VIVEKANAND EDUCATION SOCIETY

INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

Hashu Advani Memorial Complex, Collector's Colony, Chembur, Mumbai, 400074, Maharashtra, India
www.vesit.ac.in

Syllabus Approved By:

Academic Council of V.E.S. Institute of Technology Effective from: 2024-25

Preamble

Engineering education forms the cornerstone of technological innovation, industrial advancement, and societal transformation. As the world navigates an era of rapid change driven by automation, artificial intelligence, sustainable technologies, and global connectivity, VESIT positions itself as a catalyst for cultivating a dynamic learning ecosystem.

At VESIT, we strive to foster critical thinking, technical expertise, academic excellence, and holistic development among aspiring engineers. We are committed to shaping professionals who are adaptable, collaborative and are also deeply conscious of their social and environmental responsibilities.

Leveraging its autonomous status and affiliation with the University of Mumbai, VESIT designs a forward-thinking, outcome-based curriculum that emphasizes industry relevance and experiential learning.

The syllabus at VESIT has been structured in alignment with the principles of the National Education Policy (NEP) 2020, focusing on flexibility and multidisciplinary learning. The key thrust areas of education at VESIT include :-

Student-Centric Approach:

The programme is designed to offer students greater autonomy in shaping their academic journey. The syllabus comprises of **Core (Major) and Minor courses** from Diverse Disciplines as well as a wide range of **Open Electives**. Students can tailor their learning paths based on their interests and career aspirations. The curriculum also integrates mentored field projects and on the job training, providing valuable hands-on experience. Additionally, students with a research inclination can also explore **research-based projects** or pursue **Honours by Research.**

Multidisciplinary Approach:

VESIT's curriculum reflects a strong interdisciplinary focus,incorporating emerging fields and cutting-edge technologies. Courses are designed to bridge various domains with offerings such as **Machine learning, Artificial Intelligence & Data Science, Cyber Security, Geographic Information Systems (GIS), Internet of Things (IoT), Register transfer level VLSI, Robotics, Quantum Technologies, Mobile application development, Industrial Automation, Edge Computing and Embedded Intelligence and Information Security.**

This approach encourages broader thinking and prepares students for diverse career paths.

Emphasis on Conceptual Clarity:

The curriculum lays stress also on a strong theoretical foundation, ensuring that students gain deep conceptual understanding, which is essential for mastering advanced topics and solving real-world problems.

Fostering Creativity and Critical Thinking:

Courses are designed to nurture a critical and creative mindset, promoting analytical reasoning, problem-solving, and innovation. Students are encouraged to question, explore, and think beyond conventional solutions.

Comprehensive Evaluation and Assessment:

Student performance is assessed through a number of assessment tools that includes the Mid-term Tests, Continuous Assessments, End-Semester Examinations. These evaluation tools are designed to measure the knowledge retention of students as well as their ability to apply concepts effectively in practical situations.

Guided by a vision of excellence and inclusivity, and supported by a passionate faculty, VESIT aspires to be a hub where ideas flourish, startups emerge, and industry-academia partnerships thrive. Our goal is to transform students into innovators, entrepreneurs, researchers and responsible leaders poised to drive sustainable growth and meaningful change in society.

Dr. J M Nair	Dr. M Vijayalakshmi	Dr. Mrs. Gresha S Bhatia
Principal, VESIT	Vice Principal, VESIT	Academic Coordinator, VESIT

Department of Master of Computer Applications (MCA)

Preamble –

The **Master of Computer Applications (MCA)** program at Vivekanand Education Society's Institute of Technology is designed to produce industry-ready professionals with a strong foundation in both theoretical and applied aspects of Computer Science and Information Technology. In alignment with the National Education Policy (NEP) 2020, the program emphasizes interdisciplinary learning, skill-based training, and flexible academic pathways.

With a curriculum that integrates cutting-edge Technologies such as Big Data Analytics, Artificial Intelligence, Deep Learning, Blockchain, Cloud Computing, Microservices, Digital Marketing and Business Analytics and Ethical Hacking, the MCA program prepares students to meet the evolving demands of the global IT industry. The course structure also promotes research, innovation, and entrepreneurship through project-based learning, hands-on lab sessions, and Industry-oriented Internships.

The MCA department fosters an environment of academic excellence, critical thinking, and ethical responsibility. The inclusion of emerging domains such as Sustainable Computing and Digital Forensics reflects the department's commitment to sustainability, cybersecurity, and digital trust. Students are further encouraged to engage in MOOCs, Hackathons, and self-paced learning platforms to enrich their academic journey.

This dynamic and forward-looking program not only nurtures Technical Competencies but also aims to shape responsible, innovative, and socially aware IT professionals and Researchers who can contribute effectively to the digital transformation of society.

PROGRAM OUTCOMES

1. **PO1 (Foundation Knowledge):** Apply knowledge of mathematics, programming logic and coding fundamentals for solution architecture and problem solving.

2. **PO2 (Problem Analysis):** Identify, review, formulate and analyse problems for primarily focusing on customer requirements using critical thinking frameworks.

3. **PO3 (Development of Solutions):** Design, develop and investigate problems with as an innovative approach for solutions incorporating ESG/SDG goals.

4. **PO4 (Modern Tool Usage):** Select, adapt and apply modern computational tools such as development of algorithms with an understanding of the limitations including human biases.

5. **PO5 (Individual and Teamwork):** Function and communicate effectively as an individual or a team leader in diverse and multidisciplinary groups. Use methodologies such as agile.

6. **PO6 (Project Management and Finance):** Use the principles of project management such as scheduling, work breakdown structure and be conversant with the principles of Finance for profitable project management.

7. **PO7 (Ethics):** Commit to professional ethics in managing software projects with financial aspects. Learn to use new technologies for cyber security and insulate customers from malware.

8. **PO8 (Life-long learning):** Change management skills and the ability to learn, keep up with contemporary technologies and ways of working.

Dr. Shiv Kumar Goel
(H.O.D.)

Dr. Dhanamma Jagli
(Dy. H.O.D.)

VIVEKANAND EDUCATION SOCIETY'S
INSTITUTE OF TECHNOLOGY

(Autonomous Institute Affiliated to University of Mumbai)

Master of Computer Applications

MCA

Sem III & Sem IV Syllabus (NEP Scheme)

Effect from the academic year 2025–2026

Second Year MCA Semester III & IV

Year (2 Yr PG)	Level	Sem.	Major				Cum. Cr.	Degree
			Mandatory		Electives Any one			
II	6.5	Sem III	NMCA31	3	NMCAE31X **(Cr:4)**		22	**MCA Degree** **(After 3/4 Year UG)**
			NMCAL31	1	NMCAE311	3		
			NMCAL34	2	NMCAE312	3		
			NMCARP31	4	NMCAE313	3		
					NMCAEL31X			
					NMCAEL311	1		
					NMCAEL312	1		
					NMCAEL313	1		
					NMCAE32X**(Cr:4)**			
					NMCAE321			
					NMCAE322			
					NMCAE323			
					NMCALE32X			
					NMCALE321	1		
					NMCALE322	1		
					NMCALE323	1		
					NMCAE33X**(Cr:4)**			
					NMCAE331	4		
					NMCAE332	4		
					NMCAE333	4		
		Sem IV	**NMCAOJT41**	12			20	
			NMCARP42	2				
			NMCAM43	6				
Cumulative Credits for 1 Year PG Degree			**30**		**12**		**42**	
Cumulative Credits for 2 Year PG Degree			**67**		**24**		**91**	

Vivekanand Education Society's Institute of Technology
An Autonomous Institute Affiliated to University of Mumbai
Hashu Advani Memorial Complex, Collector Colony, Chembur East, Mumbai - 400074.

Semester III

Vivekanand Education Society's Institute of Technology
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CURRICULUM SCHEME FOR NEP POSTGRADUATE ACADEMIC PROGRAM AT VESIT
2025 : Branch: MCA Semester III

Semester III Scheme									
Type of Course	**Course Code**	**Name of Course**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
			Theory	**Pract.**	**Tutorial**	**Theory**	**Pract.**	**Tutorial**	**Total**
Major (Mandatory)	NMCA31	Big Data Analytics and Visualization	3	--	--	3	--	--	3
Major (Elective)	NMCAE31X	Elective - 4	3	--	--	3	--	--	3
Major (Elective)	NMCAE32X	Elective - 5	3	--	—	3	--	–	3
Major (Elective)	NMCAE33X	Elective - 6	3	--	1	3	--	1	4
Major (Mandatory)	NMCAL31	Big Data Analytics and Visualization Lab	--	2	--	--	1	--	1
Major (Elective)	NMCALE31X	Elective 4 Lab	--	2	--	--	1	--	1
Major (Elective)	NMCALE31X	Elective 5 Lab	--	2	--	--	1	--	1
Major (Mandatory)	NMCAL34	Skill based Lab Mobile Computing Lab	1	2	--	1	1	–	2
Research Project	NMCARP31	Project Stage -2 (Research Project)	--	8	--	--	4	--	4
Total			**13**	**16**	1	**13**	**08**	**1**	**22**

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CURRICULUM SCHEME FOR NEP POSTGRADUATE ACADEMIC PROGRAM
AT VESIT
2025 : Branch: MCA Semester III

Semester III Marks Scheme

Type of Course	Course Code	Name of Course	Examination Scheme							
			Theory					Term Work	Pract & oral	Total
			Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
			CA	MT	Tot					
Major (Mandatory)	NMCA31	Big Data Analytics and Visualization	20	20	40	60	2	--	--	100
Major (Elective)	NMCAE31X	Elective –4	20	20	40	60	2	--	--	100
Major (Elective)	NMCAE32X	Elective - 5	20	20	40	60	2	—	--	100
Major (Elective)	NMCAE33X	Elective - 6	20	20	40	60	2	25	--	125
Major (Mandatory)	NMCAL31	Big Data Analytics and Visualization Lab	--	--	--	--	--	25	50	75
Major (Elective)	NMCALE31X	Elective 4 Lab	--	--	--	--	--	25	50	75
Major (Elective)	NMCALE32X	Elective 5 Lab	--	--	--	--	--	25	50	75
Major (Mandatory)	NMCAL34	Skill based Lab Mobile Computing Lab	--	--	--	--	--	50	50	100
Research Project	NMCARP31	Project Stage-2 (Research Project)	--	--	--	--	--	150	-	150
Total			--	--	**160**	**240**	--	**300**	**200**	**900**

Elective 4

Sr. No.	Course Code	Name of Course	Lab Course Code
1	NMCAE311	Natural Language Processing	NMCAEL311
2	NMCAE312	Deep Learning	NMCAEL312
3	NMCAE313	Blockchain	NMCAEL313

Elective 5

Sr. No.	Course Code	Name of Course	Lab Course Code
1	NMCAE321	Microservices and Applications Cloudops	NMCAEL321
2	NMCAE322	Ethical Hacking	NMCAEL322
3	NMCAE323	Distributed system and cloud computing	NMCAEL323

Elective 6

Sr. No.	Course Code	Name of Course
1	NMCAE331	Digital Forensic
2	NMCAE332	Intellectual Property Rights
3	NMCAE333	Sustainable Computing

Course Code	Course Name	Teaching Scheme		Credits Assigned		
		Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
		3	--	3	--	3
		Examination Scheme				
		Theory		Term Work	End Sem Exam	Total
NMCA31	Big Data Analytics and Visualization	CA	MT	Total		
		20	20	40	--	60	100

Prerequisite: Some prior knowledge about SQL, Data Mining, DBMS would be beneficial.

Course Objectives: The Course aim to

Sr.No.	Course Objective
1	Provide an overview of exciting and growing field of big data analytics
2	Enhance the big data programming skills using technologies like HIVE.
3	Enhance the database and scripting skills using big data technologies NoSQL, Hbase
4	Understand the concept of PIG for problem analysis and solving.
5	Use of Apache Kafka and Spark applications to explore, process, and analyze distributed data
6	Understand why visualization is important for data analysis, using various data visualization techniques.

Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate the key issues in big data management and its associated application for business decision	Understanding
CO2	Develop problem solving and critical thinking skills in fundamental enabling techniques like HIVE	Applying
CO3	Develop problem solving skills in fundamental enabling techniques using NoSQL, Hbase	Applying
CO4	Applying scripting language like Pig to develop problem-solving techniques.	Applying
CO5	Use of Apache kafka RDD and Dataframe to create Application in Spark	Applying
CO6	Implement exploratory data analysis using visualization	Applying

Module	Detailed Contents	Hrs.
1	**Introduction to Big Data and Hadoop:** Introduction to Big Data, Big Data characteristics, Types of Big Data, Traditional vs. Big Data, Big Data Applications. Hadoop architecture: HDFS, YARN 2, YARN Daemons. Hadoop Ecosystem. **Self-Learning Topics:** Yet Another Resource Negotiator YARN 1.X	6
2	**HDFS and Map Reduce** **HDFS:** HDFS architecture, Features of HDFS,Rack Awareness,HDFS Federation **Hadoop Ecosystem:** HIVE: background, architecture, warehouse directory and meta-store, HIVE query language, loading data into table, HIVE built-in functions, joins in HIVE, Partitioning. HiveQL: querying data, sorting and aggregation, **Self-Learning Topics: Concept of Sorting and Natural Joins**	6
3	**NoSQL:** Introduction to NoSQL, NoSQL Business drivers NoSQL Data architecture patterns: key value stores, Column family Stores, Graph Stores, Document Stores. NoSQL to manage big data: Analyzing big data with shared nothing architecture, choosing distribution master slave vs. peer to peer. HBASE overview,HBASE data model, Read Write architecture. **Self-Learning Topics: Cassandra Case Study**	6
4	**Hadoop Ecosystem: PIG** PIG: background, architecture, PIG Latin Basics, PIG execution modes, PIG processing – loading and transforming data, PIG built-in functions, filtering, grouping, sorting data Installation of PIG and PIG Latin commands. **Self-Learning Topics:Cloudera IMPALA**	9

5	**Apache Kafka:** Kafka Fundamentals, Kafka architecture, **Apache Spark:** Spark Basics, Working with RDDs in Spark, Spark Framework, Spark SQL and Data Frames. **Self-Learning Topics: KMeans and Page Rank in Apache Spark**	**6**
6	**Data Visualization:** Importance and benefits of data visualization, Principles of effective data visualization, Types of data visualization techniques, Tools and technologies for data visualization,Challenges of big data, visualization, Power BI as a Visualization tool, Creation of Dashboards - Power BI. **Self-Learning Topics: Splunk via web Interface.**	**6**

Reference Books:

Reference No	Reference Name
1	Tom White, "HADOOP: The definitive Guide" O Reilly 2012, Third Edition, ISBN: 978-1-449-31152-0
2	Chuck Lam, "Hadoop in Action", Dreamtech Press 2016, First Edition ,ISBN:13
	9788177228137
3	Shiva Achari," Hadoop Essential " PACKT Publications, ISBN 978-1-78439-668-8
4	RadhaShankarmani and M. Vijayalakshmi ,"Big Data Analytics "Wiley Textbook Series, Second Edition, ISBN 9788126565757
5	Jeffrey Aven,"Apache Spark in 24 Hours" Sam's Publication, First Edition, ISBN: 0672338513
6	Bill Chambers and MateiZaharia,"Spark: The Definitive Guide: Big Data Processing Made Simple "O'Reilly Media; First edition, ISBN-10: 1491912219;
7	James D. Miller," Big Data Visualization" PACKT Publications.ISBN-10: 1785281941

Web References:

Reference No	Reference Name
1	https://hadoop.apache.org/docs/stable/
2	https://pig.apache.org/
3	https://hive.apache.org/
4	https://spark.apache.org/documentation.html
5	https://powerbi.microsoft.com/en-in/

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	Assignment/Tutorials Based on Syllabus	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Course Name	Teaching Scheme		Credits Assigned		
NMCAE311	Natural Language Processing	Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
		3	—	3	—	3
		Examination Scheme				
		Theory		Term Work	End Sem Exam	Total
		CA	MT	Total		
		20	20	40	—	60	100

Prerequisite:

