

# **Nagindas Khandwala College (Autonomous)**

**Affiliated to University of Mumbai**



**MKES's Nagindas Khandwala College (Autonomous),  
Gate No 5, Bhavishya Bharat Campus, S. V. Road, Malad (West)  
Mumbai-400 064**

**Programme Code: PMSCIT**

**Post Graduate Programme: Master of Science in Information  
Technology (M. Sc. IT) Programme**

**Two Year Integrated Programme - Four Semesters**

***Course Structure***

***Under Choice Based Credit, Grading and Semester System***

***Implemented for Academic Year- 2022-23***

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## **1. Preamble**

Masters of Science (MSc.) in Information Technology is a Post-graduation programme of 104 credits offered by the Department of Information technology and Computer Science, Nagindas Khandwala College [Autonomous], under the Choice Based Credit and Grading System. The programme is designed to fulfil the demand for trained professionals in Information Technology. The curriculum is designed to develop strong theoretical foundation while ensuring the applications of acquired knowledge in various fields. The Master's Degree Program will provide students the right blend of knowledge and skills.

## **2. Objectives of the programme**

The curriculum is framed to accomplish the following program objectives by the end of study.

- To provide maximum practical experience to enrolled students in order to help them choose their path and pace according to their aptitude and ability.
- To prepare the students with the capabilities of independently designing and executing research projects and apply their knowledge to come up with technical solutions to problems.
- To facilitate inclusive development of the student technically, managerially and individually through various support courses along with the core subjects.

## **3. Program Outcome:**

After completion of two years Master of Science Information Technology (MSC IT) Programme, the learner will:

PO-1: Demonstrate (i) a fundamental and systematic or coherent understanding of the academic field of Information Technology and its linkages with related disciplinary areas/subjects;

PO-2: Procedural knowledge that creates different types of professionals related to the disciplinary/subject area of Information Technology, including professionals engaged in research and development, teaching and government/public service;

PO-3: Skills in areas related to one's specialization within the disciplinary/subject area of Information Technology and current and emerging developments in the field of Information Technology.

PO-4: Demonstrate the ability to use the knowledge of Information Technology in formulating and tackling IT-related problems and identifying and applying appropriate principles and methodologies to solve a wide range of problems associated with Information Technology.

PO-5: Recognise the importance of qualitative as well as quantitative data and approaches/methods for solving IT related problems.

PO-6: Plan and execute programming experiments or field investigations, analyse and interpret data/information collected using appropriate methods, including the use of appropriate software such as programming languages and special-purpose packages, and report accurately the findings of the experiment/field investigations while relating the conclusions/findings to relevant theories of Information Technology and data Science.

PO-7: Demonstrate relevant global competencies such as problem solving skills that are required to solve different types of IT related problems with well-defined solutions, and tackle open ended problems that may cross disciplinary-area boundaries;

PO-8: Demonstrate investigative skills, including skills of independent investigation of Information Technology -related issues and problems;

PO-9: Develop (i) communication skills involving the ability to listen carefully, to read texts and research papers analytically and to present complex information in a concise manner to different groups/audiences; (ii) ICT skills such as presentation skills, documentation, etc; (iii) personal skills such as the ability to work both independently and in a group

PO-10: Develop analytical skills involving paying attention to detail and ability to construct logical arguments using correct technical language related to Information Technology and Computer Science.

PO-11: Demonstrate professional behaviour such as (i) being objective, unbiased and truthful in all aspects of work and avoiding unethical behavior such as fabricating, falsifying or misrepresenting data or to committing plagiarism; (ii) the ability to identify the potential ethical issues in work-related situations;

PO-12: Inculcate the mentality for (i) the appreciation of intellectual property, environmental and sustainability issues; and (ii) promoting safe learning and working environment.

#### 4. Program Specific Outcome:

- To develop logic and problem solving skills towards the requirements of the society and develop software tools in the field.
- To create an exposure to the emerging areas in the field of technology

#### PO – CO MAPPING

Sem	Course	Course Code	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
Sem 1	Research in Computing	2211PITRC	*	*			*	*	*	*	*	*		*
	Research in Computing Practical	2211PITRCP	*	*			*	*	*	*	*	*		*
	Machine Learning	2212PITML	*	*	*	*	*				*	*	*	*
	Machine Learning Practical	2212PITMLP	*	*	*	*	*				*	*	*	*
	Foundations of Data Science	2213PITFD	*	*	*			*	*		*			*
	Foundations of Data Science Practical	2213PITFDP	*	*	*			*	*		*			*
	Distributed Systems	2214PITDS	*	*	*	*					*			
	Distributed Systems Practical	2214PITDSP	*	*	*	*					*			
	Cyber and Information Security	2215PITCS	*	*	*	*					*			
	Cyber and Information Security Practical	2215PITCS	*	*	*	*					*			
	Analysis of Algorithms	2216PITAA	*	*	*			*	*	*	*	*		*
	Analysis of Algorithms Practical	2216PITAAP	*	*	*			*	*	*	*	*		
	Soft Skills for Professionals		*									*	*	*
	Foundations of Mathematics	2221PITFM	*	*	*	*	*	*	*			*		
	Soft Computing	2222PITSC	*	*	*			*	*		*	*		
	Soft Computing Practical	2222PITSCP	*	*	*			*	*		*	*		
	Internship/ Research paper/ miniproject	2223PITRPM	*	*	*	*	*	*	*	*	*	*		*
	Paper Presentation / Paper Publication	2224PITPP	*	*	*	*	*	*	*	*	*	*		*
	Foundations of Big Data	2225PITBD	*	*	*			*			*	*	*	*

	Foundations of Big Data Practical	2225PITBDP	*	*	*			*			*	*	*	*
	Cloud Computing	2226PITCC	*	*	*	*						*		*
	Cloud Computing Practical	2227PITCF	*	*	*	*						*		*
	Computer Forensic	2227PITCFP	*	*	*	*	*				*			*
	Computer Forensic Practical	2228PITOT	*	*	*	*					*			*
	Optimization Techniques	2228PITOTP	*	*	*			*	*		*			
	Optimization Techniques Practical	2227PITCF	*	*	*			*	*		*			
Sem III	Artificial Intelligence	2131PITAI	*		*	*	*	*				*		
	Artificial Intelligence Practical	2131PITAIP	*		*	*	*	*	*	*		*		
	Entrepreneurship and Ethics in IT	2132PITEE	*	*	*			*	*		*		*	*
	Project	2133PITPR	*	*	*	*	*	*	*	*	*	*		*
	Engineering Blockchain Applications	2134PITEBC	*	*	*	*	*		*			*		
	Engineering Blockchain Applications Practical	2134PITEBCP	*		*	*	*	*		*		*	*	*
	Ethical Hacking Offensive Penetration Testing	2135PITEH	*	*	*	*	*		*			*		*
	Ethical Hacking Offensive Penetration Testing Practical	2135PITEHP	*		*	*	*	*		*		*	*	*
	Image Processing	2136PITIP	*		*	*	*		*			*	*	
	Image Processing Practical	2136PITIPP	*		*	*	*		*			*	*	
	Mastering Microservices with Python, Flask, and Docker	2137PITMS	*		*	*	*	*	*			*		
	Mastering Microservices with Python, Flask, and Docker Practical	2137PITMSP	*		*	*	*	*	*			*	*	*
	Introduction to Deep Learning	2141PITDL	*		*	*	*	*	*			*		
	Introduction to Deep Learning Practical	2141PITDLP	*		*	*	*	*	*			*		
	Project	2142PITPR	*	*	*	*	*	*	*	*	*	*		*

Sem IV	Developing Blockchain-Based Identity Applications	2143PITDBC	*		*	*	*	*	*	*		*		*
	Developing Blockchain-Based Identity Applications Practical	21435PITDBCP	*		*	*	*	*	*	*		*	*	
	Security Operations Management	2144PITSOM	*	*	*	*	*	*	*	*		*	*	
	Security Operations Management Practical	2144PITSOMP	*	*	*	*	*	*	*	*		*	*	
	Advanced Image Processing	2145PITAIP	*		*	*	*		*			*	*	
	Advanced Image Processing Practical	2145PITAIPP	*		*	*	*		*			*	*	
	Advanced Linux System Administration	2146PITLSA	*	*	*		*			*	*		*	*
	Advanced Linux System Administration Practical	2146PITLSAP	*	*	*		*			*	*		*	*

## 5. Scheme of Examination

The scheme of Examination shall be divided into parts i.e. Continuous Internal Evaluation including Assignment, Projects, Seminars, Case Studies and Class Tests which will be of 40 marks, Semester End Examinations which will be of 60 marks and Practical Examination which will be of 50 Marks. The semester wise Credit Points may vary from course to course but the value of Credits for the Post-Graduate Programme shall be of 96 Credits. Students will have to earn 8 extra credits under autonomy. This will be achieved by doing different courses listed below summing up to 8 credits.

### Scheme of Total Credits (For the students admitted before Academic Year 2022-2023)

Sr No	Year	Credits
1	Year 1	48
2	Year 2	48
	Total Credits from Academics	96
3	Additional Credits	08
	<b>Total</b>	<b>104</b>

**List of Certifications for Additional Credits (For the students admitted before  
Academic Year 2022-2023)**

Sr No	Certification	Credits
1	Online Courses (IIT Spoken Tutorials/ Coursera/ Swayam and similar) / certificate courses / short term course	Each Course will be for 2 credits
2	Mentoring for UG students (60 hours)	2
3	Paper Presentation/publications (in conferences/journals in the core or allied areas)	2
4	Participation in Conferences	1

## 6. Credit Based Evaluation System Scheme of Examination

For all 4 semesters, the performance of the learners shall be evaluated into two components. The first component shall carry 40% marks which will be a Continuous Internal Evaluation while the second component shall carry 60% marks at semester end examination. The concerned faculty will decide on the exact nature of Continuous Internal Evaluation (CIE) and Semester End Examinations (SEE). However, the faculty must inform and give details of the evaluation methods to the Department of MSc IT as well as to the participants in the program at the beginning of the Semester. Apart from these, the students will have to appear for Practical Exam which will be of 50 marks.

### Structure of Continuous Internal Evaluation – 40% = 40 marks

Sr. No.	Particulars	Marks
1	Class test or using any open source learning management system such as Moodle or a test based on an equivalent online course on the contents of the concerned course offered by or build using MOOC platform.	30 marks
2	Active participation in routine class instructional deliveries	10 marks



Semester End Examination will be organized after all modules of the course are discussed in the class. It will be a written examination / or as per the needs of the course a practical examination or a combination of both. This examination will be for 60 marks. The assessment of Continuous Internal Evaluation and Semester End Examination as mentioned above for the Semesters I to IV shall be processed by the College – ‘Institutions of their Learners’ and issue the grade cards to them after the conversion of marks into grade as the procedure mentioned below.

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Continuous Internal Evaluation & Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Continuous Internal Evaluation and 40% marks in Semester End Examination (i.e. 24 Out of 60) separately, and 40% marks in Practical Examination (i.e. 20 out of 50) to pass the course and minimum of Grade D in each project, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Continuous Internal Evaluation & Semester End Examination together.

#### **Passing Standards**

<b>Grade</b>	<b>Marks (CIE + SEE)</b>	<b>Practical Marks</b>	<b>Grade Points</b>
O	80 & Above	40 & Above	10
A+	70 to 79.99	35 to 39	9
A	60 to 69.99	30 to 34	8
B+	55 to 59.99	28 to 29	7
B	50 to 54.99	25 to 27	6
C	45 to 49.99	23 to 24	5
D	40 to 44.99	20 to 22	4
F	Less than 40	Less than 20	0

*Master of Science (MSc) Programme in Information Technology*

**Two Year Integrated Programme - Four Semesters**

**Basic Structure: Distribution of Courses**

**About the Credit Scheme:**

- 104 Credits for the entire MSc course:
  - 24 Credits for each semester ( $24 \times 4 = 96$ ), + 8 Extra credits for the students admitted in MSc Semester-I before 2022
  - 28, 28, 24, 24 Credits each for Semester I, II, III and IV ( $28 + 28 + 24 + 24 = 104$ ) for the students admitted in MSc Semester-I from 2022-2023
  
- 60 teaching hours per course (core/elective/IC/Ability Enhancement) during the Semester.

*Masters in Science (MSc) Programme in Information Technology*

**Two Year Integrated Programme -**

**Four Semesters**

**Basic Structure: Distribution of Courses (before Academic Year 2022-2023)**

<b>Sr. No</b>	<b>Type</b>	<b>No of Papers</b>	<b>Credits</b>
1	Ability Enhancement Compulsory Course (AECC)	1 Paper of 4 credits (1*4)	<b>4</b>
2	Skill Enhancement Compulsory Course (SEC)	15 Papers of 2 Credits each (13*2) 1 Paper of 6 credits (1*6)	<b>36</b>
3	Core Course (CC)	6 Papers of 4 Credits each (6*4)	<b>24</b>
4	Discipline Specific Elective (DSE)	8 Papers of 4 Credits each (8*4)	<b>32</b>
		<b>Total Credits</b>	<b>96</b>

**Basic Structure: Distribution of Courses (from Academic Year 2022-2023)**

<b>Sr. No</b>	<b>Type</b>	<b>No of Papers</b>	<b>Credits</b>
1	Ability Enhancement Compulsory Course (AECC)	1 Paper of 4 credits (1*4)	<b>4</b>
2	Skill Enhancement Compulsory Course (SEC)	13 Papers of 2 Credits each (13*2) and 1 paper of 4 credits 1 Paper of 6 credits (1*6)	<b>40</b>
3	Core Course (CC)	7 Papers of 4 Credits each (7*4)	<b>28</b>
4	Discipline Specific Elective (DSE)	8 Papers of 4 Credits each (8*4)	<b>32</b>
		<b>Total Credits</b>	<b>104</b>

**Post Graduate Programme: Master of Science Information Technology  
(MSc IT)**

**CONCEPTUAL FRAMEWORK**

**Part – I, Semester I & II (2022-2023)**

Sr No	Semester I	Subject code	Marks	Credits	Sr No	Semester II	Subject code	Marks	Credits
1	<b>Core 1:</b> Research in Computing	2211PITRC	40-60 100	04	1	<b>Core 3:</b> Foundations of Mathematics	2221PITFM	40-60 100	04
	<b>Core 1:</b> Research in Computing Practical	2211PITRCP	50	02	2	<b>Core 4:</b> Soft Computing	2222PITSC	40-60 100	04
2	<b>Core 2:</b> Machine Learning	2212PITML	40-60 100	04		Soft Computing Practical	2222PITSCP	50	02
	<b>Core 2:</b> Machine Learning Practical	2212PITMLP	50	02	3	<b>AECC 1:</b> Internship/ Research paper/ mini-project	2223PITRPM	40-60 100	04
	<b>DSE-1 (Any One)</b>					Paper Presentation/ Paper Publication	2224PITPP	50	02
3(i)	<b>DSE-1</b> Foundations of Data Science	2213PITFD	40-60 100	04		<b>DSE-3 (Any One)</b>			
	Foundations of Data Science Practical	2213PITFDP	50	02	4(i)	<b>DSE-3</b> Foundations of Big Data	2225PITBD	40-60 100	04
(ii)	<b>DSE-1</b> Distributed Systems	2214PITDS	40-60 100	04		Foundations of Big Data Practical	2225PITBDP	50	02
	Distributed Systems Practical	2214PITDSP	50	02	(ii)	<b>DSE-3</b> Cloud Computing	2226PITCC	40-60 100	04
	<b>DSE-2 (Any One)</b>					Cloud Computing Practical	2226PITCCP	50	02
4(i)	<b>DSE-2</b> Cyber and Information Security	2215PITCS	40-60 100	04		<b>DSE-4 (Any One)</b>			
	Cyber and Information Security Practical	2215PITCS	50	02	5(i)	<b>DSE-4</b> Computer Forensic	2227PITCF	40-60 100	04
(ii)	<b>DSE-2</b> Analysis of Algorithms	2216PITAA	40-60 100	04		Computer Forensic Practical;	2227PITCFP	50	02
	Analysis of Algorithms Practical	2216PITAAP	50	02	(ii)	<b>DSE-4</b> Optimization Techniques	2228PITOT	40-60 100	04
5	<b>SEC:</b> Soft Skills for Professionals		100	04		Optimization Techniques Practical	2228PITOTP	50	02
	TOTAL		700	28		TOTAL		700	28

**Part – II, Semester III & IV**

Sr. No.	Semester III	Subject code	Marks	Credits	Sr. No.	Semester IV	Subject code	Marks	Credits
1	<b>Core 4:</b> Artificial Intelligence	2131PITAI	40-60 100	04	1	<b>Core 6:</b> Introduction to Deep Learning	2141PITDL	40-60 100	04
	Artificial Intelligence Practical	2131PITAI P	50	02		Introduction to Deep Learning Practical	2141PITDLP	50	02
2	<b>Core 5:</b> Entrepreneurship and Ethics in IT	2132PITE E	40-60 100	04	2	<b>AECC-3</b> Project	2142PITPR	150	06
3	<b>AECC-2</b> Project	2133PITP R	50	02					
<b>DSE 5 and 6 (Any Two)</b>					<b>DSE 7 and 8 (Any Two)</b>				
4(i)	Engineering Blockchain Applications	2134PITE BC	40-60 100	04	3(i)	Developing Blockchain-Based Identity Applications	2143PITDBC	40-60 100	04
	Engineering Blockchain Applications Practical	2134PITE BCP	50	02		Developing Blockchain-Based Identity Applications Practical	21435PITDBC P	50	02
(ii)	Ethical Hacking Offensive Penetration Testing – 1	2135PITE H	40-60 100	04	(ii)	Security Operations Management	2144PITSOM	40-60 100	04
	Ethical Hacking Offensive Penetration Testing – 1 Practical	2135PITE HP	50	02		Security Operations Management Practical	2144PITSOMP	50	02
(iii)	Image Processing	2136PITIP	40-60 100	04	(iii)	Advanced Image Processing	2145PITAIP	40-60 100	04
	Image Processing Practical	2136PITIP P	50	02		Advanced Image Processing Practical	2145PITAIPP	50	02
(iv)	Mastering Microservices with Python, Flask, and Docker	2137PITM S	40-60 100	04	(iv)	Advanced Linux System Administration	2146PITLSA	40-60 100	04
	Mastering Microservices with Python, Flask, and Docker Practical	2137PITM SP	50	02		Advanced Linux System Administration Practical	2146PITLSAP	50	02
	<b>TOTAL</b>		<b>600</b>	<b>24</b>		<b>TOTAL</b>		<b>600</b>	<b>24</b>

