Syllabus

Minor Programme in
Artificial Intelligence and Machine Learning

(Offered by the the Department of Computer Engineering)

From
Academic Year 2024-25
Revision 2

(Approved in Academic Council meeting dated April 22, 2024)

K J Somaiya College of Engineering, Mumbai-77

(A Constituent College of Somaiya Vidyavihar University)

Minor Programme in Artificial Intelligence and Machine Learning

Offered by Department of Computer Engineering

Introduction:

Artificial Intelligence (AI) currently encompasses a huge variety of subfields, from general-purpose areas such as perception and logical reasoning, to specific tasks such as game playing, proving mathematical theorems, writing poetry, automated cars and diagnosing diseases. Often, scientists in other fields move gradually into artificial intelligence, where they find the tools and vocabulary to systematize and automate the intellectual tasks. In this sense, AI is truly a universal field.

The programme will focus on introducing AI & ML and their related technologies. The focus will be also related topics like machine learning, deep learning, Data science and their applications and solutions.

Objective:

- Understand Artificial Intelligence and related technologies of artificial intelligence
- Understand design and development of new artificial intelligence technologies and solutions
- Implement Machine learning and deep learning algorithms for application and solutions
- Understand the concepts of Data science and trends in data analytics.

Learning Outcomes:

At the successful completion of this minor program, an Engineering Graduate will be able to:
LO1 : Design and develop intelligent solutions to problems in their application domain.
LO2 : Apply principles of Data Science for analytics.
LO3 : Implement various machine learning and deep learning algorithms for applications.

Eligibility Criteria:

Students of UG, B. Tech. Programmes in Electronics Engineering / Mechanical Engineering who have cleared their first year.

Assessment Methods:

Evaluation is done by a variety of tools including Open Book tests, MCQ (multiple choice questions), Study of research papers, Internal Assessment tools and End Semester examinations etc. Mini-Projects are offered in courses also to encourage project based learning among students.

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M18C401	Data Science and Analytics	3 – 0 – 0	03	3 – 0 – 0	03	IV
216M18L401	Data Science and Analytics	0 – 2 - 0	02	0 – 2 – 0	01	IV
216M18C501	Artificial Intelligence	3 – 0 – 0	03	3 – 0 – 0	03	V
216M18L501	Artificial Intelligence	0 – 2 - 0	02	0 – 2 – 0	01	V
216M18C601	Machine Learning	3 – 0 – 0	03	3 – 0 – 0	03	VI
216M18L601	Machine Learning	0 – 2 - 0	02	0 – 2 – 0	01	VI
216M18C701	Deep Learning	3 – 0 – 0	03	3 – 0 – 0	03	VII
216M18L701	Deep Learning	0 – 2 - 0	02	0 – 2 – 0	01	VII
216M18P702	Mini Project	0 – 4 – 0	04	0 – 4 – 0	02	VII
Total		**12—12 – 0**	**24**	**12 – 12 – 0**	**18**	

***Internship of four weeks / more approved by department.**

Examination Scheme

Course Code	Course Name	Examination Scheme				
		Marks				
		CA		ESE	LAB/CA	Total
		ISE	IA			
216M18C401	Data Science and Analytics	30	20	50		100
216M18L401	Data Science and Analytics	-	-	-	50	50
216M18C501	Artificial Intelligence	30	20	50		100
216M18L501	Artificial Intelligence	-	-	-	50	50
216M18C601	Machine Learning	30	20	50		100
216M18L601	Machine Learning	-	-	-	50	50
216M18C701	Deep Learning	30	20	50		100
216M18L701	Deep Learning	-	-	-	50	50
216M18P702	Mini Project	-	-	-	50	50

Total	**120**	**80**	**200**	**250**	**650**

Course Code	**Course Title**					
216M18C401	**Data Science and Analytics**					
	TH			**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**03**			**-**	**--**	**03**
Credits Assigned	**03**			**-**	**--**	**03**
Examination Scheme	**Marks**					
	CA		**ESE**	LAB CA		**Total**
	ISE	**IA**				
	30	**20**	**50**	**-**		**100**

Course prerequisites (if any):
Students are expected to have basic knowledge of algorithms and programming experience.

Course Objectives

1. To comprehend practical data analysis skills, which can be applied to practical problems.
2. To understand fundamental knowledge of mathematical concepts needed for data science applications.
3. To explain how math and information sciences can be used for developing better algorithms and software.
4. To teach the fundamental techniques and principles in achieving big data analytics with Scalability and streaming capability.
5. To use practical skills for data science process.
6. To apply the tools to implement data science process for developing applications

Course Outcomes

At the end of successful completion of the course the student will be able to

CO 1	Explain the basic terms of Statistical Inference and commonly used probability distributions for fitting data.

CO 2	Comprehend the fundamentals of data science to enable, reproduce and scalable data from a variety of sources.
CO 3	Apply statistical methods, regression techniques, and machine learning algorithms to analyze and interpret the data
CO 4	Interpret business models and scientific computing paradigm for solving real World problems.
CO 5	Implement the Data Science Process and understand how its components interact.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Data Science**		**06**	**CO1, CO2**
	1.1	Introduction to Applied Data Science: Introduction to major steps of Data Science, Big Data and Data Science, Big data characteristics Datafication: Current scenario and perspectives, Skill sets needed for various application areas.		
	1.2	Impact of applying Data Science in business scenario, Introduction to NoSQL, Types of NoSQL.		
2	**Introduction to Mathematical Foundation**		**12**	**CO3**
	2.1	**Introduction to the mathematical foundation**: Discrete and Continuous random variables, Probability distribution of a random variable. Gaussian, Poisson, Exponential random variables, Expected value of function of random variables. **Parameter estimation:** Concept of parameter estimation, Maximum Likelihood Estimation (MLE) method, MLE for parameters of Bernoulli, Poisson, Gaussian and Uniform distribution.		
	2.2	**Data summarization:** sample mean, sample mode, sample median, sample variance, sample standard deviation, sample percentiles, concept of correlation coefficient and its range. **Statistical Inference:** Populations and samples, Statistical modelling, Probability distribution, Fitting a model.		
3	**Exploratory Data Analysis**		**12**	**CO4, CO5**
	3.1	Important steps of Exploratory Data Analysis for Data Science Process.		
	3.2	**Regression analysis:** Simple linear regression, Least Square Estimators of the regression parameters, distribution of the estimators, statistical inferences about the regression parameters, Coefficient of determination, sample correlation coefficient, analysis of residuals.		
	3.3	The basic tools (plots, graphs and summary statistics) of EDA **#Self-Learning: Python libraries useful for EDA.**		
4	**Basics of Big Data Algorithms**		**07**	**CO4, CO5**
	4.1	**Big data Algorithms**: The Datar-Gionis-Indyk-Motwani Algorithm, Flajolet-Martin Algorithm. The A-Priori Algorithm, Algorithm of Park, Chen, and Yu, The SON Algorithm.		
5	**Data Visualization**		**08**	**C05**
	5.1	Introduction to feature detection and feature description for extracting meaningful Data for creating knowledge base.		

	5.2	**Data Visualization:-** Basic principles, ideas and tools for data visualization and its applications, Introduction to data visualization tools.		
Total			**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Cathy O'Neil and Rachel Schutt	Doing Data Science, Straight Talk From The Frontline	O'Reilly	2014
2.	Davy Cielen, Meysman, Mohamed Ali	Introducing Data Science	Dreamtech Press	2016
3.	Sheldon M. Ross	Probability and Statistics for Engineers and Scientists	Academic Press	Fourth Edition, 2014
4.	Cathy O'Neil and Rachel Schutt	Doing Data Science, Straight Talk From The Frontline	O'Reilly	2014
5.	Valliappa Lakshmanan	Data Science on the Google Cloud platform	O'Reilly	2019, First edition, Third Indian reprint
6.	Radha Shankarmani M. Vijaylakshmi	Big Data Analytics	Wiley	2st edition, 2018
7.	Sosulski, K.	Data Visualization Made Simple: Insights into Becoming Visual	New York: Routledge.	First edition, 2018

<table>
<tr><td>Course Code</td><td colspan="5">Course Title</td></tr>
<tr><td>216M18L401</td><td colspan="5">Data Science and Analytics</td></tr>
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<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB / CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
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Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course ‘Data Science and Analytics’. Students will be graded based on continuous assessment of their term work.

Course Code	Course Title			
216M18C501	**Artificial Intelligence**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	03	-	--	03
Credits Assigned	03	-	--	03

Examination Scheme	Marks				
	CA		ESE	LAB CA	Total
	ISE	IA			
	30	20	50	-	100

Course prerequisites (if any):
Data structures, algorithms

Course Objectives: The objective of the course is to present an overview of artificial intelligence principles and approaches. To enable students to develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents: Search, Knowledge representation, inference and logic with some advanced concepts in AI. The knowledge of artificial intelligence plays a considerable role in some applications students develop for courses in the program

Course Outcomes
At the end of successful completion of the course the student will be able to

CO 1	Conceptualize the basic & advanced ideas and techniques to develop **ethical** intelligent systems
CO 2	Solve various problems through searching techniques
CO 3	Represent the knowledge and reason through inference
CO 4	understand and Design AI solutions with advanced concepts in AI

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to AI**		06	CO1
	1.1	what is AI, AI History, Classification of AI, Applications of AI,		
	1.2	Artificial stupidity- guarding against mistakes, AI humanoids, their citizenships and rights, Privacy & Surveillance, Manipulation of Behavior, Opacity of AI Systems, Bias in Decision Systems, Human-Robot Interaction, Automation and Employment, Autonomous Systems, Machine Ethics, Artificial Moral Agents and Singularity		
		#Self-Learning- study AI projects of varying complexities, verify chatbots for Turing test		
2	**Intelligent Agents**		10	CO 1
	2.1	Structure of intelligent agent, Agent task environments and PEAS, Rational agents		
		#Self-Learning - Designing intelligent agent solutions for the problems of varying complexity like Kitchen cleaning, chess playing, hardware troubleshooting agent, automated translator, query answering chatbot etc		
3	**Problem solving through searching**		13	CO2
	3.1	problem analysis and formulation, problem space and search, study and analysis of various searching strategies, problem solving agent,		
	3.2	Blind Search, Informed / Heuristic search and exploration, Adversarial search, Constraint Satisfaction problems		
		#Self-Learning: Designing optimal solutions for various problems. e.g. map explorations, blocks world, map exploration, Tic tac toe, GO, checkers, Sudoku, Crypt arithmetic, quantitative analysis problems		
4	**Logical Agents and Knowledge Representation**		10	CO3
	4.1	knowledge based agents, Representing knowledge using predicate logic, inferences in FOL, forward chaining , backward chaining, proof with resolution		
		#Self-Learning : knowledge engineering for various problems of varying complexities		

5	**Natural language processing and Expert system**		**6**	**CO4**
	5.1	Steps in NLP, Parsing and semantic interpretation, discourse and pragmatic processing, implementation aspects of syntactic analysis		
	5.2	Expert system, components of expert system		
		#Self-Learning: case studies on Expert system		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Stuart J. Russell and Peter Norvig	Artificial Intelligence: A Modern Approach	Pearson Education.	Second Edition
2.	*Elaine Rich and Kevin Knight	Artificial Intelligence	The McGraw-Hill	Third Edition
3.	George F Luger	Artificial Intelligence	Pearson Education	Fourth Edition
4.	Ethics of Artificial Intelligence and Robotics	Stanford encyclopedia of philosophy on **https://plato.stanford.edu/entries/ethics-ai/**	Website, maintained by Stanford center for the study of language and information	Last accessed on July 21, 2020

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<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td colspan="3">50</td><td>50</td></tr>
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Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course ‘Artificial Intelligence’. Students will be graded based on continuous assessment of their term work.

<table>
<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td>216M18C601</td><td colspan="6">Machine Learning</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="3">03</td><td>-</td><td>--</td><td>03</td></tr>
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<tr><td>30</td><td>20</td><td>50</td><td colspan="2">-</td><td>100</td></tr>
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Course prerequisites: Probability concepts, calculus, linear algebra.

Course Objectives:

1. Introduction to basic concepts and techniques of Machine Learning.
2. To understand the usage of recent machine learning methods for solving practical Problems.
3. To gain experience of doing independent study and research in machine learning.

Course Outcomes:

At the end of successful completion of the course the student will be able to:

1. Describe the fundamental issues and challenges of machine learning: data, model selection, model complexity.
2. Apply and extract various features using supervised learning approaches.
3. Implement and evaluate basic neural network models for machine learning
4. Understand and apply various dimensionality reduction techniques on various machine learning datasets.
5. Apply & implement unsupervised learning techniques for data modeling and analysis.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction - Machine Learning**		08	CO1
	1.1	What is Machine Learning? Types of learning, concept of hypothesis space, Bias variance dichotomy, Evaluation, cross validation.		
2	**Supervised learning – Regression & Classification**		10	CO2
	2.1	Linear Regression (multiple variable) and Problem of overfitting, regularization, logistic regression, support vector machines, Maximum Margin Linear Separators.		
	2.2	Naïve bayes,K nearest neighbor, Decision, trees.		
	#Self-Learning - Ensemble methods, Scikitlearn framework for machine learning			
3	**Supervised learning – Neural networks:**		09	CO3
	3.1	Neural network: Concepts of perceptron, activation function, learning rules, multilayer network, backpropagation, and gradient descent algorithm. Introduction to deep neural networks.		
	#Self-Learning – Classification using neural network case study.			
4	**Dimensionality reduction & feature selection for machine learning.**		09	CO4
	4.1	Dimensionality Reduction Techniques: Feature selection, principal component analysis and Linear Discriminant Analysis (LDA) for Dimension Reduction		
	#Self-Learning – singular value decomposition technique.			
5	**Unsupervised Learning**		09	CO5
	5.1	Basic clustering methods - Partitional, Hierarchical, K-means, Gaussian mixture model, EM algorithm and fuzzy c means.		
	#Self-learning topics: Clustering algorithm on different datasets using scikit learn framework.			
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Tom M. Mitchell	Machine Learning	McGraw Hill	2017
2.	Christopher M. Bishop	Pattern Recognition and Machine Learning	Springer	2007
3.	M Gopal	Applied machine learning	McGraw Hill	2018
4.	Ian Goodfellow, Yoshua Bengio, Aaron Courville	Deep Learning	An MIT Press book	2016
5.	Deng & Yu	Deep Learning: Methods and Applications	Now Publishers	2013

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<tr><td>-</td><td>-</td><td>-</td><td colspan="2">50</td><td>50</td></tr>
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Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course 'Machine Learning'. Students will be graded based on continuous assessment of their term work.

<table>
<tr><th>Course Code</th><th colspan="4">Course Title</th></tr>
<tr><td>216M18C701</td><td colspan="4">Deep Learning</td></tr>
<tr><td></td><td>TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td>03</td><td>-</td><td>--</td><td>03</td></tr>
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<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>50</td><td>-</td><td>100</td></tr>
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Course prerequisites:

Linear Algebra, Calculus (vectors, matrices, basic integrals), Probability (Bayes theorem, expectation, variance) & Basic machine learning (linear models, regression, decision trees)

Course Objectives:

This course covers the basics of machine learning, neural networks and deep learning. Model for deep learning technique and the various optimization and generalization mechanisms are included. Major topics in deep learning and dimensionality reduction techniques are covered. The objective of this course is:

1. To present the mathematical, statistical and computational challenges of building neural networks
2. To study the concepts of deep learning
3. To introduce dimensionality reduction techniques
4. To enable the students to know deep learning techniques to support real-time applications
5. To examine the case studies of deep learning techniques

Course Outcomes:

At the end of successful completion of the course the student will be able to

1. Describe basics of deep learning.
2. Design & implement various deep learning models
3. Apply Realignment on high dimensional data using reduction techniques
4. Analyze optimization and generalization in deep learning
5. Apply a variety of deep learning techniques to design efficient algorithms for real-world applications.

