	
8	SARI THOMAS	Assistant Professor and Course Coordinator Department of Statistics M A College (Autonomous), Kothamangalam
9	GIGI PAULOSE	Assistant Professor Department of Statistics M A College (Autonomous), Kothamangalam
10	ANU V A	Assistant Professor Department of Statistics

		M A College (Autonomous), Kothamangalam
11	ELBY ALIAS	Assistant Professor Department of Statistics M A College (Autonomous), Kothamangalam
12	Dr. T. M. JACOB	Associate Professor Department of Statistics Nirmala College, Muvattupuzha
13	Dr. MADHU S. NAIR	Associate Professor Department of Computer Science Cochin University of Science & Technology Cochin-22
14	Dr. JERIN PAUL	Assistant Professor Department of Statistics Vimala College, Thrissur
15	Dr.RAJESH THUMBAKKARA	Assistant Professor and Head Department of Mathematics Mar Athanasius College, Kothamangalam
16	Smt. SHINY JOHN	Assistant Professor and Head Department of Computer Science Mar Athanasius College, Kothamangalam

SCHEME AND SYLLABUS

The University Grants Commission (UGC) had launched a scheme on 27 February, 2014 for skills development based higher education as part of college/university education, leading to Bachelor of Vocation (B.Voc.) degree with multiple entry and exit points. Considering the implementation modalities, the guidelines of the scheme have been revised in the year 2015. The B.Voc. the programme is focused on universities and colleges providing undergraduate studies which would also incorporate specific job roles and their NOSs along with broad based general education. This would enable the graduates completing B.Voc to make a meaningful participation in accelerating India's economy by gaining appropriate employment, becoming entrepreneurs and creating appropriate knowledge.

Objectives

1. To provide a judicious mix of skills relating to a profession and appropriate content of general education.

2. To ensure that the students have adequate knowledge and skills, so that they are work ready at each exit point of the programme.

3. To provide flexibility to students by means of pre-defined entry and multiple exit points.

4. To integrate NSQF within the undergraduate level of higher education in order to enhance employability of the graduates and meet industry requirements. Such graduates apart from meeting the needs of local and national industry are also expected to be equipped to become part of the global workforce.

5. To provide vertical mobility to students coming out of (a) 10+2 with vocational subjects; and (b) Community Colleges.

Governance and Coordination

An Advisory Committee will be set-up for effective governance and coordination of the courses under the scheme. The Advisory Committee will include the representative(s) of the affiliating university, relevant industries, relevant Sector Skills Council(s), and Nodal Officer of B.Voc Scheme. The Vice Chancellor of the university or his Nominee or Principal of the college, as the case may be, will be the Chairman of the Advisory Committee and the Nodal Officer will be the

Member-Secretary. The Committee will meet periodically to review the functioning of the courses, as and when required, but at least once in six months. The Advisory Committee will also ensure the timely submission information to UGC and uploading of data in Skill Development Monitoring

System (SDMS). Nodal Officer will submit quarterly progress report to UGC and copy of the same may also be endorsed to Head, Standards & Q.A., National Skill Development Corporation, Block A, Clarion Collection, Shaheed Jeet Singh Marg, New Delhi - 110016.

Assessment

i.   The Skill component of the course will be assessed and certified by the respective Sector Skill Councils. In case, there is no Sector Skill Council for a specific trade, the assessment may be done by an allied Sector Council or the Industry partner. The certifying bodies may comply with and obtain accreditation from the National Accreditation Board for Certification Bodies (NABCB) set up under Quality Council of India (QCI). Wherever the university/college may deem fit, it may issue a joint certificate for the course(s) with the respective Sector Skill Council(s).

ii.   The credits for the skill component will be awarded in terms of NSQF level certification which will have 60% weightage of total credits of the course in the following manner.

Name of the Course	NSQF Level Certificate	Cumulative Credits
Certificate	Level – 4	18 credits
Diploma	Level – 5	36 credits
Advanced Diploma	Level – 6	72 credits
B.Voc Degree	Level – 7	108 credits

iii.   The general education component will be assessed by the concerned university as per the prevailing standards and procedures. The following formula may be used for the credit calculation in general education component of the courses:

   • General Education credit refers to a unit by which the course work is measured. It determines the number of hours of instructions required per

week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week. Accordingly, one Credit would mean the equivalent of 1415 periods of 60 minutes each or 28 – 30 hrs of workshops / labs.

- For internship / field work, the credit weightage for equivalent hours shall be 50% of that for lectures/tutorials.

- For self-learning, based on e-content or otherwise, the credit weightage for equivalent hours of study shall be 50% of that for lectures / tutorials.

GRADUATE ATTRIBUTES

Job Roles proposed to be covered in each year (Along with NSQF level)

Semester / Year	NSQF Level

First Semester	**Level 4**
	1. Domestic Data Entry Operator
	    NOS REFERENCE ID: SSC/Q2212
	Maintain proper entry of required data of customers through use of various data entry softwares and techniques.
	2. Collections Executive
	    NOS REFERENCE ID: SSC/Q2214
	Individuals in this job are responsible for reconciliation of customer accounts through payment follow ups, sending payment reminders, investigating and solving customers' problems, which may lead to delay in payments, and communicating the right information to the customers.
	3. Domestic IT Helpdesk Attendant
	    NOS REFERENCE ID: SSC/Q0110
	Managing and resolving client queries / issues primarily through telephonic calls.
	• Statistical Enumerator: Statistical Data Collection and preprocessing tasks.
	• Office Assistant: Administrative tasks, word processing jobs and maintaining records in an office.

	• DTP Operators: Operates office equipment such as printers, copy machines. Akshaya e-centre personnel: Giving e-literacy training to ASHA workers, Anganvadi workers etc.

Year I	**Level 5**
	
	1. Associate: Customer Relationship Management
	
	        NOS REFERENCE ID: SSC/Q2202
	
	Individuals in this job receive and make telephone calls which are primarily scripted, basic and routine with the assistance of a computerized system. They answer inquiries, resolve problems, record complaints and/or receive feedback.
	
	2. Associate – Recruitment
	
	        NOS REFERENCE ID: SSC/Q2501
	
	Individuals at this job are responsible for supporting recruitment activities such as candidate management, first level screening,scheduling and coordination and headhunting.
	
	3. Technical Support Executive-Non-Voice
	
	        NOS REFERENCE ID: SSC/Q7201
	
	Individuals at this job are responsible for resolving queries and customer cases over web-chat or email.
	
	4. Associate-Customer Care (Non-Voice)
	
	        NOS REFERENCE ID: SSC/Q2201
	
	Individuals at this job are responsible for resolving queries and customer cases over web-chat or email.
	
	5. Technical Writer
	
	        NOS REFERENCE ID: SSC/Q0505
	
	Individuals at this job are responsible for creating technical documentation related to an application like job-aids, help documents and training materials. These documents serve the core purpose of transferring knowledge between the application development teams and the user teams. The information may be presented in the form of user guides for software applications,

	reference manuals, training guides or online help incorporated into software and operating guides. • Statistical Investigator: Statistical Data Collection and analyses tasks. Data Analyst

Year-II	**Level 6**
	
	   1. <u>AI - Data Quality Analyst</u>
	
	       <u>NOS REFERENCE ID: SSC/Q8101</u>
	
	Individuals at this job are responsible for performing different aspects of data quality management. S/he will be responsible for importing and preprocessing data as per pre-defined specifications or as desired for analysis.
	
	   2. <u>AI - Business Intelligence Analyst</u>
	
	       <u>NOS REFERENCE ID: SSC/Q8102</u>
	
	Individuals at this job are responsible for performing different aspects of Business Analysis. S/he will be responsible for importing and pre-processing data and perform exploratory analysis to derive actionable insights.
	
	   3. <u>AI - Visualization Specialist</u>
	
	       <u>NOS REFERENCE ID: SSC/Q8103</u>
	
	Individuals at this job are responsible for performing different aspects of visualization. S/he will be responsible for creating reports, charts and dashboards using appropriate visualization tools. S/he will also ensure that the desired output is available across different formats based on the needs of various users.
	
	• Business Process Outsourcer: Enable to undertake and carry out data processing activities in computerized environments. Analyse business operations, trends, costs, revenues, financial commitments

Year-III	**Level 7** 1. <u>AI - Test Engineer</u> <u>NOS REFERENCE ID: SSC/Q8116</u>

	Individuals at this job are responsible for performing different aspects of product testing. S/he will be responsible for developing test cases and simulations for end-to-end testing and QA of hardware and software systems.
	2. <u>AI - Data Steward</u>
	<u>NOS REFERENCE ID: SSC/Q8111</u>
	Individuals at this job are responsible for defining data standards, assessing quality, completeness and timeliness of data. They are also responsible for implementing good data governance processes and practices.
	3. <u>Technical Writer</u>
	<u>NOS REFERENCE ID:</u> <u>SSC/Q4501</u> Individuals at this job are responsible for creating technical documentation related to an application like job-aids, help documents and training materials. These documents serve the core purpose of transferring knowledge between the application development teams and the user teams. The information may be presented in the form of user guides for software applications, reference manuals, training guides or online help incorporated into software and operating guides.
	4. <u>Junior Data Associate</u>
	<u>NOS REFERENCE ID: SSC/Q0401</u>
	Individuals at this job are responsible for designing and implementing processes and layouts for complex, large-scale data sets used for
	modeling, data mining, and research purposes. Responsibilities also include designing and implementing statistical data quality procedures around new data sources.
	5. <u>AI - Machine Learning Engineer</u>
	<u>NOS REFERENCE ID: SSC/Q8113</u>

	Individuals at this job are responsible for developing applications and platforms in AI & Big Data Analytics. S/he will be responsible for developing software code to deploy algorithmic models as per the needs of the business and evaluating the technical performance of the same.
	6. <u>AI - Applied Scientist</u>
	<u>NOS REFERENCE ID: SSC/Q8105</u>
	Individuals at this job are responsible for performing different aspects of data science. S/he will be responsible for importing and preprocessing data, performing exploratory analysis and applying pre-designed algorithmic models for various use cases/scenarios. 7. <u>AI - Data Engineer</u>
	<u>NOS REFERENCE ID: SSC/Q8106</u>
	Individuals at this job are responsible for working on different aspects of data architecture. S/he will be responsible for developing data integrations.
	8. <u>AI - Database Administrator</u>
	<u>NOS REFERENCE ID: SSC/Q8109</u>
	Individuals at this job are responsible for performing different aspects of administration and governance. S/he will be responsible for creating and maintaining databases.
	• Entrepreneurship: Pursue self-employable opportunities in business process services.
	Data Analyst: Can carry out Statistical Data Analysis activities

AIMS AND OBJECTIVES

Data Science is a multidisciplinary field that utilizes logical techniques, procedures, calculations and frameworks to separate information and bits of knowledge from organized and unstructured data. Data Science is an idea to bind together Statistics, data investigation, AI and their related techniques so as to understand and analyse the actual phenomena within the data. It utilizes procedures and hypotheses drawn from numerous fields inside the setting of Mathematics, Statistics, Computer Science and Information science. Turing award winner Jim Gray envisioned Data Science as a "fourth paradigm" of science. Data Science, as a field of study, is making a boom all over the world. It is being applied to every aspect of life. Newer domains of applications are being found out. All these points to the importance of getting knowledge in Data Science concepts for a job aspirant student.

The proposed vocational programme in Data Analytics and Machine Learning will be a judicious mix of skills, professional education related to Data Analytics and Machine Learning and also appropriate content of general education. It is designed with the objective of equipping the students to cope with the emerging trends and challenges in the field of Data Analytics and Machine Learning.

PROGRAMME DESIGN

As per the UGC guidelines, there are multiple exit points for a candidate admitted in this course. If he/she is completing all the six credits successfully, he/she will get B. Voc. Degree in Data Analytics and Machine Learning. If he/she is completing the first four semesters successfully, he/she will get an Advanced Diploma in Data Analytics and Machine Learning. If he/she is completing the first two semesters successfully, he/she will get a Diploma in Data Analytics and Machine Learning. If he/she is completing the first one semester successfully, he/she will complete a Certificate Course in Data Analytics and Machine Learning.

Cumulative credits awarded to the learners in skill based vocational courses.

NSQF Level/Year	Skill Component Credits	General Component Credits	Normal Duration	Exit Points/ Awards
Level 7/Year 3	108	72	Six Semesters	B. Voc. Degree
Level 6/Year 2	72	48	Four Semesters	Advanced Diploma
Level 5/Year 1	36	24	Two Semesters	Diploma
Level 4/6 Months	18	12	One Semester	Certificate Course

The curriculum in each of the years of the programme would be a suitable mix of general education and skill development components. As is evident from Table above, the General Education Component shall have 40 % of the total credits and balance 60% credits will be of Skill Component.

The curriculum details should be finalized before introduction of the courses.

NATURE OF THE COURSE

i.   No open course is envisaged

ii.   No Electives are included

iii.   Total credits are 180

iv.   Working hours per week is 30 hours

v.   All vocational subjects are treated as core course

vi.   Multiple exit points are permitted.

vii.   A candidate who failed in a semester may get two supplementary chances. Only failed papers are to be written in the supplementary examination.

PROGRAMME STRUCTURE

   a) Title

   Regulations for conducting B. Voc Programme under Mahatma Gandhi University

   b) Scope

   The regulations stated in this document shall apply to all B.Voc Programmes conducted by colleges affiliated to Mahatma Gandhi University, sanctioned by University Grants Commission with effect from 2014 admission.

c) Definitions

B.Voc: Bachelor of Vocation-is a scheme introduced by UGC for skill development based higher education as part of college/university education.

NSQF: National Skills Qualification Framework

Programme: A Programme refers to the entire course of study and examinations for the award of the B. Voc degree.

Semester: A term consisting of a minimum of 450 contact hours distributed over 90 working days, inclusive of examination days, within 18 five- day academic weeks.

Course: Refers to the conventional paper, which is portion of the subject matter to be covered in a semester. A semester shall contain many such courses from general and skill development areas.

Credit: B. Voc programme follows a credit semester system and each Course has an associated credit.

Grade: Uses seven-point grading system suggested by Hrdayakumari Commission to assess the students.

Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes.

Eligibility for Admission

Pass in Plus Two of the Higher Secondary Board of Kerala or that of any other University or Board of Examinations in any state recognized as equivalent to the Plus Two of the Higher Secondary Board in Kerala, with Mathematics as one of the mandatory subjects. The total no. of seats allotted is 30.