**Nagindas Khandwala College (Autonomous)**

**Syllabus and Question Paper Pattern  
of Courses of**

**Master of Science Information Technology (MSc IT)  
Programme**

**Part – I, First Year**

***Semester I and II***

**Under Choice Based Credit, Grading and Semester System**

***(Implemented during Academic Year 2022-2023)***

**Post Graduate Programme: Master of Science Information Technology  
(MSc IT)**

**CONCEPTUAL FRAMEWORK**

**Part – I, Semester I & II**

Sr No	Semester I	Subject code	Marks	Credits	Sr No	Semester II	Subject code	Marks	Credits
1	<b>Core 1:</b> Research in Computing	2211PITRC	40-60 100	04	1	<b>Core 3:</b> Foundations of Mathematics	2221PITFM	40-60 100	04
	<b>Core 1:</b> Research in Computing Practical	2211PITRCP	50	02	2	<b>Core 4:</b> Soft Computing	2222PITSC	40-60 100	04
2	<b>Core 2:</b> Machine Learning	2212PITML	40-60 100	04		Soft Computing Practical	2222PITSCP	50	02
	<b>Core 2:</b> Machine Learning Practical	2212PITMLP	50	02	3	<b>AECC 1:</b> Internship/ Research paper/ mini-project	2223PITRPM	40-60 100	04
	<b>DSE-1 (Any One)</b>					Paper Presentation/ Paper Publication	2224PITPP	50	02
3(i)	<b>DSE-1</b> Foundations of Data Science	2213PITFD	40-60 100	04		<b>DSE-3 (Any One)</b>			
	Foundations of Data Science Practical	2213PITFDP	50	02	4(i)	<b>DSE-3</b> Foundations of Big Data	2225PITBD	40-60 100	04
(ii)	<b>DSE-1</b> Distributed Systems	2214PITDS	40-60 100	04		Foundations of Big Data Practical	2225PITBDP	50	02
	Distributed Systems Practical	2214PITDSP	50	02	(ii)	<b>DSE-3</b> Cloud Computing	2226PITCC	40-60 100	04
	<b>DSE-2 (Any One)</b>					Cloud Computing Practical	2226PITCCP	50	02
4(i)	<b>DSE-2</b> Cyber and Information Security	2215PITCS	40-60 100	04		<b>DSE-4 (Any One)</b>			
	Cyber and Information Security Practical	2215PITCS	50	02	5(i)	<b>DSE-4</b> Computer Forensic	2227PITCF	40-60 100	04
(ii)	<b>DSE-2</b> Analysis of Algorithms	2216PITAA	40-60 100	04		Computer Forensic Practical;	2227PITCFP	50	02
	Analysis of Algorithms Practical	2216PITAAP	50	02	(ii)	<b>DSE-4</b> Optimization Techniques	2228PITOT	40-60 100	04
5	<b>SEC:</b> Soft Skills for Professionals		100	04		Optimization Techniques Practical	2228PITOTP	50	02
	<b>TOTAL</b>		700	28		<b>TOTAL</b>		700	28

**Syllabus for Programme of  
Master of Science Information Technology (M.Sc.IT)  
SEMESTER –I**

*(Implemented during Academic Year 2022-2023)*

**Core 1: Research in Computing**

(w.e.f Academic Year 2020-2021)

**Course Objectives:**

1. To inculcate research aptitude by providing basic understanding in the research methodology
2. To be able to conduct business research with an understanding of all the latest theories.
3. To develop the ability to explore research techniques used for solving any real world or innovate problem
4. To develop analytical skills by applying scientific methods.

**Learning Outcomes:**

Upon completion of this course, learner should be able to:

CO1: Solve real world problems with scientific approach. (Level: Apply)

CO2: Recognize, understand and apply the language, theory and models of the field of business analytics (Level: Apply)

CO3: Critically analyze, synthesize and solve complex unstructured business problems (Level: Analysis and Apply)

CO4: Apply the concepts and methods of business analytics identify, model and solve decision problems in different settings (Level: Create)

CO5: Interpret results/solutions and identify appropriate courses of action for a given managerial situation whether a problem or an opportunity. (Level: Analyse and Evaluate)

CO6: Create viable solutions to decision making problems (Level: Create)



Sr. No	Modules	No of hours
1	Introduction to Research	12
2	Research Process	12
3	Research Methods	12
4	Sampling and Field Work	12
5	Data Analysis and Presentation	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
<b>1</b>	<b>UNIT 1</b>
	Introduction: Role of Business Research, Information Systems and Knowledge Management, Theory Building, Organization ethics and issues
<b>2</b>	<b>UNIT 2</b>
	Beginning Stages of Research Process: Problem definition, Qualitative research tools, Secondary data research
<b>3</b>	<b>UNIT 3</b>
	Research Methods and Data Collection: Survey research, communicating with respondents, Observation methods, Experimental research
<b>4</b>	<b>UNIT 4</b>
	Measurement Concepts, Sampling and Field work: Levels of Scale measurement, attitude measurement, questionnaire design, sampling designs and procedures, determination of sample size
<b>5</b>	<b>UNIT 5</b>
	Data Analysis and Presentation: Editing and Coding, Basic Data Analysis, Univariate Statistical Analysis and Bivariate Statistical analysis and differences between two variables. Multivariate Statistical Analysis

**Reference Books:**

1. Business Research Methods, William G.Zikmund, B.J Babin, J.C. Carr Atanu Adhikari, Cen gage 8e, 2016.
2. Business Analytics AlbrightWinston, Cengage 5e, 2015
3. Research Methods for Business Students Fifth Edition Mark Saunders 2011
4. Multivariate Data Analysis Hair Pearson 7e, 2014

**Practical: (2 credits)**

1. (a) Write a program for obtaining descriptive statistics of data. (b) Import data from different data sources (from Excel, csv, mysql, sql server, oracle to R/Python/Excel)
2. (a) Design a survey form for a given case study, collect the primary data and analyze it (b) Perform suitable analysis of given secondary data.
3. (a) Perform testing of hypothesis using one sample t-test. (b) Perform testing of hypothesis using two sample t-test. (c) Perform testing of hypothesis using paired t-test.
4. (a) Perform testing of hypothesis using chi-squared goodness-of-fit test. (b) Perform testing of hypothesis using chi-squared Test of Independence
5. Perform testing of hypothesis using Z-test.
6. (a) Perform testing of hypothesis using one-way ANOVA. (b) Perform testing of hypothesis using two-way ANOVA. (c) Perform testing of hypothesis using multivariate ANOVA (MANOVA).
7. (a) Perform the Random sampling for the given data and analyse it. (b) Perform the Stratified sampling for the given data and analyse it.
8. Compute different types of correlation.
9. (a) Perform linear regression for prediction. (b) Perform polynomial regression for prediction.
10. (a) Perform multiple linear regression. (b) Perform Logistic regression.

## ***Core 2: Machine Learning***

(w.e.f Academic Year 2020-2021)

### **Course Objectives:**

1. Develop in depth understanding of the key technologies in data science and business analytics: data mining, machine learning, visualization techniques, predictive modeling, and statistics.
2. Practice problem analysis and decision-making.
3. Gain practical, hands-on experience with statistics programming languages and big data tools through coursework and applied research experiences.
4. To introduce students to the basic concepts and techniques of Machine Learning.
5. To develop skills of using recent machine learning software for solving practical problems.

### **Learning Outcome:**

After successful completion of this course, Learners will be able to:

CO1: Demonstrate the fundamental issues and challenges of machine learning (Level: Understand)

CO2: Apply ethical practices in everyday business activities and make well-reasoned ethical business and data management decisions. (Level: Apply)

CO3: Demonstrate knowledge of statistical data analysis techniques utilized in business decision making. (Level: Understand)

CO4: Apply principles of Machine Learning to the analysis of business problems. (Level: Analyze)

CO5: Use appropriate software to model real-world problems and suggest solutions (Level: Create)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Learning-Standard Linear methods	12
2	Selection and improvements of linear learning methods	12
3	Non-Linear Learning methods	12
4	Support Vector machines, PCA and Classification	12
5	Unsupervised Learning, Clustering	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
1	<b>UNIT 1</b>
	Unit I: Learning-Standard Linear methods Statistical Learning: What Is Statistical Learning, Assessing Model Accuracy. Linear Regression: Simple Linear Regression, Multiple Linear Regressions, Other Considerations in the Regression Model, The Marketing Plan, Comparison of Linear Regression with K-Nearest Neighbors. Classification: An Overview of Classification, Why Not Linear Regression? , Logistic Regression, Linear Discriminant Analysis, a Comparison of Classification Methods.
2	<b>UNIT 2</b>
	Unit II: Selection and improvements of linear learning methods Resampling Methods: Cross-Validation, The Bootstrap. Linear Model Selection and Regularization: Subset Selection, Shrinkage Methods, Dimension Reduction Methods, Considerations in High Dimensions.
3	<b>UNIT 3</b>
	Unit III: Non-Linear Learning methods Polynomial Regression, Step Functions, Basis Functions, Regression Splines, Smoothing Splines, Local Regression, Generalized Additive Models, Tree- Based Methods: The Basics of Decision Trees. Bagging, Random Forests, Boosting.
4	<b>UNIT 4</b>
	Unit IV: Support Vector machines, Principle Component Analysis and Classification Support Vector Machines: Maximal Margin Classifier. Support Vector Classifiers: Support Vector Machines, SVMs with More than Two Classes Relationship to Logistic Regression.
5	<b>UNIT 5</b>
	Unit V : Unsupervised Learning: The Challenge of Unsupervised Learning, Principal Components Analysis, Clustering Methods: K-Means Clustering, Hierarchical Clustering, Practical Issues in Clustering.

**Text book:**

1. An Introduction to Statistical Learning with Applications in R: Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer 2013.
2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction (Second Edition): Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer (2008).

**References:**

1. Introduction to Machine Learning (Second Edition): Ethem Alpaydm, The MIT Press (2010).
2. Pattern Recognition and Machine Learning: Christopher M. Bishop, Springer (2006)
3. Bayesian Reasoning and Machine Learning: David Barber, Cambridge University Press (2012)
4. Machine Learning: The Art and Science of Algorithms that Make Sense of Data: Peter Flach, Cambridge University Press (2012) Machine Learning for Hackers: Drew Conway and John Myles White, O'Reilly (2012)
5. Machine Learning in Action: Peter Harrington, Manning Publications (2012).
6. Machine Learning with R: Brett Lantz, Packt Publishing (2013)
7. <https://class.coursera.org/ml-005/lecture/preview>
8. <https://github.com/josephmisiti/awesome-machine-learning>.

**Practical (2 Credits)**

Note: Use R software to do the following

1. Implement simple linear regression model on a standard data set and plot the least square regression fit. Comment on the result. [One may use inbuilt data sets like Boston, Auto etc]
2. Implement multiple regression model on a standard data set and plot the least square regression fit. Comment on the result. [One may use inbuilt data sets like Carseats, Boston etc].
3. Fit a classification model using following: (i) logistic regression (ii) Linear Discriminant Analysis (LDA) and (iii) Quadratic Discriminant Analysis (QDA) on a standard data set and compares the results. [Inbuilt datasets like Smarket, Weekly, Auto, Boston etc may be used for the purpose].

4. Fit a classification model using K Nearest Neighbour (KNN) Algorithm on a given data set. [One may use data sets like Caravan, Smarket, Weekly, Auto and 34 Boston].
5. Use bootstrap to give an estimate of a given statistic. [Datasets like Auto, Portfolio and Boston etc may be used for the purpose].
6. For a given data set, split the data into two training and testing and fit the following on the training set: (i) Linear model using least squares (ii) Ridge regression model (iii) Lasso model (iv) PCR model (v) PLS model Report test errors obtained in each case and compare the results. [Data sets like College, Boston etc may be used for the purpose].
7. For a given data set, perform the following: (i) Perform the polynomial regression and make a plot of the resulting polynomial fit to the data. (ii) Fit a step function and perform cross validation to choose the optimal number of cuts. Make a plot of the fit to the data. [Use data set like Wage for the purpose].
8. For a given data set, do the following: (i) Fit a classification tree (ii) Fit a regression tree [One may choose data sets like Carseats, Boston etc for the purpose].
9. For a given data set, split the dataset into training and testing. Fit the following models on the training set and evaluate the performance on the test set: (i) Boosting (ii) Bagging (iii) Random Forest [Data sets like Boston may be used for the purpose].
10. Fit a support vector classifier for a given data set. [Data sets like Car, Khan, Boston etc may be used for the purpose].
11. Perform the following on a given data set: (i) Principal Component Analysis (ii) Hierarchical clustering. [Data set like NC160, USArrests etc may be used for the purpose].

## *Elective – 1 Foundations of Data Science*

(w.e.f 2020-2021)

### **Course Objectives:**

1. The main goal of this course is to help students learn, understand, and practice different techniques used in data science.
2. Develop in depth understanding of the key technologies in data science and business analytics: data mining, machine learning, visualization techniques, predictive modeling, and statistics.
3. Practice problem analysis and decision-making.
4. Gain practical, hands-on experience with statistics programming languages and big data tools through coursework and applied research experiences.

### **Learning Outcome:**

After successful completion of course, Learner will be able to understand and apply diverse data representations, visualization and analysis tools.

CO1: Apply principles of Data Science to the analysis of business problems. (Level: Apply)

CO2: Use data mining software to solve real-world problems. (Level: Apply)

CO3: Employ cutting edge tools and technologies to analyze Big Data. (Level: Apply)

CO4: Apply algorithms to build machine intelligence. (Level: Apply)

CO5: Demonstrate use of team work, leadership skills, decision making and organization theory. (Level: Apply)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Data Science Technology Stack	12
2	Management and Retrieve Superstep	12
3	Assess Superstep	12
4	Process Superstep	12
5	Transform, Organize and Report Supersteps	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
<b>1</b>	<b>UNIT 1</b>
	<p>Data Science Technology Stack: Rapid Information Factory Ecosystem, Data Science Storage Tools, Data Lake, Data Vault, Data Warehouse Bus Matrix, Data Science Processing Tools ,Spark, Mesos, Akka , Cassandra, Kafka, Elastic Search, R ,Scala, Python, MQTT, The Future Layered Framework: Definition of Data Science Framework, Cross- Industry Standard Process for Data Mining (CRISP-DM), Homogeneous Ontology for Recursive Uniform Schema, The Top Layers of a Layered Framework, Layered Framework for High-Level Data Science and Engineering</p> <p>Business Layer: Business Layer, Engineering a Practical Business Layer</p> <p>Utility Layer: Basic Utility Design, Engineering a Practical Utility Layer</p>
<b>2</b>	<b>UNIT 2</b>
	<p>Three Management Layers: Operational Management Layer, Processing-Stream Definition and Management, Audit, Balance, and Control Layer, Balance, Control, Yoke Solution, Cause-and-Effect, Analysis System, Functional Layer, Data Science Process</p> <p>Retrieve Superstep : Data Lakes, Data Swamps, Training the Trainer Model, Understanding the Business Dynamics of the Data Lake, Actionable Business Knowledge from Data Lakes, Engineering a Practical Retrieve Superstep, Connecting to Other Data Sources</p>
<b>3</b>	<b>UNIT 3</b>
	<p>Assess Superstep: Assess Superstep, Errors, Analysis of Data, Practical Actions, Engineering a Practical Assess Superstep</p>
<b>4</b>	<b>UNIT 4</b>
	<p>Process Superstep : Data Vault, Time-Person-Object-Location-Event, Data Science Process, Data Science</p> <p>Transform Superstep : Transform Superstep, Building a DataWarehouse, Transforming with Data Science, Hypothesis Testing, Overfitting and Underfitting, Precision-Recall, Cross-Validation Test</p>
<b>5</b>	<b>UNIT 5</b>
	<p>Transform Superstep: Univariate Analysis, Bivariate Analysis, Multivariate Analysis, Linear Regression, Logistic Regression, Clustering Techniques,</p>



	<p>ANOVA, Principal Component Analysis (PCA), Decision Trees, Support Vector Machines, Networks, Clusters, and Grids, Data Mining, Pattern Recognition, Machine Learning, Bagging Data, Random Forests, Computer Vision (CV) , Natural Language Processing (NLP), Neural Networks, TensorFlow.</p> <p>Organize and Report Supersteps : Organize Superstep, Report Superstep, Graphics, Pictures, Showing the Difference</p>
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**Reference books:**

1. Practical Data Science Andreas François Vermeulen APress 2018
2. Principles of Data Science Sinan Ozdemir PACKT 2016
3. Data Science from Scratch Joel Grus O’Reilly 2015
4. Data Science from Scratch first Principle in python Joel Grus Shroff Publishers 2017
5. Experimental Design in Data science with Least Resources N C Das Shroff Publishers 2018

**Practical (2 Credits)**

1. Setup and Use NumPy and Panda for Data Analysis.
2. Setup and Use Matplotlib for Data Visualisation.
3. Perform Linear Regression on the given Dataset.
4. Perform Logistic Regression on the given Dataset.
5. Perform K-means clustering on the given Dataset.
6. Perform Time Series Analysis on the given Dataset.
7. Perform Hypothesis Testing on the given Dataset.
8. Perform Decision Tree Classification on the given Dataset.
9. Create a handwritten digit classification model.
10. Create an image classifier in python.

## *Elective – 1 Distributed Systems*

(w.e.f 2020-2021)

### **Course Objectives:**

1. To introduce the fundamentals of distributed computing architectures and paradigms.
2. To understand the technologies, system architecture, and communication architecture that propelled the growth of parallel and distributed computing systems.
3. To develop and execute basic parallel and distributed application using basic programming models and tools.