Module No.	Unit No.	Details	Hrs.	CO
Name of the subject: Deep Learning				
1	**Introduction to machine learning**		08	CO1
	1.1	Introduction to machine learning models.		
	1.2	Intro to Neural Nets: What a shallow network computes- Training a network: loss functions		
	1.3	Back propagation and stochastic gradient descent		
	1.4	Learning rates and data normalization, activation functions, Optimizers, Regularization, Dropout, Momentum & Batch Norm.		
2	**Deep Networks**		10	CO2 & CO5
	2.1	History of Deep Learning- A Probabilistic Theory of Deep Learning, Neural Nets-Deep Vs Shallow Networks-		
	2.2	Convolutional Neural Networks: Motivation, Convolution operations, Pooling		
	2.3	Image classification		
	2.4	Modern CNN architectures (VGG, ResNet, etc.)		
3	**Deep Unsupervised Learning**		10	CO3 & CO5
	3.1	Auto encoders		
	3.2	Dimensionality reduction in networks		
	3.3	Adversarial Generative Networks		
4	**Recurrent Neural Networks**		10	CO2
	4.1	Motivation		

	4.2	Vanishing/Exploding gradient problem		**& CO5**
	4.3	Applications to sequences (text)		
	4.4	Modern RNN architectures (LSTM, GRU, etc.)		
5	**Optimization and Generalization**		**07**	**CO4 & CO5**
	5.1	Optimization in deep learning		
	5.2	Non-convex optimization for deep networks-		
	5.3	Stochastic Optimization & Generalization in neural networks.		
	5.4	**#Self-Learning topic:** Applications of Deep Learning to Computer Vision : Image segmentation, object detection, automatic image captioning, video to text with LSTM models		
		Total	**45**	

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Recommended Books:

Sr. No.	**Name/s of Author/s**	**Title of Book**	**Name of Publisher with country**	**Edition and Year of Publication**
1.	Ian Goodfellow, YoshuaBengio, Aaron Courville	Deep Learning	An MIT Press book	2016
2.	Deng & Yu	Deep Learning: Methods and Applications	Now Publishers	2013
3.	Michael Nielsen	Neural Networks and Deep Learning	Determination Press	2015
4.	Josh Patterson , Adam Gibson	Deep Learning: A Practitioner's Approach	Shroff/O'Reilly	First edition (2017)
5.	Nikhil Buduma, Nicholas Locascio	Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms	O'Reilly Media	First edition (June 29, 2017)

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<tr><td>216M18L701</td><td colspan="5">Deep Learning</td></tr>
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Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course 'Deep Learning'. Students will be graded based on continuous assessment of their term work.

<table>
<tr><th>Course Code</th><th colspan="7">Course Title</th></tr>
<tr><td>216M18P702</td><td colspan="7">Mini Project</td></tr>
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<tr><td rowspan="4">Examination Scheme</td><td colspan="7">Marks</td></tr>
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<tr><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">50</td><td>50</td></tr>
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Course prerequisites:

Course Objectives: The objectives are to address a real-world problem, which includes identifying and solving the problem by implementing the solution using the courses learned in earlier semesters. Recognize various hardware and software requirements for solving the problem. It will also inculcate qualities such as working in a team, meeting deadlines, making and following work plans. The Project may include some software or techniques not covered in the courses taught to provide a solution of the chosen problem.

Course Outcomes:
At the end of successful completion of the course the student will be able to

CO1. Define the problem statement and scope of problem.
CO2. Identify various hardware and software requirements for problem solution
CO3. Describe the design with the help of flowchart/block diagrams or any design Tool.
CO4. Implement and test the design to meet the desired specifications.
CO5. Analyze, interpret results and correspondingly modify the designed system to get the desired results.
CO6. Prepare a technical report based on the project.

Distribution of LAB CA:

Criterion	Marks
Project demonstration 1	20
Project demonstration 2	20
Orals based on project	10

This is an activity to be undertaken by a group of 3-4 participants preferably from different major programmes. Each project will be assigned one faculty member as a supervisor. There will be a continuous assessment and progress report of the project that needs to be maintained by student(s). The final oral will be a presentation based on a demonstration of the project in front of a committee of examiners.

Proposed areas for Projects:

1. Chatbots
2. Recommendation System i.e. music (Spotify app)
3. Monitoring System i.e. fake product review, movie review etc.
4. Game Design i.e. snake
5. Expert System for Health, Agriculture etc.
6. Classification Systems
7. Detection Systems
8. Recognition System
9. Data Analysis and Visualization

Alternative online courses:

- Fundamentals of Artificial Intelligence by NPTEL Prof. Shyamanta M. Hazarika
- Artificial Intelligence Search Method by NPTEL Prof. Deepak Khemani
- Python for Data Science by NPTEL Prof. Ragynathan Rengasamy
- Artificial Intelligence by Udacity
- Machine Learning Engineer by Udacity
- Deep Learning by Udacity
- Machine Learning by COURSERA Andrew Ng
- Deep Learning by COURSERA Andrew Ng
- Data Analysis with Python by COURSERA Joseph Santarcangelo
- Analyzing Data with Python by edX Joseph Santarcangelo
- Data Analysis with Python and SQL by Udacity

Somaiya Vidyavihar University

Syllabus

Minor Programme in
Data Science

Jointly offered by Department of Computer Engineering and Electronics and Telecommunication Engineering

From
Academic Year 2024-25
Revision 2

(Approved in Academic Council meeting dated April 22,2024)

K J Somaiya College of Engineering, Mumbai-77
(A Constituent College of Somaiya Vidyavihar University)

Department of Computer Engineering & Electronics and Telecommunication Engineering

Minor Degree Programme in Data Science

Abstract:
In today's data-driven society, Data Science provides a foundation for problem solving that impacts virtually all areas of the economy, including science, engineering, medicine, banking, finance, sports and the arts. Data science is an interdisciplinary field that focuses on analysing large amounts of data to identify inherent patterns, extract underlying models, and make relevant predictions. The data science minor is designed to prepare students in wide disciplines who want to gain practical know-how of data analytics methods as it relates to their field of interest. It is designed to empower them to employ computational thinking and data science tools to solve practical business problems. The coursework consists of courses that cover the spectrum of Data Science to equip the students with knowledge of data analysis techniques and data-centric computation to address problems that require large data.

Objectives:

- Apply principles of Data Science to the analysis of diverse problems.
- Use software tools and algorithms from statistics, applied mathematics, Computer Science to model and analyze real-world data, communicate findings, and effectively present results using data visualization techniques.
- Employ cutting edge tools and technologies to analyze large amounts Data.
- Understand the ethical practices that are importantly and inevitably tied to data-driven decision-making

Learning Outcomes of the Minor Degree Program:
At the successful completion of this minor program, an Engineering Graduate will be able to:

1. Learn and recognize the fundamental concepts of data science including data visualization, statistical analysis and machine learning.
2. Build skills and techniques of organizing and analysing big data for different applications.
3. Apply the data-driven modelling and machine learning algorithms to solve practical problems in engineering, social, scientific and business applications.

Eligibility Criteria:
Student who has earned all credits of First Year of Engineering in Electronics Engineering / Mechanical Engineering.

Assessment Methods:
Evaluation will be done by a variety of tools including Open book tests, MCQs (multiple choice questions), Study of research papers, Internal Assessment tools and End Semester Examinations etc. Mini-Projects are offered to encourage project based learning among students.

Minor Programme in Data Science

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M20C401	Data Science: Principles & Techniques	3 – 0 – 0	03	3 – 0 – 0	03	IV
216M20L401	Data Science: Principles & Techniques	0 – 2 – 0	02	0 – 2 – 0	01	IV
216M20C501	Introduction to Machine Learning	3 – 0 – 0	03	3 – 0 – 0	03	V
216M20L501	Introduction to Machine Learning	0 – 2 – 0	02	0 – 2 – 0	01	V
216M20C601	Data Management and Information Systems	3 – 0 – 0	03	3 – 0 – 0	03	VI
216M20L601	Data Management and Information Systems	0 – 2 – 0	02	0 – 2 – 0	01	VI
216M20C701	Fundamentals of Big Data Analytics	3 – 0 – 0	03	3 – 0 – 0	03	VII
216M20L701	Fundamentals of Big Data Analytics	0 – 2 – 0	02	0 – 2 – 0	01	VII
216M20P702	Mini Project	0 – 4 – 0	04	0 – 4 – 0	02	VII
Total		**12—12 – 0**	**24**	**12 – 12 – 0**	**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme				
		Marks				
		CA		ESE	LAB CA	Total
		ISE	IA			
216M20C401	Data Science: Principles & Techniques	30	20	50		100
216M20L401	Data Science: Principles & Techniques	-	-	-	50	50
216M20C501	Introduction to Machine Learning	30	20	50		100
216M20L501	Introduction to Machine Learning	-	-	-	50	50
216M20C601	Data Management and Information Systems	30	20	50		100
216M20L601	Data Management and Information Systems	-	-	-	50	50
216M20C701	Fundamentals of Big Data Analytics	30	20	50		100
216M20L701	Fundamentals of Big Data Analytics	-	-	-	50	50

216M20P702	Mini Project	-	-	-	50	50
Total		**120**	**80**	**200**	**250**	**650**

Course Code	Course Title					
216M20C401	Data Science: Principles & Techniques					
	TH			P	TUT	Total
Teaching Scheme(Hrs.)	03			-	--	03
Credits Assigned	03			-	--	03
Examination Scheme	Marks					
	CA		ESE	LAB / CA		Total
	ISE	IA				
	30	20	50	-		100

Course prerequisites: Basic Probability theory, Calculus, Linear Algebra, basic programming skill

Course Objectives: In this course the students will learn fundamental knowledge of mathematical concepts needed for data science applications to develop practical data analysis skills, which can be applied to practical problems. The course will help to develop applied experience with data science software, programming, applications and Processes.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Learn foundations and applications of Data science.
CO2: Explain the basic terms of statistical analysis and commonly used probability distributions for fitting data.
CO3: Explain the significance of exploratory data analysis (EDA) in data science.
CO4: Use appropriate model of analysis, derive insight from results, and investigate issue under study.
CO5: Apply basic tools to carry out EDA for the Data Science process.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Applied Data Science**		06	CO1
	1.1	Introduction to Applied Data Science, Big Data and Data Science, Datafication - Current landscape of perspectives - skill sets needed, various application areas.		
	1.2	Impact of applying Data Science in business scenario.		
	1.3	Introduction to need of estimation and validation for added value due to data science		
2	**Introduction to Mathematical Foundation-I**		05	CO2
	2.1	Discrete and Continuous random variables, cdf, pdf, pmf of a random variable. Gaussian, Poisson, Exponential random variables, Expected value of function of random variables, joint distributions of random variables		
	2.2	Data summarization: sample mean, sample mode, sample median, sample variance, sample standard deviation, sample percentiles, concept of correlation coefficient and its range		
3	**Introduction to Mathematical Foundation-II**		08	CO2
	3.1	Parameter estimation: Concept of parameter estimation, Maximum Likelihood Estimation(MLE) method, MLE for parameters of Bernoulli, Poisson, Gaussian and Uniform distribution		
	3.2	Statistical Inference: Populations and samples, Hypothesis testing, Statistical modeling, Probability distribution, Fitting a model		
	3.3	Introduction to Python programming Language		
4	**Exploratory Data Analysis**		**14**	CO3, CO4
	4.1	Exploratory Data Analysis and the Data Science Process		
	4.2	Regression analysis: Simple linear regression- Least Square Estimators of the Regression parameters, distribution of the estimators, statistical inferences about the regression parameters, Coefficient of Determination,		

		sample correlation coefficient, analysis of residuals; multiple linear regression, interaction effects; polynomial regression; prediction of future responses. Introduction to Logistic regression models		
	4.3	The basic tools (plots, graphs and summary statistics) of EDA;Introduction to Python libraries useful for EDA		
5	**Data Visualization & Data Wrangling**		**12**	**CO4, CO5**
	5.1	Introduction to Feature Generation and Feature Selection; Meaningful Data extraction by feature extraction.		
	5.2	Data Visualization - Basic principles, ideas and tools for data visualization and its applications		
	5.3	Data Wrangling: APIs and other tools for scraping the Web		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Cathy O'Neil and Rachel Schutt	Doing data Science, Straight Talk From The Frontline	O'Reilly	2014
2.	Sheldon M. Ross	Probability and Statistics for Engineers and Scientists	Academic Press	4th edition, 2014
3.	Dr. J. Ravichandran	Probability and Statistics for Engineers	Wiley India	1st edition, 2014
4.	Mohammed J. Zaki and Wagner Miera Jr.	Data Mining and Analysis: Fundamental Concepts and Algorithms	Cambridge University Press	2014
5.	James, G., Witten, D., Hastie, T., Tibshirani, R.	An introduction to statistical learning with applications in R	Springer	2013

Course Code	**Course Title**			
216M20C401	**Data Science: Principles & Techniques**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	-	**02**	**--**	**02**
Credits Assigned	-	**01**	**--**	**01**

<table>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB / CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30

Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course 'Data Science and Analytics'. Students will be graded based on continuous assessment of their term work.

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M20C501</td><td colspan="5">Introduction to Machine Learning</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="2">03</td><td>-</td><td>--</td><td>03</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">03</td><td>-</td><td>--</td><td>03</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>50</td><td>-</td><td>100</td></tr>
</table>

Course prerequisites: Probability theory concepts, Calculus, Linear Algebra.

Course Objectives: This introductory course gives an overview of many concepts, techniques, and algorithms in machine learning. The course will give the student the basic ideas and intuition behind machine learning methods along with understanding of how to apply them to solve real life problems. The course provides foundation to undertake independent study and research in the field of machine learning.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Describe the fundamental issues and challenges of machine learning: data processing, model selection, model complexity.
CO2: Learn and apply supervised learning approaches for data modeling.
CO3: Implement common neural network models for machine learning and apply dimensionality reduction techniques.
CO4: Apply unsupervised learning techniques to implement data modeling and analysis.
CO5: Understand the working of Reinforcement learning.

Module No.	Unit No.	Details	Hrs.	CO
1		**Introduction to Machine Learning**	08	CO1
	1.1	What is Machine Learning? Types of data variables; Types of learning; Concept of hypothesis space; Classification versus regression; Bias variance dichotomy.		
	1.2	Evaluation metrics.		
	1.3	Cross validation methods.		
2		**Supervised learning : Regression & Classification**	13	CO2
	2.1	Linear Regression (single and multiple variable), Gradient descent; Problem of overfitting, regularization; Logistic regression; Naïve Bayes' classifier, Bayesian Belief networks; Support Vector Machines, Maximum Margin Linear Separators, Concept of kernels and feature spaces.		

	2.2	K nearest neighbor, Decision trees-CART, ID3.		
3	**Neural networks & Dimensionality Reduction Techniques:**		12	CO3
	3.1	Neural networks: Concept of perceptron, multilayer networks, backpropagation algorithm; introduction to deep neural networks.		
	3.2	Dimensionality Reduction Techniques: Need of dimensionality reduction techniques; Feature Selection Techniques, filter methods, wrapper methods, embedded methods, forward feature selection algorithm; Feature Reduction techniques, principle component analysis.		
4	**Unsupervised Learning:**		06	CO4
	4.1	Basic clustering methods – Difference between Partitioning, Hierarchical, Model based, Fuzzy and Density based methods.		
	4.2	K-means, Distance measures, Fuzzy c means, Gaussian Mixture Model, EM algorithm.		
5	**Reinforcement Learning:**		06	CO5
	5.1	Reinforcement Learning: Introduction, Elements of Reinforcement Learning, Q learning, Temporal Difference Learning, Generalization.		
		Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Tom M. Mitchell	Machine Learning	McGraw Hill	1st edition, 2017
2.	Christopher M. Bishop	Pattern Recognition and Machine Learning	Springer	1st edition, 2007
3.	M Gopal	Applied machine learning	McGraw Hill	1st edition, 2019
4.	S.N. Sivanandam, S. N. Deepa	Principles of Soft Computing	Wiley, India	3rd edition, 2018
5.	Ian Goodfellow, Yoshua Bengio,	Deep Learning	An MIT Press book	1st edition, 2016

	Aaron Courville			

Course Code	Course Title			
216M20L501	**Introduction to Machine Learning**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	-	**02**	**--**	**02**
Credits Assigned	-	**01**	**--**	**01**

<table>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB / CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course 'Data Science and Analytics'. Students will be graded based on continuous assessment of their term work.

Course Code	Course Title					
216M20C601	**Data Management and Information Systems**					
	TH			**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**03**			-	--	**03**
Credits Assigned	**03**			-	--	**03**
Examination Scheme	**Marks**					
	CA		**ESE**	LAB / CA		**Total**
	ISE	**IA**				
	30	**20**	**50**	-		**100**

Course prerequisites: Nil

Course Objectives: The objective of the course is to understand the need of database systems. This course provides an introduction to database and information systems, covering topics related to structured data modeling to logical foundations and languages, system implementations and theory of relational data modeling, design and Information systems.

Course Outcomes

After successful completion of the course the student will be able to :

CO1: Conceptualize and Design Entity-Relationship model for different database application.
CO2: Develop relational database design using the designed Entity-Relationship model.
CO3: Use SQL for Relational database creation, maintenance and query processing.
CO4: Conceptualize Information systems and database design.