The B.Voc. Data Analytics and Machine Learning shall include:

a) Language courses

b) General Education Components

c) Skill Components

d) Internship

e) Field Visits

f) Project

g) Soft Skills and Personality Development Programmes

h) Study tours

Calculation of Index Marks

Total marks obtained in Part III of the qualifying examination less handicap marks plus marks obtained for Mathematics plus bonus marks if any.

Marks obtained for the subjects in streams other than Kerala State streams, viz., CBSE, CISCE etc., will be standardized to that of Kerala Higher Secondary i.e., 200 marks per paper (200marks X 6=1200 i.e., total marks). Marks obtained for vocational subjects in VHSE/THSE, etc. are to be excluded while calculating index marks.

B.Voc. Data Analytics and Machine Learning

A	Program Duration	6 Semesters
B	Total Credits required for successful completion of the Programme	180
C	Credits required from Common Course I	24
D	Credits required from Skill course and General courses including Project	156
E	Minimum attendance required	75%

SCHEMES OF COURSES

Sl. No.	Courses	No. of Papers	Credits
1.	General Education Components (+ Common Courses)	18	72
2.	Skill Components	27	99
3.	Project	1	5
4.	Internship	1	4
Total		**47**	**180**

DURATION OF THE COURSE

- The duration of U.G. Programmes shall be 6 semesters. Each semester shall have 90 working days inclusive of all examinations.
- A student may be permitted to complete the programme, on valid reasons, within a period of 12 continuous semesters from the date of commencement of the first semester of the programme.
- Attendance: Students having a minimum of 75% average attendance for all the courses only, can register for the examination.

Readmission

Readmission will be allowed as per the prevailing rules and regulations of the university.

There shall be 3 level monitoring committees for the successful conduct of the scheme. They are:

1. Department Level Monitoring Committee (DLMC), comprising HOD and two senior-most teachers as members.
2. College Level Monitoring Committee (CLMC), comprising Principal, Dept. Co – Ordinator and A.O/Superintendent as members.
3. University Level Monitoring Committee (ULMC), headed by the Vice – Chancellor and Pro –Vice – Chancellor, Convener of Syndicate subcommittees on Examination, Academic Affairs and Staff and Registrar as members and the Controller of Examinations as member-secretary.

EXAMINATIONS

The evaluation of each course shall contain two parts:

(i) Internal or In-Semester Assessment (ISA)

(ii) External or End-Semester Assessment (ESA)

- The internal to external assessment ratio shall be 1:4.
- Both internal and external marks are to be rounded to the next integer.
- Grades are given **on a 7-point scale** based on the total Percentage of marks,

    (ISA+ESA) as given below: -

Percentage of Marks	Grade	Grade Point
95 and above	S Outstanding	10
85 to below 95	A+ Excellent	9
75 to below 85	A Very Good	8
65 to below 75	B+ Good	7
55 to below 65	B Above Average	6
45 to below 55	C Satisfactory	5
35 to below 45	D Pass	4
Below 35	F Failure	0
	Ab Absent	0

Note: Decimal are to be rounded to the next whole number

GRADE POINT AND GRADE POINT AVERAGE

Grade Point (GP) of a course is calculated using the formula

CP = C × GP, where C = Credit; GP = Grade point

Semester Grade Point Average (SGPA) of a Semester is calculated using the formula: -
SGPA = TCP/TC, where TCP is the Total Credit Point of that semester.

Cumulative Grade Point Average (CGPA) is calculated using the formula: -

CGPA = TCP/TC, where TCP is the Total Credit Point of that programme.

Grade Point Average (GPA) of different category of courses viz. Common Course I, Common Course II, Complementary Course I, Complementary Course II, Vocational course, Core Course is calculated using the formula: -

GPA = TGP/TG, where TGP is the Total Grade Point of a category of course. TG is the total grade of that category of course

Grades for the different courses, semesters and overall programme are given based on the corresponding CPA.

CPA

GPA	Grade
9.5 and above	**S Outstanding**
8.5 to below 9.5	**A+ Excellent**
7.5 to below 8.5	**A Very Good**
6.5 to below 7.5	**B+ Good**
5.5 to below 6.5	**B Above Average**
4.5 to below 5.5	**C Satisfactory**
3.5 to below 4.5	**D Pass**
Below 3.5	**F Failure**

MARKS DISTRIBUTION FOR EXTERNAL AND INTERNAL EVALUATIONS

The external theory examination of all semesters shall be conducted by the College at the end of each semester. Internal evaluation is to be done by continuous assessment. For all courses without practical, total marks of external examination is 80 and total marks of internal evaluation is 20. Marks distribution for external and internal assessments and the components for internal evaluation with their marks are shown below:

For all Theory Courses

1) **Marks of external Examination: 80**

2) **Marks of internal evaluation   : 20**

Components of Internal Evaluation–Theory	Marks
Attendance	5
Assignment/Seminar/Viva	5
Test paper (s)(1 or 2) (1×10=10;2×5=10)	10
Total	20

For all Practical Courses total marks for external evaluation is 80 and total marks for internal evaluation is 20.

For all Practical Courses

a) **Marks of external Examination**   : 80
b) **Marks of internal evaluation**   : 20

Components of Internal Evaluation–Practical	Marks
Attendance	5
Record	5
Skill Test	5
Lab Performance / Punctuality	5
Total	20

*Marks awarded for Record should be the related to number of experiments recorded and duly signed by the teacher concerned in charge.

All three components of internal assessments are mandatory.

PROJECT EVALUATION

a)   **Marks of external Examination**   :   80
b)   **Marks of internal evaluation**   :   20

Components of Internal Evaluation	Marks
Punctuality	5
Experimentation/Data Collection	5
Skill Acquired	5
Report	5
Total	**20**

Components of External Evaluation	Marks
Dissertation (External)	50
Viva-Voce (External)	30
Total	**80**

(Decimals are to be rounded to the next higher whole number)

INTERNSHIP

After the completion of fourth semester, the student will undergo Internship Programme in an Industry, having a good exposure in the concerned skill (Established at least two years prior), capable of delivering the skill sets to the students.

At the end of the Internship, the students should prepare a comprehensive report.

a) **Marks of external Examination** **:** **80**
b) **Marks of internal evaluation** **:** **20**

Components of Internal Evaluation	Marks
Punctuality	5
Internal Viva Voce	5
Skill Acquired	5
Report	5
Total	**20**

Components of External Evaluation	Marks
Report	50
Viva-Voce (External)	30
Total	**80**

(Decimals are to be rounded to the next higher whole number)

Attendance Evaluation for all papers

Attendance Percentage	Marks
Lessthan75%	1 Mark
75% & less than 80%	2 Marks
80% & less than 85%	3 Marks
85% & less than 90%	4 Marks
90% & above	5 Marks

(Decimals are to be rounded to the next higher whole number)

ASSIGNMENTS

Assignments are to be done from 1st to 4th Semesters. At least one assignment per course per semester should be submitted for evaluation.

INTERNAL ASSESSMENT TEST PAPERS

Two test papers are to be conducted in each semester for each course. The evaluations of all components are to be published and are to be acknowledged by the candidates. All documents of internal assessments are to be kept in the college for one year and shall be made available for verification by the University. The responsibility of evaluating the internal assessment is vested on the teacher(s), who teach the course.

GRIEVANCE REDRESSAL MECHANISM

Internal assessment shall not be used as a tool for personal or other type of vengeance. A student has all rights to know, how the teacher arrived at the marks. In order to address the grievance of students, a three-level Grievance Redressal mechanism is envisaged. A student can approach the upper level only if grievance is not addressed at the lower level.

Level 1: Department Level:

The Department cell chaired by the Nodal Officer/HOD, Department Coordinator, Faculty Advisor and Teacher in-charge as members.

Level 2: **College level**

A committee with the Principal as Chairman, College Coordinator, HOD of concerned Department and Department Coordinator as members.

Level 3: **University Level**

A Committee constituted by the Vice-Chancellor as Chairman, Pro-Vice-Chancellor, Convener - Syndicate Standing Committee on Students Discipline and Welfare, Chairman- Board of Examinations as members and the Controller of Examination as member- secretary.

The College Council shall nominate a Senior Teacher as coordinator of internal evaluations. This coordinator shall make arrangements for giving awareness of the internal evaluation components to students immediately after commencement of I semester

The internal evaluation marks/grades in the prescribed format should reach the University before the 4th week of October and March in every academic year.

EXTERNAL EXAMINATION

The external examination of all semesters shall be conducted by the University at the end of each semester.

- Students having a minimum of 75% average attendance for all the courses only can register for the examination. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of 2 times during the whole period of the programme may be granted by the University on valid grounds. This condonation shall not be counted for internal assessment. Benefit of attendance may be granted to students attending University/College union/Co-curricular activities by treating them as present for the days of absence, on production of participation/attendance certificates, within one week, from competent authorities and endorsed by the Head of the institution. This is limited to a maximum of 10 days per semester and this benefit shall be considered for internal assessment also. Those students who are not eligible even with condonation of shortage of attendance shall repeat the **semester** along with the next batch after obtaining readmission.

- Benefit of attendance may be granted to students attending University/College union/Co- curricular activities by treating them as present for the days of absence, on production of participation/attendance certificates, within one week, from competent authorities and endorsed by the Head of the institution. This is limited to a maximum of 10 days per semester and this benefit shall be considered for internal assessment also.

- Those students who are not eligible even with condonation of shortage of attendance shall repeat the course along with the next batch.

- There will be no supplementary exams. For reappearance/ improvement, the students can appear along with the next batch.

- Student who registers his/her name for the external exam for a semester will be eligible for promotion to the next semester.

- A student who has completed the entire curriculum requirement, but could not register for the Semester examination can register notionally, for getting eligibility for promotion to the next semester.

- A candidate who has not secured minimum marks/credits in internal examinations can redo the same registering along with the University examination for the same semester, subsequently.

PATTERN OF QUESTIONS

Questions shall be set to assess knowledge acquired, standard and application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. The question setter shall ensure that questions covering all skills are set. She/he shall also submit a detailed scheme of evaluation along with the question paper. A question paper shall be a judicious mix of short answer type, short essay type /problem solving type and long essay type questions.

Pattern of questions for external examination–Theory paper (GC & SC)

Question Type	Total no. of questions	Number of questions to be answered	Marks of each question	Total marks
Very short answer type	12	10	2	20
Short answer (Not to exceed 60 words)	9	6	5	30
Long essay	4	2	15	30
TOTAL	**25**	**18**		**80**

Pattern of questions for external lab examination

Question Type	Total no. of questions	Number of questions to be answered	Marks of each question	Total marks
Skill Assessment- Practical	1	1	50	50
TOTAL	**1**	**1**		**50**

Record	Theory/ Procedure/ Design	Activity/ Neatness	Result	Viva	Total
10	30	10	10	20	80

PROGRAMME OUTCOMES FOR UNDERGRADUATE PROGRAMMES

PO No:	. Upon completion of undergraduate programme, the students will be able to
PO-1	Understand the discipline at both theoretical and application levels.
PO-2	Achieve an aim to expand their studies in the discipline at higher level.
PO-3	Work as a team with enhanced communication and coordination skills.
PO-4	Attain skills for employment in their programme related professions.
PO-5	Acquire awareness on socio-cultural and environmental issues.
PO-6	Develop entrepreneurship and leadership abilities.
PO-7	Inculcate a sense of ethics, discipline, time management, emotional intelligence and self-awareness.
PO-8	Expand the mindset to pursue lifelong learning.

PROGRAMME SPECIFIC OUTCOMES OF B.Voc DATA ANALYTICS AND MACHINE LEARNING

PSO No.	Upon completion of B.Voc Data Analytics and Machine Learning programme, the students will be able to :	PO No:
PSO 1	Ability to apply knowledge of basic sciences, mathematics, probability and statistics, computer science and solve problems.	1,4,7
PSO 2	Ability to understand, model, analyse, design effective algorithm, visualize and realize physical systems or processes of increasing size and complexity.	1,2,4,7,8
PSO 3	Development of soft skills and practicing professional ethics, cyber regulations, responsibilities, and norms of professional computing practices.	5,7
PSO 4	The ability to understand, analyse and demonstrate the knowledge of human cognition, Machine Learning and data engineering in terms of real-world problems to meet the challenges of the future.	1,2,4,6
PSO 5	An ability to analyse very large data sets in the context of real-world problems and interpret results using data analytics.	1,2,4,6
PSO 6	Develop skills via group projects, assignments, seminar presentations and viva voce sessions.	1,3,6,8
PSO 7	Acquire the skills in handling scientific tools towards problem solving and apply research-based knowledge for solution analysis.	1,4,7

PROGRAMME STRUCTURE

		Semester – I			
Sl. No.	Course Code	Title	GC/SC/CC	Hrs/Week	Credits
1	UG20BV1CC01	Listening and Speaking Skills in English	CC	4	4
2	UG20DM1GC01	Introduction to IT	GC	4	4
3	UG20DM1GC02	Calculus and Real Analysis	GC	4	4
4	UG20DM1SC01	Descriptive Statistics	SC	4	4
5	UG20DM1SC02	Introduction to Python Programming	SC	4	4
6	UG20DM1SC03	Office Automation Packages	SC	3	3
7	UG20DM1P01	Python Lab (SC104)	SC-Practical	4	4
8	UG20DM1P02	Office Automation Lab (SC105)	SC-Practical	3	3

		Semester – II			
Sl. No.	Course Code	Title	CC/GC/SC	Hrs/Week	Credits
1	UG20BV2CC01	Reading Skills	CC	4	4
2	UG20DM2GC01	Statistical Distributions	GC	4	4
3	UG20DM2GC02	Linear Algebra I	GC	4	4
4	UG20DM2SC01	Introduction to R Programming	SC	4	4
5	UG20DM2SC02	Statistical Inference	SC	4	4
6	UG20DM2SC03	Introduction to DBMS	SC	4	4
7	UG20DM2P01	R Lab (SC203)	SC-Practical	3	3
8	UG20DM2P02	DBMS Lab (SC205)	SC-Practical	3	3

		Semester – III			
Sl. No.	Course Code	Title	CC/GC/SC	Hrs/Week	Credits
1	UG20BV3CC01	Writing and Presentation Skills	CC	4	4
2	UG20DM3GC01	Enterprise Resource Planning	GC	4	4
3	UG20DM3GC02	Linear Algebra II	GC	4	4
4	UG20DM3SC01	Advanced Python Programming	SC	4	4
5	UG20DM3SC02	Advanced R Programming	SC	4	4
6	UG20DM3SC03	Multivariate Analysis	SC	4	4
7	UG20DM3P01	Advanced Python Lab (SC303)	SC-Practical	3	3
8	UG20DM3P02	Advanced R Lab (SC304)	SC-Practical	3	3