### **Learning Outcome:**

Upon completion of this course, learner should be able to:

CO1: Understand foundations of Distributed Systems (Level: Understand)

CO2: Introduce the idea of peer-to-peer services and file system (Level: Understand)

CO3: Understand in detail the system level and support required for distributed system (level: Understand)

CO4: Understand the issues involved in studying process and resource management. (Level: Understand)

CO5: Design and develop distributed programs using sockets and RPC/RMI. (Level: Create)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Characterization and system models	12
2	Networking, IPC, Coordination & agreement	12
3	Transactions, concurrency controls and replication	12
4	Peer to peer system and file system	12
5	Distributed transactions and process management	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
1	<b>UNIT 1</b>
	<p><b>Characterization Of Distributed Systems:</b> Introduction, Examples of Distributed Systems, Trends In Distributed Systems, Focus On Resource Sharing, Challenges, Case Study: The World Wide Web.</p> <p><b>System Models:</b> Physical Models, Architectural Models, Fundamental Models</p>
2	<b>UNIT 2</b>
	<p><b>Networking And Internetworking:</b> Types Of Network, Network Principles, Internet Protocols, Case Studies: Ethernet, Wifi And Bluetooth.</p> <p><b>Interprocess Communication:</b> The Api For The Internet Protocols, External Data Representation And Marshalling, Multicast Communication, Network Virtualization: Overlay Networks, JAVA RMI: Creating Distributed Applications Using RMI and JDBC: Understanding Remote Method Invocation (RMI), Creating a Multitier Database Application Using RMI. Case Study: MPI</p> <p><b>Name Services:</b> Name services and the Domain Name System, Directory services, Case study: The Global Name Service, Case study: The X.500 Directory Service.</p> <p><b>Time And Global States:</b> Clocks, events and process states , Synchronizing physical clocks , Logical time and logical clocks, Global states, Distributed debugging</p> <p><b>Coordination And Agreement:</b> Distributed mutual exclusion, Elections Coordination and agreement in group communication, Consensus and related problems</p>
3	<b>UNIT 3</b>
	<p><b>Transactions and Concurrency Control:</b> Introduction, Transactions, Nested transactions, Locks Optimistic concurrency control. Timestamp ordering, Comparison of methods for concurrency control.</p> <p><b>Distributed Transactions:</b> Introduction, Flat and nested distributed transactions, Atomic commit process, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery.</p> <p><b>Replication:</b> Introduction, System model and group communication, Fault-tolerant services.</p> <p>Case study: The gossip architecture, CODA</p>
4	<b>UNIT 4</b>

	<p><b>Peer-to-peer Systems:</b> Introduction, Napster and its legacy, Peer-to-peer – Middleware, Routing overlays.</p> <p>Overlay case studies: Pastry, Tapestry- Distributed File Systems, Introduction, File service architecture, Andrew File system.</p> <p><b>File System:</b> Features-File model, File accessing models, File sharing semantics</p> <p>Naming: Identifiers, Addresses, Name Resolution, Name Space Implementation, Name Caches, LDAP.</p>
5	<b>UNIT 5</b>
	<p><b>Distributed Transactions:</b> Flat and nested distributed transactions, Atomic commit protocols, Concurrency control in distributed transactions, Distributed deadlocks.</p> <p><b>Process Management:</b> Process Migration: Features, Mechanism, Threads: Models, Issues, Implementation. Resource Management: Introduction- Features of Scheduling Algorithms, Task Assignment Approach, Load Balancing Approach, Load Sharing Approach.</p> <p><b>People Skills and Team Composition:</b> Introduction, Individual Skills, Test Team Dynamics, Fitting Testing within an Organization, Motivation, Communication.</p>

**Text books:**

1. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair , Distributed Systems - Concepts and Design (Unit I-Unit 5 )
2. Pradeep K Sinha, “Distributed Operating Systems: Concepts and Design”, Prentice Hall of India, 2007.( Unit 5)
3. Dynamic Web Programming : using Java, JavaScript, and Informix / Graham Harrison. 2000 ISBN: 0130861847.  
<http://catalogue.pearsoned.co.uk/samplechapter/0130861847.pdf> ( Unit 2)

**Reference books:**

1. Tanenbaum A.S., Van Steen M., “Distributed Systems: Principles and Paradigms”, Pearson Education, 2007.
2. Liu M.L., “Distributed Computing, Principles and Applications”, Pearson Education, 2004.

3. Nancy A Lynch, “Distributed Algorithms”, Morgan Kaufman Publishers, USA, 2003.

### **Practical (2 Credits)**

1. Write a program for implementing Client Server communication model.
2. Write a program to show the object communication using RMI.
3. Show the implementation of Remote Procedure Call.
4. Write a program to execute any one mutual exclusion algorithm.
5. Write a program to implement any one election algorithm.
6. Show the implementation of any one clock synchronization algorithm.
7. Write a program to implement two phase commit protocol.
8. Design and develop a distributed Hotel booking application using Java RMI. A distributed hotel booking system consists of the hotel server and the client machines. The server manages hotel rooms booking information. A customer can invoke the following operations at his machine
  - a. Book the room for the specific guest
  - b. Cancel the booking of a guest
  - c. Enquire the check in date for the specified customer/guest.
9. Design a distributed application using MapReduce which processes a log file of a system. List out the users who have logged for maximum period on the system. Use simple log file from the Internet and process it using a pseudo distribution mode on Hadoop platform.
10. Design and develop a distributed application to find the coolest/hottest year from the available weather data. Use weather data from the Internet and process it using MapReduce.
11. Show the distributed file system implementation with manets in NS2 simulator

## ***Elective – 2: Cyber and Information Security***

(w.e.f 2020-2021)

### **Course Objectives:**

1. Describe the principles and techniques associated with the cyber security Practices
2. Evaluate techniques used to break into an insecure web application and identify relevant Counter measures (K4)
3. Integrate approaches to secure networks, intrusion detection and prevention systems(K3)

### **Learning Outcome:**

After successful completion of course, Learner will be able to understand and apply diverse security testing and suggest solutions to them.

CO1: Explain the basic information on cybercrime. (Level: Understand)

CO2: Describe cyber laws for various crime activities. (Level: Understand)

CO3: Identify the security policies for cyber issues. (Level: Understand)

CO4: Analyze the role of organization for securing cyberspace. (Level: Analyze)

CO5: Explain the need for security in organizations. (Level: Understand)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Computer and OS Security	12
2	Network Security	12
3	Cloud Security	12
4	Mobile Security	12
5	Attacks and vulnerabilities in cellular service	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
1	<b>UNIT 1</b>
	Unit I: Computer Security: Principles of Security, Different Attacks: malicious and non-malicious program, Types of Computer Criminals. Operating System Security: Protected objects and methods of protection. Memory address protection: Fence, Relocation, Base/Bound Registers, Tagged Architecture, Segmentation, Paging, Directory, access control list. Database Security: Security requirements, Integrity, Confidentiality, Availability, Reliability of Database, Sensitive data, Multilevel database, Proposals for multilevel security.
2	<b>UNIT 2</b>
	Unit II: Network Security: Different types of network layer attacks, Firewall (ACL, Packet Filtering, DMZ, Alerts and Audit Trails) – IDS, IPS and its types (Signature based, Anomaly based, Policy based, Honeypot based). Web Server Security: SSL/TLS Basic Protocol-computing the keys- client authentication- PKI as deployed by SSL Attacks fixed in v3- Exportability-Encoding-Secure Electronic Transaction (SET), Kerberos.
3	<b>UNIT 3</b>
	Unit III: Cloud Security: How concepts of Security apply in the cloud, User authentication in the cloud; How the cloud provider can provide this- Virtualization System Security Issues: e.g. ESX and ESXi Security, ESX file system security- storage considerations, backup and recovery- Virtualization System Vulnerabilities, security management standards- SaaS, PaaS, IaaS availability management- access control- Data security and storage in cloud.
4	<b>UNIT 4</b>
	Unit IV: Mobile Security: Mobile system architectures, Overview of mobile cellular systems, GSM and UMTS
5	<b>UNIT 5</b>
	Security & Attacks, Vulnerabilities in Cellular Services, Cellular Jamming Attacks & Mitigation, Security in Cellular VoIP Services, Mobile application security. Securing Wireless Networks: Overview of Wireless Networks, Scanning and Enumerating 802.11 Networks, Attacking 802.11 Networks, Bluetooth Scanning and Reconnaissance, Bluetooth Eavesdropping, Attacking & Exploiting Bluetooth, Zigbee Security & Attacks.

**Text books:**

1. Security in Computing 4th edition, Charles P. Pfleeger, Charles P. Pfleeger, Shari Lawrence Pfleeger, Prentice Hall; 4th edition (2006)
2. Mobile and Wireless Security and Privacy, Kia Makki, Peter Reiher, Springer, (2007)
3. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory and practice), Tim Mather, Subra Kumaraswamy, Shahed Latif., O'Reilly Media; 1 edition (2009)

**Reference books:**

1. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley (2010)
2. Network Security, Charlie Kaufman, Radia Perlam, Mike Speciner, Prentice Hall, 2nd Edition (2002)
3. Cryptography and Network Security 3rd edition, Atul Kahate, Tata McGraw Hill Education Private Limited (2013)
4. Network Security, Charlie Kaufman, Radia Perlam, Mike Speciner, Prentice Hall, 2nd Edition (2002)
5. Cryptography and Network Security: Principles and practice 6th edition, William Stallings, Pearson Education (2013)

**Practical (2 Credits)**

1. Implementation to gather information from any PC's connected to the LAN using whois, port scanners, network scanning, Angry IP scanners etc.
2. Implementation of MITM- attack using wireshark/ network sniffers
3. Implementation of Windows security using firewall and other tools
4. Implementation to identify web vulnerabilities, using OWASP project
5. Implementation of IT Audit, malware analysis and Vulnerability assessment and generate the report.
6. Implementation of OS hardening and RAM dump analysis to collect the Artifacts and other information's.
7. Implementation of Mobile Audit and generate the report of the existing Artifacts.
8. Implementation of Cyber Forensics tools for Disk Imaging, Data acquisition, Data extraction and Data Analysis and recovery
9. Implement ESX file system security in cloud.
10. Develop application to implement Zigbee security.
11. Demonstrate and implement Bluetooth security.



## *Elective-2 Analysis of Algorithms*

(w.e.f 2020-2021)

### **Course Objectives:**

1. To study fundamental concepts of algorithms and problem-solving strategies
2. To impart the basic concepts of data structures and algorithms.
3. To assess how the choice of data structures and algorithm design methods impacts the performance of programs.
4. To provide an insight into the intrinsic nature of the problem and to develop software systems of varying complexity

### **Learning Outcome:**

At the end of this course learner will be able to:

CO1: Evaluating and providing suitable techniques for solving a problem using basic properties of Data Structures. (Level: Analyse and Apply)

CO2: Analyse the performance of algorithms using asymptotic notations. (Level: Analyse and Evaluate)

CO3: Demonstrate knowledge of basic data structures and legal operations on them. (Level: Understand)

CO4: Illustrate different types of algorithmic approaches to problem solving and assess the tradeoffs involved. (Level: Evaluate)

CO5: Analyse basic graph algorithms, operations and applications through a structured (well defined) algorithmic approach. (Level: Analyse)

CO6: Categorize the feasibility and limitations of solutions to real-world problems. (Level: Analyse)

CO7: Provide efficient algorithmic solution to real-world problems (Level: Create)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Design Strategies	12
2	Randomized algorithms and greedy algorithms	12
3	Advanced design and analysis techniques	12
4	Number theoretic algorithms	12
5	NP-Completeness	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
1	<b>UNIT 1</b>
	<p>Design strategies:</p> <p>The Role of Algorithms in Computing: Algorithms as a technology. Getting Started: Insertion sort, Analyzing algorithms, Designing algorithms. Growth of Functions: Asymptotic notation, Standard notations and common functions. Divide-and-Conquer: The maximum-subarray problem, Strassen's algorithm for matrix multiplication, The substitution method for solving recurrences.</p>
2	<b>UNIT 2</b>
	<p>Probabilistic Analysis and Randomized Algorithms: The hiring problem, Indicator random variables, Randomized algorithms.</p> <p>Greedy Algorithms: An activity-selection problem, Elements of the greedy strategy, Problem solvable and unsolvable using Greedy strategy.</p>
3	<b>UNIT 3</b>
	<p>Advanced Design and Analysis Techniques</p> <p>Dynamic Programming: Rod cutting, Elements of dynamic programming, longest common subsequence. Elementary Graph Algorithms: Representations of graphs, Breadth-first search, Depth-first search. Minimum Spanning Trees: Growing a minimum spanning tree, Algorithms of Kruskal and Prim. Single-Source Shortest Paths: The Bellman-Ford algorithm, Single-source shortest paths in directed acyclic graphs, Dijkstra's algorithm.</p>
4	<b>UNIT 4</b>
	<p>Number-Theoretic Algorithms: Elementary number-theoretic notions, Greatest common divisor, Modular arithmetic, Solving modular linear equations, The Chinese remainder theorem, Powers of an element, The RSA public-key cryptosystem</p>
5	<b>UNIT 5</b>
	<p>NP-Completeness: Polynomial time, Polynomial-time verification, NP-completeness and reducibility, NP-complete problems. Approximation Algorithms: The vertex-cover problem, The traveling-salesman problem, The set-covering problem, subset-sum problem.</p>

**Text books:**

1. Introduction to Algorithms, Third Edition, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, PHI Learning Pvt. Ltd-New Delhi (2009).
2. Researching Information Systems and Computing, Brinoy J Oates, Sage Publications India Pvt Ltd (2006)

**Reference books:**

1. Algorithms, Sanjoy Dasgupta , Christos H. Papadimitriou, Umesh Vazirani, McGraw-Hill Higher Education (2006)
2. Grokking Algorithms: An illustrated guide for programmers and other curious people, MEAP, Aditya Bhargava, <http://www.manning.com/bhargava>

**Practical (2 Credits)**

1. Write a program to implement insertion sort and find the running time of the algorithm.
2. Write a program to implement merge sort algorithm. Compare the time and memory complexity.
3. Given an array of numbers of length, write a program to generate a random permutation of the array using (i) permute-by-sorting() and(ii) permute-by-cyclic().
4. Write a program to implement Longest Common Subsequence (LCS) algorithm
5. Write a program to implement Huffman's code algorithm
6. Write a program to implement Kruskal's algorithm.
7. Write a program to implement Dijkstra's algorithm
8. Write a program to implement Euclid's algorithm to implement gcd of two non negative integers a and b. Extend the algorithm to find x and y such that  $\text{gcd}(a,b) = ax+by$ . Compare the running time and recursive calls made in each case.
9. Write a program to verify (i) Euclid's theorem (ii) Fermat's theorem.
10. Write a program to implement greedy set cover algorithm to solve set covering problem.

## *Evaluation Scheme*

### **I. Internal Exam-40 Marks**

**(i) Test– 30 Marks - Duration 60 mins**

It will be conducted either as a written test or using any open source learning management system such as Moodle (Modular object-oriented dynamic learning environment) Or a test based on an equivalent online course on the contents of the concerned course(subject) offered by or build using MOOC (Massive Open Online Course) platform.

**(ii) 10 Marks – Presentation and active participation in routine class instructional deliveries**

Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.

### **II. External Examination- 60 Marks**

**(i) Duration - 2.5 Hours.**

**(ii) Theory question paper pattern:-**

All questions are compulsory.

Question	Based on	Marks
Q.1	Unit I	12
Q.2	Unit II	12
Q.3	Unit III	12
Q.4	Unit IV	12
Q 5	Unit V	12

All questions shall be compulsory with internal choice within the questions.

Each Question may be sub-divided into sub questions as a, b, c, d & e, etc & the allocation of Marks depends on the weightage of the topic.

### **Practical Examination – 50 marks (Duration: 2 Hours)**

- Each practical course carries 50 Marks : 40 marks + 05 marks (journal)+ 05 marks(viva)
- Minimum 75% practical from each core/allied course are required to be completed and written in the journal.

**(Certified Journal is compulsory for appearing at the time of Practical Exam)**

# Soft Skills for Professionals

(Implemented during Academic Year 2022-23)

## Course Objectives (CO):

1. To enhance the public speaking skills of students
2. To improve the group discussion skills of students
3. To enrich the ability of students to manage interviews
4. To help the students to enhance their writing skill

## Course Outcomes:

After the completion of the Course, the Learner will be able to:

**CO1:** Demonstrate public speaking skills and business etiquettes (Level: Apply)

**CO2:** Apply group discussion strategies (Level: Apply)

**CO3:** To illustrate effective interview strategies (Level: Apply)

**CO4:** Demonstrate writing skills for professional success (Level: Apply)

## Module at a Glance

Sr. No	Modules	No of hours
1	Public Speaking and Etiquettes	15
2	Group Discussion	15
3	Interview	15
4	Writing Skills	15
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

## Detailed Syllabus

Unit	Content
1	<b>Public Speaking and Etiquettes</b>
	<b>Public Speaking</b> <ul style="list-style-type: none"><li>• The power of Public Speaking</li><li>• Developing confidence</li><li>• Planning</li><li>• Preparation</li><li>• Successful and effective delivery of speech</li><li>• Principles of effective presentation</li><li>• How to communicate on camera online and offline</li></ul>

	<b>Etiquettes</b> <ul style="list-style-type: none"> <li>• Work Etiquettes</li> <li>• Telephone / Mobile Etiquettes</li> <li>• Email Writing Etiquettes</li> <li>• Social Etiquettes</li> </ul>
2	<b>Group Discussion</b>
	<b><u>Understanding what is Group Discussion and its importance</u></b> <ul style="list-style-type: none"> <li>• Where lies the need of Group Discussion</li> <li>• Pre – requisites of a Group Discussion</li> <li>• Myths about Group Discussion</li> <li>• Discussion Vs Debates</li> <li>• External Arrangements <ul style="list-style-type: none"> <li>○ Atmosphere</li> <li>○ Seating Arrangement</li> <li>○ No. of members</li> <li>○ Length of Discussion</li> </ul> </li> </ul> <b><u>Dos and Don'ts of a Group Discussion</u></b> <ul style="list-style-type: none"> <li>• Allow others to speak</li> <li>• Speak clear and sensible</li> <li>• Positive attitude</li> <li>• Careful listener</li> <li>• Formal dress</li> </ul>
3	<b><u>Interview</u></b>
	<ul style="list-style-type: none"> <li>• Interviewing in the 21st century</li> <li>• Types of Interview</li> <li>• Interview Preparation</li> <li>• On the day of Interview</li> <li>• Documents to be taken for interview</li> <li>• During the Interview</li> <li>• After the interview</li> <li>• Developing an Interview Strategy</li> <li>• Taking Care of the Details</li> <li>• Practicing for the Interview</li> </ul>
4	<b>Writing Skills</b>
	<ul style="list-style-type: none"> <li>• Basics of writing</li> <li>• Effective Résumé writing</li> <li>• Drafting of notice, agenda and resolutions of meeting</li> <li>• Social Media and Communication</li> <li>• Facebook and Twitter as a new ways of communication.</li> </ul>

## Reference Books

1. Keller Kevin Lane, Strategic Brand Management: Building, Measuring and Managing Brand.
2. Kapferer, Jean-Noel, Strategic Brand Management-2000.
3. Elliot, Richard, Strategic Brand Management-2008.
4. Kishen, Ram, Strategic Brand Management- 2013.
5. Keller Kevin Lane, Strategic Brand Management 4e-2015.