Module No.	Unit No.	Details	Hrs	CO
1		**Introduction**	**05**	CO1
	1.1	Introduction, Characteristics of databases, advantages of using Database approach , when not to use DBMS approach,		
	1.2	3-Schema Architecture and Data Independence, DBMS system architecture, Centralized and client server architectures for DBMS. Classification of Database Management Systems		
2		**Data Modeling: Enhanced-Entity-Relationship Model**	08	CO1
	2.1	Introduction, Benefits of Data Modeling, Types of Models, Phases of Database Modeling, The Entity-Relationship (ER) Model		
	2.2	Enhanced -Entity-Relationship (EER)- Model Generalization, Specialization and Aggregation		

3	**Relational Data Model, Relational Algebra and SQL**		13	CO2, CO3
	3.1	Introduction , Data Manipulation , Data Integrity, Advantages of the Relational Model		
	3.2	Mapping EER Model to Relational Model		
	3.3	Relational Algebra: operators selection, projection, Set and Join operations, Aggregate functions ,		
	3.4	Overview of SQL : Data Definition Commands, Data Manipulation commands-CURD Set operations, joins, aggregate functions, Indexing, procedures, triggers, roles		
4	**Database Design**		10	CO4
	4.1	Overview of First Normal Form, Pitfalls in Relational-Database designs		
	4.2	Function Dependencies, , Decomposition, desirable properties of decomposition		
	4.3	2nd , 3rd , BCNF and 4th normal form		
5	**Information systems**		09	C04
	5.1	Foundations of Information systems in Business		
	5.2	Role of Information systems in organizations ,database design and Implementation process macro and micro life cycle		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Elmasri and Navathe	Fundamentals of Database Systems	Pearson Education	7th edition, 2017
2.	Korth, Silberchatz, Sudarshan	Database System Concepts	McGraw Hill	6th edition, 2013
3	James A.O'Brien	Management Information system"	McGraw Hill	10th edition, 2017

4	Raghu Ramakrishnan, Johannes Gerhke,	Database Management Systems	McGraw Hill	3rd edition, 2014
5	G. K. Gupta	Database Management Systems	McGraw Hill	1st edition, 2011

Course Code	Course Title				
216M20L601	Data Management and Information Systems				
	TH		P	TUT	Total
Teaching Scheme(Hrs.)	-		02	--	02
Credits Assigned	-		01	--	01
Examination Scheme	Marks				
	CA		ESE	LAB / CA	Total
	ISE	IA			
	-	-	-	50	50

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course 'Data Science and Analytics'. Students will be graded based on continuous assessment of their term work.

Course Code	Course Title						
216M20C701	**Fundamentals of Big Data Analytics**						
	TH			**P**	**TUT**		**Total**
Teaching Scheme(Hrs.)	**03**			-	--		**03**
Credits Assigned	**03**			-	--		**03**
Examination Scheme	**Marks**						
	CA		**ESE**	LAB CA			**Total**
	ISE	**IA**					
	30	**20**	**50**	-			**100**

Course prerequisites:

- Database and Information systems

Course Objectives:

In this course the students will develop skills to practice Big Data Analytics, which includes study of modern computing big data technologies and scaling up mining techniques focusing on industrial applications. It introduces to the tools required to manage and analyze big data like Hadoop, Apache Spark, NoSql, Map-Reduce. It familiarizes students with fundamental techniques and principles in achieving big data analytics with scalability and streaming capability. Thus this course will enable students to develop skill that helps them to solve complex real-world problems in for decision support.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Understand Big Data and various Big Data Frameworks

CO2: Apply fundamental enabling techniques like Hadoop, Map Reduce and NO SQL and scalable algorithms in big data analytics

CO3: Interpret business models and scientific computing paradigms and apply software tools for big data analytics

CO4: Model perspectives of big data analytics in social networking applications etc.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Big Data and Big Data Frameworks**		9	CO 1
	1.1	Introduction to Big Data, Big Data characteristics, Types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions.		
	1.2	**Cloud Computing for Big Data**: Introduction to cloud computing , Cloud Computing to support Big Data		
	1.2	**Hadoop**: Core Hadoop Components; Hadoop Ecosystem, Physical Architecture; Hadoop limitations.		
	1.3	**Apache Spark:** Need of Spark, Architecture of spark, , Resilient Distributed Datasets, Spark Execution		
2	**MapReduce and the New Software Stack**		8	CO2

	2.1	**Distributed File Systems:** Physical Organization of Compute Nodes, Large-Scale File-System Organization		
	2.2	**MapReduce:** The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.		
	2.3	**Algorithms Using MapReduce:** Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step.		
3	**Mining Data Streams**		**10**	**CO2, CO 3**
	3.1	**The Stream Data Model:** A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing, Concept of sliding windows.		
	3.2	**Counting Distinct Elements in a Stream**: The Count-Distinct Problem, The Flajolet-Martin Algorithm		
	3.3	**Counting Ones in a Window:** The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Concept of decaying Windows		
4	**No SQL**		**8**	**CO2**
	4.1	Introduction to NoSQL, NoSQL business drivers; NoSQL case studies;		
	4.2	**NoSQL data architecture patterns:** Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns;		
	4.3	**Using NoSQL to manage big data:** Big Data NoSQL solution, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems		
5	**Mining Social Networks and Graphs**		**10**	**CO4**
	5.1	Social Networks as Graph, Clustering of Social-Network Graphs, Direct Discovery of Communities, Counting triangles		

Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Anand Rajaraman and Jeff Ullman	Mining of Massive Datasets	Cambridge University Press	3rd edition, 2020
2.	Alex Holmes	Hadoop in Practice	Dreamtech Press	2nd edition, 2014
3.	Dan McCreary and Ann Kelly	Making Sense of NoSQL	Manning Press	1st edition, 2013
4.	Radha Shankarmani, M. Vijayalakshmi	Big Data Analytics	Wiley	2nd edition , 2016
5.	Bill Chambers and Matei Zaharia	Spark: The Definitive Guide.	O'Reilly	1st edition, 2018
6.	Yun Li, Qian Liu	Big Data and Cloud Computing	Springer	1st edition, 2019

Broad areas of lab Projects which can be applied to the diverse domains:

1. Forecasting
2. Recommendation systems
3. Surveillance
4. Prediction
5. Recognition systems

Alternative online courses

- Python for Data Science, IIT Madras
- Data Analytics with Python, IIT Roorkee
- Introduction to Data Analytics, IIT Madras
- Data Science for Engineers, IIT Madras
- Machine Learning, IIT Madras
- Machine Learning for Engineering and Science Applications, IIT Madras

- Machine Learning, KTH Royal Institute of Technology, Stockholm, Sweden, IIT Ropar
- Practical Machine Learning with Tensorflow, IIT Madras
- Database Management Systems, IIT Kharagpur
- Introduction to Database Systems and Design, IIT Madras
- Fundamentals of Database Systems, IIT Kanpur
- Big Data Computing, IIT Patna

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M20L701</td><td colspan="5">Fundamentals of Big Data Analytics</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">-</td><td>02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">-</td><td>01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB / CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td colspan="2">50</td><td>50</td></tr>
</table>

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course 'Data Science and Analytics'. Students will be graded based on continuous assessment of their term work.

<table>
<tr><th>Course Code</th><th colspan="7">Course Title</th></tr>
<tr><td>216M20P702</td><td colspan="7">Mini Project</td></tr>
<tr><td></td><td colspan="4">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs./Week)</td><td colspan="4">-</td><td>04</td><td>-</td><td>04</td></tr>
<tr><td>Credits Assigned</td><td colspan="4">-</td><td>02</td><td>-</td><td>02</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="7">Marks</td></tr>
<tr><td colspan="3">CA(TH)</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB CA</td><td rowspan="2">Total</td></tr>
<tr><td colspan="2">ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">50</td><td>50</td></tr>
</table>

Course prerequisites:

Course Objectives: The objectives are to address a real-world problem, which includes identifying and solving the problem by implementing the solution using the courses learned in earlier semesters. Recognize various hardware and software requirements for solving the problem. It will also inculcate qualities such as working in a team, meeting deadlines, making and following work plans. The Project may include some software or techniques not covered in the courses taught to provide a solution of the chosen problem.

Course Outcomes:
At the end of successful completion of the course the student will be able to

CO1. Define the problem statement and scope of problem.
CO2. Identify various hardware and software requirements for problem solution
CO3. Describe the design with the help of flowchart/block diagrams or any design Tool.
CO4. Implement and test the design to meet the desired specifications.
CO5. Analyze, interpret results and correspondingly modify the designed system to get the desired results.
CO6. Prepare a technical report based on the project.

Term Work and Oral: This is an activity to be undertaken by a group of 3-4 participants preferably from different major programmes. Each project will be assigned one faculty member as a supervisor. There will be a continuous assessment and progress report of the project that needs to be maintained by student(s). The final oral will be a presentation based on a demonstration of the project in front of a committee of examiners.

Proposed areas for Projects:

1. Chatbots
2. Recommendation System i.e. music (Spotify app)
3. Monitoring System i.e. fake product review, movie review etc.
4. Game Design i.e. snake
5. Expert System for Health, Agriculture etc.
6. Classification Systems
7. Detection Systems
8. Recognition System
9. Data Analysis and Visualization

Alternative online courses:

- Fundamentals of Artificial Intelligence by NPTEL Prof. Shyamanta M. Hazarika
- Artificial Intelligence Search Method by NPTEL Prof. Deepak Khemani
- Python for Data Science by NPTEL Prof. Ragynathan Rengasamy
- Artificial Intelligence by Udacity
- Machine Learning Engineer by Udacity
- Deep Learning by Udacity
- Machine Learning by COURSERA Andrew Ng
- Deep Learning by COURSERA Andrew Ng
- Data Analysis with Python by COURSERA Joseph Santarcangelo
- Analyzing Data with Python by edX Joseph Santarcangelo
- Data Analysis with Python and SQL by Udacity

Syllabus

Minor in Augmented and Virtual Reality

(Programme commenced from AY 2024-25)
Offered by Department of Electronics and Computer Engineering

From
Academic Year 2024-25
(SVU-KJSCE 2.0)

(Approved by BOS dated 23-Apr-24)

Minor programme on

Augmented and Virtual Reality Systems

Offered by Department of Electronics Engineering

Introduction

The emergence of Augmented and Virtual Reality (AR/VR) is taking technology through the next level of immersive experience. Augmented Reality is the technology that helps the user to connect its direct or indirect physical world with the help of digital information provided by computers in real-time. It helps people to think beyond their imagination. AR combines both real and virtual objects and is one of the most interactive technologies in the present scenario.AR applications are widely available in mobile devices, audio-visual media like news, entertainment, sports becoming an essential part of our lives. Virtual reality is the experience that can be similar or different to the real world. It helps to educate and entertain users and therefore find wide applications in gaming, entertainment, medicine, training industries, and military purposes.

Objective

To train students in designing and building AR/VR platforms. The course focuses on developing industry-ready AR/VR Engineers who can develop hardware and corresponding software along with it. Students will be introduced to all the aspects of AR/VR technology, which is going to become an integral part of daily life in the near future. Students will able to create systems that allow the user to interact with the immersive 3D world.

At the successful completion of this minor program an engineering graduates will be able to

LO1. Understand the basics of augmented and Virality systems to design and develop small applications.

LO2. Gain insights into AR/VR industrial applications and future technologies like mixed reality.

Eligibility Criteria:

Students who have passed First Year of Engineering in any branch at K. J. Somaiya College of Engineering.

Assessment Methods: Projects, App developments, Tests, Laboratory experiments, Presentation / Video making, Quiz, study of research papers etc

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216 M06C 301	Sensors and Actuators in Augmented and Virtual Reality	3 – 0 – 0	3	3-0-0	3	III
216 M06C 301	Sensors and Actuators in Augmented and Virtual Reality Laboratory	0 – 2 – 0	2	0-1-0	1	III
216 M06C 401	Virtual Reality System and Virtual Reality Hardware	3 – 0 – 0	3	3-0-0	3	IV
216 M06C 401	Virtual Reality System and VR Hardware Laboratory	0 – 2 – 0	2	0-1-0	1	IV
216 M06C 501	Augmented Reality and Multidimensional System (4DX, DTS)	3 – 0 – 0	3	3-0-0	3	V
216 M06C 501	Augmented Reality and Multidimensional System (4DX, DTS) Laboratory	0 – 2 – 0	2	0-1-0	1	V
216 M06 P 601	Mini Project	0 – 4 – 0	2	0-2-0	2	VI
216 M06C 701	Mixed Reality and Advanced System (XR, DR)	3 – 0 – 0	3	3-0-0	3	VII
216 M06C 701	Mixed Reality and Advanced System (XR, DR) Laboratory	0 – 2 – 0	2	0-1-0	1	VII
Total		**12–10–0**	**22**	**12–5 – 1**	**18**	

Examination Scheme

Course Code	Course Category	Course Name	Lab/CA	CA		ESE	Total
				IA	ISE		
216 M06C 301	PC	Sensors and Actuators in Augmented and Virtual Reality	-	20	30	50	100

216 M06C 301	PC	Sensors and Actuators in Augmented and Virtual Reality Laboratory	50	-	-	-	50
216 M06C 401	PC	Virtual Reality System and Virtual Reality Hardware	-	20	30	50	100
216 M06C 401	PC	Virtual Reality System and VR Hardware Laboratory	50	-	-	-	50
216 M06C 501	PC	Augmented Reality and Multidimensional System (4DX, DTS)	-	20	30	50	100
216 M06C 501	PC	Augmented Reality and Multidimensional System (4DX, DTS) Laboratory	50	-	-	-	50
216 M06 P 601	PC	Mini Project	50	-	-	-	50
216 M06C 701	PC	Mixed Reality and Advanced System (XR, DR)	50	20	30	-	50
216 M06C 701	PC	Mixed Reality and Advanced System (XR, DR) Laboratory	50	-	-	-	50
Total			**250**	**80**	**120**	**200**	**650**

Course Code	Course Name						
216M06C301	Sensors and Actuators in Augmented and Virtual Reality						
	TH			P	TUT	Total	
Teaching Scheme (Hrs.)	03			-	-	03	
Credits Assigned	03			-	-	03	
Examination Scheme	Marks						
	CA		ESE	LAB/TUT CA		Total	
	ISE	IA					
	30	20	50	-		100	

Course prerequisites: None

Course Objectives:

The objective of this subject is to introduce students with sensors and actuators in Augmented and Virtual reality (AR/VR) technology. The course also covers advances in integrated circuit and manufacturing techniques that raised the capabilities of VR and AR systems.

Course Outcomes:

At the end of successful completion of the course, the student will be able to

CO1: Study basic sensors used in Augmented reality systems

CO2: Gain basic knowledge sensors in Virtual reality headsets

CO3: Understand advanced sensors and actuators used in Augmented reality

CO4: Understand advanced sensors and actuators used in Virtual reality hardware

CO5: Interface sensors and actuators to AR and VR systems

Module No.	Unit No.	Details	Hrs.	CO
1		**Introduction to Sensors in Augmented Reality**	9	CO1
	1.1	Introduction to sensors Augmented Reality, next-generation sensors, applications Sensors in Tablet/ Computer/ Smart phones,		
	1.2	Optical sensors, Inertial Measurement Unit (IMU), accelerometers, GPS, gyroscopes, solid-state compasses, Radio-frequency identification (RFID)		

2	**Introduction Sensors in Virtual Reality**		**6**	**CO2**
	2.1	History of sensors in Virtual Reality, next-generation sensors, applications areas, Current Developments		
	2.2	Magnetometer, Gyroscope. Head tracking Merchanisms: Working Principle and Limitations		
3	**Advanced Sensors and Actuators in Augmented Reality**		**9**	**CO3**
	3.1	Vibretor motors, Speaks systms in Augmented reality, AR headsets (Construction and working)		
	3.2	Advanced sensors, Special Cameras: Time of Flight (ToF) Cameras, Binocular Depth Sensing, Structured-light sensors Heads-Up Display, Tethered headset-based sensors, Mobile Headset-based sensors		
4	**Advanced sensors and actuators in Virtual Reality**		**9**	**CO4**
	4.1	vehicle Simulator, CAVE (Cave Automated Virtual Environment), tethered headset personal computer game console-based actuators, Mobile headset Smartphone-based actuators.		
	4.2	Input devices like joysticks, force Balls/Tracking balls, controller wands, data gloves, trackpads, On-device control buttons, motion trackers, MEMS sensors, Magnetic Hall effect sensors and Integrated Magneto Concentrators (IMC)		
5	**Software and interfacing of Sensors and Actuators with AR/VR applications**		**12**	**CO5**
	5.1	Softwares used for programming (Arduino, Keil, Proteous, Vuforia, SimX), Hardware interfacing of sensors with Raspberry pi, Arduino		
	5.2	Actuator simulation software (FluidSIM, MATLAB/ SCILAB, Autosim, Fluid draw), Unity, Unreal Engine, SketchUp		
		Total	**45**	

Recommended Books:

Sr. No.	**Name/s of Author/s**	**Title of Book**	**Name of Publisher with country**	**Edition and Year of Publication**
1.	Alan B. Craig	Understanding Augmented Reality : Concepts and Applications	Elsevier , USA	1st Edition , Year 2013
2.	Peter Riendeau	Augmented And Virtual Reality: The Next Big Thing In Marketing	Press Books , USA	1st Edition, Year 2017

3.	Bruno Arnaldi , Pascal Guitton, Guillaume Moreau	Virtual Reality and Augmented Reality: Myths and Realities	Wiley, USA	1st Edition, Year 2018
4.	Nawaz Mohamudally	State of the Art Virtual Reality and Augmented Reality Knowhow	IntechOpen , USA	1st Edition , Year 2018
5.	Rabe, Johannes	Lane-Precise Localization with Production Vehicle Sensors and Application to Augmented Reality Navigation	KIT Scientific Publishing, Germany	1st Edition, Year 2018

Course Code	**Course Title**				
216M06C301	**Sensors and Actuators in Augmented and Virtual Reality**				
	TH				**Total**
Teaching Scheme(Hrs.)	–				**02**
Credits Assigned					**01**
Examination Scheme	**Marks**				
	LAB / TUT CA	**CA**		**ESE**	**Total**
		ISE	**IA**		
	50	–	–	-	**50**

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Term work will consist of experiments covering the entire syllabus of " **Sensors and Actuators in Augmented and Virtual Reality**" (216M06C301). Students will be graded based on continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

<table>
<tr><th>Course Code</th><th colspan="5">Course Name</th></tr>
<tr><td>216M06C401</td><td colspan="5">Virtual Reality systems and Virtual Reality Hardware</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="3">03</td><td></td><td>-</td><td>03</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">03</td><td></td><td>-</td><td>03</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>50</td><td colspan="2">-</td><td>100</td></tr>
</table>

Course prerequisites:
None
Course Objectives:

The course is aimed at training students on different Virtual reality (VR) hardware and software used in the industry. This course will also help students in selecting proper hardware from existing systems and they will able to design VR hardware on their own.
Course Outcomes:

At the end of successful completion of the course, the student will be able to
CO1: Understand the concepts of virtual reality.
CO2: Understand the interfacing devices used for input and output in virtual reality.
CO3: Understand the VR hardware technology and to create a VR application.
CO4: Program complete VR hardware using the Unity software.
CO5: Implement VR hardware in real-life scenarios.