Probability, Python programming, Data structure & Algorithms

Course Objectives: Course is aim to

Sr.No.	Course Objective
1	Understand natural language processing and learn how to apply basic algorithms in this field.
2	Get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics.
3	Implement a rule-based system to tackle the morphology and syntax of a language.
4	Compare and contrast use of different statistical approaches for different types of applications
5	Design a tag set to be used for statistical processing, keeping an application in mind, design a Statistical technique for a new application
6	Design an innovative application using NLP components

Course Outcomes: On successful completion of course, the learner/student will be able to

CO No.	Outcome	Bloom Level
CO1	Understand the computational properties of natural languages and the commonly used algorithms for processing linguistic information.	Understanding
CO2	Understand the information retrieval techniques using NLP	Understanding
CO3	Apply mathematical techniques that are required to develop NLP applications.	Applying

CO4	Analyze various NLP algorithms and text mining NLP applications	Analyzing
CO5	Design real-world NLP applications such as machine translation, text categorization, text summarization, and information extraction by applying NLP techniques.	Creating
CO6	Implement innovative application using NLP components	Creating

Module No.	Detailed Contents	Hrs
1	**Introduction to Language modeling** Origins and challenges of NLP, Language and Grammar, Processing Indian Languages, Components of NLP, Levels of NLP, Ambiguity in Natural Language, Stages in NLP, Applications of NLP. -- **Self-learning topics:** Empirical laws	**6**
2	**Word Level Analysis** Morphology analysis—survey of English Morphology, Inflectional Morphology & Derivational Morphology, Lemmatization, Regular Expression, N-Grams-N-Gram language model. **Self-learning topics:** N-gram for spelling correction	**6**
3	**Syntax analysis and Semantic Analysis** Part-Of-Speech tagging (POS): Tag set for English (Penn Treebank) , rule-based POS tagging, Stochastic POS tagging, Issues: Multiple tags & words, Unknown words. **Self-learning topics:** conditional Random Field (CRF).	6
4	**Semantic Analysis** Lexical Semantics, Attachment for fragment of English—sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses—Homonymy, Polysemy, Synonymy, Hyponymy, **Self-learning topics:** WordNet	**6**

5	**Text Summarization, Classification and Sentiment** Text summarization- (LEXRANK), optimization-based approaches for summarization , Summarization evaluation, Text classification Sentiment Analysis: Affective lexicons **Self-learning topics:** NLKT , Naïve Bayes Theorem	**6**
6	**Introduction to LLMs and Generative AI:** Introduction to Large Language Models (LLMs), History and evolution of LLMs, Architecture of LLMs, Training LLMs, Key concepts in Generative AI, Variational Autoencoders (VAEs), Text generation using LLM**s** . **Self-learning topics:** Generative Adversarial Networks (GANs)	**9**

Reference Books:

Reference No	Reference Name
1	Dan Jurafsky and James Martin. "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, Second Edition, 2009.
2	Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
3	Christopher D.Manning and Hinrich Schütze, — Foundations of Statistical Natural Language Processing —, MIT Press, 1999.
4	Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
5	Daniel M Bikel and ImedZitouni — Multilingual natural language processing applications‖ Pearson, 2013
6	Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) — The Handbook of Computational Linguistics and Natural Language Processing — ISBN: 978-1-118
7	Brian Neil Levine, An Introduction to R Programming
8	Niel J le Roux, SugnetLubbe, A step by step tutorial : An introduction into R application and programming

Web References:

Reference No	Reference Name
1	https://youtu.be/xvqsFTUsOmc
2	https://www.coursera.org/learn/language-processing
3	https://nptel.ac.in/courses/106/105/106105158/
4	https://youtu.be/IIaYk2hIYKk
5	https://www.udemy.com/course/natural-language-processing/?trk=profile_certification_title&utm_source=adwords&utm_medium=ud emyads&utm_campaign=DSA

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	Assignment/Tutorials Based on Syllabus	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course	Name of Course	Teaching Scheme			Credits Assigned				
		Contact Hours							
		Theory	Pract	Tut	Theory	Practical	Tut.	Total	
NMCAE312	Deep Learning	3	-	-	3	-	-	3	
		Examination Scheme							
		Theory			End Sem Exam	Term Work	Practical	Oral	Total
		CA	MT	Total					
		20	20	40	60	-	-	-	100

Prerequisite: Basic knowledge of mathematical and machine learning concepts.

Course Objectives: Course aims to

Sr.No.	Course Objective
1	Understand the concepts of neural networks and deep learning.
2	Understand the appropriate learning rules for each of the architectures and learn several neural network paradigms.
3	Understand major deep learning algorithms and the problem settings for problem-solving
4	Learn about the different regularization techniques and apply them to real world applications.
5	Understand the optimization algorithms used for training deep learning models.
6	Demonstrate deep learning algorithms -CNN and RNN to solve real-world problems.

Course Outcomes:

Sr. No.	Outcome	Bloom Level
CO1	Demonstrate the concepts, architectures, and algorithms of Neural Networks to solve real-world problems.	Understanding
CO2	Understand deep feed-forward networks and applications.	Applying
CO3	Understanding various regularization techniques and their importance in Deep learning .	Applying
CO4	Demonstrate different optimization algorithms used in Deep learning models	Analyzing
CO5	analyze the challenges in developing Convolutional Networks and apply them to real world-problems.	Analyzing
CO6	Analyze challenges in developing Recurrent and recursive networks and apply them to real world-problems.	Analyzing

Module No.	Detailed Contents	Hrs
01	**Introductuion to ANN** : The Neuron, Expressing Linear Perceptron as Neuron, Feed Forward Neural Networks, Liner Neuron and their Limitations, Sigmoid, Tanh and ReLU Neurons, Softmax Output Layers **Self-learning Topic: -**Mexican Hat Net.	**8**
02	**Deep Feed-forward Networks**: Introduction to Deep Learning, Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, and Other Architectural Considerations. **Self-learning Topic: -** Applications of Deep neural networks.	**6**
03	**Regularization**: Regularization for Deep Learning - Dataset Augmentation, Noise Robustness, Semi-Supervised Learning, Multi-Task Learning, Early Stopping. **Self-learning Topic:-**Regularized Linear Regression.	**6**
04	**Optimization for Training Deep Models-** Need for Optimization, Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies. **Self-learning Topic**:-Conjugate Gradients Method.	**5**
05	**Convolutional Networks**: Motivation, Pooling, Convolutional layers, Additional layers, Residual Nets, Applications of deep learning. **Self-learning Topic:-**Application of CNN.	**6**
06	**Recurrent and Recursive Nets:** Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder -Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, and Recursive Neural Networks. **Self-learning Topic:-**Application of RNN.	**8**

Reference Books:

Reference No	Reference Name
1	Dr. S. N. Sivanandam and Dr. S. N. Deepa, Principles of Soft Computing, John Wiley
2	S. Rajasekaran & G.A. VijayalakshmiPai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, Prentice Hall of India.
3	Goodfellow I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016
4	Christopher M Bishop., Pattern Recognition and Machine Learning, McGraw-Hill, ISBN No 0-07-115467-1.
5	Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
6	Simon Haykin, Neural Networks, and Learning Machines, 3rd Edition Prentice Hall of India, ISBN-10: 0-13-147139-2.
7	Anandita Das., Artificial Intelligence and Soft Computing for Beginners, ShroffPublication.ISBN 9789351106159.
8	Raul Rojas, Neural Networks: A Systematic Introduction, 1996 ISBN 978-3-540-60505
9	Deep Learning Tutorial Release 0.1, LISA lab, University of Montreal

Web References:

Reference No	Reference Name
1	https://olympus.greatlearning.in/courses/10905/pages/courseoutline?module_item_id=445065
2	https://www.youtube.com/watch?v=ve-Tj7kUemg&feature=youtu.be
3	https://www.coursera.org/specializations/deep-learning
4	https://www.tutorialspoint.com/python_deep_learning/index.htm

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	Assignment/Tutorials Based on Syllabus	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Name of Course	Teaching Scheme			Credits Assigned		
NMCAE313	Block Chain	Contact Hours					
		Theory		Tutorial	Theory	Tutorial	Total
		3		--	3	--	3
		Examination Scheme					
		Theory			Term Work	End Sem Exam	Total
		CA	MT	Tot			
		20	20	40	--	60	100

Prerequisite:

Basic knowledge of cryptography, networking, distributed systems and expertise in object oriented programming.

Course Objectives (CO): Course aim to

Sr.No.	Course Objective
1	Provide the overview of the structure and mechanisms of Blockchain
2	Understand cryptographic techniques used in Blockchain
3	Understand cryptocurrency transactions and mining Bitcoin .
4	Understand and write the smart contracts in Ethereum .
5	Understand the applications of Blockchain technology
6	Understand the different case studies in Blockchain .

Course Outcomes:

Sr. No.	Outcome	Bloom Level
CO1	Explain Blockchain technologies and their components.	Understanding
CO2	Interpret the uses of cryptographic techniques in Blockchain	Understanding
CO3	Demonstrate the use of Bitcoin and its components	Understanding
CO4	Build the smart contracts in Ethereum	Applying
CO5	Analyze the use of Blockchain technology in various domains	Analyzing
CO6	Applying the use of Blockchain technology in various domains	Applying

Description

Module	Detailed Contents	Hrs
1	**Introduction:** Basics of blockchain ,History and evolution of blockchain,Blockchain vs. traditional databases, Components of blockchain: Blocks, Chains, Nodes, Hashing, Public Ledger, Distributed Consensus,Peer to peer systems, centralized and decentralized systems, Types of blockchain,Usecases of Blockchain **Self-learning Topics:** Basics of cryptography (Symmetric and Asymmetric),RSA algorithm	06
2	**Cryptographic Primitives:** Cryptographic hash functions - collision free, hiding, puzzle friendly (properties), Hash Chain, Hash tree- Merkle Tree, Public Key cryptography, Digital signatures. Use of hash functions and digital signatures in blockchain,Zero-Knowledge Proofs (ZKP) **Self-learning Topics:** ,Elliptic Curve Cryptography (ECC)	06
3	**Bitcoin:** Basics (Structure of block, creation of coins),Double Spending,BitCoin Script, Mining Process, Objectives of consensus mechanisms, Consensus in Bitcoin – Proof of Work, Proof of Elapsed Time, Proof of Stake, Proof of Burn,Sybil Attack,51% attacks **Self-learning Topics:** HashGraph,Study of other Cryptocurrencies	08
4	**Permissioned Blockchain:** Smart Contracts, Distributed Consensus, Faults in DC, Algorithms - Paxos, RAFT, Byzantine Fault Tolerance, Practical BFT **Self-learning Topics:** Scalability solutions: Sharding, Layer 2, Sidechains,Federated Consensus	06

5	**Ethereum:** History, Architecture, Account Types ,ETH, Gas, Structure (Blocks, Transactions), Ethereum Virtual Machine, Ethereum Mining process, Solidity. **Hyperledger Fabric:** Features of hyperledger , Architecture, ordering service, Transaction Flow,Chaincode,Consensus in Hyperledger Fabric ,Gossip Protocol **Self-learning Topics:**Web3, Metaverse, and AI-integrated blockchain	06
6	**Case Study:** Blockchain in Government (Digital Identity, Tax Payments, Land Registration , Audit and Compliances),Blockchain in finance (DeFi, CBDCs, and Payments),Blockchain in supply chain management, Blockchain in healthcare and identity management,blockchain in iot security	07

References:

Reference No	Reference Name
1	Arvind Narayanan , Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Bitcoin and Cryptocurrency Technologies , Princeton University Press
2	Don Tapscott,AlexTapscott , Blockchain Revolution, ISBN No. 9781101980132
3	Mark Gates, Blockchain ultimate Guide to understanding Blockchain, Bitcoin,Cryptocurrencies , Smart Contracts and Future of money, Wise Fox Publishing
4	VikramDhillon , David Metcalf, Max Hooper, Blockchain Enabled Applications, Apress, ISBN No. 13:978-1-4842-3081-7
5	Melanie Swan,Blockchain Blueprint for a new economy, O'Reilly, First Edition, ISBN No.978-1-491-92049-7
6	MayukhMukhopadhyay , Ethereum Smart Contract Development , Packt publishing, First Edition, ISBN No.978-1-78847-304-0
7	Chris Dannen, Introducing Ethereum and Solidity, Apress, ISBN No.978-1-4842- 2535-6
8	Martin Quest, Cryptocurrency Master Bundle
9	Nitin Gaur, Luc Desrosiers, Petr Novotny, Venkatraman Ramakrishna , Anthony O'Dowd, Salman A. Baset, Hands-On Blockchain with Hyperledger, Packt

Web References:

Reference No	Reference Name
1	https://blockexplorer.com/
2	https://en.wikipedia .om/wiki/Digital signature
3	https://www.usenix.org/legacy/events/osdi99/full_papers/castro/castro_html/castro.ht ml
4	httns://www .hvoerledrrer.om /oroi ects/fabric
5	https://hyperledger-fabric .readthedocs.io/en/release-2.01
6	https://eprint.iacr.org/2017 /375.pdf
7	https://hbr.org/2017 /01/the-truth-about-blockchain
8	https://bitcoin .org/bitcoin .pdf
9	https://blockgeeks .com/guides/what-is-blockchain-technology /
10	https://www .cs.hmc.edu/geoff/classes/hmc .cs070 .200101/homeworkl O/hashfuncs.html
11	https ://www .globalsign .com/en/ssl-information-center /what-is-public-key- cryptography
12	https://Isearchsecurity .techtarget.com/definition/asymmetric-cryptography
13	https://www .cryptocompare.com/coins/guides/what-is-a-block-header-in-bitcoin /
14	https://github.com/ethereum/wiki/wiki/White-Paper
15	http://ethdocs.org/en/latest/introduction/index.html
16	https ://blockgeeks .com/guides/proof-of-work-vs-proof-of-stake /
17	https://www.coindesk.com/leam /ethereum-101/how-ethereum-works
18	httns://www .coindesk.com/short-m1ide-blockchain-consensus-orotocols

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	Assignment/Tutorials Based on Syllabus	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Name of Course	Teaching Scheme		Credits Assigned		
NMCAE321	Microservices and Applications Cloudops	Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
		3	--	3	--	3
		Examination Scheme				
		Theory		Term Work	End Sem Exam	Total
		CA	MT	Total		
		20	20	40	—	60	100

Prerequisite: Understanding of Software Development & Architecture, Basic knowledge of Cloud Computing, Familiarity with Docker & Kubernetes, Knowledge of DevOps practices

Course Objectives: The course is aim to

Sr.No.	Course Objective
1	**Understand the core principles of Microservices Architecture**, its advantages, challenges, and industry adoption.
2	**Learn about Microservices Design Patterns** such as API Gateway, Circuit Breaker, CQRS, and Saga to build scalable and resilient applications.
3	To equip students with the practical skills and theoretical knowledge to effectively deploy, orchestrate, and manage microservices in production environments using containerization, Kubernetes, and serverless technologies.
4	To enable students to automate and secure the deployment and management of cloud-based microservices using DevOps and CI/CD practices.
5	To equip students with the knowledge and skills to secure and monitor microservices effectively.
6	To enable students to design and implement highly scalable, performant, and resilient microservice architectures, while avoiding common pitfalls and understanding future trends.