### Evaluation Pattern

The performance of the learners shall be evaluated into two components viz. by Continuous Internal Evaluation (CIE) or Internal Assessment with 40% marks in the first component and by conducting the Semester-End Examinations (SEE) with 60% marks as the second component. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:

#### **A) Continuous Internal Evaluation (CIE)**

**40 Marks**

It will include:

1. Public Speaking – 10 marks
2. Group Discussion – 10 marks
3. Case Study – 10 marks
4. Assignment of Written Communication – 10 marks

#### **B) Semester End Examinations (SEE)**

**60 Marks**

1. Submission of Resume – 20 marks
2. Group Discussion – 20 marks
3. Interview – 20 marks

**Syllabus for Programme of  
Master of Science Information Technology (M.Sc.IT)  
SEMESTER –II**

*(Implemented during Academic Year 2022-2023)*

**Foundations of Mathematics**

*(Implemented during Academic Year 2022-23)  
(w.e.f 2022-23)*

**Course Objectives (CO):**

1. To build the mathematical foundation for the computing concepts
2. To improve the understanding of complexity of algorithms
3. To suggest and implement suitable mathematical models

**Course Outcomes:**

After the completion of the Course, the Learner will be able to:

CO1: To familiarize the students with some basic concepts of optimization techniques and approaches. (Level: Understand)

CO2: To formulate a real-world problem as a mathematical programming model.  
(Level: Apply)

CO3: To develop the model formulation and solve decision problems. (Level: Apply)

CO4: To solve specialized linear programming problems like the transportation and assignment (Level: Apply)

**Module at a Glance**

Sr. No	Modules	No of hours
1	Mathematical Foundations	15
2	Optimization	15
3	Linear Programming	15
4	Multiobjective Optimization	15
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>



## Detailed Syllabus

Unit	Content
1	<b>Mathematical Foundations</b>
	Mathematical Foundations: Functions and Continuity, Review of Calculus, Vectors, Matrix Algebra, Eigenvalues and Eigenvectors, Optimization and Optimality, General Formulation of Optimization Problems. Algorithms, Complexity, and Convexity: What Is an Algorithm? Order Notations, Convergence Rate, Computational Complexity, Convexity, Stochastic Nature in Algorithms
2	<b>Optimization</b>
	Optimization: Unconstrained Optimization, Gradient-Based Methods, Gradient-Free Nelder–Mead Method Constrained Optimization: Mathematical Formulation, Lagrange Multipliers, Slack Variables, Generalized Reduced Gradient Method, KKT Conditions, Penalty Method Optimization Techniques: Approximation Methods: BFGS Method, Trust-Region Method, Sequential Quadratic Programming, Convex Optimization, Equality Constrained Optimization, Barrier Functions, Interior-Point Methods, Stochastic and Robust Optimization
3	<b>Linear Programming</b>
	Linear Programming: Introduction, Simplex Method, Worked Example by Simplex Method, Interior-Point Method for LP Integer Programming: Integer Linear Programming, LP Relaxation, Branch and Bound, Mixed Integer Programming, Applications of LP, IP, and MIP
4	<b>Multiobjective Optimization</b>
	Multiobjective Optimization: Introduction, Pareto Front and Pareto Optimality, Choice and Challenges, Transformation to Single Objective Optimization, The Constraint Method, Evolutionary Approaches Constraint-Handling Techniques: Introduction and Overview, Method of Lagrange Multipliers, Barrier Function Method, Penalty Method, Equality Constraints via Tolerance, Feasibility Criteria, Stochastic Ranking, Multiobjective Constraint-Handling and Ranking

### Reference Books

1. Xin-She Yang, Optimization Techniques and Applications with Examples, Wiley, 3<sup>rd</sup> Ed., 2018
2. A.K. Malik, S.K. Yadav, S.R. Yadav, Optimization Techniques, I.K. International Publishing House, 1st Ed., 2012
3. Marco Cavazzuti, Optimization methods: from theory to design, Springer, 1<sup>st</sup> Ed., 2012
4. Chander Mohan, Kusum Deep, Optimization Techniques, New Age International, 1<sup>st</sup> Ed., 2009

### **Evaluation Pattern**

The performance of the learners shall be evaluated into two components viz. by Continuous Internal Evaluation (CIE) or Internal Assessment with 40% marks in the first component and by conducting the Semester-End Examinations (SEE) with 60% marks as the second component. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:

**A) Continuous Internal Evaluation (CIE) 40 Marks**

It will include:

5. Problem Solving – 20 marks
6. Presentation – 10 marks
7. Assignment – 10 marks

**B) Semester End Examinations (SEE) 60 Marks**

4. Case Study – 40 marks
5. Demonstration – 10 marks
6. Viva – 10 marks

## ***AECC 1: Internship/ Research paper/ mini-project***

### **Course Objectives:**

1. The course is designed so as to expose the students to industry environment and to take up on-site assignment as trainees or interns.
2. To evaluate complex arguments and to articulate their own positions on a range of technical and general topics.

### **Learning Outcome:**

Upon completion of this course, learner should be able to:

CO1: Have an exposure to industrial practices and to work in teams (Level: Apply)

CO2. Communicate effectively (Level: Apply)

CO3. Explain the impact of engineering solutions in a global, economic, environmental and societal context (Level: Understand)

CO4. Develop the ability to engage in research and to involve in life-long learning (Level: Apply and Analyse)

CO5. Formulate solution to contemporary issues (Level: Create)

CO6. Engage in establishing his/her digital footprint (Level: Apply)

<b>Paper Presentation/ Paper Publication (2025PITRP)</b>
<ol style="list-style-type: none"><li>1. Students are required to present a paper in any national/international conference</li><li>2. Publish a paper in any national or international peer reviewed journal</li></ol>

## ***Core 3: Soft Computing***

(w.e.f 2020-2021)

### **Course Objectives:**

1. To introduce students to the basic concepts and techniques of soft computing.
2. Identify and describe soft computing techniques
3. Understand soft computing approaches in problem solving
4. Formulate real-world methodologies to data mining using soft computing tools

### **Learning Outcome:**

After successful completion of course, Learners will be able to:

CO1: Differentiate between soft and hard computing (Level: Understand)

CO2: Implement artificial neural networks and fuzzy logic (Level: Apply)

CO3: Implement supervised and unsupervised learning networks (Level: Apply)

CO4: Demonstrate the suitable soft computing strategy to solve a given problem (Level: Analyse and Apply)

CO5: Demonstrate the advantages and drawbacks of soft computing strategies in problem solving (Level: Analyse and Evaluate)

CO6: Model complex problems using evolutionary algorithms and other soft computing models and compare the performance (Level: Create and Evaluate)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Introduction	12
2	ANN and supervised learning networks	12
3	Unsupervised learning networks	12
4	Fuzzy Logic	12
5	Genetic Algorithm	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
<b>1</b>	<b>UNIT 1</b>
	Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, Fuzzy Computing, Neural Computing, Genetic Algorithms, Associative Memory, Adaptive Resonance Theory, Classification, Clustering, Bayesian Networks, Probabilistic reasoning, applications of soft computing.
<b>2</b>	<b>UNIT 2</b>
	Artificial Neural Network: Fundamental concept, Evolution of Neural Networks, Basic Models, McCulloch-Pitts Neuron, Linear Separability, Hebb Network. Supervised Learning Network: Perceptron Networks, Adaptive Linear Neuron, Multiple Adaptive Linear Neurons, Back propagation Network, Radial Basis Function, Time Delay Network, Functional Link Networks, Tree Neural Network. Associative Memory Networks: Autoassociative memory network, heteroassociative memory network
<b>3</b>	<b>UNIT 3</b>
	UnSupervised Learning Networks: Fixed weight competitive nets, Kohonen self-organizing feature maps, learning vectors quantization, counter propagation networks, adaptive resonance theory networks. Special Networks: Simulated annealing, Boltzman machine, Gaussian Machine, Cauchy Machine, Probabilistic neural net, cascade correlation network, cognition network, neo-cognition network, cellular neural network, optical neural network
<b>4</b>	<b>UNIT 4</b>
	Introduction to Fuzzy Logic, Classical Sets and Fuzzy sets: Classical sets, Fuzzy sets. Classical Relations and Fuzzy Relations: Cartesian Product of relation, classical relation, fuzzy relations, tolerance and equivalence relations, non-iterative fuzzy sets. Membership Function: features of the membership functions, fuzzification, methods of membership value assignments.

	Defuzzification: Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations, Defuzzification methods. Fuzzy Arithmetic and Fuzzy measures: fuzzy arithmetic, fuzzy measures, measures of fuzziness, fuzzy integrals.
5	<b>UNIT 5</b>
	Genetic Algorithm: Biological Background, Traditional optimization and search techniques, genetic algorithm and search space, genetic algorithm vs. traditional algorithms, basic terminologies, simple genetic algorithm, general genetic algorithm, operators in genetic algorithm, stopping condition for genetic algorithm flow, constraints in genetic algorithm, problem solving using genetic algorithm, the schema theorem, classification of genetic algorithm, Holland classifier systems, genetic programming, advantages and limitations and applications of genetic algorithm.

**References:**

1. Artificial Intelligence and Soft Computing, Anandita Battacharya Das, SPD 3rd 2018
2. Principles of Soft computing S.N.Sivanandam , S.N.Deepa, Wiley 3rd 2019
3. Neuro-Fuzzy Computing and Soft J.S.R.Jang, C.T.Sun and E.Mizutani, Prentice Hall of India 2004
4. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S. Rajasekaran, G. A. Vijayalakshami Prentice Hall of India 2004
5. Fuzzy Logic with Engineering Applications Timothy J.Ross McGraw-Hill 1997

### **Practical (2 Credits)**

1. Implement clustering algorithms
2. Write a program of Perceptron Training Algorithm.
3. Write a program to implement Hebb's rule
4. Write a program for Back Propagation Algorithm
5. Generate ANDNOT function using McCulloch-Pitts neural net
6. Generate XOR function using McCulloch-Pitts neural net
7. Write a program for Perceptron net for an AND function with bipolar inputs and targets.
8. Write a program to calculate the weights for the following patterns using hetero-associative neural net for mapping four input vectors to two output vectors
9. Write program to store vector[-1 -1 -1 -1] and [-1 -1 1 1] in an auto-associative net. Find weight matrix. Test the net with [1 1 1 1] as input.
10. Implement an unsupervised learning net
11. Write a program to plot various membership functions.
12. Use Fuzzy toolbox to model tip value that is given after a dinner which can be-not good, satisfying, good and delightful and service which is poor, average or good and the tip value will range from Rs. 10 to 100.
13. Implement genetic algorithm functions.
14. Implement travelling sales person using genetic Algorithm.

## *Elective – 3 Foundations of Big Data*

(w.e.f 2020-2021)

### **Course Objectives:**

1. To learn, understand, and practice different techniques used in big data analysis.
2. To understand the concept of big data
3. To Formulate big data analysis
4. To implement Hadoop and map reduce

### **Learning Outcome:**

After successful completion of course, Learner will be able to:

CO1: Describe the significance of privacy and ethics in big data environment (Level: Understand)

CO2: Analyze the steps to secure big data. (Level: Analyze)

CO3: Build security in Hadoop environment and its ecosystem. (Level: Create)

CO4: Analyze data security and event logging in Hadoop environment (Level: Analyze)

CO5: Compare various application business models of different domains. (Level: Analyze and Apply)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Introduction	12
2	Analytical Theory and Methods	12
3	Analytical Theory and Methods	12
4	Hadoop	12
5	Advanced MapReduce	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>



Sr. No.	Modules / Units
<b>1</b>	<b>UNIT 1</b>
	<p>Introduction to Big Data, Characteristics of Data, and Big Data, Evolution of Big Data, Definition of Big Data, Challenges with big data, Why Big data? Data Warehouse environment, Traditional Business Intelligence versus Big Data. State of Practice in Analytics, Key roles for New Big Data Ecosystems, Examples of big Data Analytics.</p> <p>Big Data Analytics, Introduction to big data analytics, Classification of Analytics, Challenges of Big Data, Importance of Big Data, Big Data Technologies, Data Science, Responsibilities, Soft state eventual consistency. Data Analytics Life Cycle</p>
<b>2</b>	<b>UNIT 2</b>
	<p>Analytical Theory and Methods: Clustering and Associated Algorithms, Association Rules, Apriori Algorithm, Candidate Rules, Applications of Association Rules, Validation and Testing, Diagnostics, Regression, Linear Regression, Logistic Regression, Additional Regression Models.</p>
<b>3</b>	<b>UNIT 3</b>
	<p>Analytical Theory and Methods: Classification, Decision Trees, Naïve Bayes, Diagnostics of Classifiers, Additional Classification Methods, Time Series Analysis, Box Jenkins methodology, ARIMA Model, Additional methods. Text Analysis, Steps, Text Analysis Example, Collecting Raw Text, Representing Text, Term Frequency-Inverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments</p>
<b>4</b>	<b>UNIT 4</b>
	<p>Data Product, Building Data Products at Scale with Hadoop, Data Science Pipeline and Hadoop Ecosystem, Operating System for Big Data, Concepts, Hadoop Architecture, Working with Distributed file system, Working with Distributed Computation, Framework for Python and Hadoop Streaming, Hadoop Streaming, MapReduce with Python</p>
<b>5</b>	<b>UNIT 5</b>
	<p>Advanced MapReduce. In-Memory Computing with Spark, Spark Basics, Interactive Spark with PySpark, Writing Spark Applications, Distributed Analysis and Patterns, Computing with Keys, Design Patterns, Last-Mile</p>

	Analytics, Data Mining and Warehousing, Structured Data Queries with Hive, HBase, Data Ingestion, Importing Relational data with Sqoop, Ingesting stream data with flume. Analytics with higher level APIs, Pig, Spark's higher level APIs.
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**Reference books:**

1. Big Data and Analytics Subhashini Chellappan, Seema Acharya, Wiley First Ed.
2. Data Analytics with Hadoop An Introduction for Data Scientists, Benjamin Bengfort and Jenny Kim, O'Reilly 2016
3. Big Data and Hadoop , V.K Jain Khanna Publishing, First Ed. 2018.

**Practical:**

1. Install and Setup MongoDB. Also, perform CRUD operations on the given dataset.
2. Implement Apriori algorithm to find the underlying patterns in the given dataset.
3. Create a model to classify the underlying dataset into different groups.
4. Implement Naive Bayes classifier.
5. Create a model to cluster the underlying dataset.
6. Setup and install Hadoop.
7. Implement the Map Reduce framework to solve a given problem.
8. Explore and execute different commands on the Hadoop Distributed File System.
9. Explore and execute different commands on Hive.

## *Elective – 3 Cloud Computing*

(w.e.f 2020-2021)

### **Course Objectives:**

1. To study the cloud computing fundamentals and cloud architectures.
2. Understand fundamentals of cloud computing
3. Understand the industrial platforms and cloud architectures
4. Understand the security aspects of cloud computing
5. Implement applications on cloud platforms

### **Learning Outcome:**

At the end of this course learner will be able to:

CO1: Describe the fundamentals of cloud computing and its security. (Level: Understand)

CO2: Analyze risk issues and legal aspects in cloud computing. (Level: Analyse)

CO3: Illustrate various data security methods in cloud computing. (Level: Apply)

CO4: Explore security controls and monitoring in cloud computing. (Level: Analyse)

CO5: Investigate security and evaluation criteria in internal and external cloud. (Level: Analyse)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Cloud Computing and Virtualization	12
2	Cloud Computing Architecture	12
3	Cloud and Security Mechanisms	12
4	Fundamental Cloud Architecture	12
5	Cloud Delivery Model Considerations and pricing	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
1	<b>UNIT 1</b>
	<p><b>Introduction to Cloud Computing:</b> Introduction, Historical developments, Building Cloud Computing Environments, <b>Principles of Parallel and Distributed Computing:</b> Eras of Computing, Parallel v/s distributed computing, Elements of Parallel Computing, Elements of distributed computing, Technologies for distributed computing. <b>Virtualization:</b> Introduction, Characteristics of virtualized environments, Taxonomy of virtualization techniques, Virtualization and cloud computing, Pros and cons of virtualization, Technology examples.</p>
2	<b>UNIT 2</b>
	<p><b>Cloud Computing Architecture:</b> Introduction, Fundamental concepts and models, Cloud Characteristics, Cloud Delivery models, Cloud Deployment models, Economics of the cloud, Open challenges. <b>Industrial Platforms and New Developments:</b> Amazon Web Services, Google App Engine, Microsoft Azure. <b>Fundamental Cloud Security:</b> Basics, Threat agents, Cloud security threats, additional considerations</p>
3	<b>UNIT 3</b>
	<p><b>Specialized Cloud Mechanisms:</b> Automated Scaling listener, Load Balancer, SLA monitor, Pay-per-use monitor, Audit monitor, fail over system, Hypervisor, Resource Centre, Multi-device broker, State Management Database. <b>Cloud Security Mechanisms:</b> Encryption, Hashing, Digital Signature, Public Key Infrastructure (PKI), Identity and Access Management (IAM), Single Sign-On (SSO), Cloud-Based Security Groups, Hardened Virtual Server Images</p>
4	<b>UNIT 4</b>
	<p><b>Fundamental Cloud Architectures:</b> Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture.</p>
5	<b>UNIT 5</b>

	<b>Cloud Delivery Model Considerations:</b> Cloud Delivery Models: The Cloud Provider Perspective, The Cloud Consumer Perspective, <b>Cost Metrics and Pricing Models:</b> Business Cost Metrics, Cloud Usage Cost Metrics, Cost Management Considerations, <b>Service Quality Metrics and SLAs:</b> Service Quality Metrics, SLA Guidelines
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### Reference books:

1. Mastering Cloud Computing Foundations and Applications Programming, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Elsevier (2013).
2. Cloud Computing Concepts, Technology & Architecture, Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, Prentice Hall (2013).
3. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley (2010).
4. Distributed and Cloud Computing, From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dongarra, Geoffrey Fox, MK Publishers (2012).

### Practical (2 Credits)

1. Implement Client Server Communication Model
2. Implement Object Communication using RMI
3. Implement Remote Procedural Call.
4. Implement Xen virtualization and manage with Xen Center
5. Implement virtualization using VMWare ESXi Server and managing with vCenter
6. Implement Windows Hyper V virtualization
7. Develop application for Microsoft Azure
8. Develop application for Google App Engine

## *Elective – 4 Computer Forensic*

(w.e.f 2020-2021)

### **Course Objectives:**

1. To learn, understand, and practice different cyber forensic and investigation techniques.
2. Summarize the activities of initial and incident responses.
3. Investigate web server attacks, DNS attacks and router attacks.
4. Describe the techniques related to system investigation.