Module No.	Unit No.	Details	Hrs.	CO

1	**Introduction to Virtual Reality (VR) Concepts and Technologies**		**6**	**CO1**
	1.1	Overview of VR history and evolution.,Explanation of core VR concepts, including immersion, presence, and interaction.Introduction to various VR hardware components (headsets, controllers, sensors) and their functionalities.		
2	**Interface to the virtual world-input and output**		**12**	**CO2**
	2.1	User input to the virtual world, position tracking, body tracking, and other physical input devices, Dynamic input to the virtual world, persistent virtual worlds and bringing the real world into the virtual world		
	2.2	Visual displays, visual depth, properties of visual displays monitors, VR projection, VR headgear, VR see headset displays handheld VR, Auditory input devices with VR displays, Head-gear aural displays, speakers combining aural display systems, haptic displays, other sensors		
3	**Virtual Reality hardware and its applications**		**9**	**CO3**
	3.1	Introduction to VR hardware, Pneumatic, Hydraulic, Electric actuator, VR glasses, Google Cardboard VR, Sony PS-VR, HTC Vive, Oculus Rift, Samsung Gear, etc.		
	3.2	VR based industry training and simulators, Gaming and performance analysis and Medical and physical fitness application.		
4	**Interfacing VR hardware**		**9**	**CO4**
	4.1	Different sensors interfacing with VR glasses, Rain sensors, Wind, Snow, flash, Bubble generator.		
	4.2	Peripheral interface USB camera, Capacitive touchscreen, VR Sticks, Gloves, Joystick, Microphone. Introduction to software (Unity) interfacing and synchronization		
5	**Designing VR systems**		**9**	**CO5**
	5.1	Creating a VR application adapting from other media, adapting from an existing VR experience creating a new VR. Design with the audience in mind, consider design tradeoffs, design the user objective, deploy and evaluate the experience		
	5.2	Future Virtual Reality systems, Expectations from VR technology, VR research trends technology, Futures		

		display technologies, Latest input technologies, Software to hardware interface in VR, software applications with VR.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Willam R. Sherman Alan Clag	Understanding virtual Reality	Morgan Kaupmann, USA	2nd Edition, Year 2018
2.	Tony Parisi	Learning Virtual Reality: Developing Immersive Experiences and Applications	O'Reilly Media Inc, USA	1st Edition, Year 2015
3.	Jason Jerald	The VR book :Human centered design for virtual Reality	Association for computing Machinery and Morgan and Clay pool publishers, USA	1st Edition, Year 2016
4.	Paul Mealy	Virtual & Augmented Reality For Dummies	John Wiley & Sons, USA	1st Edition, Year 2018
5.	Grigore C. Burdea, Philippe Coiffet	Virtual Reality Technology	John Wiley & Sons, USA	1st Edition, Year 2003

Course Code	**Course Title**				
216M06C401	**Virtual Reality systems and VR Hardware**				
	TH				**Total**
Teaching Scheme(Hrs.)					**02**
Credits Assigned	–				**01**
Examination Scheme	**Marks**				
	LAB / TUT CA	**CA**		**ESE**	**Total**
		ISE	**IA**		
	50	–	–	-	**50**

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Term work will consist of experiments covering the entire syllabus of "**Virtual Reality systems and VR Hardware**"(216M06C401) . Students will be graded based on continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Course Code	Course Name			
216M06C601	Augmented Reality and Multidimensional Systems(4DX, DTS)			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	02	-	05
Credits Assigned	03	01	-	04

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	-	100

Course prerequisites: None

Course Objectives:
The course is aimed at training students on different Augmented reality (AR) systems and covers software used in AR industry. This course will also help students in understanding the importance of Multidimensional systems and 4D-X systems

Course Outcomes:

At the end of successful completion of the course, the student will be able to
CO1: Understand emerging digital technology of Augmented reality.

CO2: Learn Different techniques for the development of AR application.

CO3: Learn to develop a model with 4D-X

CO4: Learn to create and animate virtual environments with Unity and other software.

CO5: Design and develop application in Augmented reality and Multidimensional systems.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Augmented Reality**		9	CO1
	1.1	Introduction to AR, 3D systems, Light, and shadows in AR		
	1.2	Augmented reality hardware systems (Google glass, Magic leap one)		
	1.3	Augmented reality softwares (Spark AR, Unity, Augment)		
2	**Multidimensional system**		9	CO2
	2.1	Introduction to Multidimensional systems (4D-X cinema, &D chair, Motion feedback controllers)		
	2.2	Softwares in Multidimensional systems (3D max, AutoCAD, Unity) Basic concepts of 3d Modeling Surfaces, Light, and Rendering: Creating material, editing material.		
	2.3	Different channels in Multidimensional systems, The basic channel setting: The diffuse channel, The Luminance Channel, The Transparency channel, The Reflection channel, The Environment channel, The Fog channel, The Bump channel, The Normal channel, The Alpha channel		
3	**Hardware used in Multidimensional systems**		9	CO3
	3.1	Pneumatic controllers, Hydraulic controllers, Electric servos, Cave systems, Headset and Other hardware simulators (Bike, CAR, Plane cockpit, Spacecraft, Parachute)		
	3.2	Interfacing 4D-X software with hardware, Deploying and synchronizing software in 4D-X movies. Sound mixing and Multichannel video synchronization.		
4	**Softwares in AR and multidimensional systems**		9	CO4
	4.1	AR development with Unity, C# programming basics, Making apps with Spark AR, GearAR, Augment		
	4.2	Basics of Preparing the scene, Starting the render process, The virtual photo studio, using a camera, working with area lights, applying the material, Modelling and texturing, Rendering and saving images, Output setting, Antialiasing setting, Option setting		
	4.3	4D-X movie making software (Movavi, Motion graphics software, Blender, Premiere Pro)		
5	**Applications of AR and Multidimentinal systems**		9	CO5
	5.1	Applications in Gaming, Case study: Pokemon GO AR. Applications in Industry (Manufacturing, Travel, Retail, Food, Navigation, Healthcare, Education)		

	5.2	Case study Inox 4D-X, Transformers ride in Universal studio, Mastiii 7D Theater, Smash gaming arena		
	5.3	Application of Multidimensional systems in Industry (Flight simulators, Space shuttle simulator, Heavy engineering simulators (Mining simulators, Bus/Truck simulators)		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Arndt von Koenigsmarck	Cinema 4D 10 Workshop	Focal Press, Burlington, MA	1st Edition, Year 2007
2.	Ray Zone	3-D Revolution: The History of Modern Stereoscopic Cinema	University Press of Kentucky, USA	1st Edition,Year 2012
3.	J. LaViola Jr., E. Kruijff, R. McMahan, D. Bowman, and I. Poupyrev.	3D User Interfaces: Theory and Practice	Addison-Wesley, USA	2nd Edition., Year 2017
4.	D. Schmalstieg and T. Höllerer	Augmented Reality: Principles and Practice.	Addison-Wesley, USA	1st Edition, Year 2016
5	Steve Aukstakalnis	Practical Augmented Reality	Addison-Wesley Professional, USA	1st Edition, Year 2016

<table>
<tr><td>Course Code</td><td colspan="5">Course Title</td></tr>
<tr><td>216M06C601</td><td colspan="5">Augmented Reality and Multidimensional Systems(4DX, DTS)</td></tr>
<tr><td></td><td colspan="4">TH</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="4"></td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="4"></td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td rowspan="2">LAB / TUT CA</td><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
</table>

	50	–	–	-	50

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Term work will consist of experiments covering the entire syllabus of "**Augmented Reality and Multidimensional Systems(4DX, DTS) "**(216M06C60).

Students will be graded based on continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Course Code	Course Name				
216M06C701	Mixed reality and advanced systems (XR, DR)				
	TH		P	TUT	Total
Teaching Scheme (Hrs.)	03		02	-	05
Credits Assigned	03		01	-	04
Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	-	100

Course prerequisites:
Augmented reality, Virtual reality

Course Objectives:

The course aims at combining the knowledge that students gained, during augmented and virtual reality and make use of it, to deploy mixed reality systems. The course covers advanced topics like diminishing reality, extended reality, and applications of mixed reality to the industry which will benefit students in becoming industry-ready AR/VR engineers.

Course Outcomes:

At the end of successful completion of the course, the student will be able to
CO1: Understand the mixed reality systems.

CO2: Create real-time 3D objects with advanced augmentation

CO3: Understand the latest hardware used in mixed reality

CO4: Apply concepts of diminished reality and extended reality

CO5: Implement simple applications on mixed reality hardware

Module No.	Unit No.	Details	Hrs.	CO
1	**Mixed reality**		**9**	**CO1**
	1.1	Introduction to mixed reality (MR), Vision-based tracking for mixed reality, Evolution and framework of mixed reality, Social and physical interactive paradigms for mixed reality environment		
2	**Advanced augmentation**		**9**	**CO2**
	2.1	Projector-based augmentation, Mobile phone-based augmentation		
	2.2	Processing screen space, Real-time 3d Modelling of outdoor structures		
3	**Mixed reality hardware**		**9**	**CO3**
	3.1	Creating Mixed reality environments, Abstraction, and implementation strategies for mixed reality		
	3.2	Latest mixed reality hardware (HoloLens, Nreal, Moverio, eyesight Raptor)		
4	**Advanced systems**		**9**	**CO4**
	4.1	Introduction to Diminished reality (DR) and extended reality (XR)		
	4.2	Future of mixed reality, supporting hardware for MR, DR, and XR		
5	**Applications of MR, DR, and XR**		**9**	**CO5**

	5.1	Industrial applications of mixed reality, Human communication in collaborative mixed reality systems, Mixed reality in architecture, Mixed reality in construction		
	5.2	Applications of DR and XR, Enhance reality in learning environments		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Haller, Michael, Billinghurst, Mark, Thomas, Bruce	Emerging Technologies of Augmented Reality: Interfaces and Design	Idea Group Inc., Canada	1st Edition, Year 2006
2.	Yuichi Ohta, Hideyuki Tamura	Mixed Reality: Merging Real and Virtual Worlds	Springer, Germany	1st Edition, Year 2014
3.	Kenneth J. Varnum	Beyond Reality: Augmented, Virtual, and Mixed Reality in the Library	American Library Association, U.S.A.	1st Edition, Year 2019
4.	Xiangyu Wang, Marc Aurel Schnabel	Mixed Reality In Architecture, Design, And Construction	Springer Science & Business Media, Germany	1st Edition, Year 2008
5.	Jolanda G. Tromp, Dac-Nhuong Le, Chung Van Le	Emerging Extended Reality Technologies for Industry 4.0	John Wiley & Sons,	1st Edition, Year 2020

Course Code	**Course Title**			
216M06C701	**Mixed reality and advanced systems (XR, DR)**			
	TH			**Total**
Teaching Scheme(Hrs.)				**02**
Credits Assigned				**01**
Examination Scheme	**Marks**			
	LAB /	**CA**	**ESE**	**Total**

	TUT CA	ISE	IA		
	50	–	–	-	50

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Term work will consist of experiments covering the entire syllabus of "**Mixed reality and advanced systems (XR, DR)**"216M06C701

Students will be graded based on continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Syllabus
Second Year
Minor in Drone Technology

(Programme commenced from AY 2024-25)
Offered by Department of Electronics and Computer Engineering

From
Academic Year 2024-25

(SVU-KJSCE 2.0)

(Approved by BOS dated 23-Apr-24)

Minor Programme on Drone Technology

Offered by Department of Electronics and Computer Engineering

Introduction

A minor in Drone Technology offers students a comprehensive exploration of unmanned aerial and underwater systems, providing a valuable complement to various major disciplines. This interdisciplinary program equips students with essential knowledge and skills in the design, operation, and applications of drones. The curriculum begins with foundational courses covering drone types, components, and applications, creating a solid understanding of the technology's breadth. Practical, hands-on experiences in laboratories allow students to develop proficiency in operating drones and applying theoretical concepts to real-world scenarios. As students progress, specialized courses delve into areas such as underwater drones, aerial surveying, and drone programming, enhancing their expertise in specific applications. The program also addresses legal and ethical considerations, ensuring graduates are well-versed in the regulatory landscape and ethical implications of drone use. A capstone project crowns the minor, providing an opportunity for students to showcase their skills and apply knowledge to solve practical challenges. With an industry-relevant focus, the minor in Drone Technology prepares students for careers in fields such as agriculture, environmental monitoring, and surveying, offering a competitive edge in a technology-driven job market. This minor not only cultivates technical proficiency but also fosters innovation and entrepreneurship in the rapidly evolving field of drone technology.

Objective

The objective of the Drone Technology minor is to empower students with a specialized skill set in unmanned aerial and underwater systems. Through a comprehensive curriculum, students gain a deep understanding of drone types, components, and applications, coupled with hands-on laboratory experiences. The program aims to foster interdisciplinary learning, providing expertise in design, programming, and ethical considerations related to drone technology. By offering a well-rounded education, the minor prepares students for diverse career opportunities in industries such as agriculture, environmental science, and surveying. Ultimately, the objective is to equip graduates with the knowledge and practical skills necessary to thrive in a technology-driven workforce increasingly reliant on drone applications.

Learning Outcomes:

At the successful completion of this minor program an engineering graduates will be able to

- **LO1:** Foster an Interdisciplinary Mindset: Integrate drone technology knowledge with concepts from the student's major discipline, facilitating the application of drones in specialized contexts. Demonstrate proficiency in interdisciplinary thinking, enabling the synthesis of diverse knowledge for effective problem-solving.

- **LO2:** Cultivate Collaboration and Innovative Problem-Solving: Promote collaboration and teamwork across diverse fields, equipping students with the skills to effectively leverage drone technology.

Develop creative problem-solving abilities, empowering students to innovate and apply drone technology in novel ways within their chosen career paths.

List of proposed courses

- Introduction to Drones
- Unmanned Aerial Systems Design
- Fundamentals of Underwater Drones
- Fundamentals of Autonomous Drones Programming

Eligibility Criteria:
Students who have passed the First Year of Engineering in any branch at K. J. Somaiya College of Engineering.

Assessment Methods: Projects, Drone developments, Flight Tests, Laboratory experiments, Presentation / Video making, Quiz, study of research papers etc.