Course Outcomes: On successful completion of course learner/student will be able to

Sr.No	Outcome	Bloom Level
CO1	Demonstrate a deep understanding of Microservices Architecture and its real-world applications.	Remembering
CO 2	will be able to design and implement scalable and resilient microservices using API Gateway, Circuit Breaker, CQRS, and Saga design patterns.	Understanding
CO 3	able to deploy, manage, and scale microservices using Docker, Kubernetes, and serverless technologies, ensuring consistent deployments, efficient communication, and resilience.	Applying
CO 4	Students can implement CI/CD pipelines, automate infrastructure with IaC, and ensure secure, observable cloud deployments for microservices.	Analyzing
CO5	Students can implement security measures (authentication, authorization, API security, edge security) and observability practices (logging, monitoring, resilience) for microservices.	Analyzing
CO6	Students will be able to apply scaling strategies, optimize performance with caching and database techniques, implement fault tolerance, recognize anti-patterns, and understand emerging trends in microservices.	Analyzing

Description

Module	Detailed Contents	Hrs
1	**Module 1: Fundamentals of Microservices** Introduction to Microservices Architecture, Monolithic vs. Microservices, Principles & Characteristics of Microservices, Advantages & Challenges of Microservices, Use Cases & Industry Adoption **Self-Learning Topics:** History of Service-Oriented Architecture (SOA), Twelve-Factor Apps	**04**
2	**Module 2: Microservices Design & Architecture** Domain-Driven Design (DDD), Event-Driven Architecture (EDA), Service Decomposition Strategies, Inter-Service Communication (REST, gRPC, Messaging), Microservices Design Patterns-API Gateway, Circuit Breaker Pattern, CQRS (Command Query Responsibility Segregation), and Saga Pattern, Service Mesh Patterns, case study on Amazon, Netflix,Uber **Self-Learning Topics:** CAP Theorem & Its Implications, Message Brokers: RabbitMQ vs. Kafka	**05**

3	**Module 3: Deployment & Orchestration of Microservices** Containerization with Docker, Introduction to Kubernetes (K8s), **Kubernetes Architecture & Components, Deploying Microservices on Kubernetes (AKS, EKS, GKE), Service Discovery & Load Balancing (Ingress, Traefik, Istio), Scaling & Auto-Healing (Horizontal Pod Autoscaler, Cluster Autoscaler)** Microservices Deployment Strategies, Serverless Microservices & Function as a Service (FaaS), Cloud-Native Microservices (Azure, AWS, GCP) **Self-Learning Topics:** Kubernetes Operators & Helm Charts, Service Discovery in Kubernetes, Multi-Cloud Deployment Strategies	**08**
4	**Module 4: DevOps and CI/CD for Microservices** **Cloud Application Deployment & DevOps** CI/CD Pipelines for Cloud Applications, GitHub Actions & Azure DevOps Pipelines, Canary Releases & Blue-Green Deployments, Infrastructure as Code (IaC) with Terraform, Kubernetes & Container Orchestration in Cloud, Monitoring, Logging, and Observability, DevSecOps & Secure Cloud Deployments **Self-Learning Topics:** Pulumi vs. Terraform vs. CloudFormation, GitOps vs. Traditional CI/CD, Feature Flags for Microservices	**08**
5	**Module 5: Microservices Security & Observability** Microservices Security landscape, principles and key elements , Edge security, principles and practices, Authentication & Authorization (OAuth2, JWT), API Security & Rate Limiting, Logging & Monitoring in Microservices, Circuit Breaker Patterns & Resilience **Self-Learning Topics**: Zero Trust Security Model, SIEM (Security Information and Event Management), Data Encryption in Microservices	**07**
6	**Module 6: Scalability, Performance & Best Practices** Scaling Microservices (Vertical vs. Horizontal), Caching Strategies & Database Scaling, Fault Tolerance & Retry Mechanisms, Microservices Anti-Patterns, Future Trends in Microservices **Self-Learning Topics:** Edge Computing & Microservices, AI & Machine Learning for Microservices Optimization, Blockchain-Based Microservices	**07**

Reference Books:

Reference No	Reference Name
1	*Building Microservices* – Sam Newman
2	*The Kubernetes Book* – Nigel Poulton
3	Microservices Patterns– Chris Richardson
4	Kubernetes Up & Running – Kelsey Hightower, Brendan Burns, Joe Beda
5	Cloud Native Patterns– Cornelia Davis
6	Microservices Security in Action – *Prabath Siriwardena, Nuwan Dias*

Web References:

Reference No	Reference Name
1	https://martinfowler.com/articles/microservices.html
2	https://learn.microsoft.com/en-us/dotnet/architecture/cloud-native/
3	https://kubernetes.io/docs/
4	https://opentelemetry.io/
5	https://learn.microsoft.com/en-us/azure/architecture/guide/architecture-styles/microservices
6	https://aws.amazon.com/microservices/

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	Assignment/Tutorials Based on Syllabus	10 marks

7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Name of Course	Teaching Scheme		Credits Assigned		
NMCAE322	Ethical Hacking	Contact Hours				
		Theory	Tutorial	Theory	Tutorial	Total
		3	--	3	--	3
		Examination Scheme				
		Theory		Term Work	End Sem Exam	Total
		CA	MT	Total		
		20	20	40	—	60	100

Prerequisite: Networking concepts, Structured Query Language, encryption algorithms

Course Objectives: Course is aim to

Sr.No.	Course Objective
1	Teach students to think like an ethical hacker and at the same time follow the code of professional ethics and the prescribed cyber laws.
2	Make oneself aware of the cybercrimes that are taking place in the real world.
3	Learn about the different hacking tools and techniques and practically use these tools to gain a better understanding of the ethical hacking concepts.
4	Provide a deep understanding of security issues, threats and concerns in the cyber world and provide countermeasures to curb hacking.
5	understanding of security threats in the cyber world and provide countermeasures to curb hacking.
6	Provide a deep understanding of security concerns in the cyber world and provide countermeasures to curb hacking.

Course Outcomes: On successful completion of course learner/student will be able to

Sr.No	Outcome	Bloom Level
CO1	Recall the networking, sql, and encryption algorithm concepts to further study ethical hacking techniques, threats, tools and prevention against attacks.	Remembering
CO 2	Understand ethical hacking concepts, cases, ethics and cyber laws.	Understanding
CO 3	Apply available hacking tools to find a solution to a given hacking issue.	Applying
CO 4	Analyze the real-world hacking cases	Analyzing
CO5	classify the real-world hacking situations.	Analyzing
CO6	Analyze and implement hacking cases and situations.	Analyzing

Description

Module	Detailed Contents	Hrs
1	**Introduction to Ethical Hacking:** What is ethical hacking? Types of hacking, advantages, disadvantages and Purpose of hacking, Types of hackers, Code of ethics, Types of attacks and attack vector types, Prevention from hackers ,Phases of hacking.ethical hacking tools **Self-Learning Topics:** The Indian IT Act 2000 and Amendments to the Indian IT Act(2008)	**04**
2	**Footprinting and Reconnaissance.** What is footprinting? Active and passive footprinting, purpose of footprinting , objectives of footprinting, footprinting threats, Types of footprinting, footprinting countermeasures. **Self-Learning Topics:** footprinting tools	**05**

3	**Scanning networks, Enumeration and sniffing:** **Scanning networks:** Network scanning and its types, objectives of network scanning, scanning live systems, scanning techniques-TCP Connect / Full Open Scan, Types of Stealth scans,port scanning countermeasures, IDS evasion techniques, Banner grabbing and its tools, vulnerability scanning, proxy servers, anonymizers, IP spoofing and its countermeasures. **Enumeration and Sniffing:** What is Enumeration? Enumeration techniques, Enumeration types, Enumeration countermeasures, what is sniffing? Wiretapping and its types, packet sniffing, sniffing threats, how sniffers work?, sniffing methods-ARP spoofing and MAC flooding, active and passive sniffing, types of sniffing attacks, sniffing countermeasures, sniffing detection techniques. **Self-Learning Topics:** Scanning, enumeration and sniffing tools.	**08**
4	**Trojans and other Attacks:** Worms, viruses, Trojans, Types of worms, viruses and worms, Preventing malware attacks, types of attacks**:** (DoS /DDoS), Waterhole attack, brute force, phishing and fake WAP, Eavesdropping, Man-in-the-middle, buffer overflow, DNS poisoning, ARP poisoning, Identity Theft, IoT Attacks, BOTs and BOTNETs, Steganography - text, image and audio and video, types of Social Engineering: Physical social engineering**,** Remote social engineering and hybrid social engineering. **Self-Learning Topics: case studies, malware tools and steganographic tools.**	**08**
5	**Hacking web servers, web applications and sql injection: Session hijacking**: What is session hijacking? Why is session hijacking successful? session hijacking techniques, session hijacking process, Types of session hijacking, session hijacking countermeasures: protecting and preventing, Hacking web servers and web applications: Causes of web servers being compromised, web server attacks, stages of web server attacks, defending against web server attacks, web application components, its working, architecture, web server attack vectors, web application threats and countermeasures. SQL Injection: What is SQL injection, SQL injection threats, SQL injection attacks, SQL injection detection, Types of SQL injection, SQL injection methodology, SQL injection prevention and countermeasures. **Self-Learning Topics**: tools of session hijacking, web servers and applications and SQL injection.	**07**

6	**Wireless network hacking, cloud computing security, cryptography,** **Pen testing:** Types of wireless Architecture, wireless encryption techniques-WEP and WPA, breaking WEP/WPA and defending WPA encryption, wireless Sniffing, Characteristics, types of cloud computing services, models , threats, attacks, countermeasures, cryptography and its types, cryptography attacks, countermeasures **Self-Learning Topics:** Tools of WEP/WPA, cloud computing, cryptography.	**07**

Reference Books:

Reference No	Reference Name
1	Matt Walker, All-In-One-CEH-Certified-Ethical-Hacker-Exam-Guide.
2	Manthan Desai Basics of ethical hacking for beginners.
3	SunitBelapure and Nina Godbole, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives.
4	Srinivasan, J. Suresh, Cloud Computing: A practical approach for learning and implementation, Pearson.
5	Sean-Philip Oriyano, Sybex, Certified Ethical Hacker Study Guide v9, Study Guide Edition,2016.
6	Emmett Duley and Chuck Easttom ,Comptia Security+ Study Guide.
7	Alana Maurushat, Ethical Hacking.
8	TutorialsPoint Professionals, Ethical Hacking by TutorialsPoint.

Web References:

Reference No	Reference Name
1	Code of ethics link https://cert.eccouncil.org/code-of-ethics.html
2	https://arc.bukancoder.co/Certified-Ethical-Hacker-Module-V8/

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	Assignment/Tutorials Based on Syllabus	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Name of Course	Teaching Scheme			Credits Assigned		
NMCAE323	Distributed System and Cloud Computing	Contact Hours					
		Theory		Tutorial	Theory	Tutorial	Total
		3		–	3	–	3
		Examination Scheme					
		Theory			Term Work	End Sem Exam	Total
		CA	MT	Total			
		20	20	40	–	60	100

Prerequisite: Computer Networks, Operating Systems

Course Objectives: Course is aim to

Sr.No.	Course Objective
1	Introduce concepts of Distributed Operating System, design issues IPC and RMI.
2	Understand the concepts of clock synchronization and shared memory.
3	Analyze various algorithms in Distributed System Management, File management and process management.
4	Analyze the concepts of Distributed System management
5	Analyze the principles and paradigm of Cloud Computing.
6	Understand the various design issues and challenges in cloud computing

Course Outcomes: On successful completion of the course learner/ student will be able to

Sr.No.	Outcome	Bloom Level
CO1	Illustrate principles and communication protocols of Distributed systems	Understanding
CO2	Analyze clock synchronization and various algorithms	Analyzing
CO3	Analyze Distributed shared memory and management concepts.	Analyzing
CO4	Analyze Distributed system management	Analyzing
CO5	Analyze Cloud computing concepts	Analyzing
CO6	Analyze cloud computing models	Analyzing

Module	Detailed Contents	Hrs
1	**Introduction to Distributed Computing Concepts:** Basic concepts of distributed systems, distributed computing models, issues in designing distributed systems **Inter Process Communication** Fundamental concepts related to inter process communication including message passing mechanism, Concepts of group communication **Remote Communication** Remote Procedure Call (RPC), Remote Method Invocation (RMI) **Self Learning Topics:** Case study on Java RMI	9
2	**Clock synchronization:** Introduction of clock synchronization, Global state, Mutual Exclusion Algorithms, Election algorithms. **Self Learning Topics:** Synchronization in Wireless Networks	4
3	**Distributed Shared Memory:** Fundamental concepts of DSM, types of DSM, various hardware DSM systems, Consistency models, issues in designing and implementing DSM systems. **Self Learning Topics:** MemNet Architecture	5
4	**Distributed System Management:** Resource Management Scheduling Algorithms, Task Assignment, Load balancing approach, Load sharing approach **Process Management** Process Migration Mechanism **Self Learning Topics:** Case Study of anyone distributed system	4
5	**Introduction to Cloud Computing:** Cloud Computing history and evolution, benefits of cloud computing. **Cloud Computing Architecture** Cloud Architecture model, Types of Clouds: Public Private & Hybrid Clouds, Cloud based services: Platform as a service (PaaS), Software as a service (SaaS), Infrastructure as a service (IaaS) **Self Learning Topics:** Cluster computing, Grid computing, Fog computing	7

6	**Classification of Cloud Implementations:** Amazon Web Services, Microsoft Azure & Google Cloud-- Compute Services, Storage Services, Database services. Google AppEngine (GAE), Comparative study of various Cloud Computing Platforms. **Cloud Issues and Challenges** Cloud computing issues and challenges like Security, Elasticity, Resource management and scheduling, QoS (Quality of Service) and Resource Allocation, Identity and Access Management **Self Learning Topics:** Windows Azure Platform Appliance	**10**

Reference Books:

Reference No	Reference Name
1	Pradeep K. Sinha, Distributed Operating System: Concepts and Design, PHI Learning, ISBN No. 978-81-203-1380-4
2	Dr. Sunita Mahajan , Seema Shah, Distributed Computing, Oxford University Press, Second Edition, ISBN No. 978-01-980-9348-0
3	Andrew S. Tanenbaum, Distributed Operating Systems, Pearson Education, ISBN No. 978-81-317-0147-8
4	James Broberg and Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms Wiley, First edition, ISBN No. 978-04-708-8799-8
5	Anthony T.Velte, Toby J.Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, Tata McGraw Hill, First Edition, ISBN No. 978-00-706-8351-8
6	RajkumarBuyya, Christian Vecchiola, S. ThamaraiSelvi, Mastering Cloud Computing, Tata Mcgraw Hill, ISBN No. 978-12-590-2995-0

Web References:

Reference No	Reference Name
1	https://nptel.ac.in/courses/106/104/106104182/
2	https://webee.technion.ac.il/~idish/sigactNews/
3	https://curlie.org/Computers/Computer_Science/Distributed_Computing/
4	https://nptel.ac.in/courses/106102114/
5	https://nptel.ac.in/courses/106104024/

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	Assignment/Tutorials Based on Syllabus	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Course Code	Course Name	Teaching Scheme			Credits Assigned		
		Contact Hours					
		Theory	Tutorial		Theory	Tutorial	Total
		3	1		3	1	4
NMCAE331	Digital Forensic	Examination Scheme					
		Theory			Term Work	End Sem Exam	Total
		CA	MT	Tot			
		20	20	40	25	60	125

Prerequisite:
Computer Networks, Computer Network Security, Internet Security

Course Objectives: The course is aim to

Sr. No.	Course Objective
01	Understand the fundamentals of forensics and Cyber Crime
02	To explore the fundamentals of digital forensics, digital evidence and incident response.
03	To understand the network attacks and tools and techniques required to perform network Forensics and Email Forensic
04	To learn how to investigate attacks on mobile platforms.
05	To explore how to investigate attacks on clouds.
06	Acquire knowledge to write a Lawful Forensic Investigation report for the evidence

Course Outcomes (CO): On successful completion of course learner/student will be able to

Sr. No.	Course Outcome	Bloom Level
CO1	Develop computer forensic awareness	Remembering
CO2	Utilizing the knowledge for investigations in order to solve computer crime	Analysing
CO3	Attain knowledge to Detect the network attacks and analyze the evidence.	Evaluating
CO4	Acquire adequate knowledge to identify digital forensic investigation in mobile devices	Understanding
CO5	Attain the perspectives of digital forensic investigation in cloud	Understanding
CO6	Apply the knowledge of Forensic Investigation and learn to generate reports which offer valid conclusions.	Creating

Module	Topics of Coverage	Hours
1 **Introduction**	**Introduction to cybercrime** Introduction of Cyber Crime, Categories of Cyber Crime ,Types of Cyber Crime, Computer roles in Crime, Cybercrime statistics in India **Introduction to Digital Forensics** Introduction and History of Digital Forensics and its goals. Branches of Digital Forensic, Digital Forensic Challenges and Benefits ,Computer Forensic , Steps of Computer Forensic **Self-Learning Topics:**-Types of hackers , hacking methods, password cracking methods and Viruses	05