### **Learning Outcome:**

After successful completion of course, learners will be able to:

CO1: Understand and apply diverse security issues and investigation methods. (Level: Understand)

CO2: Explain the role of digital forensics in the business and private world. (Level: Understand)

CO3: Identify potential sources of electronic evidence and explain the importance. (Level: Understand)

CO4: Recognize current techniques and tools for forensic investigations. (Level: Understand)

CO5: Explain and perform forensic analysis in various fields. (Level: Understand)

CO6: Describe the procedures for virtual, network and mobile device forensics. (Level: Understand)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Digital Forensic, IPR and Cyber Law	12
2	Fundamentals of host forensic	12
3	Forensic analysis database system	12
4	Web application security	12
5	Machine learning in cyber security	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
1	<b>UNIT 1</b>
	<p><b>Digital forensics</b> : Locard's exchange principle, code of ethics, digital forensic process models of Lee, Carrier, Casey and Cohen. Framework for digital forensic evidence collection with Chain of Custody (CoC), standard evidence collection procedures (SOP).</p> <p><b>IPR and cyber laws in India</b>, setting up a forensic laboratory, NIST tools (CFReDS, CFTT and NSLR), debate on exceptional cyber crime case reports and hands-on with open-source tools</p>
2	<b>UNIT 2</b>
	<p><b>Fundamentals of host forensics</b> for unix derivatives - linux operating system forensics, epoch formats and audit mechanisms. Network Sniffing-wireshark and Password Cracking-John the Ripper; Encrypting and Signing Emails: PGP- GPG/openPGP, DKIM and SPF; Single Sign On (SSO)-OAUTH and OPENID; Network packet creation and Manipulation using scapy and dpkt libraries.</p>
3	<b>UNIT 3</b>
	<p><b>Forensic analysis of database systems</b> and identifying database tampering. Slack space forensics, swap space forensics, network device forensics, investigating logs, network traffic and web attacks, mobile device forensics, wireless forensics, anti-forensics, steganography, email investigation, social media forensics, investigating copiers, IVR, DVR and SIM cards.</p>
4	<b>UNIT 4</b>
	<p><b>Web application security:</b> Security Development Lifecycle - Security Requirements Engineering, Use/Misuse case - Design – Secure Software Development Principles, Threat Modelling – STRIDE. Risk Assessment - DREAD, Common Vulnerabilities and Exploits, CVSS scoring. Web Application Development and Security - OWASP Top10 flaws - Core Defense Mechanisms - Web Application Technologies - Vulnerabilities - OS command injection - Directory traversal - SQL injection - Cross site Scripting (XSS) - Cross site Request Forgery(CSRF) – Click jacking - Web Cache Poisoning - DOM based vulnerabilities - Access Control</p>

	Vulnerabilities and Privilege Escalation - Cross-origin resource sharing (CORS) -- XML external entity(XXE) injection - - Server-side request forgery (SSRF) - HTTP request smuggling - Web sockets security.
5	<b>UNIT 5</b>
	<b>Machine learning in cyber security:</b> Machine learning for anomaly detection using Probabilistic Learning, Unsupervised learning, Combination learners, Evaluation methods, Hybrid detection. Machine learning for scan detection and Network traffic profiling, Privacy-Preserving Data Mining, Applications in malware analysis and anomaly detection.

**Reference books:**

1. E. Casey, Handbook of Digital Forensics and Investigation, Academic Press, 2010.
2. Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, 2012.
3. David Cowen, Computer Forensics: A Beginners Guide, Mc Graw Hill Education, 2013.
4. Bill Nelson, Amelia Phillips, Christopher Steuart, Guide to Computer Forensics and Investigations, 4th Edition, 2014.
5. C. Kaufman, R. Perlman and M. Speciner, Network Security: Private Communication in a Public World, 2nd Edition, Prentice Hall PTR, 2002.
6. Vincent J. Nestler et. al, Principles of computer security Lab Manual, 4th Edition, McGraw-Hill, 2014
7. Shostack, Adam. Threat modeling: Designing for security. John Wiley & Sons, 2014.
8. Dafydd Stuttard, and Marcus Pinto, The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws, 2nd Edition, John Wiley & Sons, 2011.
9. Wenliang Du, Computer Security – A hands-on Approach, First Edition, Createspace Independent Pub, 2017
10. <https://www.owasp.org>
11. D. K. Bhattacharyya and J. K. Kalita, Network Anomaly Detection: A Machine Learning Perspective, 1st Edition, Chapman and Hall/CRC, 2013.



## **Practical (2 Credits)**

1. Creating a Forensic Image using FTK Imager/Encase Imager :
2. To Use 'nmap' tool to perform vertical and horizontal scanning for checking open and closed ports.
3. To implement cryptographic algorithm using Crypto Tools. for building a secure communication network
4. To exploit the vulnerabilities in a LAN environment to launch attacks :  
Ettercap/arpspoof tool to perform ARP Cache Poisoning based attacks
5. To analyze the network packet using WIRESHARK
6. To perform the web penetration testing using BURPSUITE
7. To perform vulnerability assessment of wireless devices and audit the same with penetration testing : Perform a VA/PT on your local Wi-Fi network and try automated attacks with NetStumbler and Kismet to gather information wireless network and try attacks like CowPatty and Airsnort.
8. To perform the Log analysis using SPLUNK
9. Mobile & Smart Phone Security Lab Familiarize with Android application .apk files. By performing static and dynamic analysis on the app find the vulnerable application and document the inferences
10. Familiarization with Network testbeds Familiarization with advanced testbed technologies (e.g. Emulab, DETER and PlanetLab, etc.)

## *Elective-4 Optimization Techniques*

(w.e.f 2020-2021)

### **Course Objectives:**

1. To develop a knowledge in the field of optimization techniques their basic concepts, principles, linear programming and queuing theory
2. Understand importance of optimization of industrial process management
3. Apply basic concepts of mathematics to formulate an optimization problem
4. Analyse and appreciate variety of performance measures for various optimization problems

### **Learning Outcome:**

At the end of this course learner will be able to:

CO1: Demonstrate the concept of optimization and classification of optimization problems (Level: Understand)

CO2: Formulate simplex method variable with upper bounds (Level: Create)

CO3: explain the Queuing Model, poisson and exponential distributions (Level: Understand)

CO4: implement the maximization and minimization of convex functions (Level: Apply)

CO5: demonstrate equality constraints, inequality constraints (Level: Understand)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Introduction	12
2	Linear programming	12
3	Queuing theory	12
4	Unconstrained optimization	12
5	Constrained optimization	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
1	<b>UNIT 1</b>
	Introduction to Linear programming Problems: Concept of optimization – classification of optimization – problems. Examples of linear programming problems – formulation simplex methods variable with upper bounds
2	<b>UNIT 2</b>
	Linear Programming: Principle duality -dual simplex method - sensitivity analysis – revised simplex procedure – solution of the transportation problem – assignment – network minimization – shortest route problem – maximal two problem – L.P. representation of networks.
3	<b>UNIT 3</b>
	Queuing Theory: Queuing Model, poisson and exponential distributions - Queues with combined arrivals and departures-random and series queues.
4	<b>UNIT 4</b>
	Unconstrained Optimization: Maximization and minimization of convex functions. Necessary and sufficient conditions for local minima – speed and order of convergence – univariate search – steepest and descent methods- Fletcher reeves method -conjugate gradient method.
5	<b>UNIT 5</b>
	Constrained Optimization: Necessary and sufficient condition – equality constraints, inequality constraints -kuhn – tucker conditions – gradient projection method – penalty function methods – cutting plane methods of subgradients.

**Text books:**

1. Rao S. S, “Optimization – Theory and applications”, Wiley Eastern Ltd., 1979.

**Reference books:**

1. David G.Luerbeggan, “Introduction to Linear and Non Linear Programming”, Addison Wesley Publishing Co. 1973.
2. Hadley G. “Nonlinear and – dynamic programming” Addison Wesley Publishing Co. 1964.

3. Cordan C.C. Beveridge and Robert S. Schedther, "Optimization, Theory and Practice" McGraw Hill Co.1970.
4. HarndyA.Tahh. "operations Research, An Introduction", Macmillan Publishers Co.NewYork,1982.
5. Beightferand S. others, "Foundations of Optimization Pill", New Delhi, 1979.

**Practical (2 Credits)**

1. To solve Linear Programming Problem using Graphical Method with (i) multiple constraints (ii) Unbounded solution (iii) Infeasible solution (iv) Alternative or multiple solution
2. Solution of LPP with simplex method.
3. Solution of LPP with unrestricted variables through Simplex method.
4. Problem solving using M-Charnes method.
5. Problem solving using Two Phase method.
6. Illustration of following special cases in LPP using Simplex method (i) Unrestricted variables (ii)Unbounded solution (iii)Infeasible solution (iv)Alternative or multiple solution
7. Problems based on Dual simplex method.
8. Problems based on sensitivity analysis.
9. Implement a queuing model.
10. Implement constraint and unconstrained optimization.

## *Evaluation Scheme*

### **Evaluation of Core-5 (2021PITRP and 2025PITRP):**

Evaluation will be based on

- (i) Documentation: 100 marks (**2021PITRP**)  
40 marks will be based on the continuous internal evaluation and 60 marks will be based on the document evaluation by the internal examiner and an external examiner. Quality of the documentation will be evaluated based on the contents and the innovation, presentation and organization, plagiarism checking, open source resources used, contribution to the subject community and society, ethics and coding practices followed.
- (ii) Presentation/ paper publication: 50 marks (**2025PITRP**)  
Presentation will be evaluated based on the content of the project, innovative ideas, quality and clarity of the presentation, demonstration of the work, presentation of the results and analysis, scope for future work and viva-voce.

### **Internal Exam-40 Marks**

**Test– 30 Marks - Duration 60 mins**

It will be conducted either as a written test or using any open source learning management system such as Moodle (Modular object-oriented dynamic learning environment)Or a test based on an equivalent online course on the contents of the concerned course(subject)offered by or build using MOOC (Massive Open Online Course)platform.

**10 Marks** – Presentation and active participation in routine class instructional deliveries

Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc

### **External Examination- 60 Marks**

Duration - 2.5 Hours.

Theory question paper pattern:-

All questions are compulsory		
Question	Based on	Marks
Q.1	Unit I	12
Q.2	Unit II	12
Q.3	Unit III	12
Q.4	Unit IV	12
Q 5	Unit V	12

All questions shall be compulsory with internal choice within the questions.

Each Question may be sub-divided into sub questions as a, b, c, d & e, etc & the allocation of Marks depends on the weightage of the topic.

### **Practical Examination – 50 marks (Duration: 2 Hours)**

- Each practical course carries 50 Marks : 40 marks + 05 marks (journal)+ 05 marks(viva)
- Minimum 75% practical from each course are required to be completed and written in the journal.

**(Certified Journal is compulsory for appearing at the time of Practical Exam)**

**Nagindas Khandwala College (Autonomous)**

**Syllabus and Question Paper Pattern  
of Courses of**

**Master of Science Information Technology (MSc IT)  
Programme**

**Part – II, Second Year**

***Semester III and IV***

**Under Choice Based Credit, Grading and Semester System**

***(Implemented during Academic Year 2021-2022)***

**Post Graduate Programme: Master of Science Information Technology  
(MSc IT)**

**CONCEPTUAL FRAMEWORK**

**Part – II, Semester III & IV (2022-2023)**

Sr. No.	Semester III	Subject code	Marks	Credits	Sr. No.	Semester IV	Subject code	Marks	Credits
1	<b>Core 4:</b> Artificial Intelligence	2131PITAI	40-60 100	04	1	<b>Core 6:</b> Introduction to Deep Learning	2141PITDL	40-60 100	04
	Artificial Intelligence Practical	2131PITAI P	50	02		Introduction to Deep Learning Practical	2141PITDLP	50	02
2	<b>Core 5:</b> Entrepreneurship and Ethics in IT	2132PITE E	40-60 100	04	2	<b>AECC-3</b> Project	2142PITPR	150	06
3	<b>AECC-2</b> Project	2133PITP R	50	02					
<b>DSE 5 and 6 (Any Two)</b>					<b>DSE 7 and 8 (Any Two)</b>				
4(i)	Engineering Blockchain Applications	2134PITE BC	40-60 100	04	3(i)	Developing Blockchain-Based Identity Applications	2143PITDBC	40-60 100	04
	Engineering Blockchain Applications Practical	2134PITE BCP	50	02		Developing Blockchain-Based Identity Applications Practical	21435PITDBCP	50	02
(ii)	Ethical Hacking Offensive Penetration Testing – 1	2135PITE H	40-60 100	04	(ii)	Security Operations Management	2144PITSOM	40-60 100	04
	Ethical Hacking Offensive Penetration Testing – 1 Practical	2135PITE HP	50	02		Security Operations Management Practical	2144PITSOMP	50	02
(iii)	Image Processing	2136PITIP	40-60 100	04	(iii)	Advanced Image Processing	2145PITAIP	40-60 100	04
	Image Processing Practical	2136PITIP P	50	02		Advanced Image Processing Practical	2145PITAIPP	50	02
(iv)	Mastering Microservices with Python, Flask, and Docker	2137PITM S	40-60 100	04	(iv)	Advanced Linux System Administration	2146PITLSA	40-60 100	04
	Mastering Microservices with Python, Flask, and Docker Practical	2137PITM SP	50	02		Advanced Linux System Administration Practical	2146PITLSAP	50	02
	<b>TOTAL</b>		<b>600</b>	<b>24</b>		<b>TOTAL</b>		<b>600</b>	<b>24</b>

**Syllabus for Programme of  
Master of Science Information Technology (M.Sc.IT)  
SEMESTER –III**

*(Implemented during Academic Year 2022-2023)*

Part – II, Semester III & IV

***Core 4: Artificial Intelligence***

(w.e.f 2021-2022)

**Course Objective:**

1. To make learner able to identify and solve problems using AI techniques
2. To identify suitable technique for specific problem.
3. To apply reasoning techniques to the problem solving
4. To understand the probabilistic reasoning
5. To construct and apply the decision tree efficiently for a given problem
6. To understand the reinforcement learning

**Learning Outcome:**

After completion of this course learners will be able to:

CO1: Identify the problems solvable using AI techniques (Level: Analyze)

CO2: Suggest and implement suitable search strategies applicable to a given problem. (Level: Analyze)

CO3: Apply reasoning techniques to the problem solving. (Level: Apply)

CO4: Understand the probabilistic reasoning (Level: Understand)

CO5: Construct and apply the decision tree efficiently for a given problem. (Level: Create)

CO6: Understand the reinforcement learning. (Level: Understand)

Sr. No	Modules	No of hours
1	Problem solving	12
2	Heuristic search	12
3	Automated reasoning	12
4	Probabilistic reasoning	12
5	Inductive learning	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>



Sr. No.	Modules / Units
1	<b>UNIT 1</b>
	Problem Solving: AI Problems, AI Techniques and Types, The Level of the Model, Criteria for Success, Defining the Problem as a State Space Search, Problem Characteristics Un-Informed Search
2	<b>UNIT 2</b>
	Heuristic Search Techniques: Generate and Test, Hill Climbing, Constraint Satisfaction Problem, game trees, Adversarial Search: Minimax algorithm, Alpha beta pruning, Game playing.
3	<b>UNIT 3</b>
	Automated Reasoning: Logic Agent, Knowledge Representation, Propositional logic, First Order Predicate Logic, inferences in first order logic, forward chaining, backward chaining, Natural Deduction, Representing Knowledge using rules, Techniques, Matching Techniques.
4	<b>UNIT 4</b>
	Quantifying Uncertainty, Probabilistic Reasoning, Probabilistic Reasoning over Time, planning with state-space search, Partial-order planning, planning graphs, planning and acting in the real world
5	<b>UNIT 5</b>
	Learning from observation: Inductive learning, Decision trees, Explanation based learning, Statistical Learning methods, Reinforcement Learning

**References:**

1. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, Third Edition, 2009.
2. I. Bratko, Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc, 2011.
3. Kishan Mehrotra, "Elements of ANN", II Edition, Pen ram International Publishing Pvt. Ltd. Unit.
4. M. Tim Jones, Artificial Intelligence: A Systems Approach (Computer Science), Jones and Bartlett Publishers, Inc.; 1 edition, 2008
5. Nils J. Nilsson, The Quest for Artificial Intelligence, Cambridge University Press

**Practical (2 Credits)**

1. Write a program to implement Breadth First Search algorithm
2. Write a program to implement Depth First Search algorithm
3. Write a program to implement Hill Climbing algorithm
4. Write a program to implement Simulated Annealing algorithm
5. Write a program to implement A\* algorithm
6. Write a program to implement AO\* algorithm
7. Write a program to implement Water Jug Problem
8. Write a program to implement X-O Problem
9. Frame the predicates for the given statements.
10. Convert the predicates to clause form

## ***Core 5: Entrepreneurship and Ethics in IT***

(w.e.f 2021-2022)

### **Course Objective:**

The objective of the coursework is to-

1. To introduce to the basic concepts of ERP and their importance.
2. Infer the importance of intellectual property rights and relate the institutional support
3. Provide students with the fundamental knowledge of basics of philosophy of science and ethics, research integrity, publication ethics.
4. Hands-on sessions are designed to identify research misconduct and predatory publications.
5. Indexing and citation databases, open access publications, research metrics (citations, hindex, Impact Factor etc).
6. Guide and mentor students in presenting plagiarism tools for a valid and ethical research report

### **Learning Outcome:**

The students should be able to:

CO1: Define entrepreneur, planning, staffing, ERP and outline their importance in entrepreneurship. (Level: Understand)

CO2: Utilize the resources available effectively through ERP (Level: Apply)

CO3: Make use of IPRs and institutional support in entrepreneurship (Level: Apply)

CO4: Follow the research ethics and understand the plagiarism tools, research metrics, publications (Level: Apply)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Introduction	12
2	Micro and small enterprise	12
3	IPR	12
4	Philosophy and ethics	12
5	Publication ethics, databases and indexing	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

<b>Sr. No.</b>	<b>Modules / Units</b>
<b>1</b>	<p><b>UNIT 1</b></p> <p>Entrepreneur – meaning, characteristics of entrepreneurs, various stages in entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India and barriers to entrepreneurship. Identification of business opportunities, market feasibility study, technical feasibility study, financial feasibility study and social feasibility study.</p> <p>Preparation of project and ERP - meaning of project, project identification, project selection, project report, need and significance of project report, contents, formulation, guidelines by planning commission for project report, Enterprise Resource Planning: Meaning and Importance- ERP, Types of reports and methods of report generation</p>
<b>2</b>	<p><b>UNIT 2</b></p> <p>Micro and Small Enterprises: Definition of micro and small enterprises, characteristics and advantages of micro and small enterprises, steps in establishing micro and small enterprises, Government of India industrial policy 2007 on micro and small enterprises, case study (Microsoft), Case study (Captain G R Gopinath), case study (N R Narayana Murthy &amp; Infosys), Institutional support: MSME-DI, NSIC, SIDBI, KIADB, KSSIDC, TECSOK, KSFC, DIC and District level single window agency</p>
<b>3</b>	<p><b>UNIT 3</b></p> <p>Introduction to intellectual property rights (IPR) 6: Scope of Patent Rights, Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. Licensing and transfer of technology, International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs</p> <p>Scientific conduct:</p> <ol style="list-style-type: none"> <li>1. Ethics with respect to science and research.</li> <li>2. Intellectual honesty and research integrity.</li> </ol>