Key Information
Duration: 3 Years
Total credits: 18
Programme Code: ______
Course Type: Minor Degree
Mode of study: Full time
Campus: Vidyavihar - Mumbai
Institute: KJSCE

Credit Scheme

Course Code	Course Category	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total credits	Semester of Major Degree
216m08C401	PC	Introduction to Drone Technology	3-0-0	03	3-0-0	03	IV
216m08L401	PC	Introduction to Drone Technology Lab	0-2-0	02	0-1-0	01	IV
216m08C501	PC	Unmanned Aerial Systems Design	3-0-0	03	3-0-0	03	V
216m08L501	PC	Unmanned Aerial Systems Design Lab	0-2-0	02	0-1-0	01	V
216m08C601	PC	Fundamentals of Underwater Drones	3-0-0	03	3-0-0	03	VI
216m08L601	PC	Fundamentals of Underwater Drones Lab	0-2-0	02	0-1-0	01	VI
216m08C701	PC	Autonomous Drone Programming	3-0-0	03	3-0-0	03	VII
216m08L701	PC	Autonomous Drone Programming Lab	0-2-0	02	0-1-0	01	VII
216m08P701	PC	Mini Project	0-2-0	02	0-2-0	04	VII
Total			**12-12-0**	**24**	**12-6-0**	**18**	

Evaluation Scheme

Course Code	Course Category	Name of the Course	CA		ESE	LAB/TUT CA	Total
			ISE	IA			
216m08C401	PC	Introduction to Drone Technology	30	20	50	-	100
216m08L401	PC	Introduction to Drone Technology Lab	-	-	-	50	50
216m08C501	PC	Unmanned Aerial Systems Design	30	20	50	-	100
216m08L501	PC	Unmanned Aerial Systems Design Lab	-	-	-	50	50
216m08C601	PC	Fundamentals of Underwater Drones	30	20	50	-	100
216m08L601	PC	Fundamentals of Underwater Drones Lab	-	-	-	50	50
216m08C701	PC	Autonomous Drone Programming	30	20	50	-	100
216m08L701	PC	Autonomous Drone Programming Lab	-	-	-	50	50
216m08P701	PC	Mini Project	-	-	-	50	50
Total			**120**	**80**	**200**	**250**	**650**

Course Code	Course Title			
216m08C401	Introduction to Drone Technology			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	03	--	--	03
Credits Assigned	04	--	--	04

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

- **Course prerequisites:** None

Course Objectives:.
Students will delve into the multifaceted world of drone technology. They will gain a comprehensive understanding of drones, tracing their historical evolution and recognizing their diverse utility across industries. Through detailed analysis of drone components and flight principles, students will grasp the intricate mechanics underlying drone operation, including aerodynamics, flight control, and safety procedures. Moreover, they will develop critical thinking skills to evaluate ethical and social implications associated with drone usage. Ultimately, students will emerge prepared to apply their newfound knowledge in practical scenarios, proficient in the fundamentals of drone operation and management.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1: define drones comprehensively, tracing their historical evolution and recognizing their diverse utility across industries.
CO2: navigate drone operation with a keen awareness of safety protocols, legal considerations, and regulatory compliance.
CO3: grasp the intricate mechanics underlying drone operation, including aerodynamics, flight control, and safety procedures.
CO4: develop critical thinking skills to evaluate ethical and social implications associated with drone usage.
CO5: prepared to apply their newfound knowledge in practical scenarios, proficient in the fundamentals of drone operation and management.

Module	Unit	Details	Hrs.	CO

No.	No.			
1	Introduction to Drone Technology		09	CO1
	1.1	Understanding the concept of drones and their significance, exploring the various applications of drones in different fields.		
	1.2	Tracing the evolution of drone technology from its early beginnings to the present day. Highlighting key milestones and breakthroughs.		
	1.3	Categorizing drones based on their design, purpose, and capabilities. Discussing differences between fixed-wing, rotary-wing, and hybrid drones		
	1.4	Investigating real-world use cases for drones, including aerial photography, agriculture, surveillance, search and rescue, and more. Examining the impact of drones on industries and society.		
	1.5	Understanding legal and regulatory frameworks related to drone operation. Discussing airspace restrictions, licensing, and safety guidelines.		
2	Drone Components		09	CO2
	2.1	Exploring the physical structure of drones, including frames, wings, and fuselage. Differentiating between fixed-wing and multirotor airframes. Propulsion System Flight Control System		
	2.2	Studying the engines, motors, and propellers that provide thrust to drones. Analyzing electric, gas-powered, and hybrid propulsion systems.		
	2.3	Investigating flight controllers, gyroscopes, and accelerometers. Understanding how flight control algorithms stabilize and maneuver drones. Examining sensors such as GPS, altimeters, cameras, LiDAR, and IMUs. Discussing their role in navigation, obstacle detection, and data collection.		
	2.4	Defining payload components, including cameras, sensors, and communication devices. Considering payload capacity and its impact on drone performance.		
3	Drone Flight Principles		09	CO3
	3.1	Exploring the principles of lift and drag in aerodynamic design. How wing shape and airfoil profiles affect drone performance.		
	3.2	Understanding lift generation through rotor blades or wings. Lift-to-weight ratio and its significance. Analyzing propulsion systems and their contribution to forward motion. Balancing thrust and drag during flight.		
	3.3	Factors affecting air resistance and drag force. Streamlining design for efficient flight. Considering the weight of the drone and its impact on flight dynamics. Payload weight and its effect on endurance.		
		Exploring pitch, roll, and yaw stability. How control surfaces and flight control algorithms maintain stability.		

4	Drone Flight Control		**09**	**CO4**
	4.1	Managing pitch, roll, and yaw angles. Role of gyroscopes and accelerometers in maintaining desired orientation.		
	4.2	Using GPS and other sensors for accurate position tracking. Implementing waypoint navigation and geofencing.		
	4.3	Creating optimal flight paths for specific missions. Collision avoidance and path optimization algorithms.		
	4.4	Techniques for detecting and avoiding obstacles during flight.Sensor-based obstacle detection systems.		
5	Drone Safety		**09**	**CO5**
	5.1	Essential steps before every drone flight. Verifying equipment, battery levels, and weather conditions.		
	5.2	Best practices for safe takeoff, flight, and landing. Emergency shutdown procedures.		
	5.3	Handling critical situations such as loss of control, low battery, or mechanical failures. Emergency landing protocols.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Serge A. Wich, Lian Pin Koh · 2018	*Conservation Drones Mapping and Monitoring Biodiversity*	Oxford University Press, UK	1st Edition, 2018
2.	A.R. Jha	*Theory, Design, and Applications of Unmanned Aerial Vehicles*	CRC Press, US	1st Edition 2016
3.	Eds. Pascual Marqués, Andrea Da Ronch	*Advanced UAV Aerodynamics, Flight Stability and Control Novel Concepts, Theory and Applications 2017*	Wiley, US	1st Edition 2017
4	Adam Juniper	*The Complete Guide to DronesWhatever Your Budget - Build + Choose + Fly + Photograph*	Book Sales, US	1st Edition 2016

Course Code	Course Title			
216m08L401	Introduction to Drone Technology Lab			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	-	2	-	2
Credits Assigned	-	1	-	1

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	-	-	-	50	50

Term-Work:
Term work will consist of experiments/ tutorials covering the entire syllabus of the course '116m76C401'. Students will be graded based on continuous assessment of their term work

Course Code	Course Title			
216m08C501	Unmanned Aerial System Design			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites: None

Course Objectives:
The "Unmanned Aerial Systems Design" course focuses on the design and engineering aspects of unmanned aerial vehicles (UAVs). Students will learn to define system requirements, encompassing mission definition, payload requirements, flight performance requirements, and environmental considerations. They will explore aerodynamic design principles, propulsion system design, flight control system design, and the integration and testing processes. By the end of the course, students will be equipped with the skills necessary to design, assemble, and test UAV systems for various applications.

Course Outcomes:
At the end of successful completion of the course the student will be able to

CO1: understand the principles of underwater vehicle hydrodynamics, including buoyancy, drag, and propulsion, enabling efficient vehicle design and maneuverability.

CO2: explore the functionality of acoustic sensors, optical sensors, inertial navigation systems, and GPS navigation tailored for underwater vehicles.

CO3: study underwater vehicle communication methods, including acoustic, optical, and RF

communication, and vehicle control systems for reliable communication and precise control.
CO4: develop sophisticated navigation systems for underwater vehicles, incorporating sensor data and navigation algorithms for precise underwater navigation.
CO5: prepared to contribute to the advancement of underwater drone technology and its applications across marine exploration, research, surveillance, and more.

Module No.	Unit No.	Topics	Hrs.	CO
1		System Requirements	09	CO1
	1.1	Understanding the purpose and objectives of the unmanned aerial system (UAS). Defining specific tasks and goals for the UAS. Identifying the payload (sensors, cameras, etc.) needed for the UAS mission. Considering weight, power, and data requirements.		
	1.2	Specifying performance metrics such as endurance, range, speed, and altitude. Balancing trade-offs between different performance parameters. Evaluating the impact of environmental factors (temperature, humidity, wind) on UAS operation. Ensuring the UAS can function effectively in various conditions.		
2		Aerodynamic Design	09	CO2
	2.1	Choosing appropriate airfoil shapes for efficient lift and drag characteristics. Analyzing lift-to-drag ratios and stability. Designing wings for optimal aerodynamic performance. Considering wing loading, aspect ratio, and wing sweep.		
	2.2	Creating a streamlined fuselage to house components and payload. Addressing structural integrity and weight distribution. Designing tail surfaces (horizontal stabilizers and vertical fins) for stability and control. Balancing pitch, roll, and yaw moments.		
3		Propulsion System Design	09	CO3
	3.1	Choosing electric motors or combustion engines based on power requirements. Evaluating efficiency and reliability		
	3.2	Selecting propellers for optimal thrust and efficiency. Matching propeller size to motor specifications.		
	3.3	Determining battery capacity and voltage for desired flight duration. Considering weight and energy density.		
	3.4	Designing power distribution systems for motors, avionics, and sensors. Ensuring stable voltage regulation.		
4		Flight Control System Design	09	CO4
	4.1	Choosing sensors (gyroscopes, accelerometers, GPS, etc.) for navigation and stability.		

		Integrating sensor data into the flight control system. Selecting servos, motors, or other actuators for control surfaces (ailerons, elevators, rudders). Achieving precise control authority		
	4.2	Developing flight control algorithms for stability, attitude control, and path following. Implementing proportional-integral-derivative (PID) controllers. Writing code for autopilot systems and mission planning. Ensuring real-time responsiveness and safety.		
5	System Integration and Testing		**09**	**CO5**
	5.1	Integrating airframe, propulsion system, avionics, and payload. Ensuring proper alignment and secure connections. System Testing		
	5.2	Conducting ground tests to verify functionality and safety. Checking communication links, sensor accuracy, and control responses. Performing test flights to evaluate overall performance. Iteratively refining the design based on flight data.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Editors:George J. Vachtsevanos, Kimon P. Valavanis	*Handbook of Unmanned Aerial Vehicles*	Springer Netherlands	1st Edition 2014
2.	Joseph Katz, Allen Plotkin	*Low- Speed Aerodynamics*	Cambridge University Press, UK	2nd Edition 2001
3.	Stephen D. Prior	*Optimizing Small Multi-Rotor Unmanned Aircraft A Practical Design Guide*	CRC Press, US	1st Edition 2018
4.	E. H. J. Pallett, Shawn Coyle	*Automatic Flight Control*	Wiley India	4th Edition 1993

Course Code	Course Title			
216m08L501	**Unmanned Aerial Systems Design Lab**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**-**	**2**	**-**	**2**

Credits Assigned	-			1	-	1
Examination Scheme	**Marks**					
	CA		**ESE**	**TW**	**LAB/TUT CA**	**Total**
	ISE	**IA**				
	-	-	-	50	--	50

Term-Work:
Term work will consist of experiments/ tutorials covering entire syllabus of the course '116m76C501'. Students will be graded based on continuous assessment of their term work

Course Code	Course Title			
216m08C601	**Fundamentals of Underwater Drones**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	**Marks**				
	CA		**ESE**	**LAB/TUT CA**	**Total**
	ISE	**IA**			
	30	20	50	-	100

Course prerequisites: None

Course Objectives:

In the "Fundamentals of Underwater Drones" course, students will explore the technology and applications of underwater drones. They will learn about different types of underwater drones, their applications, and the challenges associated with their design and operation. Additionally, students will delve into hydrodynamics, dynamics, sensors, navigation, communication, and control systems tailored for underwater environments. By the end of the course, students will emerge with the skills and knowledge necessary to design, operate, and manage underwater drones effectively for marine exploration, research, surveillance, and more.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: gain a thorough understanding of underwater drone technology, including types, applications, and design challenges.

CO2: delve into the principles of hydrodynamics and dynamics, enabling efficient design and maneuverability of underwater vehicles.

CO3: explore the intricacies of sensors, navigation systems, and communication methods tailored for underwater environments.

CO4: develop critical thinking skills to analyze and solve problems related to underwater drone technology.

CO5: emerge prepared to contribute to the advancement of underwater drone technology and its applications across various industries.

Module No.	Unit No.	Topics	Hrs.	CO
1		Introduction to Underwater Drones	09	CO1
	1.1	Types of Underwater Drones Exploring the various categories of underwater drones, including remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), and hybrid systems. Understanding their differences in design, operation, and applications.		
	1.2	Applications of Underwater Drones Investigating the wide range of tasks that underwater drones can perform: Environmental Monitoring: Collecting data on ocean currents, water quality, marine life, and pollution. Search and Rescue: Assisting in locating lost objects, wreckage, or missing persons. Scientific Research: Conducting marine biology studies, geological surveys, and habitat exploration. Infrastructure Inspection: Inspecting underwater pipelines, cables, and submerged structures. Defense and Security: Supporting naval operations, harbor security, and mine detection.		
	1.3	Challenges of Underwater Drone Design and Operation Discussing the unique challenges faced when designing and operating underwater drones: Pressure and Depth: Coping with increasing pressure as depth increases. Communication: Establishing reliable communication links underwater. Energy Efficiency: Managing power consumption for extended missions. Navigation Accuracy: Ensuring precise positioning and navigation		
2		Underwater Vehicle Hydrodynamics	12	CO2
	2.1	Understanding how underwater vehicles achieve neutral buoyancy. Balancing weight and buoyant force to maintain depth control.		
	2.2	Drag Analyzing hydrodynamic drag forces acting on the vehicle. Streamlining the vehicle shape to minimize drag.		
	2.3	Propulsion Investigating propulsion methods, such as propellers, thrusters, and jet systems. Optimizing thrust efficiency for forward motion.		
3		Underwater Vehicle Dynamics	09	CO3
	3.1	Motion Equations Formulating equations of motion for underwater drones. Considering pitch, roll, and yaw dynamics.		
	3.2	Control Systems Implementing control algorithms for stability and maneuverability. PID controllers, adaptive control, and feedback loops.		
4		Underwater Vehicle Sensors and Navigation	09	CO4
	4.1	Acoustic Sensors Using sonar systems for underwater mapping, obstacle detection, and target identification. Echo		

		sounding and side-scan sonar.		
	4.2	Optical Sensors Employing cameras and imaging systems for visual inspection. Challenges related to water clarity and lighting conditions.		
	4.3	Inertial Navigation Systems Integrating accelerometers and gyroscopes for precise position estimation. Dead reckoning and Kalman filtering. GPS Navigation Adapting GPS technology for underwater use. Combining GPS with other sensors for accurate localization.		
5	Underwater Vehicle Communication and Control		**09**	**CO5**
	5.1	Acoustic communication Transmitting data through sound waves underwater. Challenges of low bandwidth and signal attenuation		
	5.2	Optical Communication Using light-based communication for short-range links. Advantages and limitations. RF Communication Exploring radio frequency communication options. Surface-to-underwater communication.		
	5.3	Vehicle Control Systems Integrating all subsystems for seamless operation. Ensuring robust control during complex missions.		
		Total	**45**	

Recommended Books:

Sr. No.	**Name/s of Author/s**	**Title of Book**	**Name of Publisher with Country**	**Edition with Year of Publication**
1.	Robert D Christ, Robert L. Wernli Sr	*The ROV Manual A User Guide for Remotely Operated Vehicles*	Elsevier Science	2nd Edition 2013
2.	Martin Renilson	*Submarine Hydrodynamics*	Springer International	2nd Edition 2018
3.	Martin J Dougherty	*Drones*	Amber Books Ltd. UK	1st Edition 2015
4.	Editors:Henk Nijmeijer, Kristin Y. Pettersen, Thor I. Fossen	*Sensing and Control for Autonomous Vehicles Applications to Land, Water and Air Vehicles*	Springer International Publishing	1st Edition 2017

Course Code	**Course Title**

216m08L601	Fundamentals of Underwater Drones Lab					
	TH			P	TUT	Total
Teaching Scheme(Hrs.)	-			2	-	2
Credits Assigned	-			1	-	1
Examination Scheme	Marks					
	CA		ESE	LAB/TUT CA		Total
	ISE	IA				
	-	-		50		50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course '116m76C601'. Students will be graded based on continuous assessment of their term work.

Course Code	Course Title					
216m04P601	Mini Project on Drone Technology*					
	TH			P	TUT	Total
Teaching Scheme(Hrs.)	0			04	--	04
Credits Assigned	0			02	--	02
Examination Scheme	Marks					
	CA		ESE	LAB/TUT CA		Total
	ISE	IA				
	-	-	-	50		50

Course Objectives:

Applications of Drone Technology in real world applications can be designed using various platforms and concepts studied in different courses. The student can design and develop the project individually or in a pair based on scope of the work approved by faculty mentor.

*An industrial application can be developed in the form of an internship of minimum 4 weeks approved by a faculty mentor.

Course Outcomes:
At the successful completion of this minor program an engineering graduates will be able to
CO1: Develop Drone Technology based applications
CO2: Communicate the project work in the form of report, presentation/ demonstration.

Course Code	Course Title			
216m04C701	Autonomous Drone Programming			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	04
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites:

- None

Course Objectives: Autonomous Drone Programming:

The "Autonomous Drone Programming" course focuses on programming aspects tailored specifically for autonomous drone operations. Students will acquire a robust skill set in sensor integration, navigation algorithms, path planning techniques, obstacle avoidance strategies, control system implementation, and mission planning methodologies designed for autonomous drone systems. Through hands-on projects and simulations, students will develop the expertise required to tackle the challenges of developing and deploying autonomous drones across a wide range of applications, from aerial surveillance to precision agriculture and delivery services.