2 Forensic Evidence Collection, Analysis and Digital Evidence Controls	**Digital Evidences:** Definition, Types, Rules, Source and characteristic of Digital Evidence , Challenges in evidence handling, chain of custody, Evidence Handling Procedures, Forensic Duplication –Definition , Necessity and Important Terms in Forensic duplication **Data Analysis-** Steps for Forensic Analysis **Incident Response Process-** Introduction , Six stages and goals of incident response, People involved in Incident response, Incident Response methodology , investigate the incident **DFI (Digital Forensic Investigation Models)-**DFRWS, IDIP, EIDIP, CFFTPM ,CPCFIM **Self-Learning Topics:** Computer Forensic Tools-FTK, En Case, Linux DD etc	10
3 Network Forensic	Introduction, Types of IDs Advantages and disadvantages of IDs , Evidence Collection and Acquisition (Wired and Wireless), People involved in data collection,, Live data collection from Windows System and Unix System **,** Data Analysis-Investigating Windows and Unix System (Review of logs, hideen files , checking of unauthorized access point) **Email Forensic-** Email Spoofing, Email Spamming, Email Recovery and forensic steps **Self-Learning Topics:** Network Forensic open source tools, Email Forensic Tools	07
4 Mobile Forensic	Introduction-Mobile Forensic and Mobile related crimes, Mobile Hacking-what can a hacker do, what can a attacker do, what can you do , call spoofing, SMS forging, Bluesnarfing, Evidence Collection and Acquisition, Analysis of Evidences, ,Mobile Phone Forensic Procedure , Challenges in mobile forensics **Self-Learning Topics**: Tools / Techniques used in mobile forensics	07
5 Cloud forensic	Fundamentals of cloud forensics, Cloud crimes, Three dimensions of cloud Forensic, Uses of cloud forensics and its challenges, , Impact of Cloud Computing on Digital Forensic, **Self-Learning Topics:** Cloud Forensic Tools	06
6 Report Generation	Goals of Report, Layout of an Investigative Report, and Guidelines for Writing a Report, sample for writing a forensic report. **Self-Learning Topics: For an incident write a Forensic report.**	04

Reference Books:

Reference No.	Reference Name
1	Digital Forensics with open source tools.Cory Altheide and Harlan Carvey,ISBN: 978-1-59749-586-8,Elsevier Publications,April2011.
2	Digital Forensic: the fascinating world of Digital Evidence, Dr Nilakshi Jain, Dr D. Kalbande, Wiley Publication.
3	Digital Evidence and Computercrime3rdEdition: Forensics Science, Computers and the Internet by Eoghan Casey, 2011.
4	Computer Forensic and Cyber Crime: AnIntroduction3rd Edition by Marjie T. Britz 2013.
5	Network Forensics: Tracking Hackers through Cyber Space, Sherri Davidoff,Jonatha Ham PrenticeHall 2012
6	Android Forensics: Investigation and Security by Andrew Hogg, Publisher– Synergy
7	PracticalMobileForensics:SatishBommisetty,RohitTammaandHeatherMahalik,Pack Publishing LTD 2014,ISBN-978-1-78328-831-1

Web References:

Reference No	Reference Name
1	https://www.rohasnagpal.com/docs/ASCL_Cyber_Crime_Investigation_Manual.pdf
2	https://doi.org/10.6028/NIST.SP.800-86
3	https://onlinecourses.swayam2.ac.in/cec20_lb06/preview

Tutorial: Tutorial List but not limited to the following suggested List of Tutorial

Tutorials		
Sr. No	**Topic**	**Hrs.**
1	Study of AI Powered Cyber Crime	1
2	Study and Create a Chain of Custody for an evidence	2
3	Study of Tool FTK imager and Encase Imager	1
4	Study of Hashing Tool (md5sum, sha256sum)	1
5	Case Study based on different kinds of crimes in real world	1
6	Case Study: To recover deleted files form windows system using Recuva Tool	2
7	Study of Volatility (Memory forensics)	1
8	Study of Autopsy tool for Disk Analysis and file recovery	1
9	Study of IoT Forensic	1
10	Study of Email Investigation tool	1
11	Writing a Report	1

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	**Rubrics**	**Marks**
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation/Case study	10 marks

4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	Assignment/Tutorials Based on Syllabus	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Term Work: 25 marks

The term work will be based on the tutorial performance of the student.

Course Code	Course Name	Teaching Scheme			Credits Assigned		
		Contact Hours					
		Theory		Tutorial	Theory	Tutorial	Total
		3		1	3	1	4
		Examination Scheme					
NMCAE332	Intellectual Property Rights	Theory			Term Work	End Sem Exam	Total
		CA	MT	Tot			
		20	20	40	25	60	125

Prerequisite:

1. Knowledge of computer peripherals
2. Knowledge of data storage devices
3. Some awareness towards Environment as a whole

Course Objectives: The course is aim to

Sr. No.	Course Objective
01	To make students aware about the concept of Intellectual Property.
02	To make the students aware of their rights for the protection of their invention done in their project work.
03	To make students aware about the global and Indian laws regarding Intellectual Property.
04	To get knowledge of patents, copyright, trademarks, designs and information Technology Act.
05	To get acquaintance with Patent search and patent filing procedure and applications
06	To get registration in our country and foreign countries of their invention, designs and thesis or theory written by the students during their project work.

Course Outcomes (CO): On successful completion of course learner/student will be able to

Sr. No.	Course Outcome	Bloom Level
CO1	Skill to understand the concept of intellectual property rights	Remembering
CO2	Develops procedural knowledge to Legal System and solving the problem relating to intellectual property rights.	Understanding
CO3	The students once they complete their academic projects, they get awareness of acquiring the patent	Understanding
CO4	They also learn to have copyright for their innovative works	Creating
CO5	They also get the knowledge of plagiarism in their innovations which can be questioned legally	Evaluating
CO6	Relate that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about economic growth and social benefits.	Analyzing

Module	Topics of Coverage	Hours
1	**Introduction:** The Concept of Property: Its Definition, Its Features, and Classification – Intellectual Property as Creations of the Human Mind – Justifying Intellectual Property : Arguments for and Against It – Types of IPRs: Patent, Copyright, Trademark, Trade Secret, Industrial Design, Geographical Indication, Semiconductor Integrated Circuit Layout Design, Plant Variety & Farmer's Rights; Genetic Resources and Traditional Knowledge **Historical Background:** Evolution of IPRs through Various International Agreements, Treaties, & Conventions: From Paris Convention (1883) To WTO- TRIPS Agreement (1995) – Global IPR Organizations: WIPO (1967) and WTO (1995) **Self-Learning Topics:** Relevance of Intellectual Property in Today's Knowledge Economy	05
2	**Module: Patents** **Introduction to Patent:** What is a Patent? – Conditions for Grant of Patent – Patentable Inventions and Inventions Not Patentable – Process and Product Patents – Patent Specifications – The Process for Obtaining a Patent in India	

	and Abroad – PCT Patent – Post-Grant Opposition, Revocation and Compulsory Licensing – Rights Granted to a Patentee – Patent Infringement & Its Remedies – Patent Search and Databases – e-filing of Patent Application **Emergence of Technology Patents:** Patenting the Inventions of Information Technology: Patenting Computer Programs and Software – Software Patents vs Software Copyrights: Lessons for India – Patenting of Biotechnology Inventions (or Patenting Life) **Self-Learning Topics:** Biotech Patents in India	07
3	**Module: Copyrights** **Introduction to Copyright:** Nature of Copyright – Copyright as a Property, Statutory Right, Idea versus Expression – Requirements for Copyrights – Idea- Expression Dichotomy: Merging of the Idea with Expression, Originality & Fixation– Various Works Protectable Under Copyrights – Authorship and Ownership – Registration of Copyrights – Term of the Copyright – Copyright Infringement, Its Remedies & Penalties. **Copyrights in the Digital Age** – Internet and Copyright – Copyrights in Computer Software – Copyrights for Electronic Database – Digital Copyright Protection in India **Self-Learning Topics:** Fair Use – Instances of Fair Use: Using Copyrighted Works in Education and Library	05
4	**Module: Trademarks and Trade Secrets** **Trademarks:** Introduction – The Rationale and Functions of a Trademark – Different Types of Trademarks – Categories of Trademark Distinctiveness – Recognizing a Good Trademark – What Cannot be Registered as a Trademark? – Registration & Renewal of a Trademark – Rights Granted by Trademark Registration – Different Classes of Trademark Infringement – Acts of Trademark Infringement & Remedies **Trade Secrets:** Trade Secret and its Characteristics - Kinds and Examples of Trade Secrets - Protection of Trade Secrets - Patents and Trade Secrets **Self-Learning Topics:** Origin of Trademarks System in India – Misappropriation of Trade Secrets	07
5	**Module: Designs and Geographical Indications** **Design:** Defining a Design – Essentials of a Design – Registration & Term of Designs – Copyright in Registered Designs – Conditions for Registration of Industrial Designs **Geographical Indications:** Introduction - Concept of Geographical Indications - Kinds of Geographical Indications – Registration of GIs –	08

	Benefits of Registering GIs – Infringement of a Registered GI and Remedies Thereof **Self-Learning Topics:** IPRs forSemiconductor Integrated Circuit Layout Design	
6	**Module: Harnessing Intellectual Property for National Development** India's New National IPR Policy, 2016: Vision Statement, Mission Statement and Objectives – IPR Administration System in India – Govt of India Initiatives & Schemes towards Promoting IPR **Self-Learning Topics:** Managing of Intellectual Property in Organizations	07

Reference Books:

Ref No	Reference Name
1	Nithyananda, K. V., Intellectual Property Rights: Protection and Management, Cengage Learning (2017), First Edition, ISBN: 9789386668578
2	NeerajPandey&KhusdeepDharni, Intellectual Property Rights, PHI Learning (2014), First Edition, ISBN: 812034989X, 9788120349896
3	Sreenivasulu N.S, Law Relating to Intellectual Property, Partridge Publishing (2013), First Edition, ISBN: 1482813939, 9781482813937
4	Ramakrishna B & Anil Kumar H.S, Fundamentals of Intellectual Property Rights – For Students, Industrialists, and Patent Lawyers, Notion Press (2017), First Edition, ISBN:1946556327, 9781946556325
5	Siva Vaidhyanathan, Intellectual Property: A Very Short Introduction, Oxford University Press (2017), Second Edition, ISBN: 9780195372779
6	Ahuja V. K., Law Relating to Intellectual Property Rights, Lexis Nexis (2017), Third Edition, ISBN: 9788131251652

Web References:

Reference No	Reference Name
1	National IPR Policy 2016 - http://cipam.gov.in/wp-content/uploads/2017/10/National-IPR-Policy-English-.pdf
2	**Intellectual Property – The Future, CIPAM, 2017** - http://cipam.gov.in/wp-content/uploads/2017/09/bookletIPR.pdf
3	WIPO Intellectual Property Handbook – (https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf)
5	https://www.startupindia.gov.in/
6	https://dipp.gov.in/
7	http://ipindia.nic.in/

Intellectual Property Rights: Tutorials

Tutorial List,but not limited to the following suggested List of Tutorial

Sr. No	Detailed Contents	Hrs.
01	Study of a real-world case on Patents	02
02	Study of a real-world case on Copyrights	02
03	Study of a real-world case on Trademarks	02
04	Study of a real-world case on Trade Secrets	02
05	Study of a real-world case on Industrial Design	02
06	Study of a real-world case on Geographical Indication	03

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.
Continuous Assessment: -
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	Assignment/Tutorials Based on Syllabus	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Term Work: 25 marks

The term work will be based on the tutorial performance of the student.

Course Code	Course Name	Teaching Scheme			Credits Assigned		
		Contact Hours					
		Theory		Tutorial	Theory	Tutorial	Total
		3		1	3	1	4
		Examination Scheme					
		Theory			Term Work	End Sem Exam	Total
		CA	MT	Tot			
NMCAE333	Sustainable Computing	20	20	40	25	60	125

Prerequisite:

1.Knowledge of computer peripherals
2.Knowledge of data storage devices
3.Awareness towards Environment as a whole

Course Objectives: The course is aim to

Sr. No.	Course Objective
01	Explain why Green IT is important to the enterprise over all
02	Explain why Green IT is important to the enterprise overall movement.
03	Adopt special skills such as knowledge about energy efficiency, ethical IT assets disposal, carbon footprint estimation.
04	Create eco-friendly environment
05	Conduct basic equipment usage audits
06	Improve energy efficiency of their personal computing environment as well as the enterprise-wide computing environments

Course Outcomes (CO): On successful completion of course learner/student will be able to

Sr. No.	Course Outcome	Bloom Level
CO1	Acquire expertise for improving the energy efficiency for laptops and personal computers by reducing the power consumption requirements	Remembering
CO2	Assess enterprise-wide and personal computing and computing energy consumption	Understanding
CO3	Recognize the necessity for long-term sustainability in IT	Understanding
CO4	Formulate plans for reducing IT heating and cooling requirements	Creating
CO5	Evaluate the regulatory and governance issues surrounding IT	Evaluating
CO6	Choose the best sustainable hardware for their applications	Analyzing

Module	Topics of Coverage	Hours
1	**Trends and Reasons to Go Green:** ● Overview and Issues ● Consumption Issues ○ Minimizing PowerUsage ○ Cooling Carbon Credit, Carbon Trading and Carbon Footprint **Self-Learning Topics:**Current Initiatives and Standards	06
2	**Introduction to Green IT**: ● GreenIT ● Holistic Approach to Greening IT ● Greening by IT (can be used for case study also) ○ Using RFID for Environmental Sustainability ○ Smart Grids ○ Smart Buildings and Homes ○ Green Supply Chain and Logistics ○ Enterprise-Wide Environmental Sustainability **Self-Learning Topics**:Awareness to Implementation	06
3	**Sustainable Hardware and Software** **Green Hardware** ● Introduction	07

	● Life Cycle of a Device or Hardware ● Reuse, Recycle and Dispose **Green Software** ● Introduction ● Energy-Saving Software Techniques ● Sustainable Software Development **Self-Learning Topics**:Changing the way we work	
4	**Sustainable IT Infrastructure and Management** **Green Data Centers** ● Data Centre ITInfrastructure ● Data Centre Facility Infrastructure: Implications for Energy Efficiency ● IT Infrastructure Management ● Green Data Centre Metrics **Green Data Storage** ● Introduction ● Storage Media Power Characteristics ● Energy Management Techniques for Hard Disks ● System-Level Energy Management **Green Networks and Communications** ● Introduction ● Objectives of Green Network Protocols ● Green Network Protocols and Standards **Self-Learning Topics**:Refer some latest IEEE papers on the relevant topics	09
5	**Sustainable Enterprise IT Strategy and Readiness** **Enterprise Green IT Strategy:** ● Introduction ● Approaching Green IT Strategies ● Business Drivers of Green IT Strategy ● Organizational Considerations in a Green IT Strategy ● Steps in Developing a Green IT Strategy ● Metrics and Measurements in Green Strategies **Enterprise Green IT Readiness** ● Background: Readiness and Capability ● Development of the G-Readiness Framework ● Measuring an Organization's G-Readiness **Self-Learning Topics**:Sustainable IT Roadmap	06
6	**Green Cloud Computing and Environmental Sustainability** ● Cloud Computing and Energy Usage Model	05

	• Features of Clouds Enabling Green Computing • Towards Energy Efficiency of Cloud Computing • Green Cloud Architecture **CASE STUDIES** • The Environmentally Responsible Business Strategies (ERBS) – • Case Study Scenarios for Trial Runs – • Case Studies – Applying Green IT Strategies and Applications to a Home, Hospital, Packaging Industry and Telecom Sector **Self-Learning Topics:** Green IT Regulations and Standards	

Reference Books:

Reference No.	Reference Name
1	Green IT: Reduce Your Information System's Environmental Impact While Adding to the Bottom Line,Toby Velte, Anthony Velte, Robert Elsenpeter, 2008, McGraw Hill.
2	Harnessing Green IT,San Murugesan, G. R. Gangadharan, 2013, WILEY.
3	Green Computing-Tools and Techniques for saving energy, money and resources, Bud E. Smith, 2014, CRCPress.
4	GREEN IT FOR SUSTAINABLE BUSINESS PRACTICE, Mark G. O'Neill, An ISEB FoundationGuide.
5	Green Computing and Green IT BestPractices, Jason Harris
6	The Green of IT – How Companies Can Make a Difference for the Environment, John Lamb, IBM Press (2009).
7	Green Project Management, Richard Maltzman and David Shirley, CRC Press a Taylor and Francis Company (2010)
8	Foundations of Green IT, Marty Poniatowski, Prentice Hall, 2009

Web References:

http://www.carbonfootprint.com

https://www.energystar.gov

Tutorial: Tutorial List but not limited to the following suggested List of Tutorial

Sr. No.	Detailed Contents	Hrs.
1	Calculating the Energy Consumption or Carbon Footprint for a given location (eg: your College, Residence, or a specific building) and suggesting means of reducing Energy consumption or Carbon Footprint respectively	02
2	Use of Greening by IT Tools in a live location and submitting a report which indicates Before and After effects	02
3	Calculating the amount of E-waste generated from a given location (eg: your College, Residence, or a specific building) and monitoring the process of proper handling of E-waste.	02
4	Preparing a report on how Green Data Center can be feasibly applied to your Institute. Verifying the report from Industry Expert. Calculating the cost of implementing Green Data Center	02
5	Developing an Green IT Strategy for a given location (eg: your College, Residence, or a specific building) and submitting a report for the same	02
6	Studying which of the latest Green IT techniques (eg:- Remote Maintenance using Tools, E-Learning & E-Training, Web Conferencing & E-Webinar Meetings, E-Signatures, Virtual Filing & Cloud Computing) can be applied to your Institute and submitting report for the same.	03

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks

5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	Assignment/Tutorials Based on Syllabus	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Term Work: 25 marks

The term work will be based on the tutorial performance of the student.