		Semester – IV			
Sl. No.	Course Code	Title	CC/GC/SC	Hrs/Week	Credits
1	UG20BV4CC01	Soft Skills and Personality Development	CC	4	4
2	UG20DM4GC01	Business Ethics	GC	4	4
3	UG20DM4GC02	Fuzzy Mathematics	GC	4	4
4	UG20DM4SC01	Sampling and Design of Experiments	SC	4	4
5	UG20DM4SC02	Time Series Analysis	SC	4	4
6	UG20DM4SC03	Machine Learning I	SC	4	4
7	UG20DM4P01	Machine Learning I Lab (SC405)	SC-Practical	3	3
8	UG20DM4P02	Time Series Lab (SC403)	SC-Practical	3	3

Semester – V

Sl. No.	Course Code	Title	CC/GC/SC	Hrs/Week	Credits
1	UG20BV5CC01	Environmental Studies and Human Rights	CC	4	4
2	UG20DM5GC01	Business Informatics	GC	4	4
3	UG20DM5GC02	Operations Research and Numerical Methods I	GC	4	4
4	UG20DM5SC01	Data Mining	SC	4	4
5	UG20DM5SC02	Machine Learning II	SC	4	4
6	UG20DM5SC03	Internship	SC-Practical	4	4
7	UG20DM5P01	Machine Learning II Lab (SC504)	SC-Practical	3	3
8	UG20DM5P02	Data Mining Lab (SC503)	SC-Practical	3	3

Semester – VI

Sl. No.	Course Code	Title	CC/GC/SC	Hrs/Week	Credits
1	UG20BV6CC01	Entrepreneurship Development	CC	4	4
2	UG20DM6GC01	Principles of Management	GC	4	4
3	UG20DM6GC02	Operations Research and Numerical Methods II	GC	4	4
4	UG20DM6SC01	Natural Language Processing	SC	4	4
5	UG20DM6SC02	Big Data and Data Engineering	SC	5	5
6	UG20DM6SC03	Project	SC	5	5
7	UG20DM6P01	Big Data Lab (SC604)	SC-Practical	4	4

GC – General Component
SC – Skill Component
CC – Common Course

B.Voc. in Data Analytics and Machine Learning

Detailed Syllabus

SEMESTER I

UG20BV1CC01 - Listening and Speaking Skills in English
CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Module 1

Speech Sounds: Phonemic symbols – Vowels – Consonants – Syllables – Word stress – Stress in polysyllabic words – Stress in words used as different parts of speech – Sentence stress – Weak forms and strong forms – Intonation

Sample activities:

1. Practice reading aloud. Use a variety of texts including short stories, advertisement matter, brochures, etc.
2. Read out a passage and ask the students to identify the stressed and unstressed syllables.

Module 2

Basic Grammar: Articles - Nouns and prepositions - Subject-verb agreement -Phrasal verbs - Modals - Tenses - Conditionals – Prefixes and suffixes – Prepositions -Adverbs– Relative pronouns - Passives - Conjunctions - Embedded questions - Punctuation – Abbreviations-concord- collocations-phrasal verbs- idiomatic phrases

Sample activities:

• Ask students to write a story/report/brochure, paying attention to the grammar.

Module 3

Listening: Active listening – Barriers to listening – Listening and note taking – Listening to announcements – Listening to news on the radio and television.

Sample activities:

1. Information gap activities (e.g., listen to a song and fill in the blanks in the lyrics given on a sheet)
2. Listen to BBC news/ a play (without visuals) and ask the students to report what they heard.

Module 4

Speaking- Fluency and pace of delivery – Art of small talk – Participating in conversations – Making a short formal speech – Describing people, place, events and things – Group discussion skills, interview skills and telephone skills.

Sample activities:

1. Conduct group discussion on issues on contemporary relevance.
2. Ask students to go around the campus and talk to people in the canteen, labs, other departments etc. and make new acquaintances.

Book of Study

1. English for Effective Communication. Oxford University Press, 2013.

References

1. Marks, Jonathan. English Pronunciation in Use. New Delhi: CUP, 2007.
2. Lynch, Tony. Study Listening. New Delhi: CUP, 2008.

Learning Pedagogy: Chalk and talk, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.
Assessment Tools: Assignments, Seminar, Test papers, End semester examination

UG20DM1GC01- Introduction to IT

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

<u>Objectives of the Course</u>

On completion of the course, the student should be able to:

1. Understand the fundamentals of computer hardware and software.
2. Provides an overview of a personal computer operating system.

Module 1

Computer characteristics: Speed, storage, accuracy, diligence; Digital signals, Binary System,ASCII; Historic Evolution of Computers; Classification of computers: Microcomputer, Minicomputer, mainframes, Supercomputers; Personal computers: Desktop, Laptops, Palmtop, Tablet PC; Hardware & Software; Von Neumann model.

Module 2

Hardware: CPU, Memory, Input devices, output devices. Memory units: RAM, ROMdifferent types: Flash memory; Auxiliary storage: Magnetic devices, Optical Devices; Floppy, Hard disk, Memory stick, CD, DVD, CD-Writer; Input devices - keyboard, mouse, scanner, speech input devices, digital camera, Touch screen, Joystick, Optical readers, bar code reader; Output devices: Display device, size and resolution; CRT, LCD; Printers: Dot-matrix, Inkjet, Laser; Plotters, Sound cards & speaker.

Module 3

Software: System software, Application software; concepts of files and folders, Introduction to Operating systems, Different types of operating systems: single user, multitasking, timesharing multi-user; Booting, POST; Basic features of two GUI operating systems: Windows & Linux (Basic desk top management); Programming Languages, Compiler, Interpreter, Databases; Application softwares: Generic Features of Word processors, Spread sheets and Presentation softwares; Generic Introduction to Latex for scientific typesetting; Utilities and their use; Computer Viruses & Protection, Free software, open source.

Module 4

Computer Networks: Connecting computers, Requirements for a network: Server, Workstation, switch, router, network operating systems; Internet: brief history, World Wide Web, Websites, URL, browsers, search engines, search tips; Internet connections: ISP, Dialup, cable modem, WLL, DSL, leased line; email, email

software features (send receive, filter, attach, forward, copy, blind copy); characteristics of web-based systems, Web pages, introduction to HTML.

Book of Study
1. E. Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014.

References
1. Dennis P Curtain, Information Technology: The Breaking wave, McGrawhill, 2014.

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Able to use digital information technologies and applications	K2,K3	PSO2
2	CO 2: Able to use personal computer and mobile applications to assess internet and use basic computer applications like e-mails and webpage creation tools.	K2	PSO2
3	CO 3: Can use digital technology in research, analysis and critical enquiry.	K2,K3	PSO 5
4	CO 4: Understand the concept of online security and privacy and aware of social and ethical issues related to the technologies.	K2,K4	PSO 3
5	CO 5: Can evaluate and explain on going changes in technologies and their impacts in the world.	K5,K6	PSO 4
6	CO 6: Can apply different information technologies to their work such as projects, researches etc..	K4	PSO2,PSO6, PSO7
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM1GC02- Calculus and Real Analysis
CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objectives of the Course
On completion of the course, the student should be able to:

1. Improve their mathematical ability for the upcoming semesters
2. Apply the concepts of mathematical analysis in theoretical Statistics

Module 1

Sets and sequences: Bounded and unbounded sets, supremum and infimum, neighbourhood of a point, limit point of a set, derived set, Bolzano-Weierstrass theorem (without proof), open and closed sets (definitions only). Sequences-Convergence and divergence of sequences, Bolzano-Weierstrass theorem, limit inferior and limit superior (Definitions and examples only), Cauchy's general principle of convergence, Cauchy sequences. Limits of some special sequences and algebra of sequences, Sandwich theorem. Cauchy's first and second theorems on limits, Monotonic sequences, Monotone convergence theorem.

Module 2

Infinite Series: Definition, positive term series, tests for convergence -comparison test,

Cauchy's root test, D'Alembert's ratio test, Raabe's test, logarithmic test, alternating series, Leibnitz test for the convergence of alternating series, absolute convergence and conditional convergence.

Module 3

Functions of a Single Variable-1: Limits of a function, continuous functions, continuity at a point, continuity in an interval, discontinuous functions, types of discontinuity, functions continuous on closed intervals, uniform continuity.

Module 4

Functions of a Single Variable-2: Derivatives, derivability at a point, derivability in an interval, Darboux's theorem (without proof), intermediate value theorem for derivatives, Rolle's Theorem, Lagrange's Mean Value Theorem, Cauchy's Mean value theorem, Uniform convergence of sequences and series of functions, tests for uniform convergence of sequence and series of functions.

Book of Study

1. Malik, S.C. and Arora, S. (2014). Mathematical Analysis, Fourth Edition, New Age International limited, New Delhi.

References

1. Bali, N.P (2009), Real Analysis, Laxmi Publications (P) Ltd, New Delhi.
2. Shanti Narayan and Raisinghansia, M.D (2014). Elements of Real Analysis (17th ed.),
   S. Chand & Company, New Delhi.
3. Apostal, T.M (2002). Mathematical Analysis, (2nd ed.), Narosa Publishing House, New Delhi.
4. Rudin W. (2013). Principles of Mathematical Analysis, (3rd ed.), TMH.

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Identify the role and use of mathematical analysis in theoretical Statistics.	K2	PSO 1
2	CO 2: Improve their mathematical ability for the upcoming semesters.	K2	PSO 3, PSO 7
3	CO 3: Understand the important aspects of set theory, sequences and series and differential calculus.	K2	PSO 3, PSO 7
4	CO 4: Classify sequences and series based on their nature of convergence.	K4	PSO 3
5	CO 5: Implement the results in calculus for checking the continuity and differentiability of statistical functions.	K3	PSO 6
6	CO 6: Use the results on the convergence of sequences and series to determine various statistical properties of random variables.	K4	PSO 2, PSO 3

Knowledge Levels:K1-Remembering, K2-Understanding, K3-Applying K4- Analyzing K5-Evaluating and K6 -Creating

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM1SC01- Descriptive Statistics

CREDITS: 4

TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objectives of the Course

On completion of the course, the student should be able to:

1. Deal with the collection, classification, analysis and interpretation of numerical data.

2. Identify probability theory as the backbone of Statistical Science.

3. Understand the concept of random variables, its properties and the concept of Mathematical expectation.

Module 1

Introduction to Statistics: Introduction to Statistics, concepts of a statistical population and sample, Data types- qualitative and quantitative, discrete and continuous, primary and secondary. Different types of scale- nominal and ordinal, ratio and interval. Collection of data-census and sampling, sampling techniques- SRS, systematic, stratified and cluster (description only), schedule and questionnaire. Data collection: direct, using third parties, sending questionnaire, by mail/telephone, Classification and tabulation - One-way and two-way classified data, Preparation of frequency distribution, relative frequency and cumulative frequency distributions. Stem-and-leaf chart, Histogram, Frequency polygon, Frequency curve and Ogives.

Module 2

Descriptive Measures: Averages- Arithmetic Mean, Median, Mode, Geometric Mean, Harmonic Mean and Weighted averages. Quantiles- quartiles, deciles, percentiles. Absolute and relative measures dispersion - Range, Quartile Deviation, Mean Deviation and Standard Deviation, Co-efficient of variation, Box plot, Raw moments, central moments and their inter relation, skewness- Pearson's, Bowley's and moment measures of skewness, Kurtosis- percentile and moment measure of kurtosis.

Module 3

Probability & Random Variables: Random Experiments-Algebra of events-Mutually exclusive, equally likely and Independent events. Classical, Frequency and Axiomatic approaches to probability. Monotone property, Addition theorem (up to 3 events), Boole's inequality (finite case), and other simple properties. Conditional probability. Multiplication theorem (up to 3 events). Independence of events. Total

probability law. Bayes' theorem. Concept of random variables- discrete and continuous random variables. Probability mass and density functions, and distribution functions. Evaluation of conditional and unconditional probabilities. Change of variables- methods of jacobian and distribution function (one variable case). Concept of a two-component random vector, bivariate probability mass and density functions. Marginal and conditional distributions. Independence of bivariate random variables. Bivariate data- types of correlation, scatter diagram, Karl Pearson's product- moment and Spearman's rank correlation coefficients.

Module 4

Mathematical Expectation: Expectation of random variables and their functions. Definition of - Raw moments, central moments and their inter-relation, covariance, Pearson's correlation coefficient in terms of expectation. MGF and simple properties. Moments from mgf. conditional mean and variance.

Book of Study

1. S C Gupta and V K Kapoor; Fundamentals of Mathematical Statistics; Sultan Chand and Sons New Delhi

References

1. S P Gupta; Statistical Methods; Sultan Chand and Sons New Delhi
2. M R Spiegel Theory and Problems of Statistics Schaum's Outline Series.

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Identify Statistics as a scientific discipline, dealing with the collection, classification, analysis and interpretation of numerical data.	K2, K4, K5	PSO1,PSO 4
2	CO 2: Understand the basic concepts of Statistical methodologies for data collection.	K2	PSO 1
3	CO3: Compare and use various data collection methods in primary data collection.	K3,K4	PSO 1, PSO 2
4	CO 4: Use descriptive measures and graphs to represent and compare numerical data.	K4,K6	PSO 1, PSO 2
5	CO 5: Identify probability theory as the backbone of Statistical Science and understand the fundamentals of probability theory.	K2,K4	PSO1,PSO 4

6	CO 6: Describe the concept of random variables and its properties.	K2,K4	PSO1,PSO 2
7	CO7: Apply the concept of mathematical expection, its properties and various statistical measures in terms of expectation of random variables.	K3	PSO 2, PSO6, PSO 7
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4- Analyzing K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM1SC02- Introduction to Python Programming

CREDITS: 4

TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objectives of the Course

On completion of the course, the student should be able to:

1. To familiarize and understand the students with various trends in programming
2. To create an awareness of programming language python
3. To know about how programs can be created using python

Module 1

Introduction to programming: Designing a program: development cycle, pseudo code, flowcharts and algorithm development; variables, numerical data types and literals, strings, assignment and reassignment, input/output, formatted output, reading numbers and strings from keyboard; performing calculations: floating point and integer division, converting math formulas to programming statements, standard mathematical functions, mixed-type expressions and data type conversions.

Module 2

Program Decision and Control Structures: Boolean expressions, relational expressions, logical operators, Boolean variables; if, if-else, if-elif-else, inline-if statements, nested structures, and flowcharts; use of temporary variables, application: arranging a few numbers in increasing or non-decreasing, decreasing or non-increasing orders, etc.