Course Outcomes:
At the end of successful completion of the course the student will be able to

CO1: acquire a robust skill set in programming tailored specifically for autonomous drone operations.
CO2: design mission planning methodologies for autonomous drones, enabling effective execution of tasks across various applications.
CO3: design mission planning methodologies for autonomous drones, enabling effective execution of tasks across various applications.
CO4: gain proficiency in integrating sensors for autonomous drone operations, including understanding their functionality and data processing. to develop and deploy autonomous drones across a wide range of applications, from aerial surveillance to precision agriculture and delivery services..

Module No.	Unit No.	Topics	Hrs.	CO
1	Introduction to Autonomous Drone Programming		09	CO1

	1.1	What is autonomous drone programming? Defining autonomous drone programming as the process of creating software that enables drones to operate independently. Discussing the shift from manual control to autonomous behavior.		
	1.2	Challenges of autonomous drone programming Identifying key challenges faced by developers: Sensor Integration: Handling data from various sensors (GPS, IMUs, cameras, LiDAR). Real-time Decision Making: Ensuring timely responses to changing environments. Safety and Reliability: Balancing autonomy with safety measures. Energy Efficiency: Optimizing code for efficient battery usage.		
	1.3	Different approaches to autonomous drone programming Comparing rule-based approaches, machine learning, and hybrid methods. Exploring the trade-offs between simplicity and adaptability.		
2	Sensors and Navigation for Autonomous Drones		**09**	**CO2**
	2.1	Sensors for autonomous drones Understanding sensor types and their roles: GPS: Position estimation and global navigation. IMUs: Accelerometers and gyroscopes for attitude determination. Cameras: Visual data for object detection and localization. LiDAR: 3D mapping and obstacle detection.		
	2.2	Navigation algorithms for autonomous drones Implementing algorithms for: Waypoint Following: Navigating along predefined paths. SLAM (Simultaneous Localization and Mapping): Creating maps while localizing the drone. Path Following: Dynamic adjustments based on real-time sensor data.		
3	Path Planning and Obstacle Avoidance for Autonomous Drones		**09**	**CO3**
	3.1	Path planning algorithms for autonomous drones Examining techniques for finding optimal paths: A Algorithm*: Graph-based search for efficient routes. RRT (Rapidly Exploring Random Trees): Sampling-based planning. Potential Fields: Balancing attractive and repulsive forces.		
	3.2	Obstacle avoidance algorithms for autonomous drones Strategies to avoid collisions: Reactive Methods: Immediate responses to detected obstacles. Predictive Methods: Anticipating obstacles and adjusting paths. Velocity Obstacles: Dynamic collision avoidance.		
4	Control Systems for Autonomous Drones		**09**	**CO4**

	4.1	Control Systems for Autonomous Drones Designing controllers for stable flight: PID Controllers: Proportional-Integral-Derivative feedback loops. Adaptive Control: Adjusting parameters based on changing conditions. Nonlinear Control: Handling complex dynamics.		
	4.2	Flight controllers for autonomous drones Overview of onboard flight controllers: Pixhawk: Open-source autopilot platform. ArduPilot: Firmware for autonomous flight. DJI Flight Controllers: Proprietary solutions.		
5	Mission Planning and Execution for Autonomous Drones		**09**	**CO5**
	5.1	Mission Planning for Autonomous Drones Creating mission profiles: Task Sequencing: Defining a sequence of actions (takeoff, survey, return). Geofencing: Setting boundaries for safe operation. Dynamic Replanning: Adapting to unexpected events.		
	5.2	Mission execution for autonomous drones Ensuring reliable execution: Telemetry: Monitoring drone status during missions. Emergency Procedures: Handling failures or anomalies. Data Logging: Recording flight data for analysis		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Syed Omar Faruk Towaha	*Building Smart Drones with ESP8266 and Arduino*	Packt Publishing	1st Edition 2018
2.	Hailong Huang, Andrey V. Savkin, Chao Huang · 2022	*Autonomous Navigation and Deployment of UAVs for Communication, Surveillance and Delivery*	Wiley	1st Edition 2022
3.	Editors: Kimon P. Valavanis, George J. Vachtsevanos	*Handbook of Unmanned Aerial Vehicles Volume 4*	Springer Netherlands	1st Edition 2014
4.	Cybellium Ltd	*Mastering Drone*	Cybellium Ltd	1st Edition

		design and programming		2023
5.	Yasmina Bestaoui Sebbane	*Smart Autonomous Aircraft Flight Control and Planning for UAV*	CRC Press	1st Edition 2015

Course Code	**Course Title**					
216m04L701	**Autonomous Drone Programming Laboratory**					
	TH			**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**-**			**02**	**--**	**02**
Credits Assigned	**-**			**01**	**--**	**01**
Examination Scheme	**Marks**					
	CA		**ESE**	**LAB/TUT CA**		**Total**
	ISE	**IA**				
	-	**-**	**-**	**50**		**50**

Term-Work:
Term work will consist of experiments/ tutorials covering entire syllabus of the course '116m76C701'. Students will be graded based on continuous assessment of their term work.

Syllabus
Minor Programme in
Electric Vehicles

(Jointly Offered by the Department of Mechanical Engineering and the Department of Electronics and Computer Engineering)

(Programme commenced from AY 2024-25)
Offered by Department of Electronics and Computer Engineering

From
Academic Year 2024-25
(SVU-KJSCE 2.0)

(Approved by BOS dated 23-Apr-24)

Minor Degree Programme in Electric Vehicles

(Jointly offered by the Department of Mechanical Engineering and the Department of Electronics Engineering)

Abstract:

Electric Vehicles are widely gaining market across the globe. The automotive industry is rapidly shifting from traditional fuel based technology to eco-friendly technologies. Due to high pressure and fast depletion of fossil fuels, electric mobility has become necessary to reduce impact of transportation on environment and climate change. The Electric Vehicle market in India is set to go enormous, and is estimated to be around 80 lacs by 2020, and approximately 5 crores by 2030 (*NITI Ayog and RMI analysis, 2017*). The light vehicle industry is facing a shortage of engineering talent needed to retool for the use of electric drives as the primary source of motive power. The program will fill that gap with Electric Vehicle curriculum. The coursework provides knowledge and hands-on labs in characteristics of EVs. This will be a first level programme on electric vehicle. Students will be able to understand the operation of battery driven electric vehicle. The programme will start with introduction to automobile systems and vehicle dynamics to understand the basic concepts of vehicle technology. Then the course will start covering these focus areas one by one such as energy sources, battery charging technology, electric motors and power electronics in EVs. The course also includes mini project or internship which enhanced the practical knowledge of students.

Objectives: The objectives of this minor program are:

- To impart the basic knowledge of Electric Vehicle Technology.
- To make the student conversant with power sources of todays and future EV.
- To prepare the students for a career in the drastically changing automotive industry.
- To acquaint the student with prerequisite for higher studies in Electric Vehicle.
- To make the students aware with different areas of research in the field of Electric Vehicle.

Learning Outcomes (LOs) of the Minor Degree Program: At the successful completion of this minor program an engineering graduate will be able to

LO1. Explore the technology in energy sources, battery charging technology, electric motors and power electronics in todays and future electric vehicles.
LO2. Acquire knowledge for making career in drastically changing automotive industry or pursuing higher studies in the area of electric vehicles.
LO3. Criticize the issues related to safety, regulations and future of electric vehicles.

Eligibility Criteria: Students who have passed Second Year of Engineering in Computer Engineering / Information Technology /Electronics and Telecommunication Engineering /Mechanical Engineering / Electronics Engineering.

Assessment Methods: Tests, Mini projects, Laboratory, Presentation/ Video making, Quiz, internships, study of research papers etc.

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH–P–TUT	Total (Hrs.)	Credits Assigned TH–P–TUT	Total Credits	Semester of Major Degree
216M03C401	Automobile Systems and Vehicle Dynamics	3-0-0	03	3-0-0	3	IV
216M03L401	Automobile Systems and Vehicle Dynamics Laboratory	0-2-0	02	0-1-0	1	IV
216M03C501	Electric Motors and Power Electronics in EVs	3-0-0	03	3-0-0	3	V
216M03L501	Electric Motors and Power Electronics in EVs Laboratory	0-2-0	02	0-1-0	1	V
216M03C601	Fuel Cell and Battery Technology	3-0-0	03	3-0-0	3	VI
216M03L601	Fuel Cell and Battery Technology Laboratory	0-2-0	02	0-1-0	1	VI
216M03P601	Mini Project/Internship	0-4-0	04	0-2-0	2	VI
216M03C701	Safety, Regulations and Future of EVs	3-0-0	03	3-0-0	3	VII
216M03L701	Simulation and Performance Lab	0-2-0	02	0-1-0	1	VII
Total Hours		**12-12-0**	**24**	**12-6-0**	**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme				
		Marks				
		CA		ESE	LAB/TUT CA	Total
		ISE	IA			
216M03C401	Automobile Systems and Vehicle Dynamics	30	20	50	--	100
216M03L401	Automobile Systems and Vehicle Dynamics	--	--	--	25	25
216M03C501	Electric Motors and Power Electronics in EVs	30	20	50	--	100
216M03L501	Electric Motors and Power Electronics in EVs	--	--	--	25	25
216M03C601	Fuel Cell and Battery Technology	30	20	50	-	100
216M03L601	Fuel Cell and Battery Technology Laboratory	--	--	--	25	25
216M03P601	Mini Project/Internship	--	--	--	50 (TW) +50 (CA)	100
216M03C701	Safety, Regulations and Future of EVs	30	20	50	--	100
216M03L701	Simulation and Performance Lab	--	--	--	50	50
Total		**120**	**80**	**200**	**225**	**625**

Course Code	Course Title					
216M03C401	Automobile Systems and Vehicle Dynamics					
	TH			P	TUT	Total
Teaching Scheme (Hrs.)	03			--	--	03
Credits Assigned	03			--	--	03
Examination Scheme	Marks					
	CA		ESE	LAB/TUT CA		Total
	ISE	IA				
	30	20	50	--		100

Course prerequisites:

- **Engineering Mechanics**

Course Objectives:

The objective of the course is to introduce the learner with the basic systems of an automobile. The power developed by IC Engine/other source is transmitted to road wheels through many systems such as clutch, gearbox, differential etc. There are other systems of automobile described in course such as steering, brakes and suspension system. In addition to this course also emphasize on dynamics of vehicle related to propulsion. The course introduces some design considerations of EVs.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1. Discuss the various layouts of an automobile along with its merits and demerits.
CO2. Demonstrate the working of different elements of transmission systems of an automobile.
CO3. Demonstrate the various control systems of an automobile along with its classification.
CO4. Analyze resisting force, tractive effort, acceleration force and acceleration performance of small vehicles.
CO5. Explain various design considerations of Electric Vehicles.

Module No.	Unit No.	Topics	Hrs.	CO
1		**Chassis and Body Engineering**	**06**	**CO1**
	1.1	Introduction, Classification of Automobiles, Conventional layout of Car and Truck, Different vehicle layouts		
	1.2	Classification of Chassis: Open, Semi Integral and Integral Structures, Normal Control, Semi forward, Forward, Fully forward Controls, Vehicle Styling, Aerodynamics		
	1.3	Introduction of Electric Vehicles- Necessity, types, layouts, elements, cost and financial aspects of Electric Vehicles		
2		**Transmission System, Wheels and Tyres**	**12**	**CO2**
	2.1	Automotive clutches- Single plate clutch, multi-plate clutch, diaphragm clutch, centrifugal clutch, fluid coupling		
	2.2	Automotive Transmission-Necessity of transmission, sliding mesh gear box, constant mesh gearbox, synchromesh gearbox, torque convertor, automatic transmission, CVT		
	2.3	Drive Line- Propellor shaft with universal joints/CV joints Final Drive and Differential- Types of final drive, working of differential, limited slip differential		
	2.4	Live Axle- Semi-floating, Three Quarter Floating, Fully-floating Wheels- Types, Construction and Specifications Tyres- Types, Construction and Specifications		
3		**Steering, Front Axle, Suspension and Braking Systems**	**10**	**CO3**
	3.1	Steering System- Ackerman and Davis Steering Mechanism, Steering Geometry, Steering Linkages, Under steer, Over steer, Types of Steering Gears with Working and Applications, Power steering		
	3.2	Front Axle and Suspension System- Front axle, Objectives, Principle, Types of suspension system, Rigid and Independent Suspension, Air suspension, Shock absorber		

	3.3	Braking System- Requirements and Functions of Brakes, Drum and Disc Brakes, Types of Braking Systems and their Layouts: Mechanical Linkage Brakes, Hydraulic Brakes, Pneumatic Brakes, Working of Master and Wheel Cylinders, Antilock Braking System (ABS)		

4	**Vehicle Dynamics**		**09**	**CO2**
	4.1	Introduction, rolling resistance, aerodynamic drag, gradient resistance, acceleration force (linear and angular), total tractive effort		
	4.2	Vehicle Acceleration, acceleration performance parameters, acceleration of electric scooter, acceleration of small car, Electric Vehicle range		
5	**Design Considerations**		**08**	**CO4**
	5.1	Aerodynamic Consideration- Aerodynamics and energy, chassis/body aerodynamic shape,		
	5.2	Consideration of rolling resistance, transmission efficiency, vehicle mass		
	5.3	Electric vehicle chassis and body design		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Kripal Singh	*Automobile Engineering Vol 1*	Standard, India	2000
2.	Giri N. K.	*Automotive Mechanics*	Khanna Publishers	8^{th} edition, 2008
3.	Jack Erjavec	*Automatic Transmission*	Delmar Cengage Learning	2010
4.	James Larminie, John Lowry	*Electric Vehicle Technology: Explained*	Wiley, UK	2^{nd} edition, 2012
5.	Chris Mi, M. Abul Masrur	*Hybrid Electric Vehicles*	Wiley, UK	Edition 2018

<table>
<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td>216M03L401</td><td colspan="6">Automobile Systems and Vehicle Dynamics Laboratory</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">--</td><td>02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">--</td><td>01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td colspan="2">25</td><td>25</td></tr>
</table>

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course 216M51C401. Students will be graded based on continuous assessment of their term work.

Course Code	Course Title			
216M03C501	Electric Motors and Power Electronics in EVs			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites: Basic electro-mechanical conversion, Electronics devices

Course Objectives

To understand working of various Electric Motors with their torque-speed characteristic and choice of particular motor in EV. To identify role of power conversion from DC power to AC power and its variants required in EV and appreciate how power electronics systems does that. At the end of the course the student will be able to assimilate design aspects of power conversion.

Course Outcomes: At the end of successful completion of the course the student will be able to

CO1. Understand Electric Motors used in EV.
CO2. Identify use of power Electronics in EV with its special requirements and understand basic Power Electronics Devices.
CO3. Analyze, calculate and control power from DC to DC and AC to DC and vice-versa. CO4. Explore Design aspects of various power converters actually used in EV.

Module No.	Unit No.	Details	Hrs.	CO
1	**Electric Motors in EV**		09	CO 1
	1.1	Electric Motors used in EV. DC motors, Induction motors, Permanent Magnet motors, Switched Reluctance motors.		
	1.2	Torque –speed characteristics of above mentioned motors, Comparison and its layout in EV. Thermal Management of Electrical Machines.		
2	**Power Electronics required in EV**		06	CO 2

	2.1	Power conversion required in EV. Battery to Motor with speed control. Other Power Sources to Motor. Regenerative Braking requirements. Bi-directional and		

		multiple input to single output power conversion in EV. # **self-learning** Lighting and other requirements.		
	2.2	Power conversion required for DC charging and AC charging on board and off board.		
	2.3	Principle of operation, characteristics, rating and applications of power electronics devices like: SCR, TRIAC, DIAC, GTO, MOSFET, IGBT and power BJT. # **self-learning**		
3	**AC to DC controlled Rectifier**		**06**	**CO 3**
	3.1	Single phase and Three phase Half wave and Full wave controlled rectifiers with R, R-L load. Their working, output voltage and current and control circuit.		
4	**DC to DC Choppers and DC to AC Inverter**		**15**	**CO 3**
	4.1	Basic principle of step up and step down choppers.		
	4.2	**DC-DC switching mode regulators:** Buck, Boost, Buck-Boost, Cuk regulators, (CCM mode only).		
	4.3	Bi-directional Chopper working.		
	4.4	Types, topology and Working of Single phase and Three phase voltage source inverters with R and R-L and R-L-E load. Voltage and frequency control of inverters using PWM and various other techniques.		
5	**Design Aspects of Power Converters used in EV**		**09**	**CO 4**
	5.1	Design aspects of rectifiers and their actual use in EV charging methods with case study.		
	5.2	Design aspects of Choppers actually used in EV for feeding power to drives from Battery and Re-generative Braking with case study.		
	5.3	Design aspects of Inverters actually used in EV for feeding power to drives from Battery and AC charging of EVs with case study. Thermal management of Power Electronics circuits.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	M.D. Singh and K. B. Khanchandani	*Power Electronics*	Tata McGraw Hill	2nd Edition, 2016
2.	Dr. P.S. Bhimra	*Power Electronics*	Khanna Publications	4th Edition, 2018
3.	James Larmine and John Lowry	*Electrical Vehicle Technology Explained,*	John Wiely and Sons Ltd.	2nd Edition WSE 2015.
4.	Iqbal Husain,	*Electric and Hybrid Vehicles: Design Fundamental.*	CRC Press,	2nd Edition, e-library 2011
5.	Ned Mohan	*Power Electronics:Converters, Applications and Design*	John Willey	2nd Edition, 1998

 # Learners should prepare all self-learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA.

<table>
<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td>216M03L501</td><td colspan="6">Electric Motors and Power Electronics in EVs Laboratory</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">--</td><td>02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">--</td><td>01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
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<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td colspan="2">25</td><td>25</td></tr>
</table>

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course 216M51C501. Students will be graded based on continuous assessment of their term work.