Course Code	Name of Course	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
NMCAL31	Big Data Analytics and Visualization Lab	02	01	25	30	20	75

Prerequisite: Basic Understanding of SQL, Java Programming and Python

Lab Course Objectives: The Course aim to

Sr.No.	Course Objective
1	Understand several commands and basic operations in Hadoop
2	Understand Various Components of Hadoop for instance Hadoop2.x, HDFS, Map Reduce
3	Understand and gain knowledge of NoSQL DB and Data Modelling Concept
4	Teach Hadoop Ecosystem Projects Hive and Pig and its Programming Modules.
5	Learn Functional programming in spark and execute and create spark applications.
6	Teach Data Visualization and its importance using Power BI

Lab Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate HDFS Commands in Hadoop	Understanding
CO2	Analyze the Data Using Hadoop Ecosystem using HIVE	Analyze
CO3	Build No SQL Database and Query it Using MongoDB	Applying
CO4	Applying scripting language like pig for problem analysis and solving.	Applying
CO5	Explain RDD and Dataframe Creation in Apache Spark	Evaluate
CO6	Create various Visualizations using Power BI.	Creating

Description:

Module No	Detailed Contents	Hrs.
1	Set up and Configuration Hadoop Using Cloudera Creating a HDFS System with minimum 1 Name Node and 1 Data Nodes HDFS Commands **Self-Learning Topics**: Set up Hadoop in Linux Environment	2
2	Hive: Introduction Creation of Database and Table, Hive Partition, Hive Built in Function and Operators, Hive View and Index. **Self-Learning Topics**: Configure Hive Metastore to MySQL	4
3	MongoDB: Installation and Creation of database and Collection CRUD Document: Insert, Query, Update and Delete Document. **Self-Learning Topics:** HBASE Commands	4
4	Pig: Pig Latin Basic Pig Shell, Pig Data Types, Creating a Pig Data Model, Reading and Storing Data, Pig Operations **Self-Learning Topics**:Apache Pig case study	8
5	Spark: RDD, Actions and Transformation on RDD , Ways to Create -file, data in memory **Self-Learning Topics:** Machine Learning Algorithms like K-Means using Spark.	2
6	Visualization: Connect to data, Build Charts and Analyze Data, Create Dashboard, Create Stories using Power BI **Self-Learning Topics:** Power BI using the web.	6

Reference Books:

Reference No	Reference Name
1	Tom White, "HADOOP: The definitive Guide" O Reilly 2012, Third Edition,ISBN: 978-1-449-31152-0
2	Chuck Lam, "Hadoop in Action", Dreamtech Press 2016, First Edition ,ISBN:139788177228137
3	Shiva Achari," Hadoop Essential " PACKT Publications, ISBN 978-1-78439-668-8
4	RadhaShankarmani and M. Vijayalakshmi ,"Big Data Analytics "Wiley Textbook Series, Second Edition, ISBN 9788126565757
5	Jeffrey Aven,"Apache Spark in 24 Hours" Sam's Publication, First Edition, ISBN: **0672338513**

6	Bill Chambers and MateiZaharia,"Spark: The Definitive Guide: Big Data Processing Made Simple "O'Reilly Media; First edition, ISBN-10: 1491912219;
7	James D. Miller," Big Data Visualization" PACKT Publications. ISBN-10: 1785281941

Web References:

Reference No	Reference Name
1	https://hadoop.apache.org/docs/stable/
2	https://hive.apache.org/
3	https://pig.apache.org/
4	https://spark.apache.org/documentation.html
5	https://powerbihelper.org/

Suggested list of experiments

Practical No	Problem Statement
1	**HDFS:** List of Commands (mkdir, touchz, copy from local/put, copy to local/get,move from local, cp, rmr, du, dus, stat)
2	**Map Reduce:** **1.** Write a program in Map Reduce for WordCount operation. **2.** Write a program in Map Reduce for Matrix Multiplication
3	**MongoDB :** 1. Installation 2. Sample Database Creation 3. Query the Sample Database using MongoDB querying commands a. Create Collection b. Insert Document c. Query Document d. Delete Document e. Indexing
4	**Hive:** 1. Hive Data Types 2. Create Database & Table in Hive 3. Hive Partitioning 4. Hive Built-In Operators 5. Hive Built-In Functions 6. Hive Views and Indexes 7. HiveQL : Select Where, Select OrderBy, Select GroupBy, Select Joins

5	**Pig:** 1. Pig Latin Basic 2. Pig Data Types, 3. Download the data 4. Create your Script 5. Save and Execute the Script 6. Pig Operations : Diagnostic Operators, Grouping and Joining, Combining & Splitting, Filtering, Sorting
6	**Spark**: 1. Downloading Data Set and Processing it Spark 2. Word Count in Apache Spark.
7	**Visualization using Tableau:** Power BI: Tool Overview, Importing Data, Analyzing with Charts, Creating Dashboards, Telling Stories with Power BI

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous assessment exam	
1	Based on the subject and related lab of NMCAL31

Term Work: 25 marks
The term work will be based on the Continuous Assessment and Laboratory work

Course Code	Name of Course	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
NMCAEL311	Natural Language processing Lab	02	01	25	30	20	75

Prerequisite:

Probability, Python programming, Data structure & Algorithms

Lab Course Objectives: The Course aim to

Sr.No.	Course Objective
1	To understand the key concepts of NLP.
2	To learn various phases of NLP.
3	To design and implement various language models and POS tagging techniques.
4	To understand various NLP Algorithms
5	To learn NLP applications such as Information Extraction, Sentiment Analysis, Question answering, Machine translation etc.
6	Design an innovative application using NLP components

Lab Course Outcomes:

CO No.	Outcome	Bloom Level
CO1	Understand the computational properties of natural languages and the commonly used algorithms for processing linguistic information.	Understanding
CO2	Understand the information retrieval techniques using NLP	Understanding
CO3	Apply mathematical techniques that are required to develop NLP applications.	Applying
CO4	Analyze various NLP algorithms and text mining NLP applications	Analyzing

CO5	Design real-world NLP applications such as machine translation, text categorization, text summarization, and information extraction by applying NLP techniques.	Creating
CO6	Implement innovative application using NLP components	Creating

Description

Module No.	Detailed Contents	Hrs
1	**Introduction to Language modeling** Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications -- **Self-learning topics:** Empirical laws	**2**
2	**Word Level Analysis** Morphological analysis and word generation, Lemmatization, -N-Gram language model. **Self-learning topics:** N-gram for spelling correction	**2**
3	**Syntax analysis and Semantic Analysis** Part-Of-Speech tagging (POS): Tag set for English (Penn Treebank) , rule-based POS tagging, Stochastic POS tagging, **Self-learning topics:** conditional Random Field (CRF).	6
4	**Semantic Analysis** WordNet in Practice: Sense Disambiguation **Self-learning topics:** WordNet	**4**

5	**Text Summarization, Classification and Sentiment** Text summarization- (LEXRANK), optimization-based approaches for summarization , Summarization evaluation, Text classification Sentiment Analysis: Affective lexicons **Self-learning topics:** NLKT , Naïve Bayes Theorem	**6**
6	**Introduction to LLMs and Generative AI:** Introduction to Large Language Models (LLMs), History and evolution of LLMs, Architecture of LLMs, Training LLMs, Key concepts in Generative AI, Variational Autoencoders (VAEs), Text generation using LLM**s** . **Self-learning topics:** Generative Adversarial Networks (GANs)	**6**

Suggested list of experiments

Practical No	Problem Statement
1	Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, chat Bot, Plagiarism, Spelling & Grammar checkers, Sentiment / opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.
2	Apply various text preprocessing techniques for any given text : Tokenization and Filtration & Script Validation
3	Apply various other text preprocessing techniques for any given text : Stop Word Removal, Lemmatization / Stemming
4	Perform morphological analysis and word generation for any given text
5	Implement N-Gram model for the given text input.
6	Study the different POS taggers and Perform POS tagging on the given text
7	Implement Named Entity Recognizer for the given text input.
8	Perform Chunking for the given text input
9	Implement Text Similarity Recognizer for the chosen text documents.
10	Web mining using NLP (fetching web pages and extracting the human language data from them) for sentiment analysis

11	Provide a short corpus (~10 sentences) containing ambiguous words. a) Perform **Word Sense Disambiguation** for each ambiguous token using context b) Map each token to its correct WordNet synset
12	Mini Project Report: For any one chosen real world NLP application.

Reference Books:

Reference No	Reference Name
1	Dan Jurafsky and James Martin. "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, Second Edition, 2009.
2	Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
3	Christopher D.Manning and HinrichSchutze, — Foundations of Statistical Natural Language Processing —, MIT Press, 1999.
4	Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
5	Daniel M Bikel and ImedZitouni — Multilingual natural language processing applications‖ Pearson, 2013
6	Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) — The Handbook of Computational Linguistics and Natural Language Processing — ISBN: 978-1-118
7	Brian Neil Levine, An Introduction to R Programming
8	Niel J le Roux, SugnetLubbe, A step by step tutorial : An introduction into R application and programming

Web References:

Reference No	Reference Name
1	https://youtu.be/xvqsFTUsOmc
2	https://www.coursera.org/learn/language-processing
3	https://nptel.ac.in/courses/106/105/106105158/
4	https://youtu.be/IIaYk2hIYKk
5	https://www.udemy.com/course/natural-language-processing/?trk=profile_certification_title&utm_source=adwords&utm_medium=ud emyads&utm_campaign=DSA

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous assessment exam	
1	Based on the subject and related lab of NMCAE311

Term Work: 25 marks
The term work will be based on the Continuous Assessment and Laboratory work

Course Code	Name of Course	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
NMCAEL312	Deep Learning Lab	02	01	25	30	20	75

Prerequisite: Basic understanding of machine learning concepts.

Lab Course Objectives

Sr.No.	Course Objective
1	To understand datasets and pre-processing to build neural network models.
2	To apply appropriate learning rules for each of the architectures and build several neural network models.
3	To learn different regularization techniques used in deep learning
4	To learn different optimization techniques used in deep learning
5	To learn CNN algorithms and analyze the results for respective real world applications
6	To learn RNN algorithms and analyze the results for respective real world applications

Lab Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate TensorFlow/Keras deep-learning workstations.	Understanding
CO2	Choose appropriate data preprocessing techniques to build neural network models.	Applying
CO3	Analyze different regularization techniques used in deep learning.	Analyzing
CO4	Analyze different optimization techniques used in deep learning.	Analyzing
CO5	Build neural network models using deep learning algorithms-CNN to solve real-world problems.	Creating
CO6	Build neural network models using deep learning algorithms-RNN to solve real-world problems.	Creating

Description:

Module No	Detailed Contents	Hrs
1	**Introduction to TensorFlow/Keras: Installation,** Importing Libraries, and Modules. **Self-Learning Topic:-**Setting up a deep-learning workstation.	2
2	**Data Preprocessing Techniques-** Loading the dataset, Feature Scaling, Handling Missing Values, Categorical Data and String Data Types, Encoding, and Data Splitting. **Self-Learning Topic: -** Outliers detection.	2
3	**Artificial Neural Networks-** McCulloch-Pitts neuron, single-layer perceptron network, multi-layer perceptron network, Back propagation network. **Self-Learning Topic:-** Adaline Network	6
4	**Regularization Techniques-** Dataset Augmentation, Early Stopping, Dropout. **Self Learning Topic:-** Optimization techniques(anyone)	4
5	**Deep Neural Network Algorithm: Convolutional Neural Network(CNN)-** (CNN)—Introduction to convnets, Adding a classifier, Training the convnet on the given data set, The convolution operation, The max-pooling operation, Evaluating the model, analyzing and visualizing results. **Self-Learning Topic: -** Pre-trained Convnet.	6
6	**Deep Neural Network Algorithm-Recurrent Neural Network (RNN) -** Training the model with RNN layers, evaluating the model, analyzing and visualizing results. **Self-Learning Topic: -** Pre-trained RNN.	6

Reference Books:

Reference No	Reference Name
1	François Chollet, Deep Learning with Python, 2018 by Manning Publications Co. ISBN 9781617294433.
2	Deep Learning Tutorial Release 0.1, LISA lab, University of Montreal
3	Sebastian Raschka, Vahid Mirjalili, Python Machine Learning: Machine Learning and Deep Learning with Python,3rd Edititon, Packet Publishing.

Web References:

Reference No	Reference Name
1	https://www.kaggle.com/learn/deep-learning
2	https://github.com/topics/deep-learning-tutorial
3	https://towardsdatascience.com/building-our-first-neural-network-in-keras-bdc8abbc17f5
4	https://machinelearningmastery.com/tutorial-first-neural-network-python-keras/
5	https://subscription.packtpub.com/book/big_data_and_business_intelligence/9781786464453/3
6	https://data-flair.training/blogs/learning-rules-in-neural-network/

Suggested list of experiments

Practical No.	Problem Statement
1	Introduction to Tensor flow /Keras -Importing Libraries and Modules.
2	Loading the dataset, Splitting dataset into training and testing data sets.
3	Implementation of Data preprocessing techniques.
4	Implementation of Artificial Neural Networks -McCulloch-Pitts neuron with ANDNOT function, single layer perceptron network, multi-layer perceptron network for an AND function, Back propagation Network for XOR function with Binary Input and Output.
5	Implementation of Regularization Techniques.
6	Implementation and analysis of Deep Neural network algorithm: Convolutional neural network (CNN) - Object identification and classification, image recognition.
7	Implementation and analysis of Deep Neural network algorithm: Recurrent neural network (RNN) - Character recognition and web traffic Image classification.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous assessment exam	
1	Based on the subject and related lab of NMCAL312

Term Work : 25 marks
The term work will be based on the Continuous Assessment and Laboratory work

Course Code	Name of Course	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
NMCAEL313	Blockchain Lab	02	01	25	30	20	75

Prerequisite: Basic programming skill in Python/ Java Script/Java.
Lab Course Objectives: The Course is aim to

Sr.No.	Course Objective
1	Impart a thorough understanding of cryptographic algorithm and hash functions
2	Understand the concepts of Bitcoin and Smart Contract
3	Understand the concepts of Solidity language
4	Understand the Tokenization in ethereum
5	Understand the deployment of Dapp in Ethereum
6	Study use cases based on Hyperledger.