	<p>3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP).</p> <p>4. Redundant publications: duplicate and overlapping publications, salami slicing.</p> <p>5. Selective reporting and misrepresentation of data</p>
<b>4</b>	<b>UNIT 4</b>
	<p>Philosophy and Ethics: Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgments and reactions</p> <p>Publication Misconduct:</p> <p>A. Group Discussions</p> <ol style="list-style-type: none"> <li>1. Subject specific ethical issues, FFP, authorship</li> <li>2. Conflicts of interest</li> <li>3. Complaints and appeals: examples and fraud from India and abroad.</li> </ol> <p>B. Software tools Use of plagiarism software like Turnitin, Urkund and other open-source software tools</p>
<b>5</b>	<b>UNIT 5</b>
	<p>Publication Ethics:</p> <ol style="list-style-type: none"> <li>1. Publication ethics: definition, introduction and importance</li> <li>2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.</li> <li>3. Conflicts of interest</li> <li>4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types</li> <li>5. Violation of publication ethics, authorship and contributor ship</li> <li>6. Identification of publication misconduct, complaints and appeals</li> <li>7. Predatory publishers and journals PRACTICE</li> </ol> <p>Databases and Research Metrics:</p> <p>A. Databases</p> <ol style="list-style-type: none"> <li>1. Indexing databases</li> <li>2. Citation databases: Web of Science, Scopus, etc.</li> </ol> <p>B. Research Metrics</p> <ol style="list-style-type: none"> <li>1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score.</li> <li>2. Metrics: h-index, g index, i10 index, altimetric</li> </ol>

## Reference Books:

1. Dynamics of Entrepreneurial Development & Management -Vasant Desai Himalaya Publishing House.
2. Entrepreneurship Development -Small Business Enterprises -Poornima M Charantimath Pearson Education – 2006.
3. Management and Entrepreneurship - Kanishka Bedi- Oxford University Press-2017
4. The Ethics of Teaching and Scientific Research By Miro Todorovich; Paul Kurtz; Sidney Hook.
5. Research Ethics: A Psychological Approach By Barbara H. Stanley; Joan E. Sieber; Gary B. Melton
6. Research Methods in Applied Settings: An Integrated Approach to Design and Analysis By Jeffrey A. Gliner; George A. Morgan Lawrence Erlbaum Associates, 2000
7. Ethics and Values in Industrial-Organizational Psychology By Joel LefkowitzLawrence Erlbaum Associates, 2003

## References

<https://vtu.ac.in/wp-content/uploads/2019/12/B.E-in-Computer-Science-Engineering-updated-on-31.08.2018-syla-5.pdf>

<https://manavrachna.edu.in/wp-content/uploads/2020/07/Syllabus-QTRMRPE.pdf>

**Project:** Based on Module 3 and 5

## *Elective – 5 or 6: Engineering Blockchain Applications*

(w.e.f 2021-2022)

### **Course Objective:**

1. Analyse the working of blockchain.
2. Create hash functions for a blockchain.
3. Understand and create the components of a blockchain.

### **Learning Outcome:**

After successful completion of the course the learner should be able to

CO1: Understand what is a blockchain and its applications. (Level: Understand)

CO2: Understand the hash functions and their usage in building a blockchain system. (Level: Understand)

CO3: Understand the Cryptography and Mathematical Foundations for Blockchains (Level: Understand)

CO4: Understand how a distributed blockchain functions (Level: Understand)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Introduction	12
2	Hash Functions with Applications	12
3	Cryptography and Mathematical Foundations for Blockchains	12
4	Blockchain consensus	12
5	Mining	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
1	<b>UNIT 1</b>
	The Blockchain's Abstractions and Applications: Introduction to Blockchain Technology: Introduction, Blockchain Technology through an Analogy, Accompanying Factors. Benefits of Blockchain Technology, Transparency, Traceability, Security, Immutability, Availability, Cost-Saving. Blockchain Applications, Currency/Payments, Smart Contracts, Supply Chain, Governance, File Storage, Internet of Things (IoT), Identity Management, Data Management, Land Title Registration, Stock Trading. The Blockchain Ecosystem, Financial Services, General Business, UX/UI Design, Legal, Education
2	<b>UNIT 2</b>
	Hash Functions with Applications: Introduction to Hash Functions, Definition, Evaluating Security of a Hash Function, Side Channel Attacks w/Mitigation, Examples of Hash functions, MD5 (depreciated), SHA1 (depreciated), SHA256, RPEMD-160, SHA256, PBKDF2 (Password Based Key Derivation Function). Password Handling, Problems with storing passwords in plain text, Access granted to anyone maintaining the database, one database breach will divulge passwords, Rainbow table attack, appropriately salted hashes, Use of Pepper Application Appropriate Hash Function, Fast hash function, Slow hash function, Memory Hard
3	<b>UNIT 3</b>
	Cryptography and Mathematical Foundations for Blockchains: Signatures, Elliptic Curves (background for ECDSA), Public/Private Keys (ECDSA), Verifying signatures with software. Storage Considerations, Binomial Distribution, Stable Nash Equilibrium, Cold and Warm storage of private keys, Address format
4	<b>UNIT 4</b>
	Blockchain Consensus: Permission less, Proof of work, Proof of stake, Distributed Proof of Stake, Hybrid. Permissioned, Probabilistic agreement, Paxos and variants, Honey badger and similar. Semi-permissioned, Ripple



5	<b>UNIT 5</b>
	<p>Mining: Network Architecture, Nakamoto Networks, Blockchain Architecture, Blocks form a chain, “Longest” (most work) chain is considered correct. Network Attacks, Difficulty of a 51% attack, Selfish miner attack, Deriving the Global State or UTXO from a block chain, Consensus as a tool</p>

### Reference Books

1. Blockchain Quick Reference by Brenn Hill, Samanyu Chopra, Paul Valencourt

### Practical (2 Credits)

1. Introduce a Minimal working blockchain.
2. Implement a Minimal working blockchain.
3. Introduce a simple Proof-of-Work scheme to the Minimal working blockchain. Version
4. Implement a simple Proof-of-Work scheme to the Minimal working blockchain. Version
5. Introduce the concept of transactions in a Minimal working blockchain
6. Implement the concept of transactions in a Minimal working blockchain
7. Introduce a naive unencrypted wallet with simple transaction generation
8. Implement a naive unencrypted wallet with simple transaction generation

## ***Elective – 5 or 6: Ethical Hacking Offensive Penetration Testing***

(w.e.f 2021-2022)

### **Course Objective:**

1. Understanding of security requirements within an organization
2. How to inspect, protect assets from technical and managerial perspectives
3. To learn various offensive strategies to penetrate the organizations security.
4. To learn various tools that aid in offensive security testing

### **Course Outcome:**

After successful completion of the course, the learner should be able to

CO1: Identify various vulnerabilities related to memory attack. (Level: Analyze)

CO2: Apply security principles in software development. (Level: Apply)

CO3: Evaluate the extent of risks. (Level: Evaluate)

CO4: Involve selection of testing techniques related to software security in testing phase of software development. (Level: Analyze)

CO5: Use tools for securing software. (Level: Apply)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Introduction	12
2	Introduction to Metasploit and Supporting Tools	12
3	Information Gathering with Metasploit	12
4	Vulnerability detection with Metasploit auxiliaries	12
5	Developing custom modules Building a module in a nutshell	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

<b>Sr. No.</b>	<b>Modules / Units</b>
<b>1</b>	<b>UNIT 1</b>
	Social Engineering Deceptions and Defenses, What Is Vulnerability Assessment, Risk Management, Insider Threat, Disaster Recovery, Security Policies and Plans Development
<b>2</b>	<b>UNIT 2</b>
	Introduction to Metasploit and Supporting Tools, The importance of penetration testing Vulnerability assessment versus penetration testing, the need for a penetration testing framework Introduction to Metasploit When to use Metasploit? Making Metasploit effective and powerful using supplementary tools Nessus NMAP w3af Armitage Setting up Your Environment Using the Kali Linux virtual machine - the easiest way Installing Metasploit on Windows Installing Metasploit on Linux Setting up exploitable targets in a virtual environment Metasploit Components and Environment Configuration Anatomy and structure of Metasploit Metasploit components Auxiliaries Exploits Encoders Payloads Post, Playing around with msfconsole Variables in Metasploit Updating the Metasploit Framework 55
<b>3</b>	<b>UNIT 3</b>
	Information Gathering with Metasploit: Information gathering and enumeration Transmission Control Protocol User Datagram Protocol File Transfer Protocol Server Message Block Hypertext Transfer Protocol Simple Mail Transfer Protocol Secure Shell Domain Name System Remote Desktop Protocol Password sniffing Advanced search with shodan Vulnerability Hunting with Metasploit Managing the database Work spaces Importing scans Backing up the database NMAP NMAP scanning approach Nessus Scanning using Nessus from msfconsole
<b>4</b>	<b>UNIT 4</b>
	Vulnerability detection with Metasploit auxiliaries, Auto exploitation with db_autopwn Post exploitation What is meterpreter? Searching for content Screen capture Keystroke logging Dumping the hashes and cracking with JTR Shell command Privilege escalation Client-side Attacks with

	Metasploit Need of client-side attacks What are client-side attacks? What is a Shellcode? What is a reverse shell? What is a bind shell? What is an encoder? The msfvenom utility Generating a payload with msfvenom Social Engineering with Metasploit Generating malicious PDF Creating infectious media drives
5	<b>UNIT 5</b>
	Developing custom modules Building a module in a nutshell: The architecture of the Metasploit framework Understanding the file structure The libraries layout Understanding the existing modules The format of a Metasploit module Disassembling existing HTTP server scanner module Libraries and the function Writing out a custom FTP scanner module Libraries and the function Using msftidy Writing out a custom SSH authentication brute forcer Rephrasing the equation Writing a drive disabler post exploitation module Writing a credential harvester post exploitation module Breakthrough meterpreter scripting Essentials of meterpreter scripting Pivoting the target network Setting up persistent access API calls and mixins Fabricating custom meterpreter scripts Working with RailGun Interactive Ruby shell basics Understanding RailGun and its scripting Manipulating Windows API calls Fabricating sophisticated RailGun scripts. The Exploit Formulation Process The absolute basics of exploitation The basics The architecture System organization basics Registers Exploiting stack-based buffer overflows with Metasploit Crashing the vulnerable application Building the exploit base Calculating the offset Using the pattern_create tool Using the pattern_offset tool Finding the JMP ESP address Using Immunity Debugger to find executable modules Using msfbinscan Stuffing the space Relevance of NOPs Determining bad characters Determining space limitations Writing the Metasploit exploit module Exploiting SEH-based buffer overflows with Metasploit Building the exploit base Calculating the offset Using pattern_create tool Using pattern_offset tool

## Reference Books

1. Lee Allen, “Advanced Penetration Testing for Highly-Secured Environments: The Ultimate Security Guide (Open Source: Community Experience Distilled)”, Kindle Edition, Packet Publishing, 2012
2. Computer and Information Security Handbook John R. Vacca Morgan Kaufmann Publisher 3<sup>rd</sup> Edn 2017
3. Metasploit Revealed: Secrets of the Expert Pentester Sagar Rahalkar Packt Publishing 2017

## Practical (2 Credits)

NOTE: To be performed with Kali Linux and Meta-Sploit Framework

1. Installation and preparing the lab ready Virtual or physical machine with Kali Linux, Exploring and getting acquainted with the other operating distributions used for offensive security testing mainly: Lion Sec, Back Box, Parrot, Black Arch
2. Exploring the command line arguments
  - a. Environment Variables, Tab Completion, Bash History Tricks
  - b. Piping and Redirection, Text Searching and Manipulation
  - c. Editing Files from the Command Line, Comparing Files, Managing Processes
3. Implement the following:
  - a. Using NETCAT Socat
  - b. PowerShell and Powercat
  - c. Wireshark and Tcpdump
4. Passive Information Gathering
  - a. Whois Enumeration/ Google Hacking
  - b. Netcraft, Recon-ng, Shodan
  - c. SSL Server Test
5. User Information Gathering
  - a. Email Harvesting, Password Dumps
  - b. Information Gathering Frameworks- OSINT Framework, Maltego
6. Active Information Gathering
  - a. DNS Enumeration
  - b. Port Scanning, SMB Enumeration, NFS Enumeration
7. Vulnerability Scanning
  - a. Vulnerability Scanning with Nessus

- b. Vulnerability Scanning with Nmap
- 8. Web Application Assessment Tools
  - a. DIRB
  - b. Burp Suite
  - c. Nikto
  - d. SQL Injection
- 9. Client-Side Attacks
  - a. HTA Attack
  - b. Exploiting Microsoft Office
- 10. Privilege Escalation
  - a. Windows Privilege Escalation
  - b. Linux Privilege Escalation
- 11. Password Attacks
  - a. Wordlists, Brute Force Wordlists
  - b. Common Network Service Attack Methods
- 12. Port Redirection and Tunneling
  - a. Port Forwarding- RINETD
  - b. SSH Tunneling
  - c. PLINK., NETSH, HTTP Tunneling Through Deep Packet Inspection

## *Elective – 5 or 6: Image Processing*

(w.e.f 2021-2022)

### **Course Objective:**

1. Review the fundamental concepts of a digital image processing system.
2. Analyze images in the frequency domain using various transforms.
3. Evaluate the techniques for image enhancement.
4. Categorize various compression techniques and interpret Image compression standards.
5. Interpret image segmentation and representation techniques

### **Course Outcome:**

After the successful completion of course, learner will:

CO1: Understand the relevant aspects of digital image representation and their practical implications. (Level: Understand)

CO2: Understand 2-D convolution, the 2-D DFT, and have the ability to design systems using these concepts. (Level: Understand)

CO3: Understand the role of alternative color spaces, and the design requirements leading to choices of color space. (Level: Understand)

CO4: Have an understanding of the underlying mechanisms of image compression, and the ability to design systems using standard algorithms to meet design specifications. (Level: Understand)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Digital image fundamentals and spatial transformations	12
2	Filtering in frequency domain	12
3	Color and morphological processing	12
4	Compression and watermarking	12
5	Segmentation	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
1	<b>UNIT 1</b>
	<p><b>Introduction:</b> Digital Image Processing, Origins of Digital Image Processing, Applications and Examples of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System.</p> <p><b>Digital Image Fundamentals:</b> Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationships Between Pixels, Basic Mathematical Tools Used in Digital Image Processing,</p> <p><b>Intensity Transformations and Spatial Filtering:</b> Basics, Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, smoothing (Lowpass) Spatial Filters, Sharpening (High pass) Spatial Filters, Combining Spatial Enhancement Methods, Using Fuzzy Techniques for Intensity Transformations and Spatial Filtering.</p>
2	<b>UNIT 2</b>
	<p><b>Filtering in the Frequency Domain</b></p> <p>Background, Preliminary Concepts, Sampling and the Fourier Transform of Sampled Functions, The Discrete Fourier Transform of One Variable, Extensions to Functions of Two Variables, Properties of the 2-D DFT and IDFT, Basics of Filtering in the Frequency Domain, Image Smoothing Using Lowpass Frequency Domain Filters, Image Sharpening Using High Pass Filters, Selective Filtering, Fast Fourier Transform, HAAR Transform</p>
3	<b>UNIT 3</b>
	<p><b>Color and Morphological Image Processing</b></p> <p>Color Image Processing: Color Fundamentals, Color Models, Pseudo color Image Processing, Full-Color Image Processing, Color Transformations, Color Image Smoothing and Sharpening, Using Color in Image Segmentation, Noise in Color Images, Color Image Compression.</p> <p>Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transform, Morphological Algorithms, Morphological Reconstruction, Morphological Operations</p>



	on Binary Images, Grayscale Morphology
<b>4</b>	<b>UNIT 4</b>
	<b>Image Compression and Watermarking</b> Fundamentals, Huffman Coding, Golomb Coding, Arithmetic Coding, LZW Coding, Run-length Coding, Symbol-based Coding, 8 Bit-plane Coding, Block Transform Coding, Predictive Coding, Wavelet Coding, Digital Image Watermarking
<b>5</b>	<b>UNIT 5</b>
	<b>Image Segmentation</b> Fundamentals, Thresholding, Segmentation by Region Growing and by Region Splitting and Merging, Region Segmentation Using Clustering and Super pixels, Region Segmentation Using Graph Cuts, Segmentation Using Morphological Watersheds, Use of Motion in Segmentation

### Reference Books

1. Digital Image Processing Gonzalez and Woods 3rd Edition Pearson Education
2. Digital Image Processing and Analysis Bhabatosh Chanda, Dwijesh Dutta Majumder 2nd Edition PHI
3. Fundamentals of Digital Image Processing Anil K. Jain 1st Edition PHI
4. The Image Processing Handbook by J. C. Russ, Publisher: CRC [Fifth edition, 2010]

### Practical (2 Credits)

1. Apply DFT on an image
2. Apply the following Pre-Processing Techniques on an Image: Log Transform, Power Law Transform, Image Negation.
3. Write a program to plot Histogram of an image
4. Write a program to perform Histogram Equalization of an image
5. Write a program to perform Smoothing on an image
6. Write a program to perform Sharpening on an image
7. Color Image Processing – I: Splitting RGB Planes, Pseudo Coloring
8. Color Image Processing – II: Brightness Adjustment, Contrast Stretching, Thresholding, Gray Level Slicing
9. Write a program to perform Dilation and Erosion on an image
10. Write a program to implement Image Compression.