Module 3

Repeated calculations and Looping: condition-controlled and count-controlled loops, while loop (condition-controlled), infinite loops; for-loop (count-controlled), applications: calculating summation of series, Taylor expansion of mathematical functions, etc; nested loops.

Module 4

Data Structures: lists, index, iterating over a list with for-loop, operations with lists, built-in functions, finding index, sorting, etc., processing lists; Arrays: vectors and tuples, vector arithmetic, arrays, Numerical Python arrays – Numpy, Dictionaries, Sets, curve plotting: matplotlib, SciTools, making animations and videos; Higher-dimensional arrays: two- and three-dimensional arrays, matrix objects and

matrix operations: inverse, determinant, solving linear systems using standard libraries.

Book of Study
1. Tony Gaddis, Starting Out with Python, 3E, Pearson, 2015.Book contains flowcharting and pedagogical program development in an introductory Python book. Ch.1 to 5, Ch.7.

References
1. Hans Petter Langtangen, A Primer on Scientific Programming with Python, 5E, Springer, 2016. Ch. 1 to 3, Ch. 4 (carefully selected material appropriate for first year students)
2. VanderPlas, J. (2016). Python data science handbook: Essential tools for working with data. "O'Reilly Media, Inc.".
3. Guido van Rossum and Fred L. Drake Jr, —An Introduction to Python - Revised and updated for Python 3.2, Network Theory Ltd., 2011.

Lab Contents
- Running instructions in Interactive interpreter and a Python Script.
- Write a program to purposefully raise Indentation Error and correct it.
- Program to introduce the data types, variables and transforming formulas to programming statements.
- Program to illustrate the use of decision and control structures.
- Program to arrange numbers in increasing and decreasing order.
- Programs to illustrate the use of looping: while, do-while, for.
- Program to calculate summation of series.
- Program to print different patterns using for loop.
- Utilizing 'Functions' in Python.
- Demonstrate the use of Lists, Tuples
- Simple programming for one dimensional and two-dimensional arrays.
- Program to do basic trim and slice on string.
- Programs to perform basic matrix operations.
- Programs using libraries like matplotlib, NumPy.
- Program to print inverse, determinant, solving linear systems using standard libraries.
- Programs demonstrating the idea of NumPy library (E.g., 3 questions given below) o Write a NumPy program to compute the inner product of two given vectors. o Write a NumPy program to append values to the end of an array. o Write a NumPy program to compute sum of all elements, sum of each column and sum of each row of a given array.

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Explain basic principles of Python programming language.	K1, K2	PSO 1
2	CO 2: Acquire knowledge of basic search and sorting algorithm .	K2,K3	PSO2, PSO3
3	CO3: Be fluent in use of procedural statements viz conditional statements, loops etc….	K3	PSO1, PSO2
4	CO 4: Able to design, code and test small python programs	K4	PSO 1, PSO2,PSO3, PSO4
5	CO 5: Learn to read and write files in Python.	K2	PSO5
6	CO 6: Learn how to use exceptional handling in Python application for error handling.	K5	PSO5,PSO6
7	CO 7: Learn how to use class inheritance in Python for reusability.	K2	PSO 1, PSO 2 PSO 6
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4-Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM1SC03- Office Automation Packages

CREDITS: 3
TOTAL LECTURE HOURS: 3 HOURS/WEEK

Objectives of the Course

On completion of the course, the student should be able to:

1. Prepare documents and presentations with office automation tools.
2. Perform accounting skills.

Module 1

Word Package Basics: Introduction to word, work with text, formatting text, editing text, spelling and grammar, autocorrect feature. Customize ribbon, Template, insert and edit tables insert clip art and pictures to documents, formatting. Insert objects: videos, power point, spreadsheet, insert charts, Converting pdf, webpage to word document. Create word to webpage, Watermark, Page formatting: background, page color, border, design, effects. Page setup, layout, background and borders. insert headers and footers, export document, restrict editing: formatting restrictions, restrict permission with password. Perform a mail merge.

Module 2

Introduction to Spreadsheet Package: Introduction excel user interface, working with cell and cell addresses, freeze and view options, data entry, fill handle options, managing rows & columns, find and replace, basic calculations, absolute cell reference, calculations across sheets. Formulas: Mathematical functions (sum, min, max, average, sumproduct, rand, randbetween, countif, sumif etc.), textual functions (trim, concatenate, substitute, upper &lower, length, left, right & mid), logical functions (and, or, if), date-time functions (today, now, day, month, year, date & time difference), vlookup, hlookup. Formatting: font, borders, alignment tools, format painter, number format, styles and themes.

Module 3

Advanced features of spreadsheet package: Conditional formatting, sorting, filtering: text filter, number filter, data validations, text to column, remove duplicates. Pivot table, excel shortcuts, printing and saving: preview, orientation, margins, and scale, print breaks, print titles, headers and footers, basic charts: pie, column, scatter plots, line charts etc., move, resize, change chart style and type, modify chart elements, macros.

Module 4

Presentation Package Presentation packages: PowerPoint interface, basic presentation, working with slides: add slides, copy, paste, duplicate, rearrange slides, delete. Hyperlink: update file, hyperlink to file, webpage, and within the PowerPoint.

Printing a presentation, convert PowerPoint to video file, image file, pdf file Smart art styles, insert table, table style, insert rows and columns, alignment. Insert shapes and pictures, formatting. Header and footer, screen recording, insert a video file, insert video from you tube. Video editing: bookmark, editing. Insert objects: word, excel, notepad. Work with transitions, slide show, setup slide show: hide/unhide slide, custom show. Record slide show: record, rehearse timings.

Book of Study
    1. Antony Thomas, Information Technology for Office, Pratibha Publications.

References
1. Gini Courter and Annette Marquis, MS Office 2007; BPB Publications.
2. S.S Shrivastava, M S Office, Firewall media.

Lab Contents
- Prepare a document about any tourist destination of your choice with appropriate pictures and editing features.
- Prepare a News Paper Layout. Insert appropriate pictures wherever necessary.
- Create a Document consisting of Resume
- Prepare a document about any topic in mathematics which uses mathematical symbols.
- Use mail merge in composing letter.
- Work on mathematical, textual, logical functions in spreadsheet.
- Construct various visualizations in spreadsheet using the datasets.
- Use filter, sorting, pivot table to obtain suitable results.
- Prepare presentation about your favourite sports personality with all the features of power point. Include proper background and select different animations for the points you have mentioned.
- Prepare a presentation about any general topic of current relevance. Show the usage of action buttons, hyperlinks, and animations

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Understand the basics of office automation tools.	K2,K3	PSO1,PSO2
2	CO 2: Able to create documents, spreadsheets and make presentations.	K1,K2,K3	PSO2, PSO7
3	CO 3: Able to create small presentations with audio, video and graphs and would be acquainted with internet.	K1,K2,K3	PSO2, PSO3 PSO6
4	CO 4: Create, edit, save, print documents with list of tables, header, footer, spellcheck and mail merge.	K4	PSO2,PSO3, PSO6
5	CO 5: Attain the knowledge about spreadsheet with formula, macros spell checker etc.	K3	PSO1,PSO6, PSO7
6	CO 6: Able to use for master's studies and analysis and interpretation of data.	K5,K6	PSO2, PSO5

Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6-Creating

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

Semester II

UG20BV2CC01- Reading Skills

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Module 1
Recap of language skills: vocabulary, phrase, clause, sentences

Module 2
Fluency building: word match, reading aloud, recognition of attributes, parts of speech in listening and reading, listening –reading comprehension.

Module 3
Principles of communication: communication coding and decoding-signs and symbols-verbal and non-verbal symbols-language and communication; language vs. communication media/channels for communication.

Module 4
Types of communication: functional, situational, verbal and non-verbal, interpersonal, group, interactive, public, mass line, dyadic-with illustrations.

Book of Study
1. Monippally, Matthukkutty M, Business communication strategies, Tata McGraw Hill Publications, New Delhi

References
1. Sasikumar V and P V Dhamija, Spoken English: A Self-learning Guide to Conversation Practice, Tata McGraw Hill Publications New Delhi
2. Hewings, Martin, Advance English Grammar: A Self Study Reference and Practice Book for South Asian Students Cambridge University

UG20DM2GC01- Statistical Distributions

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objectives of the Course

On completion of the course, the student should be able to:
1. Describe various probability distributions - discrete and continuous, their properties and applications
2. Model data using distribution fitting techniques
3. Understand the basic concepts of sampling distributions and application in real life situation.

Module 1

Discrete Distributions: Degenerate, Uniform, Bernoulli, Binomial, Hyper geometric, Negative binomial, Geometric, Poisson - mean, variance, m.g.f, their properties-fitting of Binomial and Poisson, memory less property of Geometric distribution, multinomial distributions and its applications.

Module 2

Some Continuous Distributions: Uniform, Beta two types, Exponential, Gamma, Cauchy, Pareto, and Laplace - mean, variance, m.g.f, characteristic function, their properties - memory less property of exponential distribution.

Module 3

Normal and Lognormal Distributions: Properties and fitting of normal distribution, use of standard normal tables for various probability computation, properties and uses of Lognormal distribution.

Module 4

Sampling Distributions: Concept of sampling distributions, Statistic(s) and standard error(s). Mean and variance of sample mean when sampling is from a finite population. Sampling distribution of mean and variance from normal distribution, Central limit theorem (without proof). Chi-square, t, F distributions and statistics following these distributions. Relation among Normal, Chi-square, t and F distributions. (Problems based on these topics)

Book of Study
1. Gupta,S.C.and Kapoor, V.K. (2014).Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.

References
1. Hogg, R.V., McKean, J.W.and Craig, A.T. (2014). Introduction to Mathematical Statistics (7th ed.), Pearson Education Publication.

2. Johnson N.L, Kotz S. & Kemp A.W (1992). Univariate Discrete Distributions, John Willey.
3. Rohatgi V.K (1988). An Introduction to Probability Theory and Mathematical Statistics, Willey Eastern.

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Describe various probability distributions - discrete and continuous, their properties and applications	K1	PSO 1, PSO 2
2	CO 2: Explain various discrete distributions such as Binomial, Poisson, Geometric etc., their properties and their applications.	K2	PSO 1, PSO 4
3	CO 3: Understand various continuous distributions such as Exponential, Gamma, Beta, Normal etc., their properties and their applications.	K2	PSO 1, PSO4
4	CO 4: Model data using distribution fitting techniques	K5	PSO 2, PSO 4
5	CO 5: Describe normal distribution and Log normal distributions, its properties and solve problems using normal tables.	K3	PSO2, PSO 4
6	CO 6: Describe the basic concepts of sampling distributions and application in real life situation.	K2	PSO 4
7	CO2: Identify the role of sampling distributions such as t, F, Chi-square and their inter relationships.	K2	PSO 2
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM2GC02- Linear Algebra I

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objectives of the Course

On completion of the course, the student should be able to:

1. To become computational proficiency involving procedures in Linear Algebra.
2. To use mathematically correct language and notation for Linear Algebra
3. To solve problems that apply Linear Algebra to Statistics

Module 1
Matrices: Operations on Matrices-Addition, Multiplication, Transpose, Special types of Matrices.

Module 2
Elementary operations: Systems of linear equations, Gaussian elimination and row operations, Echelon form of a matrix, Elementary matrices and rank of a matrix, Existence of solution of AX=B.

Module 3
Matrix Algebra: Properties of determinants, Cofactor expansion, Inverse of a matrix,

Cramer's rule.

Module 4
Eigen values and Eigenvectors: Properties and evaluation of eigen values and vectors, eigen values and vectors of special types of matrices, Algebraic multiplicity and geometric multiplicity, Cayley-Hamilton theorem.

Book of Study
   1. Gilbert Strang, Linear Algebra and its Applications, Cengage.

References
1. H. Anton, C. Rorres, Elementary Linear Algebra, Wiley.
2. Derek Robinson, A Course in Linear Algebra with Applications, Allied publishers.
3. Agarwal, R. P., & Flaut, E. C. (2017). An introduction to linear algebra. Chapman and Hall/CRC.
4. Strang, G. (2007). Linear Algebra and Its Applications. Cengage learning.

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: The basic arithmetic operations on vectors and matrices, including inversion and determinants, using technology where appropriate	K1	PSO 1, PSO 2
2	CO 2: solving systems of linear equations, using technology to facilitate row reduction	K2	PSO 2, PSO 3
3	CO 3: The basic terminology of linear algebra in Euclidean spaces, including linear independence, spanning, basis, rank, nullity, subspace, and linear transformation.	K2,K3	PSO 3
4	CO 4: The abstract notions of vector space and inner product space	K5	PSO 1, PSO 2
5	CO 5: Finding eigenvalues and eigenvectors of a matrix or a linear transformation, and using them to diagonalize a matrix.	K3,K5	PSO4,PSO5,PSO6
6	CO 6: The common applications of Linear Algebra and the method of least squares.	K2,K6	PSO 3,PSO5
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM2SC01- Introduction to R Programming

CREDITS: 4
TOTAL LECTURE HOURS: 4
HOURS/WEEK

Objectives of the Course

On completion of the course, the student should be able to

1. R programming is used as a leading tool for machine learning, statistics,and data analysis.
2. Objects, functions, and packages can easily be created by R.
3. It's a platform-independent language. This means it can be applied to all operating system.

Module 1

Basics of R: Installing the base R system and R-Studio. How to run R, R Sessions and Functions, Basic Math, Variables, Data Types, Operators in R: Arithmetic, assignment, relational and logical. Data structures: vectors, matrices, arrays, factors, data frames, lists.

Module 2

R Programming Structures: Conditional statements in R, if else, nested if else, switch statement. Loops statements: for, while, repeat. Loop control statements: break, next.

Module 3

Packages in R: Installing and loading packages, familiarizing with popular packages and functions in R, Writing functions in R.

Module 4

Exploratory data analysis in R: Exploring categorical data, exploring numerical data, Numerical summaries, case studies, Basic graphics.

Book of Study

1. Sudha G. Puroohit, Sharad D. Lore, Shailaja r. Deshmukh. Statistics using R (2nd Ed.). Narosa Publishing House.

References

1. Crawley, Michael J. The R book. John Wiley & Sons, 2012.
2. Peng, Roger D. R programming for data science. Leanpub, 2016.

Lab Contents

- Data Types and operators
- Data structures: vectors, matrices, arrays, factors, data frames, lists

- Conditional statements: if else, nested if else, switch function
- Loops: for, while, repeat. Loop control statements: break, next
- Packages
- Construction of functions: with and without arguments
- Work on inbuild functions
- Exploratory data analysis
- Basic data visualization: scatter plot, line plot, histogram, pie chart etc.