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Outcome	Bloom Level
CO1	Implement encryption algorithms and hash functions	Applying
CO2	Construct a bitcoin blocks and validating	Applying
CO3	Construct a smart contract in Ethereum	Applying
CO4	Develop and Deploy Ethereum Tokens	Applying
CO5	Develop and deploy Dapp in Ethereum	Applying
CO6	Discuss the Hyperledger Use Cases	Understanding

Description:

Module	Detailed Contents	Hrs.
1	**Cryptography:** Symmetric Encryption using Caesar Cipher, Asymmetric Encryption using RSA, Hash Functions (SHA-256), Merkle Tree (Implementation in Python/Java Script/C++)	4
2	**Cryptocurrency:** Concept of Bitcoin, block, blockchain, Immutable ledger**,** Public and Private Blockchain. (Implementation in Python/Java Script/C++)	4
3	**Solidity Programming:** Introducing Solidity, Sample Code, Layout of Source File, Structure of a Contract, State Variables, Functions Types, Reference Types, Units, Special Variables and Functions, Expressions and Control Structures, Function Calls, Error Handling, Visibility for Functions and State Variable	6
4	**Ethereum:**Ethereum Virtual Machine (EVM): Accounts, Transactions, Gas, Ether, Memory, Tokens in Ethereum	4
5	**DApp architecture:** Developing a DApp, Compile and Deploy the Smart Contract, Publish the DApp, Connecting to DApp, Ganache Output for Transaction Migration	4
6	**Case Study:** Use cases based on Hyper Ledger	4

Practical No	Problem Statement
1	Implementation of Caesar Cipher (Symmetric Encryption)
2	Implementation of RSA Algorithm (Asymmetric Encryption)
3	Implementation of SHA-256
4	Implementation of Binary Tree and Merkle Tree
5	Implement the creation of Bitcoin Block (Genesis Block)
6	Implement the creation of a Blockchain (Adding the blocks to the chain and validating)
7	Implement the creation of a public/private Blockchain
8	Simple Experiments using Solidity Program Constructs (if-then, while etc...)
9	Demonstrating Tokens in ethereum
10	Creation of smart contract in Ethereum
11	Creation of Dapp in Ethereum
12	Mini Project

References:

Reference No.	Reference Name
1	David H. Hoover, Kevin Solorio, and Randall Kanna, Hands-On Smart Contract Development with Solidity and Ethereum: From Fundamentals to Deployment,O'Reilly Publications, ISBN-13: 978-1492045267
2	Jimmy Song, Programming Bitcoin: Learn How to Program Bitcoin fromScratch, O'Reilly Publications, ISBN-13: 978-1492031499
3	RiteshModi, Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Packt Publications,
4	Chris Dannen,Introducing Ethereum and Solidity: Foundations of Cryptocurrency and Blockchain Programming for Beginners, Apress

Web References:

Reference No	Reference Name
1	https://solidity.readthedocs.io/en/v0.6.7/
2	https://remix-ide.readthedocs.io/en/latest/#
3	https://www.sitepoint.com/solidity-for-beginners-a-guide-to-getting-started/
4	https://www.tutorialspoint.com/solidity/index.htm
5	https://bitcoin.org/en/getting-started
6	https://docs.python.org/3/library/hashlib.html

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous assessment exam	
1	Based on the subject and related lab of NMCAEL313

Term Work: 25 marks

The term work will be based on the Continuous Assessment and Laboratory work

Course Code	Name of Course	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
NMCAEL321	Microservices and Applications Cloudops Lab	02	01	25	30	20	75

Prerequisite: Basic understanding of fundamentals of any programming language
Lab Course Objectives: The Course aim to

Sr. No.	Course Objective
1	To understand DevOps practices and cloud native environments to achieve continuous software delivery pipelines and automated operations that address the gap between IT resources and growing cloud complexity
2	To Use Kubernetes services to structure N-tier applications
3	To be familiarized with Infrastructure as code for provisioning, compliance, and management of any cloud infrastructure, and service.
4	To understand that security and speed in software development are not inversely-related objectives Internalizing the contribution of tools and automation in DevSecOps
5	To understand various troubleshooting techniques by monitoring your entire infrastructure and business processes
6	To understand how software and software-defined hardware are provisioned dynamically

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Outcome	Bloom Level
CO1	To understand the fundamentals of Cloud Computing and be fully proficient with Cloud based DevOps solution deployment options to meet your business requirements	Applying
CO2	To deploy single and multiple container applications and manage application deployments with rollouts in Kubernetes	Applying
CO3	To apply best practices for managing infrastructure as code environments and use terraform to define and deploy cloud infrastructure	Applying
CO4	To identify and remediate application vulnerabilities earlier and help integrate security in the development process using SAST Techniques.	Applying

CO5	To use Continuous Monitoring Tools to resolve any system errors (low memory, unreachable server etc.) before they have any negative impact on the business productivity	Creating
CO6	To engineer a composition of nano services using AWS Lambda and Step Functions with the Serverless Framework	Creating

Description:

Module	**Detailed Content**	Hrs
1	Implement DevOps over Cloud Platforms. Self-Learning Topics: AWS Codestar	4
2	Installing kubectl to manage cluster and deploy Your First Kubernetes Application Self-Learning Topics: Using Services and Ingresses to Expose Deployments Perform logging, monitoring, services, and volumes in Kubernetes.	4
3	Install, Build, change and Destroy Infrastructure using Terraform. Self-Learning Topics: Terraform Basic Terminology	4
4	Identify and remediate application vulnerabilities earlier and help integrate security in the development process using tools like SonarQube / Gitlab / Perform static analysis on application source code and binaries. Spot potential vulnerabilities before deployment Analysis of java / web-based project Jenkins SonarQube / Gitlab Integration Self-Learning Topics: Snyk, OWASP ZAP, Analysis Core Plugin	4
5	Detect, report, respond to the attacks and issues which occur within the infrastructure. Introduction to Continuous Monitoring Introduction to Nagios Installing Nagios Nagios Plugins (NRPE) and Objects Nagios Commands and Notification Monitoring of different servers using Nagios Self-Learning Topics: Nagios Plugins (NRPE) and Objects Nagios Commands	4
6	Learning serverless computing platforms like AWS Lambda, which allows you to build your code and deploy it without ever needing to configure or manage underlying servers. Self-Learning Topics: AWS Lambda Create a REST API with the Serverless Framework	6

Suggested list of experiments

Practical No	Problem Statement
1	To understand the benefits of Cloud Infrastructure and Setup AWS Cloud9 IDE, Launch AWS Cloud9 IDE and Perform Collaboration Demonstration.
2	To Build Your Application using AWS CodeBuild and Deploy on S3 / SEBS using AWS CodePipeline, deploy Sample Application on EC2 instance using AWS CodeDeploy
3	To understand the Kubernetes Cluster Architecture, install and Spin Up a Kubernetes Cluster on Linux Machines/Cloud Platforms.
4	To install Kubectl and execute Kubectl commands to manage the Kubernetes cluster and deploy Your First Kubernetes Application.
5	To understand terraform lifecycle, core concepts/terminologies and install it on a Linux Machine
6	To Build, change, and destroy AWS / GCP /Microsoft Azure/ DigitalOcean infrastructure Using Terraform.
7	To understand Static Analysis SAST process and learn to integrate Jenkins SAST to SonarQube/GitLab.
8	Create a Jenkins CICD Pipeline with SonarQube / GitLab Integration to perform a static analysis of the code to detect bugs, code smells, and security vulnerabilities on a sample Web / Java / Python application
9	To Understand Continuous monitoring and Installation and configuration of Nagios Core, Nagios Plugins and NRPE (Nagios Remote Plugin Executor) on Linux Machine.
10	To perform Port, Service monitoring, Windows/Linux server monitoring using Nagios
11	To understand AWS Lambda, its workflow, various functions and create your first Lambda functions using Python / Java / Nodejs.
12	To create a Lambda function which will log "An Image has been added" once you add an object to a specific bucket in S3.

Reference Books:

Reference No	Reference Name
1	AWS Certified SysOps Administrator Official Study Guide: Associate Exam by Stephen Cole (Author), Gareth Digby (Author), Chris Fitch (Author), Steve Friedberg (Author), Shaun Qual
2	AWS Certified Solutions Architect Official Study Guide: Associate Exam by Joe Baron
3	Terraform: Up & Running - Writing Infrastructure as Code, Second Edition by Yevgeniy Brikman , O'Reilly
4	Kubernetes: Up and Running - Dive into the Future of Infrastructure, Second Editionby Brendan Burns,O'Reilly
5	Going Serverless with AWS Lambda: Leveraging the latest services from the AWS cloud by Ajay Pherwani , Shroff/X-Team;
6	Learning Nagios, Packt Publishing

Web References:

Reference No	Reference Name
1	AWS Cloud9 Docs: https://docs.aws.amazon.com/cloud9/
2	https://kubernetes.io/docs/concepts/overview/components/
3	Terraform Docs: https://developer.hashicorp.com/terraform/docs
4	AWS + Terraform: https://developer.hashicorp.com/terraform/tutorials/aws-get-started
5	S3 Trigger Lambda: https://docs.aws.amazon.com/lambda/latest/dg/with-s3.html

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous assessment exam	
1	Based on the subject and related lab of NMCAEL321

Term Work: 25 marks

The term work will be based on the Continuous Assessment and Laboratory work

Course Code	Name of Course	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
NMCAEL322	Ethical Hacking Lab	02	01	25	30	20	75

Prerequisite: Basic understanding of fundamentals of any programming language

Lab Course Objectives: The Course aim to

Sr. No.	Course Objective
1	Study and understand how to gather and review information using different footprinting techniques.
2	Study and understand network scanning, sniffing, and enumeration techniques, gather information using the different tools available and prevent hacking attacks.
3	Study different malware threats and steganography tools.
4	Study and understand sql injection techniques and session hijacking
5	Study and understand hacking web servers and web applications
6	Study and understand wireless network hacking, cryptography and its tools.

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Outcome	Bloom Level
CO1	Applying footprinting tools for information gathering issues.	Applying
CO2	Applying tools for scanning networks, enumeration and sniffing.	Applying
CO3	Applying tools for malware attacks and steganography.	Applying
CO4	Developing sql injection ,malwares and attack tools for session hijacking.	Applying
CO5	Applying tools for hacking web servers and web applications	Creating
CO6	Applying tools for wireless network hacking, cloud computing and cryptography.	Creating

Description:

Module	Detailed Contents	Hrs
1	Footprinting and Reconnaissance: Performing footprinting using Google Hacking, website information, information about an archived website, to extract contents of a website, to trace any received email, to fetch DNS information.	03
2	Scanning networks, Enumeration and sniffing: Use port scanning. network scanning tools, IDS tool, sniffing tool and generate reports.	03
3	Malware Threats: Worms, viruses, Trojans: Use Password cracking, Dictionary attack., Encrypt and decrypt passwords, DoS attack, ARP poisoning in windows, Ifconfig, ping, netstat, traceroute, Steganography tools. Self-Learning Topics: using additional hacking tools.	06
4	Developing and implementing malwares : Creating a simple keylogger in python, creating a virus, creating a trojan. SQL injection for website hacking, session hijacking. Self-Learning Topics: Additional implementation of hacking tools.	08
5	Hacking web servers, web applications: Hacking a website by Remote File Inclusion, Disguise as Google Bot to view hidden content of a website, to use Kaspersky for Lifetime without Patch	02
6	Wireless network hacking, cloud computing security, cryptography : Using Cryptool to encrypt and decrypt password, implement encryption and decryption using Caesar Cipher.	04

Suggested list of experiments

Practical No	Problem Statement
1	Use software tools/commands to perform footprinting /information gathering and generate analysis reports.
2	To study and understand the concept of port scanning using the Nmap tool.
3	To study and understand various tools available for intrusion detection systems and use snort for observing packets.
4	To study and understand the concept of network sniffing using Wireshark.
5	Use software tools/commands to perform malware attacks and other cyber attacks and generate analysis reports.
6	To study implementation of keyloggers, viruses and trojans.

7	Use of software tools/commands for web servers and web applications hacking and generating analysis report.
8	Use of software tools/commands for performing sql injection and session hijacking and generating analysis reports.
9	Create a simple cipher using the RC4 brute force tool and then attempt to decrypt it using brute-force attack.
10	To study and understand the program implementation for hacking Caesar cipher algorithm

Reference Books:

Reference No	Reference Name
1	Matt Walker, All-In-One-CEH-Certified-Ethical-Hacker-Exam-Guide.
2	Manthan Desai, Basics of ethical hacking for beginners
3	SunitBelapure& Nina Godbole, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives.
4	Alana Maurushat, Ethical hacking
5	TutorialsPoint professionals, Ethical Hacking.

Web References:

Reference No	Reference Name
1	https://www.tutorialspoint.com/ethical_hacking/ethical_hacking_arp_poisoning.html
2	https://technicalustad.com/steganography-tools/
3	https://resources.infosecinstitute.com/dos-attacks-free-dos-attacking-tools/#gref
4	https://www.greycampus.com/opencampus/ethical-hacking/enumeration-and-its types
5	https://www.youtube.com/watch?v=LUGkIvcQmGE
6	https://www.youtube.com/watch?v=zWg7U0OEAoE

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous assessment exam	
1	Based on the subject and related lab of NMCAEL322

Term Work: 25 marks

The term work will be based on the Continuous Assessment and Laboratory work

Course Code	Name of Course	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
NMCAEL323	Distributed System and Cloud Computing Lab	02	01	25	30	20	75

Prerequisite: Basic overview of Distributed systems and Cloud Computing.

Lab Course Objectives: The Course is aim to

Sr.No.	Course Objective
1	Understand the concepts of Remote Process Communication
2	Understand the concepts of Remote Procedure Call
3	Understand the concepts of Remote Method Invocation.
4	Understand the concepts of Remote Object Communication.
5	Understand the implementation of Cloud Computing Services.
6	Learn implementation of Identity Management using Cloud Computing concept.

Lab Course Outcomes:

Sr.No.	Outcome	Bloom Level
CO1	Develop Remote Process Communication	Creating
CO2	Develop Remote Procedure Call	Creating
CO3	Develop Remote Method Invocation concepts.	Creating
CO4	Develop Remote Object Communication programs.	Creating
CO5	Implementation of Cloud Computing Services.	Applying
CO6	Implementation of Identity management	Applying

Description:

Module	Detailed Contents	Hrs.
1	**Remote Process Communication:** Develop a multi-client chat server application where multiple clients chat with each other concurrently. The messages sent by different clients are first communicated to the server and then the server, on behalf of the source client, communicates the messages to the appropriate destination client. **Self Learning Topics:** Other applications based on Remote process communication	**04**
2	**Remote Procedure Call:** A remote procedure call is an inter process communication technique that is used for client-server-based applications. A client has a request message that the RPC translates and sends to the server. This request may be a procedure or a function call to a remote server. When the server receives the request, it sends the required response back to the client. The client is blocked while the server is processing the call and only resumes execution after the server is finished. **Self Learning Topics:** Other types of call semantics	**04**
3	**Remote Method Invocation:** The Remote Method Invocation is an API that provides a mechanism to create distributed applications in java. The client invokes methods via an interface. These methods are implemented on the server side. **Self Learning Topics:** Concept of client and server applications, remote interface, RMI registry tools	**04**
4	**Remote Object Communication:** Pass remote objects from the server to the client. The client will receive the stub object (through remote interfaces) and save it in an object variable with the same type as the remote interface. Then the client can access the actual object on the server through the variable. **Self Learning Topics:** Concept of JDBC	**06**

5	**Implementation of Cloud Computing Services:** Cloud Computing provides different services such as SaaS, PaaS, IaaS, Storage as service and many more. Storage as a Service is a business model in which a large company rents space in their storage infrastructure to a smaller company or individual. **Self Learning Topics:** Other types of Cloud Services	**06**
6	**Implementation of Identity Management using Cloud Computing concept:** The main goal of identity management is to ensure that only authenticated users are granted access to the specific applications, systems or IT environments for which they are authorized. **Self Learning Topics:** Other tools to implement the technique	**02**

Reference Books:

Reference No	Reference Name
1	Pradeep K. Sinha, Distributed Operating Systems concepts and design, PHI, ISBN No. 978-81-203-1380-4
2	Herbert Schildt, The Complete Reference JAVA, Tata McGraw-Hill,7th Edition, ISBN No. 978-0-07-163177-8
3	Horstmann, Cornell, Core Java 2 Volume I Fundamentals, Sun Micro System, 7th Edition, ISBN No-13:978-0131482029
4	Horstmann, Cornell, Core Java 2 Volume II Advanced Features, Sun Micro System, 7th Edition, ISBN No-13:978-0131118263
5	Dr. Kumar Saurabh, Cloud Computing insights into new-era infrastructure, Wiley ISBN No.10:8126528834
6	RajkumarBuyya, James Broberg, AndrzejGoscinski, Cloud Computing Principles and Paradigms, Willey Publication, ISBN No. 9780470887998
7	GautamShroff, Enterprise Cloud Computing Technology, Architecture, Applications, Cambridge University Press, ISBN No. 978-0-521-13735-5

Web References:

Reference No	Reference Name
1	https://onlinelibrary.wiley.com/
2	https://nptel.ac.in/courses/106106168/
3	https://nptel.ac.in/courses/106/105/106105167/

4	http://www.tutorialspoint.com
5	http://www.javapoint.com
6	https://aws.amazon.com/

Suggested list of experiments

Practical No	Problem Statement
1	To develop a program for multi-client chat server using Socket
2	To implement a Server calculator using the RPC concept. (Make use of datagram)
3	To implement a Date Time Server using the RPC concept. (Make use of datagram)
4	To retrieve day, time and date functions from server to client. This program should display server day, time and date. (Use Concept of JDBC and RMI for accessing multiple data access objects)
5	The client should provide an equation to the server through an interface. The server will solve the expression given by the client.
6	Using MySQL creates a Library database. Create table Book (Book_id, Book_name, Book_author) and retrieve the Book information from the Library database using the Remote Object Communication concept.
7	Using MySQL create Elecrtic_Bill database. Create table Bill (consumer_name, bill_due_date, bill_amount) and retrieve the Bill information from the Elecrtic_Bill database using Remote Object Communication concept.
8	Implementation of Storage as a Service using Google Docs
9	Implementation of Identity Management.
10	To develop Application for windows Azure / Amazon AWS using Windows Azure Platform Training Kit and Visual Studio.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous assessment exam	
1	Based on the subject and related lab of NMCAL323

Term Work: 25 marks
The term work will be based on the Continuous Assessment and Laboratory work

Course Code	Name of Course	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Practical	Oral	Total
NMCAL34	Mobile Computing Lab	1T+2P	02	50	30	20	100

Prerequisite: Basic understanding of java programming and xml.