## *Elective – 5 or 6: Mastering Microservices with Python, Flask, and Docker*

(w.e.f 2021-2022)

### **Course Objective:**

1. Understand microservices, Docker and flask
2. Develop microservices with flask and docker

### **Learning Outcome:**

At the end of the course the learner should be able to

CO1: Create web apps in flask. (Level: Create)

CO2: Create docker images for the given application. (Level: Create)

CO3: Develop and deploy microservices with flask and docker. (Level: Create)

Sr. No	Modules	No of hours
1	Introduction	12
2	Advanced flask	12
3	Docker	12
4	Docker compose	12
5	Microservice architecture	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
1	<b>UNIT 1</b>
	Introduction to Flask: Creating a venv and installing Flask, Creating your first, simple, text-based Flask app! Handling HTTP GET and POST Request Methods in Flask, Flask Folder Hierarchy, Getting started with Jinja2
2	<b>UNIT 2</b>

	Advanced Flask: HTML Templates, Style your Flask app with CSS, Creating a Web Form in Flask: Part 1, Creating a Web Form in Flask: Part 2, Create a BMI Calculator in Flask.
<b>3</b>	<b>UNIT 3</b>
	Docker: What is Docker? The Docker Architecture, Installing Docker, Creating and Executing Your First Container Using Docker, Images vs Containers, Images from The Dockerfile, Images from Containers, Port Mapping, Networking, Introduction to Persistent Storage Options in Docker, Tagging
<b>4</b>	<b>UNIT 4</b>
	Docker Compose: Overview, DOCKER COMPOSE PARTS, How to Create Docker Compose Files Using YAML, Features and Commands of Compose Command-Line Interface MANAGING APPLICATIONS, Deploying and Configuring a Web Application with Compose, Using Compose Configurations and Commands to Build Images, How to Compose Handles and Combines Multiple Files
<b>5</b>	<b>UNIT 5</b>
	Microservices: Microservices Vs A Monolithic Approach, The Monolithic Approach and its Problems, Characteristics of a Microservices Approach, Microservices Benefits, Challenges & Best Practices, DESIGNING & BUILDING MICROSERVICES, Designing Microservices, User Service, Product Service, Order Service, Frontend Service, Deploying Microservices

### Reference Books

1. Python Microservices Development: Build, test, deploy, and scale microservices in Python by Tarek Ziade

### Practical:

1. Create a sample hello world flask application.
2. Create a BMI Calculator in flask.
3. Create a To-Do Manager application in flask.
4. Install and run commands on the docker CLI.

5. Dockerize your Flask App
6. Design and create a User Service
7. Design and create a Product Service
8. Design and create an Order Service
9. Design and create a Frontend Service
10. Deploy To-Do Manager application as a microservice in flask. Any other practical covering syllabus can be implemented.

## *Evaluation Scheme*

### **Internal Exam-40 Marks**

- **Test– 20 Marks**

It will be conducted module wise either as a written test or using any open source learning management system such as Moodle (Modular Object-Oriented Dynamic Learning Environment) or a test based on an equivalent online course on the contents of the concerned course (subject) offered by or build using MOOC (Massive Open Online Course) platform.

- **Assignments/Presentation/Projects – 15 Marks**

Subject specific Term Work Module/assessment modes –as decided by the department in the beginning of the semester (like Extension/field/experimental work, Short Quiz; Objective test, lab practical, open book test etc. and written assignments, Case study, Projects, Posters and exhibits etc. for which the assessment is to be based on class presentations wherever applicable)

- **Active participation in routine class instructional deliveries - 5 Marks**

Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.

### **External Examination- 60 Marks**

Duration - 2.5 Hours.

Theory question paper pattern:-

All questions are compulsory.

Question	Based on	Marks
Q.1	Unit I	12
Q.2	Unit II	12
Q.3	Unit III	12
Q.4	Unit IV	12
Q.5	Unit V	12

All questions shall be compulsory with internal choice within the questions.

Each Question may be sub-divided into sub questions as a, b, c, d & e, etc & the allocation of Marks depends on the weightage of the topic.

### **Practical Examination – 50 marks (Duration: 2 Hours)**

- Each practical course carries 50 Marks : 40 marks + 05 marks (journal)+ 05 marks(viva)
- Minimum 75% practical from each course are required to be completed and written in the journal.

**(Certified Journal is compulsory for appearing at the time of Practical Exam)**

**Syllabus for Programme of  
Master of Science Information Technology (M.Sc.IT)  
SEMESTER –IV**

*(Implemented during Academic Year 2021-2022)*

***Core 6: Introduction to Deep Learning***

(w.e.f 2021-2022)

**Course Objective:**

1. Analyse the working of a deep learning model.
2. Compare the performances of different deep learning models.
3. Solve the given problem using a deep learning model.

**Course Outcome:**

After Completion of this course, the students will be able to:

CO1: Understand the concept of Deep Learning. (Level: Understand)

CO2: Understand the tensorflow framework. (Level: Understand)

CO3: Create deep learning models to solve real world problems. (Level: Create)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Introduction to deep leaning	12
2	Tensorflow	12
3	Neural network for deep learning	12
4	Hyperparameter Tuning, Regularization and Optimization	12
5	Sequence models	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

<b>Sr. No.</b>	<b>Modules / Units</b>
<b>1</b>	<b>UNIT 1</b>
	Introduction to Deep Learning: What is Deep Learning (AI, ML, Deep Learning comparison), Why Deep Learning? Why now?, Evolution of deep learning: Perceptron, Neural Net, Forward Feed Network, Back propagation, Loss function, weights, activation function. Gradient Descent, Single layer ANN, Multilayer ANN, Deep layer ANN, Quantifying Loss: Error Loss, Binary Cross Entropy Loss, Entropy Loss, Mean Squared Loss, Training a Neural Net
<b>2</b>	<b>UNIT 2</b>
	Introduction to Tensorflow: Your First Model: Fashion MNIST, Build a neural network that can recognize images of articles of clothing, Introduction to Convolutional Neural Networks ("CNNs"), Expand your image classifiers into models that can predict from multiple classes, Use a convolutional network to build a classifier for more detailed color images, Use a pre-trained network to build powerful state-of-the-art classifiers, Look at the new SAVEDMODEL format in TensorFlow 2.0 and take advantage of it for TensorFlow-Lite and TensorFlow-Serving, Learning from sequential data with recurrent neural networks. Learn how you can use TensorFlow lite to build machine learning apps on Android, iOS and IoT devices
<b>3</b>	<b>UNIT 3</b>
	Neural Networks for Deep Learning: Deep L-layer neural network, Forward Propagation in a Deep Network, Getting your matrix dimensions right, Why deep representations? Building blocks of deep neural networks, Forward and Backward Propagation in Deep Learning, Parameters vs Hyperparameters, What does this have to do with the brain?
<b>4</b>	<b>UNIT 4</b>
	Improving Deep Neural Networks: Hyperparameter Tuning, Regularization and Optimization: Practical aspects of Deep Learning, Optimization algorithms, Hyperparameter tuning, Batch Normalization and Programming Frameworks

5	<b>UNIT 5</b>
	Sequence Models in Deep Learning: Recurrent Neural Networks, Natural Language Processing & Word Embeddings in Deep Learning, Sequence models & Attention mechanism

### Reference Books

1. Deep Learning by Ian Goodfellow Yoshua Bengio Aaron Courville

### Practical (2 Credits)

1. Implement Gradient Descent algorithm.
2. Create a neural network to solve the given problem.
3. Create a Convolutional Neural Network to solve the given problem.
4. Create a Recurrent Neural Network to solve the given problem.
5. Apply Reinforcement Learning to solve the given problem.
6. Visualize a Neural Network using TensorFlow
7. Create an image classification model using deep learning.
8. Create an object detection model using deep learning.



## ***Elective 7 or 8: Developing Blockchain-Based Identity Applications***

(w.e.f 2021-2022)

### **Course Objective:**

1. Understand peer to peer networks.
2. Understand the usage of blockchain in Governance.
3. Understand the Advanced Blockchain Concepts
4. Understand the Future of Blockchain.

### **Course Outcome:**

After Completion of this course, the students will be able to:

CO1: Analyse the working of a blockchain peer to peer network. (Level: Analyze)

CO2: Create a transaction mechanism for a blockchain. (Level: Create)

CO3: Create a blockchain cryptocurrency. (Level: Create)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Peer-to-peer networks	12
2	Governance	12
3	Advanced blockchain concepts	12
4	Creating Your Own Currency	12
5	Future of blockchain	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

<b>Sr. No.</b>	<b>Modules / Units</b>
<b>1</b>	<b>UNIT 1</b>
	Peer-to-peer networks: Identify the different node types in a cryptocurrency/blockchain network, describe how nodes discover the network (other peers), Describe how nodes, once connected, choose a blockchain history and receive the historical data. Describe how

	<p>transactions/messages are verified and propagated throughout the network, Describe how blocks are verified and propagated throughout the network, : Illustrate how SPV (Simplified Payment Verification) clients work and interact with the network. Introduction to Network Topology Closed systems Decentralized networks Identification and interaction of nodes Module, Nodes Basic concepts Valid and invalid blocks Roles and behaviors in hierarchical networks, Block Verification and Propagation Signal process Signal outcomes BIP 9, block version signaling consensus change Fee amount Contentious forks/minority forks</p>
<b>2</b>	<b>UNIT 2</b>
	<p>Governance: Decision-Making on Decentralized Networks, BIPDIPEIP generalized processes, Hard and Soft Forks , Hard forks, Soft forks, Updating to achieve hard forks</p>
<b>3</b>	<b>UNIT 3</b>
	<p>Advanced Blockchain Concepts: Blockchain and banks, Unbanked, going pure crypto, fixing pegs, Buying options, Why regulated exchanges? Unbanked and unincorporated? The DAO: Decentralizing an organization, Putting a corporation on a blockchain, Cutting out the middleman, Providing capital , Social purpose, blockchain as leveler, Banking the unbanked, Silk road, privacy and ethics. Tracking all the things: Defeating some privacy issues with zero-knowledge proofs, Unwrapping the concept of zero-knowledge proofs</p>
<b>4</b>	<b>UNIT 4</b>
	<p>Creating Your Own Currency: Understanding types of cryptocurrency, Tokens based on existing blockchains, Creating a new blockchain from scratch, A forked blockchain with one's own genesis block, Litecoin's development, Creating one's own cryptocurrency: Setting up Litecoin, Platform selection, Preparation, Dependency installation, Build instructions, Setting up our own coin, Port selection, The setting of block-related parameters, Amount limit, The coinbase maturity number, Genesis block creation, Wallet address, Checkpoints, Creatives and graphics</p>

5	<b>UNIT 5</b>
	<p>Future of Blockchain: Ongoing fragmentation and specialization, Video games, Real estate, Logistics, Licensing, Industry consortiums, A large number of total-loss projects, Legal and regulatory evolution , Security token offerings, Aggregate and insurance products, Technological stabilization, Ethereum and Hyperledger, Service consolidation and product offerings, Cross-chain communication, Intersecting with AI and IoT, Blockchain-intersecting AI, Blockchain-intersecting IoT</p>

### Reference Books

1. Blockchain Quick Reference by Brenn Hill, Samanyu Chopra, Paul Valencourt

### Practical:

1. Introduce relaying of transactions in a blockchain.
2. Implement relaying of transactions in a blockchain.
3. Create a UI for the blockchain wallet.
4. Create a blockchain explorer for the blockchain wallet.
5. Connect all the pieces together and understand the overall working of a cryptocurrency.
6. Create a new blockchain crypto currency - 1
7. Create a new blockchain crypto currency – 2
8. Create a new blockchain crypto currency - 3

## ***Elective 7 or 8: Security Operations Management***

(w.e.f 2021-2022)

### **Course Objective:**

1. Understanding of security concepts within an organization
2. Understanding the web application security
3. To Learn various steganography and program obfuscation methods.
4. To learn various tools that aid in android security and security in cloud computing

### **Course Outcome:**

After Completion of this course, the students will be able to:

CO1: The student should be able to identify the different security breaches that can occur. The student should be able to evaluate the security of an organization and identify the loopholes. The student should be able to perform enumeration and network scanning.

CO2: The student should be able to identify the vulnerability in the systems, breach the security of the system, identify the threats due to malware and sniff the network. The student should be able to do the penetration testing to check the vulnerability of the system towards malware and network sniffing.

CO3: The student should be able to perform social engineering and educate people to be careful from attacks due to social engineering, understand and launch DoS and DDoS attacks, hijack and active session and evade IDS and Firewalls. This should help the students to make the organization understand the threats in their systems and build robust systems.

CO4: The student should be able to identify the vulnerabilities in the Web Servers, Web Applications, perform SQL injection and get into the wireless networks. The student should be able to help the organization aware about these vulnerabilities in their systems.

CO5: The student should be able to identify the vulnerabilities in the newer technologies like mobiles, IoT and cloud computing. The student should be able to use different methods of cryptography

Sr. No	Modules	No of hours
1	Security concepts	12
2	Web application security	12
3	Steganography and program obfuscation	12
4	Android security	12
5	Security in cloud computing	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

Sr. No.	Modules / Units
<b>1</b>	<b>UNIT 1</b>
	Security Concepts – Set UID, Environmental variables and Attacks, Shellshock attack, Common String Manipulation Errors and Vulnerabilities, stack overflow, Heap overflow, Off-by-one vulnerabilities, Return-to-libc, ROP, Integer Vulnerabilities, Memory management errors, Format string vulnerabilities, Concurrency and File I/O, Race conditions, Dirty COW Attack- Meltdown and Spectre Attack - Rules and recommendations of SEI CERT C coding Standards
<b>2</b>	<b>UNIT 2</b>
	Web application security: Security Development Lifecycle, Security Requirements Engineering, Use/Misuse case – Design, Secure Software Development Principles, Threat Modeling, STRIDE. Risk Assessment - DREAD, Common Vulnerabilities and Exploits, CVSS scoring. Web Application Development and Security, OWASP Top 10 flaw, Core Defense Mechanisms, Web Application Technologies, Vulnerabilities, OS command injection, Directory traversal, SQL injection, Cross site Scripting (XSS), Cross site Request Forgery (CSRF), Clickjacking, Web Cache Poisoning, DOM based vulnerabilities, Access Control Vulnerabilities and Privilege Escalation, Cross-origin resource sharing (CORS), XML external

	entity (XXE) injection, Server-side request forgery (SSRF), HTTP request smuggling, Web sockets security.
<b>3</b>	<b>UNIT 3</b>
	Steganography and program obfuscation: Steganographic security, Data hiding in raw images, Spatial and transform domain steganography, JPEG format, S-tool, J-Steg, OutGuess. Steganalysis, Basics of Visual Cryptography. Case study: Data hiding in digital Audio and Video, Operating System Data Hiding, Virtual Data Hiding, Data Hiding in Network Protocols, Data Hiding among Android Mobile Devices and Apple iOS, Forensics and Anti-Forensics, Mitigation Strategies. Program Obfuscation - Methods of attack and defense, Program analysis-Static, Dynamic, Taint Analysis. Abstract syntax trees, Program Slicing, Code obfuscation- Complicating control flow, Opaque predicates, Data encoding, Applications of Code Obfuscation. Software Watermarking, Dynamic watermarking, software similarity analysis
<b>4</b>	<b>UNIT 4</b>
	Android Security: App Development- Activities, Intents, Fragments, Data storage, Broadcast receivers and Content Providers, Services, Async Tasks, GPS and GoogleMaps, Sensors, Connecting WebAPIs, Emulator and ADB, APK Internals, Networking, Device Rooting, Refresher TCP/IP Attacks, TCP/IP Attacks Using Android, DAC and MAC Permissions, Android Internals, Framework, Init, Zygote, Binder, Service Manager, Activity Manager, Reverse Engineering- Apktool, Ghidra, Jadx, Static and Dynamic analysis, Native Library Exploitation, OWASP, Security Assessment with Drozer and Burpsuite, Some of the attacks and Vulnerabilities in real world android apps (A case study) - XSS, Strandhogg, Code Injection - Overlay Attacks, Insecure Deeplinks, Malware Analysis, Bouncer, Privacy Violation, System Call Hardening, ASLR, ROP, Framework Exploits
<b>5</b>	<b>UNIT 5</b>
	Security in cloud computing: Introduction to distributed systems, Distributed computing paradigms, Inter process communication mechanisms, Process models in distributed systems, The CAP theorem, Consistency models and Replication, Consensus algorithm: Clock

	<p>Synchronization – Logical clocks – Mutual Exclusion, global positioning of nodes, Distributed Commit protocols – 2PC, 3PC, Check-pointing and Recovery, Election algorithms, Failure Models, RAFT algorithm Apache Zookeeper, Distributed file system – Eg: CODA and Ceph, Distributed storage implementation – Data sharding, nosql key value stores and its properties – Eg: Google Big Table, Amazon DynamoDB. Cloud computing benefits and its challenges, Types – Private, Public and Hybrid clouds, Models – IaaS, PaaS and SaaS. Cloud Security Patterns – 1. Secure Architecture 2. Compliance &amp; Regulatory (GDPR, CCPA, HIPAA), 3. Identification, Authentication &amp; Authorization 4. Secure Development, Operations &amp; Administration 5. Policy &amp; Confidentiality. Cloud - AWS, Azure, GCP. REST API services including load balancing, server authentication and debug handling, Hadoop cloud computing framework – HDFS and MapReduce, SPARK, Cloud data processing using Pig and Hive, Amazon EMR for creating Hadoop clusters within AWS.</p>
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## Reference Books

1. Dafydd Stuttard, and Marcus Pinto, The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws, 2nd Edition, John Wiley & Sons, 2011.
2. Wenliang Du, Computer Security – A hands-on Approach, First Edition, Createspace Independent Pub, 2017
3. <https://www.owasp.org>
4. J. Cox, M. L. Miller, J. A. Bloom, J. Fridrich and T. Kalker, Digital Watermarking and Steganography, 2nd Edition, The Morgan Kaufmann Series in Multimedia Information and Systems, 2002.
5. J. Fridrich, Steganography in Digital Media: Principles, Algorithms, and Applications, 1st Edition, Cambridge University Press, 2010.
6. Y. Karim, Embedded Android, Vol. 1, O'Reilly Media, 2013.
7. E. Nikolay, Android Security Internals: An In-Depth Guide to Android's Security Architecture, No Starch Press, 2014.
8. S. Ghemawat, H. Gobioff, and S. T. Leung, The Google file system, In ACM symposium on operating systems review, Vol. 37, No. 5, pp. 29-43, 2003.
9. J. Dean and S. Ghemawat, MapReduce: simplified data processing on large clusters, Commun., ACM 51, no.1, 107-113, 2008.
10. R. Chow, P. Golle, M. Jakobsson, R. Masuoka, Jesus Molina Elaine Shi and Jessica Staddon, Controlling data in the cloud: outsourcing computation without outsourcing control, In Proceedings of the ACM workshop on Cloud computing security, pp. 85-90, 2009.

## Practical (2 Credits)

### 1. LAN based Network Security

Set up a simple LAN as shown in Figure 1. M1-3 and S1-3 are machine which have Linux and Windows running.