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: The basic arithmetic operations on vectors and matrices, including inversion and determinants, using technology where appropriate	K1,K2	PSO1
2	CO 2: solving systems of linear equations, using technology to facilitate row reduction	K2,K3	PSO1,PSO2
3	CO 3: The basic terminology of linear algebra in Euclidean spaces, including linear independence, spanning, basis, rank, nullity, subspace, and linear transformation.	K2,K3,K4	PSO4, PSO2
4	CO 4: The abstract notions of vector space and inner product space	K5,K6	PSO5, PSO2
5	CO 5: Finding eigenvalues and eigenvectors of a matrix or a linear transformation, and using them to diagonalize a matrix.	K3,K4,K5,K6	PSO5, PSO2
6	CO 6: The common applications of Linear Algebra and the method of least squares.	K4,K5,K6	PSO5,PSO2, PSO6

Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination

UG20DM2SC02- Statistical Inference

CREDITS: 4
TOTAL LECTURE HOURS: 4
HOURS/WEEK

Objectives of the Course

On completion of the course, the student should be able to:

1. Understand the concept of testing of hypothesis and to apply different types of parametric and non-parametric tests used in statistical data analysis.
2. Analyze quantitative data, interpret the result and give conclusion to the real-life situations
3. Apply the different methods of estimation in finding point and interval estimators of parameters of different populations

Module 1

Point Estimation: Concepts of Estimation, Estimators and Estimates. Point and interval estimation. Properties of good estimators- unbiasedness, efficiency, consistency and

sufficiency. Factorization theorem (statement). (Problems based on these topics)

Module 2

Methods of Estimation, Interval Estimation: Methods of moments, maximum likelihood. Invariance property of ML Estimators (without proof). Minimum variance. Cramer-Rao inequality (without proof). $100(1-\alpha)$ % confidence intervals for mean, variance, proportion, difference of means and proportions and variances (problems based on these topics).

Module 3

Testing of Hypotheses: Statistical hypotheses, null and alternate hypotheses, simple and composite hypotheses, type-I and type-II errors. Critical Region. Size and power of a test, pvalue, Neyman-Pearson approach. Large sample tests - Z-tests for means, difference of means, proportion and difference of proportion, chi-square tests for independence, homogeneity and goodness of fit. Normal tests for mean, difference of means and proportion (when σ known), t-tests for mean and difference of means (when σ unknown), t-test for $r = 0$, paired t-test, test for proportion (binomial), chi-square test, F-test for ratio of variances, one-way ANOVA.

Module 4

Non-Parametric Tests: Introduction to non-parametric tests - Sign test, Wilcoxon matched pair test, run test, Wald- Wolfowitz run test, Mann-Whitney U-test, Kolmogorov- Smirnov tests, Median test.

Book of Study

1. Rohatgi V.K. An Introduction Probabbility Theory and Mathematical Statistics, John wiley and sons

References

1. Gupta S. C. and Kapoor V. K. (2002). Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand and Sons.
2. George Casella, roger L. Berger. Statistical Inference (2nd Ed).
3. Goon A. M., Gupta M. K., and Dasgupta B. (2005). Fundamentals of Statistics, Vol.I, 8th edition, World Press, Kolkatta.
4. Gibbons J.K (1971). Non-Parametric Statistical Inference, Mcgraw Hill.

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO1: Understand the concept of point estimation, characteristics of a good estimator and their properties	K1, K2,K3	PSO 1
2	CO2: Explain the concept of testing of hypothesis and different types of parametric tests used in statistical data analysis.	K1, K2	PSO2, PSO 4
3	CO3: Test the significance of various statistical measures such as mean, variance, correlation coefficient etc.	K2, K3,K4,K5	PSO 1, PSO 2
4	CO4: Compare statistical measures like mean and variance of different datasets using testing of hypothesis	K2, K3,K4,K5	PSO1 , PSO 2
5	CO5: Understand some basic non-parametric tests used in data analysis	K2,K3,K4,K5	PSO2
6	CO6: Apply the different non-parametric tests in interpreting results in data analysis	K2, K3,K4,K5,K6	PSO2,PSO4, PSO5
7	CO7: Analyze quantitative data, interpret the result and give conclusion to the real-life situations	K2, K3,K4,K5,K6	PSO2, PSO4, PSO5

Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM2SC03- Introduction to DBMS

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objectives of the Course

On completion of the course, the student should be able to:

1. Understand the concept of testing of hypothesis and to apply different types of parametric and non-parametric tests used in statistical data analysis.
2. Analyze quantitative data, interpret the result and give conclusion to the real-life situations
3. Apply the different methods of estimation in finding point and interval estimators of parameters of different populations

Module 1

Introduction to Databases: File System Vs. DBMS, Database Architecture and Data Independence, Data Modelling-ER Model, Mapping Cardinalities, DBA, Relational Algebra and Relational Calculus. Introduction to OODBMS.

Module 2

Data Definition in SQL - Data types, Creation, Insertion, Viewing, Updation, Deletion of tables, modifying the structure of the tables, Renaming, Dropping of tables. Data Constraints – I/O constraints, Primary key, foreign key, unique key constraints, ALTERTABLE command**.**

Module 3

Database Manipulation in SQL - Computations done on table data – Select command, Logical operators, Range searching, Pattern matching, grouping data from tablesin SQL, GROUP BY, HAVING clauses, Joins – Joining multiple tables, Joining a table toitself. Views - Creation, Renaming the column of a view, destroys view, granting andrevoking permissions: Granting privileges, Object privileges, Revoking privileges.

Module 4

Functional Dependencies-Normalization:1NF, 2NF,3NF, BCNF, 4NF, 5NF.Transaction and System Concepts-ACID properties, Concurrency Control. Pitfalls in relational database design, Programming in PL/SQL, Cursor, Triggers.

Book of Study

1. Silberschatz, A., Korth, H. F., & Sudarshan, S. (1997). *Database System Concepts* (Vol. 4). New York: McGraw-Hill.

References

1. Raghurama Krishnan, Johannes Gehrke, TATA McGraw Hill (3rd Ed.), 2003.

2. Database Administration: The Complete Guide to DBA Practices and Procedures by Craig S. Mullins
3. MySQL Database Usage & Administration by Vikram Vaswani
4. Pratt, P. J. & Adamski, J. J. (2011). Database Systems: Management and Design. Boyd & Fraser Pub. Co.
5. James R Groff and Paul N Weinberg (2003) The Complete Reference SQL –, Second Edition, Tata McGraw Hill.
6. Elmasri, R. & Navathe, S. (2010). Fundamentals of Database Systems. AddisonWesley Publishing Company.)

Lab Contents
- Creation of a database and writing SQL queries to retrieve information from the database.
- Performing Insertion, Deletion, Modifying, Altering, Updating and Viewing records based on conditions.
- Creating an Employee database to set various constraints.
- Creating relationship between the databases.
- Study of PL/SQL block.
- Write a PL/SQL block to satisfy some conditions by accepting input from the user.
- Creation of Procedures.
- Creation of database triggers, cursors and functions
- Program using keyboard rollback and savepoint

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge Level	Mapping to Programme Specific Outcome
1	CO1: Understand the basic principles of database management systems.	K2,K3,K4,K5, K6	PSO1,PSO 2
2	CO2: Write SQL queries for a given context in relational database.	K1,K2,K3,K4, K5,K6	PSO 3
3	CO3: Ability to normalize the database & understand the internal data structure.	K2,K3,K4,K5, K6	PSO 2, PSO4
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

Semester III

UG20BV3CC01 - Writing and Presentation Skills
CREDITS: 4
TOTAL LECTURE HOURS: 4
HOURS/WEEK

Module 1
Writing as a skill: its importance – mechanism of writing – words and sentences – paragraph as a unit of structuring a whole text – combining different sources – functional use of writing – personal, academic and business writing – creative use of writing.

Module 2
Writing process: planning a text – finding materials - drafting – revising – editing - finalizing the draft - computer as an aid – key board skills - word processing - desk top publishing.

Module 3
Writing models: essay - précis - expansion of ideas – dialogue - letter writing – personal letters formal letters - CV – surveys – questionnaire - e-mail – fax - job application – report writing.

Module 4
Presentation as a skill: elements of presentation strategies – audience – objectives – medium– key ideas -structuring the material - organizing content - audio-visual aids – hand outs – use of power point - clarity of presentation - non-verbal communication - seminar paper presentation and discussion.

Book of Study
1. English for Effective Communication. Oxford University Press, 2013.

References
1. Robert, Barraas. Students Must Write. London: Routledge, 2006.
2. Bailey, Stephen. Academic Writing.Routledge, 2006.

UG20DM3GC01- Enterprise Resource Planning

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Course Objective:

On completion of the course, the student should be able to:
1. Understand the ERP software implementation packages in enterprises.

Module 1

ERP: Evolution of ERP, MRP and MRP 2, difference between integrated and traditional information system, early and new ERP packages, ERP products and markets, benefits of ERP system implementation, critical success rate.

Module 2

Selection and Implementation: opportunity and problems in ERP selection and implementation, ERP implementation, identifying ERP benefits, emergence of reengineering, concepts of business process-identifying reengineering need, preparing for reengineering implementing change-change management-integrating with other systems

Module 3

Modules of ERP: business modules of ERP package, salient features of each module comparison of ERP package, business process modelling, gap analysis, emerging trends in business process, selection of ERP process for implementation.

Module 4

Technical Architecture of ERP system: communication and networking facilities, client service system, concepts of business objects, distributed object, computing architecture, support for data mining and warehousing, EDI-internet and related technologies. -net technologies. ERP and supply chain management-extending scope of ERP through SCM, the concept of value chain differentiation between ERP and SCM, issues in selection and implementation of SCM solutions-E-Business and ERP, security and privacy issues-recent development-future growth of ERP –role of ERP international business

Book of Study

1. Jyotindra Zaveri, Enterprise Resource Planning.

References

1. Ptak, Carol A. and Eli Schragenheim, Enterprise Systems for Management, St. Luice Press, New York

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO1: Understand the Evolution of the ERP system	K2	PSO 4
2	CO2: Understand the selection and implementation of the ERP system	K2, K3,K4	PSO 4
3	CO3: Know about Modules of ERP	K1, K2, K4	PSO 1, PSO 2
4	CO4: Know in detail about the technical architecture of the ERP system.	K3, K4, K5	PSO 1, PSO 2
5	CO5: Understand the relationship between ERP and supply chain management.	K2, K4	PSO 4,PSO7
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM3GC01- Linear Algebra II

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Course Objective:

On completion of the course, the student should be able to:

1. Allows you to model natural phenomena and to compute them efficiently.
2. Used for projecting a three-dimensional view into a two-dimensional plane, handled by linear maps
3. Understand the concepts of vector space, subspace, linear independence, span, and basis

Module 1
Vector Spaces: Vector spaces, subspaces, span and linear independence, basis and dimension, row and column space of a matrix, change of basis.

Module 2
Linear transformations: Linear transformations, range space and rank, null space and nullity, matrix representation, isomorphism.

Module 3
Generalized inverse: Generalized inverse computation, Moore – penrose g- inverse, g-inverse of full rank.

Module 4
Quadratic Forms: Quadratic forms, definiteness of QF, canonical reduction and orthogonal reduction.

Book of Study
   1. H. Anton, C. Rorres, Elementary Linear Algebra, Wiley.

References
1. K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall.
2. Sheldon Axler, Linear Algebra Done Right, 2nd Edition, Springer.
3. Agarwal, R. P., & Flaut, E. C. (2017). An introduction to linear algebra. Chapman and Hall/CRC.
4. Strang, G (2007). Linear Algebra and Its Applications. Cengage learning.

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Demonstrate understanding of the concepts of vector space and subspace.	K2, K3,K5	PSO 1
2	CO2: Demonstrate understanding of linear independence, span, and basis.	K2, K3,K5	PSO 2
3	CO 3: Analyse mathematical statements and expressions (for example, to assess whether a particular statement is accurate, or to describe solutions of systems in terms of existence and uniqueness).	K1, K2,K4	PSO 1, PSO 2
4	CO 4: Apply linear algebra concepts to model, solve, and analyse real-world situations	K2,K3, K4, K5,K6	PSO 2, PSO 4
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM3SC01-Advanced Python Programming
CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

<u>Course Objective :</u>

On completion of the course, the student should be able to:

1. Describe the semantics of Python programming language and illustrate the process of structuring the data using lists, dictionaries, tuples, strings and sets. Learn how to import datasets.
2. Illustrate the NumPy, files, Object-oriented Programming concepts in Python. Concepts of Data   Wrangling and Exploratory Data Analysis, Data Manipulation. Introducing web scraping.

Module 1

Python Programming Fundamentals: Functions, Exception Handling, Regular Expressions, Extracting data with regular expressions, Objects and classes. Reading files with open, writing files with open, loading data with Pandas, Pandas: working with and saving data, one dimensional Numpy, two dimensional Numpy.

Module 2

Importing datasets: Understanding the data, Python packages for data science, importing and exporting data in Python, Introduction with data analyzing in python, accessing databases (SQLite & PostgreSQL) with Python- DB-API, connecting to a database, creating table, loading data and querying data, analyzing data with python. APIs and Data collection: Simple APIs, REST APIs, and HTTP Requests, HTML for Web scraping, Web scraping, Working with different file formats (csv, xml, json, xslx).

Module 3

Data Wrangling: Pre-processing data in Python, dealing with missing values in Python, data formatting in python, data normalization in python, binning, turning categorical variables into quantitative variable in Python.

Module 4

Exploratory Data Analysis: Descriptive statistics, GroupBy in Python, Correlation, correlation- statistics, association between two categorical variables: chi-square.

Book of Study

1. VanderPlas, Jake. Python data science handbook: essential tools for working with data. "O'Reilly Media, Inc.", 2016.

References

1. Grus, Joel. Data science from scratch: first principles with python. O'Reilly Media, 2019.

2. Gaddis, T., & Agarwal, R. (2015). Starting out with Python. Pearson.
3. Guido van Rossum and Fred L. Drake Jr, —An Introduction to Python - Revised and updated for Python 3.2, Network Theory Ltd., 2011.