Course Code	Course Title			
216M03C601	Fuel Cell and Battery Technology			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites: Basic Chemistry and Physics

Course Objectives:

The objective of the course is to make the student understand the possible alternatives of energy sources and storage in electric vehicles. The main focus of this course is to make the students understand the operation of electric vehicle battery, battery types and its different parameters. This course also introduces different battery charging technologies and battery charging algorithm. This course helps the students to analyze the battery performance of electric vehicle system.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand various battery configurations of an Electric Vehicle and appreciate the potential of hydrogen as an energy source.
CO2: Understand the various types and manufacturing process of batteries.
CO3: Analyze the effect of different conditions on electric vehicle battery parameter.
CO4: Compare different battery charging technologies for electric vehicle.
CO5: Understand safety parameters and testing procedure of electric

Module No.	Unit No.	Topics	Hrs.	CO
1	**Fuel Cell Basics and related technologies**		09	CO1
	1.1	**Fuel cell basics -** History, Construction and parts, Difference between batteries and fuel cells, principle of working of fuel cells, components of fuel cells; Various classifications of fuel cells		
	1.2	**Low temperature fuel cells:** Proton exchange membrane hydrogen fuel cells (PEMFC); construction, cell		

		components, materials and features, water management and operations, fuel cell stacks; Direct and indirect methanol fuel cells (DMFC), construction and operation; Alkaline Fuel Cells (AFC) – Construction and Working		
2	**Energy Storage- Battery science, types and manufacturing process**		**09**	**CO2**
	2.1	**Introduction to Energy Storage**		
	2.2	**Electrochemical Batteries** – Reactions and Thermodynamic Voltage		
	2.3	**Technology and working** – Pb-Acid batteries, Lithium -ion batteries, Manufacturing of Li-ion batteries.		
	2.4	**Advanced Batteries** – Molten Metal, Molten Salt, Na-ion batteries.		
3	**Electric Vehicle Battery Capacity**		**07**	**CO2**
	3.1	Battery Capacity, The Temperature Dependence of Battery Capacity, State of Charge of a VRLA Battery, Capacity Discharge Testing of VRLA Batteries, Battery Capacity Recovery.		
	3.2	Definition of NiMH Battery Capacity, Li-ion Battery Capacity, Battery Capacity Tests, Energy Balances for the Electric Vehicle.		
4	**Battery Charging Technology**		**11**	**CO3**
	4.1	Types of battery charging: Normal charging, Opportunity charging, Fast charging, Battery swapping.		
	4.2	Battery Charging algorithms: Improve the charging efficiency; reduce the charging time, enhancing the battery life, Protect the battery.		
	4.3	Constant current Charging (CC), Constant voltage charging (CV), Constant current constant voltage charging (CCCV), Multistage charging (MSC), Pulse Charging, Trickle Charging (TC).		
	4.4	Medium of Charge transfer: Wire and Wireless.		
5	**Electric Vehicle Battery Performance**		**9**	**CO4**
	5.1	The Battery Performance Management System, BPMS Thermal Management System, Thermal management of cells, batteries and battery pack, The BPMS Charging Control, High-Voltage Cabling and Disconnects.		

	5.2	Safety in Battery Design, Battery Pack Safety—Electrolyte Spillage and Electric Shock, Electrical Insulation Breakdown Detection, Electrical Vehicle Component Tests, Building Standards, Ventilation.		
	5.3	Testing Electric Vehicle Batteries, Safety Requirements for Electric Vehicle Batteries.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1	Bruno Scrosati Jurgen Garche Werner Tillmetz (Ed's)	*Advances in Battery Technologies for Electric Vehicles*	Woodhead Publishing, USA	1st edition, 2015
2	J. Larmine and A. Dicks	*Fuel Cell Systems Explained*	Wiley	2nd edition, 2003
3	James Larminie, John Lowry	*Electric Vehicle Technology Explained*	Wiley Publication, UK	2nd edition, 2012
4	Sandeep Dhameja	*Electric Vehicle Battery Systems*	Newnes Publication	1st edition 2001
5	C.C. Chan, K.T. Chau	*Modern Electric Vehicle Technology*	Oxford Publication, New York	1st edition 2001
6	Berg H	*Batteries For Electric Vehicles*	Cambridge Publication, UK	1st edition 2015

<table>
<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td>216M03L601</td><td colspan="6">Fuel Cell and Battery Technology Laboratory</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td colspan="2">TUT</td><td>Total</td></tr>
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<tr><td>Credits Assigned</td><td colspan="2">--</td><td>01</td><td colspan="2">--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td colspan="2">25</td><td>25</td></tr>
</table>

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course 216M51C601. Students will be graded based on continuous assessment of their term work.

<table>
<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td>216M03P601</td><td colspan="6">Mini Project/Internship</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">0</td><td>04</td><td>--</td><td>04</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">0</td><td>02</td><td>--</td><td>02</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td colspan="2">50 (TW) +50 (CA)</td><td>100</td></tr>
</table>

Course prerequisites: All courses studied in this Minor Programme

Course Objectives:

The objective of the course is to give exposure to the students about real life problems in the field of electric vehicles.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1 –Define/Select the problem statement for mini-project or internship in the field of electric vehicles.

CO2 – Obtain/decide the solution/methodology Implement and test the hardware/ software algorithms to meet the desired specifications for robotics and AI applications

CO3 - Test the obtained/decided solution/methodology using hardware or software tools Analyze, interpret results, and correspondingly modify the robotic system to get the desired results

Term Work and Oral: Students will implement electric vehicle concepts learnt in earlier courses subjects during mini project/internship. The mini project can be individual or a group project. Interdisciplinary projects are also permitted. Each project will be assigned one faculty member as a supervisor. There will be a continuous assessment and progress report of the project that needs to be maintained. The final oral will be a presentation based on a demonstration of the project in front of a committee of examiners.

Course Code	Course Title			
216M03C701	Safety, Regulations and Future of EVs			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites:

Nil

Course Objectives:

The objective of the course is to introduce the learner with the safety regulations for electric vehicles. There course also explore the future trends in electric vehicles.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1. Discuss the various basic principles of vehicle safety.

CO2. Elaborate the various static and dynamic tests conducted on vehicle.

CO3. Explain the different testing and evaluation standards for electric

Module No.	Unit No.	Topics	Hrs.	CO
1	**Introduction to Vehicle Safety**		**09**	**CO1**
	1.1	Introduction to vehicle safety, Basic concepts of vehicle safety, Risk evaluation and communication		
	1.2	Human error control, Universal design, The distracted driver		
	1.3	Special design problems: Design for children, handicap, etc.)		
2	**Vehicle testing**		**09**	**CO2**
	2.1	Accident Data, Accident Avoidance, Tests, Biomechanics and Occupant Simulation,		
	2.2	Crash Testing, Vehicle Body Testing, Dynamic Vehicle Simulation		
	2.3	Role of Seat in Crash, Occupant Protection, Pedestrian Protection		
3	**TESTING AND EVALUATION STANDARDS FOR EV/HEV**		**10**	**CO3**
	3.1	Construction and Functional Safety Requirements, Measurement of Electrical Energy Consumption, Method of Measuring the Range		
	3.2	Measurement of Net Power, Safety Requirements of Traction Batteries, CMVR Type Approval for Electric Power Train Vehicles		
	3.3	Type Approval Procedure for Electric and Hybrid Electric Vehicles introduced in market for Pilot / Demonstration Projects intended for Government Scheme, Electric Vehicle Conductive AC Charging System / DC Charging System		
4	**Future of EVs-I**		**08**	**CO4**
	4.1	Well to wheel concept, Alternative and sustainable energy via grid- Solar energy, wind energy, hydro energy, tidal energy		
	4.2	Alternative and sustainable energy via grid- biomass energy, geothermal energy, nuclear energy		
	4.3	Entrepreneurship Development for EVs		
	Future of EVs-II		**09**	**CO4**
	5.1	Global and Indian Scenario in future. Future Electric Motors, Future Batteries, Super Capacitors for high Power Density.		

5	**5.2**	Future Charging methods: wireless charging, smart Charging, Artificial intelligence, Virtual and Augmented reality in EVs		
	5.3	V2X technology like V2 home, V2Grid, Autonomous Driving, Self-driving from level 1 to level 5		
	5.4	Modelling and simulation of Electric Vehicles		
		Total	**45**	

Recommended Books:

Sr. No.	**Name/s of Author/s**	**Title of Book**	**Name of Publisher with Country**	**Edition with Year of Publication**
1.	George Peters and Barbara Peters	*Automotive vehicle safety*	Taylor and Francis, London	2002
2.	James Larminie, John Lowry	*Electric Vehicle Technology: Explained*	Wiley, UK	2nd edition, 2012
3.	C.C. Chan, K.T. Chau	*Modern Electric Vehicle Technology*	Oxford Publication, New York	1st edition 2001
4.	Ulrich Seiffert, Lothar Wech	*Automotive Safety Handbook*	SAE International	2nd edition 2007
5.	Chris Mi, M. Abul Masrur	*Hybrid Electric Vehicles*	Wiley, UK	Edition 2018

Course Code	Course Title					
216M03L701	Simulation and Performance Laboratory					
	TH			P	TUT	Total
Teaching Scheme(Hrs.)	--			02	--	02
Credits Assigned	--			01	--	01
Examination Scheme	Marks					
	CA		ESE	LAB/TUT CA		Total
	ISE	IA				
	-	-	-	50		50

Term-Work:

1. Programming for analyzing vehicle drag coefficient w.r.t vehicle velocity
2. Programming for analyzing rolling coefficient w.r.t vehicle velocity
3. Programing for developing different drive cycles
4. Programing for testing EV on drive cycle
5. Simulation of battery electric vehicle
6. Simulation of Series Hybrid electric vehicle
7. Simulation of Parallel Hybrid electric vehicle
8. Performance of electric vehicle using chassis dynamometer
9. Determine lift and drag forces using wind tunnel setup.

Any six experiments form the list given above.

Syllabus

Minor Programme in

Makerspace

(Programme commenced from AY 2024-25)
Offered by Department of Electronics and Computer Engineering

From
Academic Year 2024-25
(SVU-KJSCE 2.0)

(Approved by BOS dated 23-Apr-24)

K J Somaiya College of Engineering, Mumbai-77
(A Constituent College of Somaiya Vidyavihar University)

Minor Degree Programme in Makerspace
Offered by Department of Electronics and Computer Engineering

Introduction:

In this program, the students delve into a journey bridging diverse fields of modern engineering and innovation. This immersive experience is designed to empower learners with a comprehensive skill set spanning Electronics Design Technology, 3D Printing, IoT, Robotics, Software and IDE Tools, and hands-on DIY projects.

Exploring Electronics Design Technology, learners will unravel the intricacies of circuitry, mastering both analog and digital design principles essential for crafting efficient and functional electronic systems. Transitioning to the world of 3D Printing, learners will harness software tools to transform digital designs into tangible prototypes, gaining expertise in slicing techniques and additive manufacturing processes.

The IoT and Robotics segment immerses participants into the interconnected realm of intelligent systems, blending hardware and software using platforms such as Arduino IDE, ROS, and AWS IoT Core. Meanwhile, a deep dive into software and IDE tools equips learners with proficiency in navigating diverse programming languages and development environments.

Our DIY projects component serves as the pinnacle, where acquired knowledge is applied, fostering creativity, problem-solving, and technical acumen in crafting innovative solutions. Join us on this dynamic expedition to acquire a versatile skill set poised at the frontier of technological innovation.

Objectives:

- Equip participants with a diverse skill set encompassing Electronics Design, 3D Printing, IoT, Robotics, Software Development, and DIY project implementation
- Enable learners to comprehend and apply principles of analog and digital electronics in designing functional electronic systems
- Develop expertise in utilizing software tools for 3D design, slicing, and additive manufacturing processes to create tangible prototypes
- Familiarize participants with interconnected systems, empowering them to integrate hardware and software using platforms like Arduino, ROS, and AWS IoT Core
- Provide hands-on experience with various software and IDE tools, enabling fluency in programming languages and diverse development environments
- Encourage practical application of acquired skills by engaging in creative and innovative DIY projects, fostering problem-solving and critical thinking abilities

- Inspire participants to explore, innovate, and create solutions at the intersection of technology and creativity, preparing them to be versatile contributors in the realm of modern engineering and innovation

Learning Outcomes:
On successful completion of Maker Technology Minor Programme, an engineering graduate will be able to:

- LO1: Apply principles of electronic design to implement functional electronic systems
- LO2: Application of knowledge of 3D Printing, IoT and Robotics, and Software and IDE tools through DIY systems

Eligibility Criteria:
Students who have passed the First Year of Engineering in *any branch* at K. J. Somaiya College of Engineering.

Assessment Methods: Tests, Mini projects, Laboratory, Presentation/ Video making, Quiz, study of research papers etc.

Key Information
- Duration: 3 Years
- Total credits: 18
- Programme Code: ST16100
- Course Type: Minor Degree
- Mode of study: Full time
- Campus: Vidyavihar - Mumbai
- Institute: KJSCE

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M09C301	Electronics Design Technology	3 – 0 – 0	3	3-0-0	3	III
216M09L301	Electronics Design Technology Laboratory	0 – 2 – 0	2	0-1-0	1	III
216M09C401	3-D Printing	3 – 0 – 0	3	3-0-0	3	IV
216M09L401	3-D Printing Laboratory	0 – 2 – 0	2	0-1-0	1	IV
216M09C501	IoT and Robotics	3 – 0 – 0	3	3-0-0	3	V
216M09L501	IoT and Robotics Laboratory	0 – 2 – 0	2	0-1-0	1	V
216M09L601	Software and IDE Tools Laboratory	0 – 2 – 2	4	0-1-2	3	VI
216M09L602	Do It Yourself (DIY)	0 – 2 – 2	4	0-1-2	3	VI
Total		**9–10–0**	**23**	**9–5– 4**	**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme Marks				
		CA		ESE	LAB CA	Total
		ISE	IA			
216M09C301	Electronics Design Technology	30	20	50	--	100
216M09L301	Electronics Design Technology Laboratory	--	--	--	50	50
216M09C401	3-D Printing	30	20	50	--	100
216M09L401	3-D Printing Laboratory	--	--	--	50	50
216M09C501	IoT and Robotics	30	20	50	--	100
216M09L501	IoT and Robotics Laboratory	--	--	--	50	50
216M09L601	Software and IDE Tools Laboratory	--	--	--	75	75
216M09L602	Do It Yourself (DIY)	--	--	--	75	75
Total		**90**	**60**	**150**	**300**	**600**

Course Code	Course Title			
216M09C301	**Electronics Design Technology**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	03	-	-	03
Credits Assigned	03	-	-	03

Examination Scheme	**Marks**				
	CA		**ESE**	**LAB/CA TW**	**Total**
	ISE	**IA**			
	30	20	50	--	100

Course prerequisites: Elements of Electrical and Electronics Engineering (EEEE), Project Based Learning Laboratory (PBL)

Course Objectives:

This course aims to impart a comprehensive understanding of electronics design, progressing from foundational concepts to advanced topics. By the end, students will master circuit analysis, operational amplifier applications, microcontroller programming, and delve into high-frequency electronics and PCB design. The objective is to equip students with the skills to design and implement complex electronic systems, fostering innovation within the field of electronics design technology.