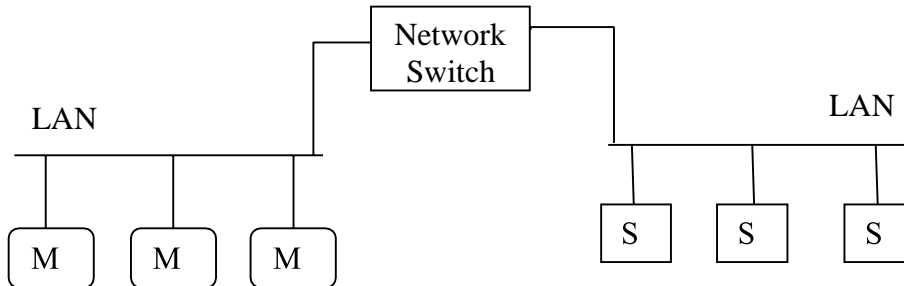


Figure 1: A Simple LAN environment

- Configure LAN-1 and LAN-2 as separate VLANs in the Network Switch (Use inter VLAN ACL)
- Create a SPAN port in the Network switch and send the mirrored traffic to a promiscuous mode port for the purpose of IDS and other packet analysis. Practice port based and VLAN based mirroring.
- Familiarize with 802.1x, Network Admission Control, Microsoft NAP, RADIUS protocol, RADIUS perport ACL

### 2. Network reconnaissance and Protection

- Installing 'iptables' in Ubuntu VM to allow/block communication between VMs
- Installing Email server and Web server in VMs. Usage of Firewall (iptables) in blocking/allowing a sub-network from accessing the servers
- Configuring iptable to block Telnet inbound and outbound connections
- Use 'nmap' tool to perform vertical and horizontal scanning for checking open and closed ports. Use nmap commands for performing the following experiments: Use ping sweeping to determine which hosts are running, Check for vulnerable services available using TCP connect scans, Perform OS Fingerprinting to determine the OS of target machine, Choose different options under each category according to your creativity.

### 3. Application of Cryptographic algorithms using Crypto Tools.

Establish a Client-Client Secure communication protocol as shown in Figure 2.

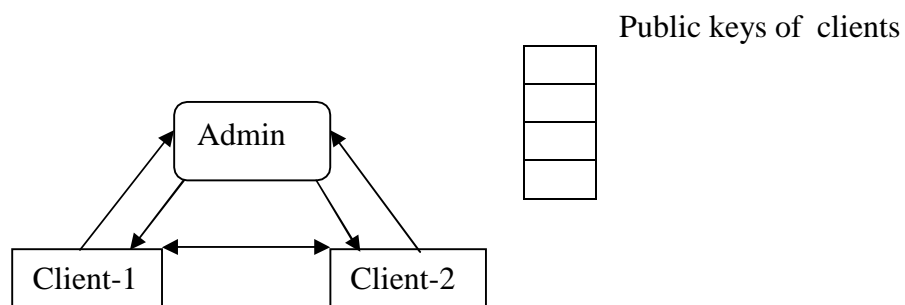


Figure 2: Secure Communication

The Client machines (Client-1 and Client-2) and Admin machine are installed in different



VMs. All the three machines are interconnected through a network switch with different IP addresses. The Admin runs a program that generates 2048 bit RSA public and private key for a Client that wants to communicate. Admin generates 2048 bit RSA public and private key for Client-1 and Client-2. The private keys are distributed to client machines and public keys are stored in a structure in the admin machine. When Client-1 wants to send message to Client-2, it encrypts the messages with public key of Client-2. The message is decrypted by Client-2 with its private key. Similar communication pattern from Client-2 to Client-1 need to be maintained. Manually capture the traffic between the hosts to ensure the proper working of the encryption. Construct an asynchronous communication between Client-1 and Client-2. Run a Wireshark/ TCP dump at the SPAN/Promiscuous port of the network switch and identify the communication between the communicating entities (Admin, Client-1, and Client-2).

#### 4. LAN based insider attacks

Make use of Ettercap/arp spoof tool to perform ARP Cache Poisoning based attacks in a LAN environment:

- a. Perform Denial of Service (DoS) attacks using ARP Cache Poisoning attacks
- b. Perform DNS Spoofing attack using ARP Cache Poisoning attacks
- c. Perform Password stealing (over plaintext) using ARP Cache Poisoning attacks
- d. Invoke 'sslstrip tool' for stealing password from any machine that is connected in a LAN by stripping the https connection.

For all the above attacks, observe the ARP cache table, CAM table, etc., before and after the attack. Run Wireshark and observe the traffic patterns before and after the attack.

#### 5. Malware & Attack evasion Techniques

Install Virtual Machines (VM) – Win2000 Server and Win 8. Install 'Poison Ivy' Remote Administration Toolkit in Server VM (admin.exe). Build and Generate a client.exe (client) program. Install the client.exe program in the Win XP machine. The client.exe communicates with the admin.exe in Win Server2000 VM.

Consider the following tasks:

- a. Enlist the processes, installed programs, dump the LM hashes, etc. from the Win XP machine
- b. Does 'client.exe' enlisted in the process list? If, write a procedure/program to hide the process(client.exe) from process table list?
- c. Set Firewall rules in Windows machine to block communication between the two VMs.

#### 6. Vulnerability Assessment and Penetration Testing (VAPT) Lab

Perform Vulnerability Assessment and Penetration Testing aimed at virtual machine images of computer network with distributed misconfigurations and vulnerabilities. The virtual machine images contain vulnerable network services, web services, social engineering and buffer overflow to be exploited. Generate VAPT Pen Test report based on standards such as Pen Test Report SANS, Offensive-security, or ISACA.

#### 7. Wireless Security Lab

Perform a VA/PT on your local Wi-Fi network and try automated attacks with NetStumbler and Kismet to gather information wireless network and try attacks like CowPatty and Aircrack-ng. Further execute aircrack-ng to simulate attacks 802.11 WEP and WPA-PSK keys for auditing wireless networks and performing airodump, aircrack, airmo, airbase, aireplay and airtun using Kali 2.0 (Sana) Linux. Attempt a Wi-Fi sniffing to gather location data

which can be used to identify device parameters of wireless communication devices.

### 8. Reverse Engineering Lab

Use Metasploit (open-source exploit framework) to write and test your own exploit into any PC/Server with existing payloads using Virtual Machines in Ubuntu Host and Windows XP Virtual disk. These traces should be executed in OllyDbg step by step, and debug the protocols every single command, laidback with registers and flags, with buffer information. Also debug standalone DLL's like Message Box and wsprintf. Use IDA Pro (evaluate a limited version of the disassembler) to examine a protected and obfuscated sample executable. (.NET Reflector can be used to search through, the class hierarchies of .NET assemblies, even without any source code).

Perform static and dynamic code auditing.

### 9. Security Data Analytics Lab

Download KDD CUP'99 dataset

(<http://kdd.ics.uci.edu/databases/kddcup99/kddcup99.html>). Separate the datasets into two class dataset such as normal-dos, normal-probe, normal-u2r, and normal-r2l. Any of the toolkits such as R, Weka, RapidMiner, Matlab, etc., can be used.

- a. Apply Correlation based Feature Selection Algorithms (FSA) in order to derive the subset of features that represent the dataset. What is the gain in applying FSA? Is there any change in detection rate with and without applying FSA? How the execution time/model building time varies with and without applying FSA?
- b. Apply Multilayer Perceptron Classification algorithm and calculate the metrics such as detection rate, false alarm rate, ROC value, F-measure for each class. Also, vary the parameters such as momentum and learning rate and calculate the metrics.
- c. Apply Simple *k*-Means Clustering algorithm and calculate the metrics such as detection rate, false alarm rate, ROC value, F-measure for each class. Also, vary the parameters such as Euclidean and Manhattan distances and calculate the metrics.
- d. Apply RIPPER algorithm (rule based classifier) to formulate the rules extracted from the dataset. Determine the number of rules extracted and enumerate each rule.

Devise a procedure/mechanism in building a dataset for the following:

1. Network Intrusion Detection system dataset
2. Host Intrusion Detection system dataset
3. Malware dataset
4. Botnet dataset
5. Spam email, Web browsing, Net flow data, firewall logs, Anomilize

Tools, DNS records Refer:

<http://www.unb.ca/research/iscx/dataset/index.html>

Systematically generate the dataset involving each of the four identified modules – Experimental set up, Data collection, Feature construction and Class labeling.

### 10. Mobile & Smart Phone Security Lab

Familiarize with mobile .apk files. Create your own Android app. Find vulnerable app in play store and perform forensics analysis on the app and document the inferences.

## ***Elective 7 or 8: Advanced Image Processing***

(w.e.f 2021-2022)

### **Course Objective:**

1. Review the fundamental concepts of a medical image processing system.
2. Evaluate the techniques for image enhancement for medical images.
3. Understand the different techniques for extracting features from an image.
4. Analysis of Image Processing in field of text extraction.

### **Course Outcome:**

After Completion of this course, the students will be able to:

CO1: Understand the relevant aspects of medical image representation and their practical implications. (Level: Understand)

CO2: Understand and execute the process of feature extraction of an image. (Level: Understand)

CO3: Apply image processing in steganography, expert systems through GIS based cloud. (Level: Apply)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Introduction to Medical Image Processing	12
2	Enhancement in Medical Image Processing	12
3	Feature Extraction and Statistical Measurement	12
4	Analysis in image processing	12
5	Digital Image Steganography	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

<b>Sr. No.</b>	<b>Modules / Units</b>
<b>1</b>	<b>UNIT 1</b>
	Introduction to Medical Image Processing Various modalities of medical imaging, Mammographic imaging, Ultrasound imaging, Magnetic resonance imaging (MRI), Problems with medical images.
<b>2</b>	<b>UNIT 2</b>
	Enhancement in Medical Image Processing Image enhancement, Spatial domain methods, Frequency domain methods, Other modalities of medical imaging, Radiography, Positron emission tomography (PET), Computed tomography angiography (CTA), Echocardiogram
<b>3</b>	<b>UNIT 3</b>
	Feature Extraction and Statistical Measurement Selection of features, Shape related features, Shape representation, bounding box, Shape matrix, Moments of region and shape, Co-occurrence matrix, Principal feature analysis (PFA), Fourier descriptors, Snake boundary detection, Snake algorithm, Feature extraction using discrete Fourier transform, Gabor filters for texture analysis
<b>4</b>	<b>UNIT 4</b>
	Analysis in Image Processing Fuzzy Approaches and Analysis in Image Processing, Text information extraction from images, Image and Video steganography based on DCT and wavelet transform
<b>5</b>	<b>UNIT 5</b>
	Digital Image Steganography Survey, Analysis, and Application, Vegetation Index: Ideas, Methods, Influences, and Trends, Expert System through GIS-Based Cloud

## Reference Books

1. Advanced Image Processing Techniques and Applications by N. Suresh Kumar, Arun Kumar Sangaiah, M. Arun, S. Anand, Publisher: IGI global [2017].
2. Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw-Hill Education Pvt. Ltd., [2009]
3. Digital Image Processing by Gonzalez and Woods, Publisher: Pearson/Prentice Hall. [Fourth edition, 2018]
4. Fundamentals of Digital Image Processing by A K. Jain, Publisher: PHI
5. The Image Processing Handbook by J. C. Russ, Publisher: CRC [Fifth edition, 2010]

## Practical (2 Credits)

Medical images can be downloaded from <http://www.barre.nom.fr/medical/samples/>

1. Apply the following Pre-Processing Techniques on a Medical Image: Log Transform, Power Law Transform, Image Negation
2. Apply the following Image Enhancement Techniques on a Medical Image: Brightness Adjustment, Contrast Stretching, Thresholding, Gray Level Slicing
3. Write a program to perform Smoothing on a Medical image
4. Write a program to perform Sharpening on a Medical image
5. Apply PCA on an image
6. Write a program for extracting text from an image
7. Apply different clustering algorithms.

## *Elective 7 or 8: Linux Server Administration*

(w.e.f 2021-2022)

### **Course Objective:**

1. Understand Linux systems
2. Understand the scope and deliverables of Linux System administration
3. Understand Linux services

### **Course Outcome:**

After Completion of this course, the students will be able to:

CO1: Setup and install software on a Linux system. (Level: Create)

CO2: Manage services on a Linux system. (Level: Apply, Analyse)

CO3: Configure security and firewall on a Linux system. (Level: Analze)

CO4: Manage users, groups and permissions on a Linux system. (Level: Apply, Analyse)

<b>Sr. No</b>	<b>Modules</b>	<b>No of hours</b>
1	Introduction to Linux Administration	12
2	Single Host Administration	12
3	Networking and Security	12
4	Internet Services	12
5	Intranet Services	12
<b>Total</b>		<b>60 hours</b>
		<b>4 Credits</b>

<b>Sr. No.</b>	<b>Modules / Units</b>
<b>1</b>	<b>UNIT 1</b>
	Introduction to Linux Administration: Technical Summary of Linux Distributions, Managing Software. Introduction to Text Editors: vi Editor, emacs Editor, The Development of Shells, Introduction to Filesystems, Using fdisk (Demo), Partitioning Considerations, vi Commands, emacs Commands, Shells, Shell Initialization, Aliases, Environment Variables, Customizing the Command Line Prompt, Special Characters, Redirection

<b>2</b>	<b>UNIT 2</b>
	Single Host Administration: Managing Users and Groups, Booting and shutting down processes, File Systems, Core System Services, Process of configuring, compiling, Linux Kernel, Using GRUB, System Initialization, Using Swap and OOM, Threading Model
<b>3</b>	<b>UNIT 3</b>
	Networking and Security: TCP/IP for System Administrators, basic network Configuration, Linux Firewall (Netfilter), System and network security, Using Predictable Network Interface Device Names
<b>4</b>	<b>UNIT 4</b>
	Internet Services: Domain Name System (DNS), File Transfer Protocol (FTP), Apache web server, Simple Mail Transfer Protocol (SMTP), Post Office Protocol and Internet Mail Access Protocol (POP and IMAP), Secure Shell (SSH), Network Authentication, OpenLDAP Server, Samba and LDAP, Network authentication system (Kerberos), Domain Name Service (DNS), Security
<b>5</b>	<b>UNIT 5</b>
	Intranet Services: Network File System (NFS), Samba, Distributed File Systems (DFS), Network Information Service (NIS), Lightweight Directory Access Protocol (LDAP), Dynamic Host Configuration Protocol (DHCP), MySQL, LAMP Applications File Servers, Email Services, Chat Applications, Virtual Private Networking

### Reference Books

1. Linux Administration: A Beginner's Guide, Wale Soyinka, Seventh Edition, McGraw-Hill Education, 2016

### Practical (2 Credits)

1. Install DHCP Server in Ubuntu 16.04
2. vi and emacs commands.
3. Initial settings: Add a User, Network Settings, Change to static IP address, Disable IPv6 if not needed, Configure Services, display the list of services which are running, Stop and turn OFF auto-start setting for a service if you don't need it, Sudo Settings

4. Configure NTP Server (NTPd), Install and Configure NTPd, Configure NTP Client (Ubuntu and Windows)
5. SSH Server : Password Authentication Configure SSH Server to manage a server from the remote computer, SSH Client : (Ubuntu and Windows)
6. Install DNS Server BIND, Configure DNS server which resolves domain name or IP address, Install BIND 9, Configure BIND, Limit ranges you allow to access if needed.
7. Configure DHCP Server, Configure DHCP (Dynamic Host Configuration Protocol) Server, Configure NFS Server to share directories on your Network, Configure NFS Client. (Ubuntu and Windows Client OS)
8. Configure LDAP Server, Configure LDAP Server in order to share users' accounts in your local networks, Add LDAP User Accounts in the OpenLDAP Server, Configure LDAP Client in order to share users' accounts in your local networks. Install php LDAP admin to operate LDAP server via Web browser.
9. Configure NIS Server in order to share users' accounts in your local networks, Configure NIS Client to bind NIS Server.
10. Install MySQL to configure database server, Install phpMyAdmin to operate MySQL on web browser from Clients.
11. Install Samba to share folders or files between Windows and Linux



## ***Guidelines for Project***

(w.e.f 2021-2022)

- The project topic may be undertaken in any area of Core Courses.
- Each of the students has to undertake a Project individually under the supervision of a teacher-guide.
- The student shall decide the topic in consultation with the teacher-guide concerned.
- College will allot P G Teacher for guidance to the students based on her / his specialization.
- There shall be double valuation of project by the teacher- guide concerned and an external examiner appointed by the College with equal weightage.
- The teacher-guide along with the external examiner appointed by the College for the valuation of project shall conduct viva voce examination with equal weightage.
- The project report shall be prepared as per the broad guidelines given below:
  - Project Report shall be typed in Times New Roman with one and half line spacing in 12 Font Size and 1.5 spacing.
  - The size of the Project Report shall be with minimum of 50 pages.
  - Project Report shall be printed on both sides of the paper.
  - The Project Report shall be bounded.
- Minimum of Grade E in the project component is needed for passing
- In case of failing in the project work, the same project can be revised for ATKT examination.
- Absence of student for viva voce: If any student fails to appear for the viva voce on the date and time fixed by the department, such student shall appear for the viva voce only along with students of the next batch.

## *Evaluation Scheme*

### **Internal Exam-40 Marks**

- **Test– 20 Marks**

It will be conducted module wise either as a written test or using any open source learning management system such as Moodle (Modular Object-Oriented Dynamic Learning Environment) or a test based on an equivalent online course on the contents of the concerned course (subject) offered by or build using MOOC (Massive Open Online Course) platform.

- **Assignments/Presentation/Projects – 15 Marks**

Subject specific Term Work Module/assessment modes –as decided by the department in the beginning of the semester (like Extension/field/experimental work, Short Quiz; Objective test, lab practical, open book test etc. and written assignments, Case study, Projects, Posters and exhibits etc. for which the assessment is to be based on class presentations wherever applicable)

- **Active participation in routine class instructional deliveries - 5 Marks**

Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.

### **External Examination- 60 Marks**

Duration - 2.5 Hours.

Theory question paper pattern:-

All questions are compulsory.

Question	Based on	Marks
Q.1	Unit I	12
Q.2	Unit II	12
Q.3	Unit III	12
Q.4	Unit IV	12
Q 5	Unit V	12

All questions shall be compulsory with internal choice within the questions.

Each Question may be sub-divided into sub questions as a, b, c, d & e, etc & the allocation of Marks depends on the weightage of the topic.

### **Practical Examination – 50 marks (Duration: 2 Hours)**

- Each practical course carries 50 Marks : 40 marks + 05 marks (journal)+ 05 marks(viva)
- Minimum 75% practical from each course are required to be completed and written in the journal.

**(Certified Journal is compulsory for appearing at the time of Practical Exam)**