Lab Contents
- Pandas library, More on NumPy, Importing datasets
- Introduction to web scraping
- Data manipulation, exploratory data analysis
- Pre-processing steps, descriptive statistics

COURSE OUTCOME

Sl. no	Expected Course Outcomes	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Learn basic principles of Python programming language	K2, K3, K5,K6	PSO 1
2	CO 2: Articulate the Object-Oriented Programming concepts such as encapsulation, inheritance and polymorphism as used in Python.	K2, K3, K5	PSO 3
3	CO 3: Identify the commonly used operations involving file systems and regular expressions	K1, K2,K4	PSO 1, PSO 2
4	CO 4: Implement database, Exploratory Data Analysis	K2, K3, K4, K5,K6	PSO 1, PSO 2
5	CO 5: Introduction to data wrangling, Web scraping,	K2, K3,K4.K6	PSO 1, PSO 2
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.
Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM3SC02- Advanced R Programming

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Course Objective :

On completion of this course the student is able to:
1. Understand the advanced concepts of R programming language.
2. Provides an overview of data analysis using R programming.

Module 1
Importing data in R: Importing data from flat files with utils, readr& data.table, importing Excel data, Reproducible Excel work with XLConnect, Importing data from database files, Importing data from web, Importing data from statistical software packages.

Module 2
Basics of Data Manipulation in R: Cleaning data in R: Introduction and exploring raw data, tidying data, preparing data for analysis, case studies

Module 3
Data Manipulation with dplyr package: select, mutate, filter, arrange and summarise verbs, the pipe operator, joining data sets with dplyr: mutating joins, filtering joins and set operations, assembling data, advanced joining, case studies

Module 4
Data visualization with ggplot2: Introduction, The grammar of graphics philosophy, different layers in ggplot, data, aesthetics, and geometries layers.

Book of Study
   1. Crawley, Michael J. The R book. John Wiley & Sons, 2012.

References
1. Wickham, Hadley, and Garrett Grolemund. R for data science: import, tidy, transform, visualize, and model data. "O'Reilly Media, Inc.", 2016.
2. Peng, Roger D. R programming for data science. Leanpub, 2016.
3. Sudha G. Puroohit, Sharad D. Lore, Shailaja r. Deshmukh. Statistics using R (2nd Ed.). Narosa Publishing House.

Lab Contents
   • Importing datasets: csv, excel, SPPS, web files etc.
   • Data manipulation
   • Exploratory data analysis

- Dplyr package
- Visualization using ggplot2

COURSE OUTCOME

Sl. no	Expected Course Outcome	Knowledge level	Mapping to Programme Specific Outcome
1	CO1: Describe concepts of Data Analysis State the use of the R and R-Studio's interactive environment.	K2,K3,K5,K6	PSO 1
2	CO2: Illustrate fundamentals of R language.	K2, K3,K5	PSO 2
3	CO3: Apply data manipulation and transformation techniques to prepare data for further processing.	K1, K2,K4	PSO 1, PSO 2
4	CO4: Analyze the nature of data with help of statistical methods, different tools, and visualization techniques.	K2,K3,K4,K5,K6	PSO 1, PSO 2
5	CO5: Evaluate various techniques and communicate observations.	K2, K3,K4, K6	PSO 4, PSO 6
6	CO6: Write R scripts to solve complex business problems from different domains.	K2, K3,K6	PSO2,PSO6
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM3SC03- Multivariate Analysis

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Course Objective:

On completion of this course the student is able to:

1. Reduce and simplify the data as much as possible without losing any important details.

2. Grouped and sorted the variables on the basis of their unique features.

Module 1
Bivariate normal distribution: marginal and conditional distributions, Multinomial distribution. Multivariate normal - marginal and conditional distributions, properties and characterizations, estimation of mean and dispersion matrix. Independence of sample mean and sample dispersion matrix

Module 2
Multivariate testing: Likelihood ratio test, Hotelling's T2 (one and two samples), Mahalanobi's D2 statistic, Fisher-Behren problem, MANOVA (one way and two-way)

Module 3
Multivariate tools: Dimension reduction methods, principal components, canonical correlation, profile analysis, factor analysis.

Module 4
Classification problem, discriminant analysis, Bayes' procedures, Fisher's approach, more than two groups, selection of variables. Testing independence of sets of variates, tests for equality of dispersion matrices, sphericity test. Cluster analysis, proximity data, hierarchical clustering, and non-hierarchical clustering methods.

Book of Study
1. Anderson T. W. (1984). An Introduction to Multivariate Statistical Analysis (2nd Ed.) John Wiley.

References
1. Johnson R.A. and Wichern D.W. (1990) Applied Multivatiate Statistical Analysis. Pearson education.

Giri N (1984). Multivariate Observation, John Wiley.

COURSE OUTCOME

Sl. no	Expected Course Outcome	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Use multivariate techniques appropriately, undertake multivariate hypothesis tests, and draw appropriate conclusions.	K2, K4,K5,K6	PSO 2
2	CO2: Know how to perform hypothesis testing (mainly the Hotelling T2 test and chi-square test) using multivariate data.	K1, K2, K3, K4,K5	PSO 2, PSO 4, PSO 5
3	CO 3: Know the theories of PCA and factor analysis (FA), and be able to apply these methods to real data	K1, K2, K3,K4,K5,K6	PSO 2, PSO 4, PSO 5
4	CO 4: Understand and being able to apply MANOVA and understand multivariate regression.	K1, K2,K3, K4, K5,K6	PSO 1, PSO 2, PSO 5
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

Semester IV

UG20BV4CC01 - Soft Skill and Personality Development
CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Course Objective:
On completion of this course the student is able to:
1. To become self-confident individuals by mastering interpersonal skills, team management skills and leadership skills

Module – 1

Personal Skills: Knowing oneself- confidence building- defining strengths- thinking creatively- personal values-time and stress management.

Module – 2

Social Skills: Appropriate and contextual use of language- non-verbal communication- interpersonal skills- problem solving.

Module – 3

Personality Development: Personal grooming and business etiquettes, corporate etiquette, social etiquette and telephone etiquette, role play and body language.

Module – 4

Presentation skills: Group discussion- mock Group Discussion using video recording – public speaking.

Module – 5

Professional skills: Organisational skills- team work- business and technical correspondencejob oriented skills-professional etiquettes.

Book of Study

1. Matila Treece: Successful communication: Allyun and Bacon Pubharkat. Jon Lisa Interatid skills in Tourist Travel Industry Longman Group Ltd.

References

1. Robert T. Reilly – Effective communication in tourist travel Industry Dilnas Publication.

1. Boves. Thill Business Communication Today Mcycans Hills Publication.
2. Dark Studying International Communication Sage Publication.
3. Murphy Hidderandt Thomas Effective Business Communication Mc Graw Hill.

COURSE OUTCOME

Sl. no	Expected Course Outcome	Knowledge Level
1	CO 1: Understand the importance of effective communication skills in daily life	K2, K4,K5,K6
2	CO 2: To make decisions and achieve their desired results	K1, K2, K3, K4,K5
3	CO 3: Have a practical understanding of personality development	K1, K2, K3,K4,K5,K6
4	CO 4: To build a strong foundation on which to keep building others skills	K1, K2,K3, K4, K5,K6
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating		

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM4GC01- Business Ethics

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Course Objective:

On completion of this course the student is able to:

1. Understand the basic principles of ethics and its importance in business.

2. Provides an overview of protection by government for business.

Module 1
Introduction-Concept, relevance and importance, Ethical principles and relevance in business, Normative and Justice & Fairness.

Module 2
Ethics and the organization. Organizational ethics, basic elements of an ethical organization, designing of code of ethics of an organization, dimensions of organizational ethics, benefits of managing ethics in the organization, current ethical related issues in organizations.

Module 3
Environmental Ethics Sustainable Development, Industrial Pollution & Environmental Issues.

Module 4
Corporate Governance Introduction to corporate governance, Importance, Issues and Obligations. Consumer Protection Consumer & Consumer protection and Legal Protection to consumers.

Book of Study
1. Business Ethics Concepts & Cases, Velasquez, TMH Publication
References
Modern Business Environment, ABPL Publications.

COURSE OUTCOME

Sl. no	Expected Course Outcome	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Able to understand about the ethical principles in business	K1,K2	PSO 4
2	CO 2: Got some ideas about the relevance of ethics in business.	K2,K4,K5	PSO 4
3	CO3: Understand the concept of ethics organization and its benefits	K2,K4,K5	PSO 1, PSO 2
4	CO 4: Understanding several current ethical issues faced in organization	K2,K4,K5	PSO 1, PSO 2
5	CO 5: Understanding about corporate governance and its importance in business	K2, K4	PSO 1, PSO 2
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM4GC01-Fuzzy Mathematics
CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Course Objective:
On completion of this course, the student is able to:
1. To know the fundamentals of fuzzy algebra.
2. To know the basic definition of fuzzy theory.

Module 1
Fuzzy Sets: Introduction, Crisp sets: An overview, Fuzzy sets: Basic types, Basic concepts.

Additional properties of α cuts, Representation of fuzzy sets, Extension principal of fuzzy sets.

Module 2
Operations on Fuzzy Sets: Types of Operations, Fuzzy complements, Fuzzy intersections: tnorm, Fuzzy unions: t-conorms, Combinations of operations.

Module 3
Fuzzy Arithemetic: Fuzzy Numbers, Arithemetic and operations on intervals, Arithemetic operations on Fuzzy numbers.

Module 4
Fuzzy Logic: Classical logic: an over view, Multi valued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic hedges, Inference from conditional fuzzy propositions.

Book of Study
1. George J Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall NJ,1995.

References
1. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers, New Delhi, 1991.
2. Kevin M Passino and Stephen Yurkovich, Fuzzy Control, Addison Wesley Longman, 1998.

Klir G.J and T. Folger, Fuzzy Sets: Uncertainty and information, Prentice Hall of India, Pvt Ld, New Delhi (1998).

COURSE OUTCOME

Sl. no	Expected Course Outcome	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Know about combining fuzzy set theory with probability to handle random and non-random uncertainty, and the decision-making process	K1, K2, K3, K4, K5,K6	PSO 4
2	CO2: Understand the basic ideas of fuzzy sets, operations and properties of fuzzy sets and also about fuzzy relations.	K1, K2, K3, K4,K5	PSO 4
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM4SC01- Sampling and Design of Experiments

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Course Objective:

On completion of this course the student is able to:

1. To obtain the maximum information about the population without examining each and every unit of the population.
2. Finding the reliability of the estimates derived from the sample can be done by computing the standard error of the statistic.
3. Apply different sampling techniques to the population.

Module 1

Sampling 1: Census and sampling methods, probability sampling and non-probability sampling, principal steps in sample surveys, sampling errors and non-sampling errors, bias, variance and mean square error of an estimator, simple random sampling with and without replacement, estimation of the population mean, total and proportions, properties of the estimators, variance and standard error of the estimators, confidence intervals, determination of the sample size.

Module 2

Sampling 2: Stratified random sampling, estimation of the population mean, total and proportion, properties of estimators, various methods of allocation of a sample, comparison of the precisions of estimators under proportional allocation, optimum allocation and srs. Systematic sampling – Linear and Circular, estimation of the mean and its variance. Comparison of systematic sampling, srs and stratified random sampling for a population with a linear trend.

Module 3

Linear estimation: standard Gauss Markoff set up, estimability of parameters, method of least squares, best linear unbiased Estimators, Gauss – Mark off Theorem, tests of linear hypotheses. Planning of experiments, Basic principles of experimental design, uniformity trails, analysis of variance, one-way, two-way and three-way classification models, completely randomized design (CRD), randomized block design (RBD), Latin square design (LSD) and Graeco-latin square designs, Analysis of covariance (ANCOVA), ANCOVA with one concomitant variable in CRD and RBD.

Module 4

Incomplete block design: balanced incomplete block design (BIBD); incidence Matrix, parametric relation; intrablock analysis of BIBD, basic ideas of partially balanced incomplete block design (PBIBD). Factorial experiments, 2n and 3n factorial experiments, analysis of 2^2, 2^3 and 3^2 factorial experiments, Yates

procedure, confounding in factorial experiments, basic ideas of response surface designs.

Book of Study
1. Das M.N. and Giri N.C. (1994) Design and analysis of experiments, Wiley Eastern Ltd.
2. Cochran W. G. (1999) Sampling Techniques, 3rd edition, John Wiley and Sons.

References
1. Mukhopadyay P. (2009) Theory and Methods of Survey Sampling, 2nd edition, PHL, New Delhi.
2. Aloke Dey (1986) Theory of Block Designs, Wiley Eastern, New Delhi.
3. Montgomery C.D (1976). Design and Analysis of Experiments, John Wiley New York. 4. Des Raj (1967)- Sampling Theory, Tata McGraw Hill, New Delhi .

COURSE OUTCOME

Sl. no	Expected Course Outcome	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: Understand the steps in the sampling process.	K1, K2,K4,K5,K6	PSO 4
2	CO 2: Understand the principles of probability sampling and how they form the basis for making statistical inferences from a sample to a population.	K1, K2,K4,K5,K6	PSO 4
3	CO 3: Distinguish among probability sampling designs, such as simple random sampling, stratified sampling, and cluster sampling.	K2, K3,K4,K5	PSO 1, PSO 2
4	CO 4: Constructing an ANOVA table for a one-way ANOVA when there are equal sample sizes. Conducting a one-way ANOVA test.	K2, K3,K4,K5,K6	PSO 1, PSO 2
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM4SC02- Time Series Analysis
CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Course Objective:

On completion of this course the student is able to:
1. To introduce the students to the main developments in time series analysis.
2. To learn theoretical, applied and computational methods for time series analysis and forecasting.
3. To gain experience in model building.

Module 1

Basics of Time series: components of time series, additive and multiplicative models, determination of trend, analysis of seasonal fluctuations, test for trend and seasonality, exponential and moving average smoothing, holt-winter smoothing, forecasting based on smoothing.

Module 2

Time series as a discrete parameter stochastic process: auto covariance and auto correlation functions and their properties, stationary processes, test for stationarity, unit root test, stationary processes in the frequency domain, spectral analysis of time series.

Module 3

Detailed study of the stationary processes: moving average (MA), autoregressive (AR), autoregressive moving average (ARMA) and autoregressive integrated moving average (ARIMA) models.

Module 4

Estimation of ARMA models: Maximum likelihood method (the likelihood function for a Gaussian AR (1) and a Gaussian MA (1) and Least squares, Yule-Walker estimation for AR Processes, choice of AR and MA periods, forecasting, residual analysis and diagnostic checking.

Book of Study
1. Chatfield C. (2004) The Analysis of Time Series - An Introduction (Sixth edition), Chapman and Hall.

References
1. Abraham B. and Ledolter J.C. (1983) Statistical Methods for Forecasting, Wiley.

2. Montgomery D. C., Cheryl L. J., and Murat K. (2015) Introduction to Time Series Analysis and Forecasting. John Wiley & Sons.
3. Brockwell P.J and Davis R.A. (2002) Introduction to Time Series and Forecasting Second edition, Springer-Verlag.