Lab Course Objectives: Course is aim to

Sr.No	Course Objective
1	Understand the Application development skills of Android and its Components.
2	Learn various Android application with different layouts and rich user interactive interfaces.
3	Develop Android application related to server-less database like SQLITE
4	Develop Android applications using graphics, animation and map API.
5	Develop Android applications using REST API integration.
6	Impart a thorough understanding of Dart and Flutter Programming

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr.No.	Outcome	Bloom Level
CO1	Demonstrate their understanding of the fundamental details of android and its components	Understanding
CO2	Implement various android applications using different layouts & rich user interactive interfaces	Applying
CO3	Demonstrate their skills of using SQLite database for android application database	Applying
CO4	Build android applications using multimedia and location based services.	Applying
CO5	Demonstrate use of REST API in android application.	Understanding
CO6	Demonstrate their ability to develop programs with dart programming and flutter.	Applying

Description:

Module	Detailed Contents	Hours
1	**Introduction to Android and its components** The android platform, the layers of android, Creating an android application, Creating the activity, Design user interface with Views, Working with intents, fragments, services and different types of layouts components. Basic Controls and UI Components ,Text view, Radio button, Checkbox, Image Button, Edit Text, Slider and other controls **Self-Learning Topics:** Android components, understanding the androidManifest.xml file, Methods of all control class	7
2	**Database Connectivity** Persistence data using the file system (external, internal, SD card), working with shared preferences, Working with content providers, CRUD operation using SQLite database connection. **Self-Learning Topics:** Interface of Database	6
3	**Graphics and animation, Multimedia and Location Based Services** Drawing graphics in android, creating animations with androids graphics API, Playing audio & video. Display Maps, Getting location data, Building location tracker. **Self-Learning Topics:** Capturing media and photos, SMS and EMail messaging	8
4	**REST API integration** Consuming Web services using HTTP (http urlconnection), Consuming using JSON services using asynctask to perform network operations, working with ok http. **Self-Learning Topics:** Publishing Android applications on Google play store.	6
5	**Introduction to Dart and Flutter** Introduction to structure of Dart Language, oops concept and classes & packages in Dart Programming, Introduction to Flutter, Flutter User Interface using widgets, Types of Widgets, Flutter List , Navigation, Effects, Building Layout. **Self-Learning Topics:** Deployment of android application on the play store	6

6	**Data Handling** Understanding JSON Format, Using Database classes to write, read and serialize JSON. **Self-Learning Topics:** Flutter Form, Styling and Managing Widgets.	**6**

Reference Books:

Reference No	Reference Name
1	Wei-Meng Lee ,BEGINNING Android™ 4 Application Development , John Wiley & Sons Crosspoint Boulevard Indianapolis ,ISBN: 978-1-118-24067-0
2	Reto Meier, Professional Android™ Application Development ,Wiley Publishing, ISBN: 978-0-470-56552-0,www.wiley.com
3	ZigurdMednieks, Laird Dornin, G. Blake Meike, and Masumi Nakamura, Programming Android , Gravenstein Highway North, Sebastopol, CA 95472.ISBN=9781449316648
4	W. Frank Ableson, RobiSen, Chris King, C. Enrique Ortiz, Dreamtech Press Android in action, Third Edition, ISBN 9781617290503
5	Alessandro Biessek Flutter for Beginners: An Introductory Guide to Building Cross-platform Mobile Applications with Flutter and Dart 2 Packt Publishing Ltd. ISBN. 9781788990523
6	Marco L. Napoli Beginning Flutter: A Hands On Guide to App Development John Wiley &Sons,ISBN:- 1119550823, 9781119550822
7	Rap Payne Beginning App Development with Flutter: Create Cross-Platform Mobile Apps Apress, ISBN 978-1-4842-5181-2

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1	https://android.google.com
2	https://codelabs.developers.google.com/codelabs/first-flutter-app-pt1/#0
3	https://flutter.dev/docs/reference/tutorials https://flutter.dev/docs/get-started/learn-more
4	https://opensourceforu.com/?s=Flutter
5	https://developer.apple.com/library/archive/referencelibrary/GettingStarted/DeveloperOSAppsSwift/
6	https://developer.apple.com/ios/
7	https://www.apple.com/in/ios/ios-13/

Suggested list of experiments

Practical No	Problem Statement
1	Android program using various UI components and different layouts and views.
2	Android program based on Intents
3	Android program for notifications and alert box
4	Android program to perform CRUD operation using SQLite DB
5	Android program using Shared Preferences, Internal and External Storage
6	Android program to work with graphics , animation , images and videos
7	Android program to work with google maps and locations
8	Android program based on RestAPI
9	Flutter program using layout widgets and state management
10	Flutter program to work with SQLite Database

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 50 Marks (Experiments: 30-marks, Attendance Theory & Practical: 10-marks, Assignments: 10-marks)
Continuous assessment exam	
1	Based on the subject and related lab of NMCAL34

Term Work: 50 marks
The term work will be based on the Continuous Assessment and Laboratory work

Course Code	Name of Course	Contact Hours	Credits Assigned	Examination Scheme			
				Term Work	Pract.	Oral	Total
NMCARP31	Project Stage-2 (Research Project)	08	04	150	-	--	150

Prerequisite: Concept of Project Development and Management

Lab Course Objectives: The course is aimed to

Sr. No.	Course Objective
1	To understand and identify the problem statement
2	Acquaint students with the process of applying basic computer applications and providing solutions to the problems in various application domains..
3	Conceptualize knowledge with emphasis on critical thinking and problem-solving skills
4	Adapt to a rapidly changing environment by having learned and applied new skills.
5	To apply standard principles of project management and validate the project using appropriate evaluation measures
6	To inculcate the process of self-learning and research.

Lab Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Course Outcome	Bloom Level
CO1	Identify methodology for solving the above problem and apply engineering knowledge and skills to solve it and Use standard norms of engineering practices.	Understanding
CO2	Validate, Verify the results using test cases/benchmark data/theoretical/ inferences/experiments/simulations	Applying
CO3	Analyze and evaluate the impact of solution / product / research / innovation / entrepreneurship towards societal / environmental / sustainable development	Creating
CO4	Design and evaluate solutions for complex problems	Creating
CO5	Communicate through technical report writing and oral presentation. The work may result in research / article / patent / research publication The work may result in business plan for entrepreneurship product created	Understanding

CO6	Gain technical competency by participating in project competitions and Demonstrate capabilities of self-learning, leading to lifelong learning	Applying

Guidelines for Research Project	
1	Research Project may be carried out in one or more form of following: Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification / development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society / environment, research oriented and application areas, etc.
2	Students shall form a group of 3 students, while forming a group shall not be allowed less than three or more than three students, as it is a group activity. Group will be same till sem III project.
3	Students should do surveys and identify needs, which shall be converted into problem statements for a Research Project in consultation with project mentor / head of the department / internal committee of faculties.
4	Students shall submit an implementation plan in the form of Gantt / PERT / CPM chart using state-of-the-art industry tools, which will cover weekly activity of Research Projects
5	A logbook may be prepared by each group, wherein the group shall record weekly work progress, project guide shall verify and record notes / comments.
6	Students under the guidance of the mentor shall convert the best solution into a working model using various components of their domain areas and demonstrate.
7	The solution to be validated with proper justification and report to be compiled in standard format. Software requirement specification (SRS) documents as per IEEE format, research papers, and competition certificates may be submitted as part of annexure to the report.
8	With the focus on self-learning, innovation, addressing societal / research / innovation problems and entrepreneurship quality development within the students through the Research Project, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Project Stage 2 in semester III.

Assessment:

Term work: 150 marks consist of two reviews and Research Project examination based on following guidelines

Review 1 and Review 2 marks can be distributed as follows:

Sr. No.	Assessment Parameters	75 Marks
1	Research Project Proposal ▪ Literature Survey and Formulation of problem statement ▪ Hypothesis/ Research Questions	10
2	Research Methodology, Data Collection, Data Analysis	10
3	Development of Model	30
4	Testing and Validations	25

Research Project examination marks can be distributed as follows:

Sr. No.	Assessment Parameters	75 Marks
1	Presentation of Research Project	20
2	Evaluation of Research Project	25
3	Evaluation of Project Report	30

Rubrics have to be followed during project evaluation. Research project evaluation will be done at Institute level by Experienced Faculty Members /Alumni/ industry experts. Records and documentation should be maintained by Mentor.

SEM III Research Project:	
1	In the third semester the entire theoretical solution shall be made ready, including components / system selection, cost, feasibility analysis**,** conceptual and Detailed design. Two reviews will be conducted based on a presentation given by a student group. ● First shall be for finalization of problem ● Second shall be on finalization of the proposed solution of the problem
2	In the third semester, a complete working project with testing and validation of results based on work completed in earlier and present semester. ● First review is based on functionality and error free working project ● Second review shall be based on the enhancement of the previous version ,poster presentation cum demonstration of working model / drafting a research paper in the last month of the said semester.
Research Project shall be assessed based on following point	
1	Clarity of problem and quality of literature Survey for problem identification

2	Requirement Gathering via Software Requirement Specification (SRS) / Feasibility Study
3	Societal / Research impact
4	Novelty, Originality or Innovativeness of project
5	Effective use of skill set : Standard engineering practices and Project management standard
6	Contribution of an individual as member or leader
7	Completeness of methodology implemented
8	Design, Analysis and Further Plan
9	Clarity in written and oral communication
10	Verification and validation of the solution / Test Cases using open source testing tools as per trends in industry
11	Full functioning of working model as per stated requirements
In the third semester evaluation may be based on the above criteria and evaluation of performance of students in research Projects.	
Guidelines for Assessment of Research Project Examination	
1	Report should be prepared as per the guidelines issued.
2	The Research Project shall be assessed through a presentation and demonstration of the working model by the student project group to a panel of Internal /External Examiners preferably from industry/ research organizations having experience of more than five years and academia having experience more than 10 years approved by the head of Institution.
3	Students shall be motivated to publish a research paper / patent / participate in National / International conferences based on the work.

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Semester IV

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CURRICULUM SCHEME FOR NEP POSTGRADUATE ACADEMIC PROGRAM AT VESIT
2025 : Branch: MCA Semester IV

Semester IV Scheme

Type of Course	Course Code	Name of Course	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
OJT	NMCAOJT41	On JOB Training(OJT) Industry Internship/ Research Internship at Research Institute/Incubation Center	Semester Long		--	12	12
Research Project	NMCARP42	Patent/Product Design/Research Paper Publication	4	--	2	--	2
MOOC	NMCAM43	Online Course-(MOOC)	4#	--	4+2*	--	6
Total			8		8	12	20

Semester IV Marks Scheme

Type of Course	Course Code	Name of Course	Examination Scheme			
			Internal Assessment		University Assessment	Total
			Mid term Presentation I	Mid term Presentation II	Final Presentation	
OJT	NMCAOJT41	On JOB Training(OJT) Industry Internship/ Research Internship at Research Institute/Incubation Center	75	75	150	300
Research Project	NMCARP42	Patent/Product Design/Research Paper Publication	50	50	--	100
Total			125	125	150	400

Work load only for students

! Credits transferred from MOOC courses

* ISR(FP) Credits allotted in semester IV based on the (ISR) work done in semesters.

Note:

- The Online Course- 1 (MOOC) has to be completed before the completion of the MCA course (it can be done in the Semester 1 to 4 but to be accounted for in semester 4).
- Maximum one workload for faculty members for Research paper to be considered.
- Maximum two workload for faculty members for Internship projects to be considered
- @ Research Paper has to be Published before the Completion of the MCA(It will accounted in SEM IV)

Course Code	Name of Course	Group	Contact Hours	Credits Assigned	
				Presentation	Total
			40	12	12
NMCAOJT41	On JOB Training(OJT) Industry Internship/ Research Internship at Research Institute/Incubation Center	OJT	Examination Scheme		
			Internal Assessment		University Assessment / Total
			Presentation I	Presentation II	End Sem. Final Presentation / Total
			75	75	150 / 300

Pre-requisite: Software Project Management, Database Management, Software Development Technologies/Programming Languages, Software tools.

Course Objectives: The course aim to

Sr. No.	Course Objective
01	Prepare students to excel in computer applications to succeed in industry/ technical professions.
02	Train students with good computing breadth so as to comprehend, analyze, design and create computing solutions for real life problems.
03	Learn professional skills and international relationships in a professional environment.
04	Design a system, component or process as per needs and specification of the clients.

Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Course Outcome	Bloom Level
CO1	Demonstrate skills to use modern tools, software and equipment to analyze problems.	Understanding
CO2	Develop an exposure to real life organizational and environmental situations.	Analyzing
CO3	Apply SDLC phases in developing software projects and in writing the project document.	Applying
CO4	Create computing solutions for the real life problems as per the requirements of the domain.	Creating
CO5	Adapt professional and interpersonal ethics.	Creating

Assessment:

Internal Assessment: 150 marks

Internal Assessment consists of two presentations of 75 marks each. The final marks should be the sum of the two presentations. Document should be maintained by a mentor.

End Semester Project Examination: 150 marks

External Examination will be based on the project completed by the candidate during his / her internship project.

Guidelines

1. The internship must be conducted within any organization, including philanthropic entities, agricultural producers, governmental bodies, research and development institutions, IT Industries laboratories, distinguished individuals or institutions that offer students the opportunity to engage in an internship during their program.

2. The internship may take place during any stage of the software development life cycle, providing students with valuable practical experience in various phases of software development.
3. Duration of the Project: The internship project is required to span a minimum of 16 weeks.
4. Project Hours: Students are required to dedicate at least 40 hours per week to the project.
5. Project Requirements:
   a) Progress Reports: Students are obligated to submit two progress reports/presentations to the academic advisor.
   b) Final Report: A comprehensive final report detailing the project outcomes, challenges encountered, achievement of Sustainable Development Goal 17 (SDG 17), and lessons learned must be submitted by the students.
   c) Presentation: Students are required to present their project findings and outcomes to the academic advisor, and external examiner.

Rubrics have to be followed during project evaluation.