Lab Contents
- Trend analysis
- Seasonality analysis
- Forecasting using smoothing methods
- Test for stationarity
- Fitting models: AR, MA, ARMA, ARIMA
- Work on non-stationary data
- Forecasting
- Residual analysis
- Diagnostic checking

COURSE OUTCOME

Sl. no	Expected Course Outcome	Knowledge Level	Mapping to Programme Specific Outcome
1	CO 1: Critical understanding of, the main concepts of time series analysis	K1, K2,K3,K4,K5	PSO 4
2	CO 2: Describe and verify mathematical considerations for analyzing time series, including concepts of white noise, stationarity, autocovariance, autocorrelation.	K1, K2,K4,K5,K6	PSO 4
3	CO 3: Learn time series as a discrete parameter stochastic process and spectral analysis of time series.	K2, K3,K4,K5	PSO 1, PSO 2
4	CO 4: Detailed study of the stationary process: MA, AR, ARMA and ARIMA models.	K2, K3,K4,K5,K6	PSO 1, PSO 2
5	CO 5: Estimation of ARMA models	K2, K3,K4,K5,K6	PSO4,PSO6

Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM4SC03- Machine Learning I
CREDITS: 4
TOTAL LECTURE HOURS: 4
HOURS/WEEK

Course Objective:
On completion of this course the student is able to**:**
1. Improve their ability for resampling methods, feature engineering
2. Develop an appreciation for what is involved in Learning models from data
3. Understand a wide variety of learning algorithms
4. Understand how to evaluate models generated from data
5. Apply the algorithms to a real problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models

Module 1
Techniques of Machine Learning: Supervised learning, Unsupervised learning, Semi supervised learning, Reinforcement learning, Machine Learning Algorithm, Application of machine learning. Capacity, Overfitting and underfitting, Hyper parameters, Estimator, Bias and Variance, Maximum likelihood estimation, Stochastic Gradient descent

Module 2
Resampling methods: Cross validation and the bootstrap, Linear model selection and Regularization: Subset selection, Shrinkage methods, Dimension reduction methods, Considerations in high dimensions.

Module 3
Feature Engineering: Feature Improvement: Dealing with missing data, Standardization & normalization; Feature Selection: Statistics based feature selection, model-based feature selection; Feature transformation: Principal Component Analysis, linear discriminant analysis; Feature Learning.

Module 4
Introduction, Simple Linear regression, multiple linear regression, Extensions of the linear model, Classification: overview, Logistic regression, linear discriminant analysis, comparison of classification methods.

Book of Study
1. G. James, R. Tibshirani, An Introduction to Statistical Learning: with applications in R, Springer.

References
1. T. Hastie, R. Tibshirani, Elements of Statistical Learning: Data mining, Inference and Predicton, Springer.
2. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press.

Lab Contents
* Maximum likelihood estimation
* Linear regression

* Multiple regression
* Logistic regression
* Feature Engineering
* Dimension reduction (Factor analysis, PCA)
* Classification algorithms

COURSE OUTCOME

Sl. no	Expected Course Outcome	Knowledge Level	Mapping to Programme Specific Outcome
1	CO 1:Define a problem to find appropriate solutions in the field of data.	K1, K2,K3,K4,K5	PSO 4
2	CO 2:Classify and explain machine learning techniques to solve real world problems.	K1, K2,K3,K4,K5,K6	PSO 4
3	CO 3: Apply various classification algorithms and examine their performance.	K2, K3,K4,K5	PSO 1, PSO 2
4	CO 4: Evaluate the performance of machine learning models by using various performance evaluation parameters.	K2, K3,K4,K5,K6	PSO 1, PSO 2
5	CO 5: Implementing application of statistical learning using machine learning.	K2, K3,K4,K5,K6	PSO 1, PSO4
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying, K4- Analyzing, K5-Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

Semester V

UG20BV5CC01 -Environmental Studies and Human Rights
CREDITS: 4
TOTAL LECTURE HOURS: 4
HOURS/WEEK
Objectives of the Course

On completion of the course, the student should be able to:

1. To understand the relationship between human rights and the environment

Module 1

Multidisciplinary nature of environmental studies: Definition, scope and importance-Need for public awareness. Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

Module 2

Ecosystems Concept of an ecosystem-Structure and function of an ecosystem-Producers, consumers and decomposers-Energy flow in the ecosystem-Ecological succession-Food chains, food webs and ecological pyramids-Introduction, types, characteristic features, structure and function of the following ecosystem : Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) Biodiversity and its conservation Introduction – Definition : genetic, species and ecosystem diversity, Biogeographically classification of India, Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts., Endangered and endemic species of India, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Module 3

Environmental Pollution Definition, Cause, effects and control measures of: - Air pollution-
Water Pollution-Soil pollution, Marine Pollution-Noise Pollution-Thermal Pollution- Radiation Pollution. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution, Pollution case studies, Disaster management: floods, earthquake, cyclone and landslides.

Module 4

Human Rights: Introduction, meaning, concept and development, fundamentals rights and duties, environment and human rights – right to clean environment and public safety, protection of environment. Value education- HIV/AIDS-women and child welfare- role of information technology in environment and human health-case studies.

Book of Study

Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education.

Further Activities

Field work

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain

Visit to a local polluted site-Urban/Rural/Industrial/Agricultural

Study of common plants, insects, birds.

Study of simple ecosystems-pond, river, hill slopes, etc. (Fieldwork Equal to 5 lecture hour)

COURSE OUTCOME

Sl No :	Expected Course Outcome	Knowledge level	Mapping to Programme Specific Outcome
1	CO 1: To understand sustainable development	K1, K2	PSO 4
2	CO 2:Critically evaluate factors that lead to environmental degradation	K1, K2,K3,K5	PSO 4
3	CO 3:Analyses the future predictions that might affect the present and future generation lives	K4,K5,K4	PSO 1, PSO 2
4	CO 4: Understand how human interacts with the environment.	K2K3,K4,K5	PSO 1, PSO 2
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4- Analyzing K5Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM5GC01- Business Informatics

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objective of the course:

Upon completion of this course, the students will be able to:

1. Prepares students to become experts in the development of business processes
2. Prepare students for the implementation and control of information systems and information and communication technology

Module 1

History of e-commerce, definition, classification- B2B, B2C, C2C, G2C, B2G sites, ecommerce in education, financial, auction, news, entertainment sectors, Doing e-Commerce.

Module 2

Electronic payment systems – relevance of currencies, credit cards, debit cards, smart cards, ecredit accounts, e-money, security concerns in e commerce, authenticity, privacy, integrity, non-repudiation, encryption, secret key cryptography, public key cryptography, digital signatures, firewalls.

Module 3

Mass marketing, segmentation, one-to-one marketing, personalization and behavioural marketing, web advertising, online advertising methods, advertising strategies and promotions, special advertising and implementation topics.

Module 4

Mobile Commerce: attributes and benefits, Mobile Devices, Computing software, Wireless Telecommunication devices, Mobile finance applications, Web 2.0 Revolution, social media and industry disruptors, Virtual communities, Online social networking: Basics and examples, Web 3.0 and Web 4.0, Civil law, intellectual property law, common law and EC legal issues

Book of Study
1. Erfan Turban et.al., Electronic Commerce–A Managerial Perspective, Pearson Education

References
2. R Kalokota, Andrew V. Winston, Electronic Commerce – a Manger's guide, Pearson

COURSE OUTCOME

S Ll N o:	Expected Course Outcome	Knowledge level	Mapping to Programme Specific Outcome
1	CO1: Analyze and model the flow of information through business processes	K1,K2,K3 K4	PSO1,PSO 2, PSO 4
2	CO2: Develop computer programs to support or automate business processes.	K4,K5, K6	PSO1,PSO 2
3	CO3: Apply networking concepts and technologies to support business needs	K3,K5,K6	PSO 1, PSO 2
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4-Analyzing K5Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM5GC02-Operations Research and Numerical Methods I

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objective of the course:

On completion of the course, the student should be able to :

1. Building capabilities in the students for analysing different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.

Module 1

Linear programming: Introduction to linear programming problems (LPP), graphical solution, solutions to an LPP, simplex method.

Module 2

Artificial variables: two-phase simplex method, big-M method, dual of linear programming, theorems of duality, dual-simplex method. Queuing theory: Poisson process, properties, M/M/1 and M/M/s models.

Module 3

Solution to algebraic and transcendental equations: - Bisection Method, Iteration method, Regula -falsi method, Newton-Raphson method. Solution to Simultaneous linear equations: - Gauss elimination method, Gauss-Jordan methods, Jacobi's method, Gauss-Seidel method, solution to non-linear equations – Newton Raphson method.

Module 4

Interpolation - Newtons forward interpolation formula, Lagrange's interpolation formula, Numerical integration- General Quadrature formula, Newton-Cotes formula, Trapeizoidal,

Simpson's (1/3), Simpson's (3/8) and Weddle's formula.

Book of Study

1. Sastry S.S. (1998) Introductory methods of numerical analysis. Third edition, Printice Hall, New Delhi.
2. Kanti Swarup, Gupta, Manmohan (2004) 10th edition, Operations Research – Principles and Practice.

References

1. Mohanan J.F (2001) Numerical methods of statistics, Cambridge University Press.

2. Srimanta Pal (2009) Numerical Methods- Principles, Analysis and Algorithms. Oxford University Press.
3. Gupta R.K (2010): Operations Research, Krishna Prakashan Media (P) Ltd., Meerut.
4. Taha H.A (2014). Operations Research, Pearson Education Publication.

COURSE OUTCOME

Sl No:	Expected Course Outcome	Knowledge Level	Mapping to Programme Specific Outcome
1	CO1: Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained.	K1,K2,K3	PSO 4
2	CO2: Determine optimal strategy for Minimization of Cost of shipping of products from source to Destination/ Maximization of profits of shipping products using various methods, Finding initial basic feasible and optimal solution of the Transportation problems	K3,K4	PSO 4
3	CO3: Optimize the allocation of resources to Demand points in the best possible way using various techniques and minimize the cost or time of completion of number of jobs by number of persons.	K4	PSO 1, PSO 2
4	CO4: Model competitive real-world phenomena using concepts from game theory. Analyse pure and mixed strategy games	K1,K4	PSO 1, PSO 2
5	CO5: Formulate Network models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Network problems	K3,K5,K6	PSO6,PSO7
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4-Analyzing K5Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM5SC01- Data Mining
CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objective of the course:
On completion of the course, the student should be able to:
1. Able to use, choose, develop, and acquire ICT solutions that enable enterprise development,
2. Able to design intra- and inter organizational information systems and are capable of participating in corresponding interdisciplinary and international projects.

Module 1
Data mining: Meaning, Definition, Goals, Scope, Related technologies, Stages involved in data mining, Data mining techniques, Major issues in data mining, Applications.

Module 2
Data objects and attribute types attribute generalization and relevance, Class comparison, Statistical measures, Data visualization, Measures of similarity and dissimilarity; Data preprocessing: Overview, Data cleaning, Data integration, Data reduction, Data transformation, Discretization, Generating concept hierarchies.

Module 3
Mining frequent patterns, associations and correlations: Basic concepts and methods, Frequent itemset mining methods -Apriori algorithm, Pattern growth approach, framing association rules, Pattern evaluation methods, Pattern mining concepts, Mining in multi-level and multidimensional space, Constraint based frequent pattern mining.

Module 4
Text mining, Web mining, Spatial mining, Illustration of mining real data, Pre-processing data from a real domain, applying various data mining techniques to create a comprehensive and accurate model of the data clustering.

Book of Study
1. Pang-Ning Tan,Michael Steinbach and Vipin Kumar , Introduction to Data Mining, Pearson Education Inc , 2003

References
1.   Alex Berson and Stephen J. Smith, *Data Warehousing*, *Data Mining & OLAP*, *Computing* Mcgraw-Hill, Tata McGraw-Hill Education, 2004
2.   Jiawei Han and Micheline Kamber,"Data Mining - Concepts and Techniques" (Second Edition), Elsevier, 2006.

Lab Contents
- Data visualization
- Data cleaning
- Data reduction
- Data Manipulation
- Data pre-processing
- Frequent itemset mining methods
- Text mining, web mining, spatial mining

COURSE OUTCOME

Sl NO :	Expected Course Outcome	Knowledge level	Mapping to Programme Specific Outcome
1	CO1: Design basic data collection strategies and obtain data from a number of open data sources	K2, K3	PSO 4
2	CO2: Choose the right algorithms for data science problems	K1, K2	PSO 4
3	CO3: Demonstrate knowledge of statistical data analysis techniques used in decision making	K2,K3,K4	PSO 1, PSO 2
4	CO4: Apply principles of Data Science to the analysis of large-scale problems	K3,K4,K5	PSO 1, PSO 2
5	CO5: Implement and use data mining software to solve real-world problems	K4, K5	PSO5,PSO6
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4-Analyzing K5Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM5SC02- Machine Learning II

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objective of the course:

On completion of the course, the student should be able to:

1. Improve their mathematical ability for the upcoming semesters
2. Apply the concepts of mathematical analysis in theoretical Statistics

Module 1

Polynomial regression, step functions, basis functions, regression splines, smoothing splines, Local regression, generalised additive models for regression and classification problems.

Module 2

Introduction to Decision Trees. Regression trees, Classification trees, comparison of trees and linear models, Bagging, Random Forests, and Boosting.

Module 3

Support Vector Machines: Hyperplane, Maximum Margin Classifier, Support Vector Classifiers, Support Vector Machines, One vs One Classification and One vs All Classification, Relationship to Logistic Regression. Unsupervised Learning: Principal Component Analysis and its applications, K-Means Clustering and Hierarchical Clustering.

Module 4

Neural Networks: Introduction, Projection Pursuit Regression, Neural Networks, Fitting Neural Networks, some issues in Training Neural Networks-Starting Values, Overfitting, Scaling of the Inputs, Number of Hidden Units and Layers, Multiple Minima. Optimization, Challenges in neural network optimization, Parameter initialization strategy, Adaptive learning rates, Optimization algorithms

Book of Study

1. G. James, R. Tibshirani, An Introduction to Statistical Learning: with applications, New York: Springer.
2. Tom M. Michell. Machine Learning, MGH

References

1. T. Hastie, R. Tibshirani, Elements of Statistical Learning: Data mining, Inference and Predicton, Springer.

2. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press.
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press. (Chapters 5-10)
4. Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.
5. Alpaydin (2014) Introduction to Machine Learning, 3rd Edition, MIT Press.
6. Frank Kane (2012) Data Science and Machine Learning. Manning Publications.

Lab Contents
- Polynomial regression
- Predictive algorithms
- Decision tree
- Random forest
- Classification tree
- Support vector machine
- More on PCA
- Clustering (K-means, hierarchical)
- Optimization algorithms

COURSE OUTCOME

Sl No:	Expected Course Outcome	Knowledge level	Mapping to Programme Specific Outcome
1	CO1: Define a problem to find appropriate solutions in the field of data science and other interdisciplinary areas.	K2, K3	PSO1,PSO 2, PSO 4
2	CO2: Classify and explain machine learning techniques to solve real world problems.	K1, K2	PSO1, PSO2,PSO 4
3	CO3: Apply various classification algorithms and examine their performance.	K3	PSO 1, PSO 2
4	CO4: Evaluate performance of machine learning models by using various performance evaluation parameters.	K3	PSO 1, PSO 2
5	CO5: Construct use case-based models by analyzing datasets from various domains.	K4, K5	PSO6,PSO 7
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4- Analyzing K5Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

Semester VI

UG20BV6CC01- Entrepreneurship Development
CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objective of the course:

Upon completion of this course, the students will be able to:

1. To make the students understand entrepreneurs and different classifications. Entrepreneur and entrepreneurship

Module 1

To make the students understand about entrepreneurs and different classifications. Entrepreneur and entrepreneurship - Definition; traits and features; classification; Entrepreneurs; Women entrepreneurs; Role of entrepreneur in Entrepreneurs in India.

Module 2

Create an awareness about EDP. Entrepreneurial development programme concept; Need for training; phases of EDP; curriculum & contents of Training Programme; Support systems, Target Groups; Institutions conducting EDPs in India and Kerala.

Module 3

General awareness about identification of project financing new enterprises. Promotion of a venture; opportunity Analysis Project identification and selection; External environmental analysis economic, social, technological a competitive factor; Legal requirements for establishment of a new unit; loans; Overrun finance; Bridge finance; Venture capital; Providing finance in Approaching financing institutions for loans.

Module 4

To identify different, Discuss opportunities in small business. Small business Enterprise - Identifying the Business opportunity in various sectors - formalities for setting up of a small business enterprise - Institutions supporting small business enterprise - EDII (Entrepreneurship Development Institute of India), SLDO (Small Industries Development Organization NSIC (National small Industries Corporation Ltd. (CNSIC) NIESBUD (National Institute for Entrepreneurship and small Business Development) Sickness in small business enterprise causes and remedies.

Module 5

To understand about a project report relating to a small business. Project formulation - Meaning of a project report significance contents formulation planningcommissions and   guidelines for formulating a project report - specimen of a project report, problems of entrepreneur's case studies of entrepreneurs.

Book of Study

1. Cliffton, Davis S. and Fylie, David E., Project Feasibility Analysis, John Wiley, New York.

References

1. Desai A. N., Entrepreneur and Environment, Ashish, New Delhi, 1990.
2. Drucker, Peter, Innovation and Entrepreileurship, Heinemann, London, 1985
3. Jain Rajiv, Planning a Small-Scale Industry: A guide to Entrepreneurs, S.S. Books, Delhi, 1984
4. Kumar S. A., Entrepreneurship in Small Industry, Discovery, New Delhi, 1990

COURSE OUTCOME

Sl No:	Expected Course Outcome	Knowledge level	Mapping to Programme Specific Outcome
1	CO1: Understand the skill in preparing the business plan	K1, K2	PSO1,PSO2, PSO3,PSO4
2	CO2: Develop skills in the customer relationship, customer validation	K2, K3	PSO3,PSO4
3	CO3: Understand how to lead and build a team in an enterprise	K2,K3,K4	PSO 5, PSO6
4	CO4: Analysis of different objectives of an entrepreneurship development program	K2,K3,K4	PSO 6, PSO 7
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4- Analyzing K5Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM1GC01-Principles of Management

CREDITS: 4
TOTAL LECTURE HOURS: 4 HOURS/WEEK

Objective of the course:

Upon completion of this course, the students will be able to**:**
1. Familiarize the students with concepts and principles of management.

Module 1

Introduction to Management - Meaning, Nature, Scope and Functional Areas of Management - Management as a Science, Art and Profession - Management & Administration Principles of Management- Managerial roles: Mintzberg Model - Functions of Management - Contributions of F.W.Taylor and Henry Fayol.

Module Il

Planning - Planning - Meaning - Nature - Importance - Types of Plans - Planning Process- Barriers to Effective Planning - M.B.O - Features - Steps - Coordination - Meaning and Importance Techniques for Effective Coordination.

Module Ill

Organizing - Meaning - Nature - Importance - Principles of Organisation - Types ofOrganisation - Organisation Chart - Organisation Manual - Centralization - Decentralization-Authority -Delegation of Authority -Responsibility and Accountability.

Module IV

Direction and Control - Principles of direction- Leadership: Concept and Styles; Trait and Situational Theory of Leadership, Managerial Grid by Blake and Mouton, Likert's Four System Model - Motivation: Concept and Importance; Maslow's Need Hierarchy Theory; Herzberg's Two Factors Theory. Control: Concept and Process-Control Techniques.

Book of Study
1. Koontz. O Donnell, Management, McGraw-Hill

References
1. Appaniah, Reddy, Essentials of Management, Himalaya Publishing House.
2. Prasad, L. M., Principles of management, Sultan Chand and Sons.
3. Srinivasan, Chunawalla, Management Principles and Practice, Himalaya Publishing House.
4. Tulsian, P.C., & Pandey, Vishal, Business Organization and Management, Pearson Education

COURSE OUTCOME

Sl No:	Expected Course Outcome	Knowledge level	Mapping to Programme Specific Outcome
1	CO1: Understand the concepts related to business.	K1, K2	PSO1, PSO2,PSO 4
2	CO2: Demonstrate the roles, skills, and functions of management.	K2	PSO 1, PSO2,PSO 4
3	CO3: Analyze effective application of principles of management knowledge to diagnose and solve organizational problems and develop optimal managerial decisions.	K3, K4	PSO2,PSO3, PSO4
4	CO4: Understand the complexities associated with management of human resources in the organizations and integrate the learning in handling these complexities.	K3,K4,K5	PSO5,PSO6, PSO7
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4- Analyzing K5Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM6GC01- Operations Research and Numerical Methods II
CREDITS: 4
TOTAL LECTURE HOURS: 4
HOURS/WEEK

Objectives of the course:
Upon completion of this course, the students will be able to:
1. To help students to understand operations research methodologies
2. To help students to solve various problems practically
3. To make students proficient in case analysis and interpretation

Module 1

Transportation problem: Introduction to TP, methods for finding IBFS, VAM method, optimal solution- Modi method, unbalanced TP and Degeneracy.

Module 2

Assignment Problem: Introduction to AP, mathematical formulation, solutions, Hungarian method, travelling salesman problem.

Module 3

Sequencing problem: Introduction to sequencing problem, n jobs through 2 machines, n jobs through k machines, GANTT.

Module 4

Network analysis, CPM, PERT.

Book of Study

1. Kanti Swarup, Gupta, Manmohan (2004) 10th edition, Operations Research – Principles and Practice.

References

1. Frederick S Hiller and Gerala Jlieberman, Introduction to Operations Research Tata Mcgraw Hill.
2. J K Sharma Operations research – Theory and Applications Macmillan.
3. Mittal S.K, Goel B.S (1990): Operations Research, Pragati Prakashan, Meerut.

COURSE OUTCOME

Sl No:	Expected Course Outcome	Knowledge Level	Mapping to Programme Specific Outcome
1	CO1: Understand the objectives, phases, and models, used in operation research.	K1, K2	PSO 4
2	CO2: Solve problems on transportation, assignment problems, and game theory.	K3, K4, K5	PSO 4
3	CO3: Understanding sequencing problem and GANTT.	K2, K3	PSO 1, PSO 2
4	CO4: Understanding network analysis.	K2, K3, K4	PSO 1, PSO 2
5	CO5: Choose the appropriate management tool to lead a team and provide solutions in complex decision-making Scenarios	K4, K5	PSO4,PSO5 , PSO6
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4- Analyzing K5Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM6SC01- Natural Language Processing

CREDITS: 4
TOTAL LECTURE HOURS: 4
HOURS/WEEK

<u>Objective of the course:</u>

Upon completion of this course, the students will be able to:

- To introduce the fundamental concept and techniques of Natural Language Processing

- To be able to map the appropriate techniques with the problem and solve real world problems.

Module 1

What is Natural Language Processing? Language Processing and Python, Natural Language Basics, Natural Language, Linguistics, Language Syntax and Structure, Language Semantics, Text Corpora, Natural Language Processing, Text Analytics; Processing and Understanding Text: Text Tokenization, Text Normalization, Understanding Text Syntax and Structure.

Module 2

Text Classification: What Is Text Classification? Automated Text Classification, Text

Classification Blueprint, Text Normalization, Feature Extraction, Classification Algorithms, Evaluating Classification Models, Building a Multi-Class Classification System

Module 3

Text Summarization: Text Summarization and Information Extraction, important concepts, Text Normalization Feature Extraction, Key phrase Extraction, Topic Modelling, Automated Document Summarization.

Module 4

Text Similarity and Clustering: Important Concepts, Text Normalization, Feature Extraction, Text Similarity, Analyzing Term Similarity, Analyzing Document Similarity, Document Clustering.

Book of Study

1. Bird, S., Klein, E., &Loper, E. (2009). Natural language processing with Python:
   analyzing text with the natural language toolkit. "O'Reilly Media, Inc.".

References

1. Dipanjan Sarkar, Text Analytics with Python, Apress/Springer, 2016
2. Jurafsky, D., & Martin, J. H. (2014). Speech and language processing. Vol. 3. Prentice Hall.

Manning, C. D., Manning, C. D., &Schütze, H. (1999). Foundations of statistical natural language processing. MIT press.

COURSE OUTCOME

Sl No:	Expected Course Outcome	Knowledge Level	Mapping to Programme Specific Outcome
1	CO1: Basics of text components and text processing.	K1, K2	PSO1,PSO2, PSO3,PSO 4
2	CO2: To differentiate among different techniques while considering different plus and minus of each technique.	K2	PSO1,PSO2, PSO 4
3	CO3: To classify text, reduce Dimensionality, use different Topic Modelling Approaches and Algorithms.	K2, K3	PSO 1, PSO 2
4	CO4: Ability to understand the advanced processor architecture and concept of RTOS.	K3, K4	PSO1,PSO2, PSO 4
5	CO5: Analyze text data from different real-world situations.	K4, K5	PSO6,PSO7
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4- Analyzing K5Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.

UG20DM6SC02- Big Data & Data Engineering
CREDITS: 5
TOTAL LECTURE HOURS: 5
HOURS/WEEK

Objective of the course:
On completion of the course, the student should be able to:
1. Able to improve operations, provide better customer service, create personalized marketing campaigns and take other actions that, ultimately, can increase revenue and profits.
2. It also helps a student to perform a variety of "analytics" on different data sets and to arrive at positive conclusions.

Module 1

Introduction to Bigdata: Key terms - Internet & data - Forms of data - What is big data - Four V's of big data - Data science vs Data engineering vs Data analytics - Hadoop : What is hadoop - Hadoop timeline - Hadoop features - Hadoop ecosystem - HDFS - HDFS architecture - Hadoop 1 vs Hadoop 2 vs Hadoop 3 - Secondary namenode - Hdfs federation - High availability - Installation of Cloudera VM - Linux commands - HDFS commands - Map Reduce - What is map reduce - map reduce architecture - map reduce program example (word count).

Module 2

Introduction to database - MySQL - Import and export table to csv - Hive: Introduction of hive - Features of hive - Hive Architecture - Partitioning & bucketing - HQL - Hive programs - Sqoop: What is sqoop - sqoop architecture - features of sqoop - Sqoop commands - Hue.

Module 3

Introduction to data processing - Python basics - Spark: Introduction to spark - Spark architecture - Spark features - Spark Ecosystem - Introduction to Pyspark - Spark (Core) - Spark SQL - Spark Dataframes - Spark programs - ETL - Build a batch data processing pipeline.

Module 4

Introduction to streaming: Data flow - Kafka: Kafka architecture - Kafka ecosystem - Kafka terms - Kafka broker - Kafka installation - Kafka data streaming programs - connecting producer source and consumer sink - Spark Streaming: What is spark streaming - spark streaming setup - spark streaming data processing pipeline.

Book of Study

1. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, Professional Hadoop Solutions, Wiley, 2015.
2. Karau, H., Konwinski, A., Wendell, P., & Zaharia, M. (2015). *Learning spark: lightning-fast big data analysis*. " O'Reilly Media, Inc.".

References

1. Tom White, Hadoop: The Definitive Guide, O'Reilly Media Inc.,

   2015.

2. Garry Turkington, Hadoop Beginner 's Guide, Packt Publishing,

   2013.

3. Chambers, B., &Zaharia, M. (2018). Spark: The definitive guide: Big data processing made simple. " O'Reilly Media, Inc.".
4. Guller, M. (2015). Big data analytics with Spark: A practitioner's guide to using Spark for large scale data analysis. Apress.

Lab Contents
- Hadoop ecosystem
- Installation of Cloudera VM
- HDFS commands
- Map Reduce architecture
- Import and export table to csv using MySQL
- Hive Architecture - Partitioning & bucketing
- HQL - Hive programs
- Sqoop - sqoop architecture
- Spark - Spark architecture
- Spark Ecosystem
- Pyspark
- Kafka architecture
- Spark streaming setup

COURSE OUTCOME

Sl No:	Expected Course Outcome	Knowledge Level	Mapping to Programme Specific Outcome
1	CO1: Understand Big Data and its analytics in the real world	K1, K2	PSO1,PSO2, PSO3,PSO 4
2	CO2: Analyze the Big Data framework like Hadoop and NOSQL to efficiently store and process Big Data to generate analytics	K4	PSO1,PSO2, PSO3,PSO 4
3	CO3: Design of Algorithms to solve Data Intensive Problems using Map Reduce Paradigm	K4, K5	PSO 1, PSO 2
4	CO4: Design and Implementation of Big Data Analytics using pig and spark to solve data intensive problems and to generate analytics	K5,K6	PSO1, PSO2,PSO6, PSO7
5	CO5: Implement Big Data Activities using Hive	K3, K4, K5	PSO6, PSO7
Knowledge Levels: K1-Remembering, K2-Understanding, K3-Applying K4-Analyzing K5Evaluating and K6 -Creating			

Learning Pedagogy: Class Room Lecture, Multimedia projection, e-content, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment.

Assessment Tools: Assignments, Seminar, Test papers, End semester examination.