Mid Term Presentations I and II

To be conducted after completion of 6 weeks and 12 weeks respectively of the Internship. The rubrics to be followed for the Mid Term Presentations are as follows

a) Progress Report (30 marks)

i. Clearly summarizes the project progress and achievements
ii. Identifies any project issues or challenges
iii. Outlines the project plans and goals for the next reporting period
iv. Includes any relevant project metrics or data
v. Learning during Project

b) Presentation (45 marks)

i. Clearly summarizes the project outcomes and achievements
ii. Effectively communicates the project results and impact
iii. Identifies any project lessons learned and best practices
iv. *Q&A and Discussion*

Rubrics for Final Presentation

a) Presentation and Project Viva (100 marks)

I. Introduction and Overview
- Clearly introduces the project and its objectives
- Provides a concise overview of the project scope and timeline
- Effectively sets the stage for the rest of the presentation

II. Technical Content
- Clearly explains the technical aspects of the project
- Effectively uses visual aids and supporting materials to illustrate key concepts
- Demonstrates a deep understanding of the project's technical requirements and challenges

III. Progress and Achievements
- Clearly summarizes the project's progress and achievements
- Effectively highlights the project's successes and accomplishments
- Identifies and discusses any challenges or obstacles overcome

IV. Conclusion and Recommendations
- Clearly summarizes the project's key findings and implications
- Effectively provides recommendations for future work or improvements
- Leaves the audience with a clear understanding of the project's significance and impact.

V. Presentation Style and Delivery
- Confident and effective presentation style
- Engaging and interactive presentation
- Properly uses visual aids and supporting materials
- Effectively answers questions and addresses comments

b) Project Report (50 marks)
- The Project Report is well-organized and easy to follow
- The Project Report effectively documents the project's progress and decisions
- The Project Report demonstrates a clear understanding of the project's technical and management aspects

MCA Semester IV Project Report Guidelines:

1. Students appearing for MCA Program (**Semester IV**) must submit their work [Project Report] done during the semester. (**REFER ANNEXURE FOR REPORT WRITING)**

2. The report must be written in the English **Language only**.
3. Project Report must be Black Colored Hard Bounded and Golden Embossed lettering.
4. Hard Copy (N+1, in Number) Report must be submitted in the institute at least **one week prior** to the final presentation.
5. One copy should be submitted for University records which will be retained by the respective colleges **(College copy)**.
6. The college copy will have names of all the students who are part of the team.
7. Each student has to submit the **soft copy of the final report** to coordinators.
8. No **water mark / Logo** are allowed in any page of the document.
9. Students must avoid plagiarism and properly cite all sources.
10. Printout should be taken on one-sided pages.
11. The project report must be of **minimum 40 pages** [excluding code].
12. Before taking the hard copy, the candidate is required to show the content to the respective faculty guide **well in advance for approval.**
13. The Report book should have Glossy finishing.
14. **Performance Appraisal (given format)** form should be submitted separately **in a sealed envelope by company / external guide** to the college / internal guide on the day of final evaluation. Students are not supposed to see this document.

If the candidate feels that the content of the Index is not applicable in the project then give valid reason to the internal guide if she/he agrees then only you can go ahead with the same.

Note:

Transparency sheet should be used before (inside cover page, Company and College letterheads and also at the end of the document inside)

It is mandatory to give the Performance Appraisal / employer's Feedback form on the day of final examination in the sealed envelope to the external examiner.

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EXTERNAL GUIDE EVALUATION OF INTERN (TEMPLATE)

VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF TECHNOLOGY

MCA DEPARTMENT

FEEDBACK FORM FROM COMPANY

In requirement with the norms of the MCA program conducted by the Vivekanand Education Society's Institute of Technology an autonomous institute Affiliated to University of Mumbai, Approved by AICTE & Recognized by Govt. of Maharashtra, Student Internship feedback by the Project Guide is requested by the company.

Project Guides are requested to fill in the following form.

Name of the Student :	
Project title:	
Company name:	
Project Guide:	
Project-start date:	
Tentative date of completion:	

Evaluation Criteria	Exceptional	Very Good	Average	Remark
Learning Ability (Adjustment with new Platforms and Technology)				
Performance (Problem handling, Overall contribution to the project)				
Team Spirit				
Punctuality/Sincerity towards completion of the job				
Communication Skill				

Signature:

Name of Project Leader:

Company Name: **Date:**

Course Code	Name of Course	Assessment (University/ Institute)	Teaching Scheme (Contact Hours)	Credits Assigned	
			Presentation	Presentation	Total
			04	02	02
NMCARP42	Patent/Product Design/Research Paper Publication	Institute	Examination Scheme		
			Internal Assessment		Total
			Mid term Presentation I	Mid term Presentation II	
			50	50	100

Pre-requisite: Research Methodology, Design Thinking

Course Objectives: The course is aimed to

Sr. No.	Course Objective
01	Understand analytic approach towards choosing a research paper and acquiring research skills.
02	Access relevant data and present new ideas related to the area of research.
03	Adhere to ethical standards of research.
04	Understand what constitutes plagiarism and how to use proper citation styles.

Course Outcomes: On successful completion of course learner/student will be able to

Sr. No.	Course Outcome	Bloom Level
CO1	Show data coherently, effectively and counter-hypothesis.	Understanding
CO2	Apply experience in preparation of research material for publication or presentation.	Applying
CO3	Identify relevant previous work that supports their research.	Applying
CO4	Analyze data and synthesize research findings.	Analyzing
CO5	Create a research paper.	Creating

Following guidelines should be followed for Research Paper / Patent / Product, MCA Sem.- IV:

A Student shall do an in depth study in the specialized area by doing a survey of published technical literature and write a research paper in IEEE format (6-9 pages or 2000 to 3000 words) during the second year (final year) of MCA program. The research topic must be approved by the Department/Institute. The Department/ Institute should set up a committee/Supervisor/Research Guide to scrutinize the topics and finalize the same

- The research paper may be written in a group of maximum 2 students under the guidance of Supervisor/Research Guide.
- The research paper must be published/presented in a national/international conference or national/ international journal.

The following points are to be included in the Research Paper presentation:

1. Introduction
2. Literature Review
3. Problem Definition
4. Objective/Scope
5. Research Methodology
6. Analysis & Findings
7. Limitations & Future Scope
8. Conclusion

RESEARCH PAPER:

- A Student shall do an in-depth study in a specialized area by following the basic principles of research viz, review of existing pool of literature related to the area of proposed research, collating data if required from primary or secondary sources, formulating a methodology for performing the proposed research study and design the experimental setup wherever required, presentation and discussion of the findings and concluding the same at the end.
- The publication of the research paper so formulated should be published anytime when the student is in the Second Year of the MCA pogramme. However, the necessary preparation and ground work on the research paper may start at an earlier stage as well.
- The research paper has to be guided / supervised by a full-time faculty of the college to which the learner belongs.
- The research paper may be written in a group of maximum 2 students under the guidance of Supervisor/Research Guide.
- The research paper must be published in journals that are recognized by Scopus, Web of Science (WoS), or UGC-approved journals only.
- Research papers written on the Research Project carried out on SEM IV may also be considered.

PATENT

- Process / Product / Design patents will be considered. Trademarks / Copyrights will not be considered.
- Only verifiable Process / Product / Design patents will be considered, and must be published or granted through a recognized registering authority. Patents authored by an individual learner or a group of up to four learners, in collaboration with a guide or mentor who is a full-time faculty member of the institution where the learners are enrolled, will be eligible for the award of credits.
- For award of credits under this category the time line for Publishing / Grant of the patent would be anywhere in between Semester II and Semester IV.
- Mere filling of an application for publication / grant will not suffice.

- Patents originating from the Research Project executed in Sem IV may also be considered.

PRODUCT-----Incubation etc

- A marketable software product / service / platform needs to be developed by a learner or a group of learners (subject to a maximum of four learners in a group) under the guidance and mentoring of a full time faculty of a college and/or an Industry mentor authorized by the college.
- The product so developed should be authenticated by either the IIC (Registered with the competent authority) or the E-Cell of the institute in which the learner is registered as a student.
- The authentication of the product so developed should be minuted in at least two of the meetings of the respective Cell/s held during the Second Year of the MCA programme (considering the fact that the development period might extend beyond six months the work may start from Sem III itself and should be minuted accordingly in the meetings of the respective Cell of the institute) and should be uploaded on the website of the college and the competent government authority wherever applicable.
- Mere presentation of a software / application programme / utility in front of an internal faculty committee will not suffice unless the above process is strictly followed in totality.

Reference:

1. James D. Lester , Writing Research Papers: A Complete Guide (10th Edition).
2. How to Write a Great Research Paper, Book Builders, Beverly Chin, July 2004, Jossey-Bass.
3. Kothari C. R. (2004), "Research Methodology, Methods and techniques"(2nd edition), New Delhi: New age International (p) Ltd.

Web References:

1. https://www.ieee.org/publications_standards/publications/authors/author_guide_interactive.pdf
2. http://www.fcsresearch.org/index.php?option=com_content&view=article&id=83&Itemid=166
3. https://www.ece.ucsb.edu/~parhami/rsrch_paper_gdlns.htm
4. http://nob.cs.ucdavis.edu/classes/ecs015-2007-02/paper/citations.html

Assessment:

Internal Assessment: 100 marks

- Internal Assessment consists of two presentations of 50 marks each. The evaluation is to be done by a team of two Internal examiners/Mentors.
- The examiners may be Internal full-time Faculty or external examiner (full time faculty) drawn from other Departments/MCA colleges or an Industry professional (with minimum 3 years of experience in relevant domain).
- Appropriate documentation as described above should be maintained by the Mentor.

The marks distribution of two presentations is as given below:

Presentation I (Mid Term)	**Marks**	**Presentation II (Mid Term)**	**Marks**
Abstract, Introduction, Originality of the problem statement	10	Research Methodology, Process / Models followed for development	15
Literature Review, Market Survey	10	Analysis, Findings & Conclusion / Adherence and completeness of the product specifications	
Objectives/ Scope / Features	10	Paper Publication • Journals Patent Publication & Patent Grant : • Marketed Product and/or hosted on e-store •Product certified and authenticated by the Institute IIC / E-Cell with appropriate documentation available in public domain	15
Presentation	20	Presentation	20
Total	**50**	**Total**	**50**

These two presentations should be taken at Institute level by Committee/Supervisor/Research Guide.

The above Rubric has to be followed during evaluation. Documentation at appropriate levels to be maintained at the institute level subject to inspection by appropriate University authorities as and when required.

Course Code	Name of Course				
NMCAM43	Online Course- MOOC				
Teaching Scheme			Credits Assigned		
Theory	Tutorial	Total	Theory	Tutorial	Total
4#	-	4	4+2*	-	6!

Workload only for students
! Credits transferred from MOOC courses
*ISR Credits allotted in semester IV based on the (ISR) work done in semesters.

The Online Course (MOOC) has to be completed before the completion of the MCA course (it can be done in the Semester 1 to 4 but to be accounted for in semester 4).

Course Objectives:
MOOC-based learning aligns with industry standards and contributes effectively to student academic progress. Students should maintain academic integrity in all online assessments and projects.

The MOOC course shall aim to:

Sr.No.	Course Objective
1	Introduce students to advanced or contemporary topics through online platforms.
2	Acquire knowledge and techniques to solve practical problems, case studies, or hands-on projects related to the course content.
3	Encourage learners to apply theoretical concepts through project-based or experiential learning models.
4	**Critically analyze** various concepts, compare different approaches, and assess their effectiveness in real-world applications.

Course Outcomes (CO): On successful completion of course learner/student will be able to

Sr.No.	Course Outcome	Bloom Level
CO1	Understand and explain key concepts, tools, and techniques in the subject area.	**Remember & Understand**
CO2	Demonstrate practical knowledge through assessments, assignments, or simulations.	**Apply & Demonstrate**
CO3	Evaluate and analyze real-world problems using theoretical knowledge.	**Analyze & Evaluate**
CO4	Develop original ideas, propose innovative solutions, and design projects that integrate their acquired knowledge from the MOOC course.	**Create & Innovate**

H

Course Contents:

MOOC-based courses from recognized platforms such as **SWAYAM-NPTEL, MKCL, NITTER, ISRO, NIELIT, or institutions with NIRF ranking within 100/Government Institutions**. The courses selected will contribute to the student's academic workload and will allow for **credit transfer** upon successful completion.

1. The course must be listed on a recognized MOOC platform (SWAYAM, NPTEL, Oracle Academy, Microsoft, ISRO, TechVarsity by Coding Ninjas etc.). With the approval of the MOOC coordinator and head of the department, other options may also be added (e.g., Smart India Hackathon, e-Yantra Competitions, etc.).
2. Courses should be relevant to the student's academic discipline.
3. The course must be approved by the Department and Academic Council before registration.
4. It must include video lectures, reading materials, quizzes, assignments, and a final project or proctored exam.
5. Instructor(s) must be qualified domain experts, preferably from recognized institutions.
6. MOOC courses will be counted towards the total academic workload.
7. A mentor/faculty guide will oversee the progress and guide students.
8. Certificate of Completion with grade and credit equivalence must be available. **The institution will verify the certificate** before granting credits.
9. A grading equivalency table will be used for credit conversion.
10. Periodic review meetings with mentors will ensure quality and effectiveness.

As per the Result from the authorised Institute, the respective MOOC Coordinator can evaluate the performance of the student with the following guidelines :

Letter Grade	Marks Range (%)	Grade Point (10-Point Scale)
O (Outstanding)	90 – 100	10
A+ (Excellent)	80 – 89	9
A (Very Good)	70 – 79	8
B+ (Good)	60 – 69	7
B (Above Average)	50 – 59	6
C (Average)	40 – 49	5
F (Fail)	Below 40	0
Ab (Absent)	-	0

Course Code	Name of Course	Contact Hours	Credits Assigned
NMCAFPS44	Institute Social Responsibility (ISR)	30 hours in the span of two years	02

Course Objective: The course is aimed to inculcate social awareness, values and environmentally responsible behavior among students.

Course Outcome: Learner/student will be able to create awareness among individuals towards institutional & individual social responsibility for societal development.

About Institute Social Responsibility (ISR) :

Institute Social Responsibility (ISR) refers to the continuous commitment by institutions to conduct them in an ethical manner and contribute towards the socioeconomic development of the society at large.

Social responsibility is an ethical theory, in which individuals are accountable for fulfilling their civic duty; the actions of an individual must benefit the whole of society. Social responsibility is a duty every individual has to perform so as to maintain a balance between economic growth and the welfare of society and the environment.

Social responsibility means sustaining the equilibrium between the two. It pertains not only to organizations but also to everyone whose action impacts the environment. This responsibility can be passive, by avoiding engaging in socially harmful acts, or active, by performing activities that directly advance social goals. As individuals we can make our small contributions to society by doing social activities, individually or in association with Institute/Social organizations/NGOs/Clubs etc.

Guidelines for ISR Activity:

- A teacher can be given responsibility as ISR coordinator, relaxation of 1 hour load can be given to the teacher.
- ISR coordinator is responsible to maintain the records of ISR activities and the students participating in the activity.
- Students shall participate in Social work activities individually or in association/collaboration with Institute/ Social organizations/NGOs/Clubs etc. with prior permission of ISR coordinator
- A Student shall complete at least 30 hours Social activities under the guidance of ISR Coordinator/HOD/Principal/Director between MCA Semester 1 to Semester 4 (preferably between semester 1 to semester 3).
- Certificate of Participation given by concerned Institute/NGO/Social organization/Private or Government organization/Club etc shall be verified by ISR coordinator.
- 2 credits will be awarded on the completion of 30 hours ISR work which is certified by ISR coordinator.

Suggestive list of Activities for social concern among students but not limited to:

- Computer Literacy Programs for ZP School Students/ Villagers/ Farmers etc. Donation of used books.
- Visits and Help to Orphanage/Old homage.
- Public Awareness Programs for Health, Road Safety, Organ Donation, Global Warming, Plastic Eradication , Aids/Cancer/Corona Awareness
- River/Beach Cleanliness Drive. Voter Registration Drive.
- Blood Donation Camps. Disaster Management Program. Swachha Bharat Abhiyan.
- E Waste Collection and Disposal. Tree Plantation Drives.
- Anti Addiction Program.
- Yoga, Meditation, Self Defense Programs for Children. Programs for Physically Challenged People