Course Outcomes:

At the end of successful completion of the course, the student will be able to
CO1: Learn fundamentals of Electronic Circuit Design
CO2: Understand analog electronics circuits using analysis techniques and operational amplifiers
CO3: Design Digital electronics using logic gates, sequential circuits, and memory elements
CO4: Implement Electronics and Embedded Systems
CO5: Design circuits on PCB using CAD tools

Module No.	Unit No.	Details	Hrs	CO
1		Foundations of Electronics Design	09	CO1
	1.1	**Introduction to Electronic Components:** Overview of resistors, capacitors, inductors, diodes, and transistors		
	1.2	**Basic Circuit Analysis**: Ohm's Law, Kirchhoff's Laws, series and parallel circuits		
2		Fundamentals of analog circuit design	09	CO2
	2.1	**Advanced Circuit Analysis:** AC circuits, transient analysis, frequency response		
	2.2	**Operational Amplifiers and Applications:** Op-Amp fundamentals, filters, non-linear applications		
3		Fundamentals of digital circuit design	09	CO3
	3.1	**Introduction to Digital Logic:** Logic gates, Boolean algebra, combinatorial circuits		
	3.2	**Sequential Logic and Memory:** Flip-flops, registers, memory design		
4		Applied Electronics and Embedded Systems	09	CO4
	4.1	**Microcontrollers and Embedded Systems:** Introduction to microcontrollers, programming basics		
	4.2	**Sensors and Actuators:** Sensor principles, interfacing, control systems		
5		Advanced Topics in Electronics Design	09	CO5
	5.1	**Advanced Analog and Digital Circuits:** High-frequency circuits, advanced logic design		
	5.2	**PCB Design and System Integration:** Advanced PCB techniques, signal integrity analysis		
		Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	V.K. Mehta and Rohit Mehta	*Principles of Electronics*	S.Chand, India	12th Edition, 2020
2.	M. Morris Mano and Michael D. Ciletti	*Digital design: With an Introduction to the Verilog HDL, VHDL, and System Verilog*	Pearson Education, India	6th Edition, 2018
3.	Abubeker K M	*Open Source Programming & Embedded System Design Using Arduino IDE*	Notion Press, India	1st Edition, 2020
4.	Raj Kamal	*Embedded Systems - Architecture, Programming and Design*	McGraw-Hill Education, India	3rd Edition, 2017
5.	Simon Monk and Duncan Amos	*Make your own PCBs with Eagle: From Schematic Designs to Finished Boards*	McGraw-Hill Education, India	2nd Edition, 2017

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M09L301</td><td colspan="5">Electronics Design Technology Laboratory</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">--</td><td>02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">--</td><td>01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td colspan="2">50</td><td>50</td></tr>
</table>

Proposed List of Experiments:

1. Design of electronic circuits using basic laws of electronics
2. Design of electronic circuits using Operational Amplifiers
3. Implementation of analog filters and analyze frequency response
4. Design basic digital electronic circuits
5. Implementation of Microcontroller based circuits
6. Implementation of Embedded circuits
7. Design a PCB
8. Mini Project

Course Code	Course Title					
216M09C401	3D Printing					
	TH			P	TUT	Total
Teaching Scheme(Hrs.)	03			-	-	03
Credits Assigned	03			-	-	03
Examination Scheme	Marks					
	CA		ESE	LAB/CA TW		Total
	ISE	IA				
	30	20	50	--		100

Course prerequisites: Project Based Learning Laboratory (PBL)

Course Objectives:

The objective of this course is to make students understand the basic principles involved in 3D printing. The students are expected to learn new trends in the emerging technology of 3D printing such as SLA, prusa, RepRap technology and additive manufacturing. Another objective is to make students learn 3D printing technology softwares and optimization of printing.

Course Outcomes:

At the end of successful completion of the course, the student will be able to

CO1: Understand the basics of 3D printing

CO2: Assemble 3D printer hardware

CO3: Decide on the components required for 3D printer to work

CO4: Design 3D object and configure slicer

CO5: Know what are the features available with Commercial 3D printers

Module No.	Unit No.	Details	Hr.	CO
1	**Introduction to 3D printing**		**10**	**CO1**
	1.1	Types of 3D printers, Comparison of different 3D printers		
	1.2	Fused deposition modeling (FDM), Stereolithography(SLA)		
	1.3	Digital Light Processing(DLP), Selective Laser Sintering (SLS)		
	1.4	Selective laser melting (SLM), Laminated object manufacturing (LOM), Digital Beam Melting (EBM)		
2	**3D printer parts**		**10**	**CO2**
	2.1	Extruder, Printer bed, Hot-end		
	2.2	3D Printing Materials: PLA, ABS, PVA, Flexible		
	2.3	Printer Assembly		
3	**Electronics in 3D printers**		**10**	**CO3**
	3.1	Driver boards, Arduino Mega, Power supply		
	3.2	Stepper motors and drivers, Heat bed and Sensors used with 3D printers		
4	**3D Printer software**		**10**	**CO4**
	4.1	Slicing software: Cura, Repetier, Slic3r, MakerBot Print		
	4.2	3D design software: AutoCAD, Solidworks, ThinkerCAD, FreeCAD, SketchUp		
	4.3	Basic G-code programming		
5	**Commercial 3D printers**		**05**	**CO5**
	5.1	Replicator, Ultimaker 3d printers and their types		
	5.2	Prusa i3 and other open source RepRap printers		
	5.3	Other 3D printers: Da Vinci, Flash forge etc.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Richard Horne, Kalani Kirk Hausman	*3D Printing For Dummies*	John Wiley & Sons, USA	1st Edition , 2017
2.	Anna Kaziunas France	*Make: 3D Printing: The Essential Guide to 3D Printers*	Maker Media, USA	1st Edition , 2013
3.	Richard Salinas	*3D Printing with RepRap Cookbook*	Packt Publishing , UK	1st Edition , 2014
4.	Floyd Kelly	*3D Printing: Build Your Own 3D Printer and Print Your Own 3D Objects*	Que Publishin g, UK	1st Edition , 2014
5.	John M. Jordan	*3D Printing*	MIT press, USA	1st Edition , 2019

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M09L401</td><td colspan="5">3D Printing Laboratory</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="2">--</td><td>02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">--</td><td>01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>50</td><td>50</td></tr>
</table>

Proposed List of Experiments:

1. Calibrating E-Steps and Flow Rate: This experiment teaches how to fine-tune the filament extrusion process for accurate dimensions and consistent printing.
2. Printing with Different Nozzle Sizes: Explore how nozzle size affects print quality, resolution, and printing speed.
3. Printing Temperature Variations: Experiment with different printing temperatures for a specific filament to observe its impact on surface finish, strength, and warping.
4. Print Speed Optimization: Investigate the relationship between print speed and print quality. Find the optimal speed for your desired outcome.
5. Support Structure Comparison: Test different support structure types (dense, sparse, custom) and materials (PLA vs. dissolvable) to see their effectiveness and ease of removal.
6. Multi-material Printing: Experiment with printing objects using two or more filament colors or materials to explore creative possibilities. (This might require a dual extrusion machine)
7. Infill Optimization: Design and print objects with different infill patterns (honeycomb, gyroid, etc.) to analyze their impact on weight, strength, and printing time.
8. Layer Height Variation: Investigate how layer height affects print resolution, surface texture, and printing time.
9. Breakaway Support Structures: Design and print breakaway support structures that dissolve in a solvent for a cleaner finished product. (Requires additional post-processing)
10. Modifying Slicer Settings for Specific Materials: Explore advanced slicer settings like retraction distance, coasting, and combing to optimize printing for a particular filament type.

(e.g., flexible filament)

Course Code	Course Title			
216M09C501	**IoT and Robotics**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	03	-	-	03
Credits Assigned	03	-	-	03

Examination Scheme	Marks				
	CA		ESE	LAB/CA TW	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites: PCB Design, Basics of Programming Concepts, Electronic Design Technology

Course Objectives:

This course introduces students to the world of Makerspace and the essential interdisciplinary skills required with a focus on the Internet of Things (IoT) and Robotics. Students will learn how to design, build, and program IoT devices and robots with hands-on experience while exploring various hardware and software tools. This course aims at fostering creativity and problem-solving skills through practical projects.

Course Outcomes:

At the end of successful completion of the course, the student will be able to

CO1: Develop a strong foundation in IoT and Robotics.

CO2: Gain hands-on experience in building, debugging and programming IoT devices and robots.

CO3: Recognize the interdisciplinary nature of Makerspace and how IoT and Robotics intersect with fields such as engineering, computer science, and design.

CO4: Demonstrate problem-solving skills, creativity, and innovation in designing and developing IoT devices and robots.

Module No.	Unit No.	Details	Hrs	CO
1	**Introduction to Makerspace**		05	CO 1
	1.1	The Maker Movement, History and evolution of IoT and Robotics, Circuit design and prototyping using breadboards, Soldering techniques and Basics of PCB design.		
2	**Programming Fundamentals**		12	CO 2
	2.1	Introduction to programming languages for IoT and Robotics (e.g., Python, Arduino), Writing and debugging code for microcontrollers, Robot Operating System.		
	2.2	Sensors (temperature, light, motion, etc.) and actuators (servo motors, LEDs, etc.), Hands-on coding and project work.		
3	**Building IoT Devices**		14	CO 3
	3.1	IoT architecture and components (sensors, microcontrollers, connectivity modules), Setting up and configuring IoT development platforms, Developing IoT applications using platforms like Arduino IoT, Raspberry Pi, or ESP8266, Integrating IoT devices with cloud services (e.g. AWS IoT, Google Cloud IoT, etc.), Introduction to Big Data.		
	3.2	Designing IoT projects, including sensor selection and placement, Microcontrollers and development boards (e.g., Arduino, Raspberry Pi), Data acquisition, processing, and transmission, Building a complete IoT system and monitoring data remotely.		
4	**Building Robots**		14	CO 4
	4.1	Introduction to robotics concepts (kinematics, dynamics, sensors, and actuators), Types of robots (wheeled, legged, drones, etc.) and their applications, Robot kinematics and control theory, Controlling and programming simple robots.		
	4.2	Building and assembling robots (e.g., robot chassis, motors, wheels), Robot control systems (motor drivers, microcontrollers), Robot programming using high-level languages and libraries, Building practical robot projects.		
	4.3	Ethical, legal, and societal implications of IoT and robotics, Responsible technology development and the impact on society.		
		Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Massimo Banzi and Michael Shiloh	*Getting Started with Arduino*	Make: Community	4th Edition, 2022
2.	Simon Monk	*Raspberry Pi Cookbook: Software and Hardware Problems and Solutions"*	O'Reilly Media, Inc.	3rd Edition, 2019
3.	Bruno Siciliano and Lorenzo Sciavicco	*Robotics: Modelling, Planning and Control*	Springer, London	1st Edition, 2010
4.	Arshdeep Bahga and Vijay Madisetti	*"Internet of Things: A Hands-On Approach*	University Press, India	1st Edition, 2015
5.	Nikolaus Correll, Bradley Hayes, et al.	*"Introduction to Autonomous Robots"*	MIT Press, MA	1st Edition, 2022

Activities that can be additionally implemented:

- **Hackathons and Competitions:** Incorporate hackathons, robotics competitions, or Maker Faires, where students can showcase their projects and compete with peers, fostering a spirit of innovation and healthy competition.

- **Design Thinking:** Incorporate design thinking principles to encourage students to approach problem-solving with a user-centered perspective, fostering creativity and innovation.

<table>
<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td>216M09L501</td><td colspan="6">IoT and Robotics Laboratory</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">--</td><td>02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">--</td><td>01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">Lab CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td colspan="2">50</td><td>50</td></tr>
</table>

Proposed List of Experiments:

1. Experiment on interfacing sensor to Arduino for data collection
2. Experiment on IoT Data transmission
3. Experiment on constructing and programming a robot to follow a predefined path using sensors
4. Building a robot arm and programming its movements for various tasks
5. Integrating IoT communication to remotely control a robot's movements
6. Implementing algorithms for autonomous navigation using sensors and decision-making logic
7. Programming multiple robots to collaborate on a task or communicate with each other
8. Mini Project

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M09L601</td><td colspan="5">Software and IDE Tools Laboratory</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="2">--</td><td>02</td><td>02</td><td>04</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">--</td><td>01</td><td>02</td><td>03</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">Lab CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>–</td><td>--</td><td>75</td><td>75</td></tr>
</table>

Proposed List of Experiments

1) Implementation of Integrated Development Environment (IDE) setup and basics.
2) Implementation of debugging and error handling using IDE tools.
3) Implementation of unit testing (using frameworks like JUnit for Java or NUnit for .NET) in software development.
4) Implementation of circuit design using CAD tools
5) Implementation of CAD model design and 3D printing.
6) Implementation of cloud platforms for IOT
7) Implementation of algorithms for object detection using sensors.
8) Implementation of security measures such as encryption, authentication, and access control in IoT devices and networks.

<table>
<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td>216M09L602</td><td colspan="6">Do It Yourself (DIY)</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">--</td><td>02</td><td>02</td><td>04</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">--</td><td>01</td><td>02</td><td>03</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">Lab CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>–</td><td>--</td><td colspan="2">75</td><td>75</td></tr>
</table>

Proposed List of DIY:

1) Design a simple battery charging circuit using diodes and resistors for charging rechargeable batteries like Ni-Cd or Li-ion.
2) Design a system using sensors to detect soil moisture and automate watering for plants.
3) Design IoT-based weather station that collects data (temperature, humidity, pressure) using sensors and transmits it to a cloud platform. Display the data on a web dashboard.
4) Design and develop a simple task manager application using a programming language like Java, Python, or C#.
5) Design a system to monitor and manage energy consumption in a building using IoT devices and display real-time data on a web interface.
6) Create a voice-controlled assistant (similar to Alexa or Google Assistant) using a Raspberry Pi and microphone/speaker setup.
7) Design a temperature monitoring system with Arduino to monitor and display temperature readings on an LCD or serial monitor.(Use a temperature sensor e.g.,DHT11 or DS18B20).
8) Design an embedded data logger using sensors (temperature, humidity, light) interfaced with a microcontroller to record environmental data at regular intervals and store it on an SD card or transmit it wirelessly.

Syllabus

Minor Programme in
Power Electronics and Industrial Drives

Offered by Department of Electronics and Computer Engineering

From
Academic Year 2024-25

(SVU-KJSCE 2.0)

(Approved by BOS dated 23-Apr-24)

Minor Degree Programme in Power Electronics and Industrial Drives

Offered by Department of Electronics and Computer Engineering

Introduction:

Advent of electronic switching devices with high frequencies could make all types of power conversions possible with high efficiency and accuracy. Power electronics is the application of solid-state electronics to the control and conversion of electric power. Simultaneous developments in electric motors both AC and DC with flexibility in torque-speed characteristics were put in to use for various drives in Industry. From simple constant speed drive to variable speed drive (VSD) many applications were emerged in Industry. With tailor made various torque-speed requirement of load in different time zones of application cycle and with the availability of energy source an engineer has to design the complete system. The system will need selection of motor, feedback control system, controller design and power converter. When this is integrated, will be the Drive.This minor program in Power Electronics and Drives of KJSCE is designed to carve young professionals from UG students who will be able to perform as experts in Industrial Drives and Automation field. This minor degree helps students in developing analytical and investigative skills needed to design a complete electric drive. Case studies, Internships in Industry and mini projects which are the essential components of this program will give opportunity for experiential learning on real life problems through well formulated curriculum that foster hands-on learning.

Objectives:

- Analyze different converter circuits like controlled rectifiers, inverters, choppers and cycloconverters for power conversion.
- Prepare the students for a career in the drastically changing Industrial automation and automotive sector.
- Familiarize the operation principles, and design of starting, braking, and speed control arrangements for electric motors and their applications.
- Provide strong foundation to assess performance of different industrial drives considering issues such as, energy efficiency, power quality, economic justification, environmental issues, and practical viabilities
- Inculcate professional and ethical attitude and ability to relate power system issues to society at large.
- Facilitate strong base of basic scientific & engineering knowledge with professional ethics, lifelong learning attitude society globally.

Learning Outcomes:

On successful completion of Minor Programme in Power Electronics and Industrial Drives, an engineering graduate will be able to:

- Understand the basic concepts of power electronics and industrial drives.
- Develop industrial applications using AC, DC drives.

List of Courses:

1. Power Electronics
2. Smart Sensors and Industry 4.0
3. Digital Controllers in Power Electronics

4. Mini Project

5. Industrial Drives

Eligibility Criteria:
Students who have passed the First Year of Engineering in any branch at K. J. Somaiya College of Engineering.

Assessment Method:

- Laboratory performance evaluation- H/W +simulation
- Unit tests
- Mini project
- Internal assessment
- presentation/ report writing
- End semester examination

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
Course Code	**Course Name**	**Teaching Scheme (Hrs.) TH – P – TUT**	**Total (Hrs.)**	**Credits Assigned TH – P – TUT**	**Total Credits**	**Semester of Major Degree**
216M02C401	Power Electronics	3 –0– 0	03	3 – 0 – 0	03	IV
216M02L401	Power Electronics	0 – 2 – 0	02	0 – 1 – 0	01	IV
216M02C501	Smart sensors and Industry 4.0	3 –0– 0	03	3 – 0 – 0	03	V
216M02L501	Smart sensors and Industry 4.0 Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	V
216M02C601	Digital controllers in power electronics	3 –0– 0	03	3 – 0 – 0	03	VI
216M02L601	Digital controllers in power electronics Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	VI
216M02P601	Mini Project	0 – 4– 0	04	0 – 2– 0	02	VI
216M02C701	Industrial Drives	3 – 0– 0	03	3 – 0 – 0	03	VII

216M02L701	Industrial Drives Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	VII
Total		**12—12 -- 0**	**24**	**12-06-0**	**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme				
		Marks				
		CA		ESE	LAB/TUT CA	Total
		ISE	IA			
216M02C401	Power Electronics	30	20	50	-	100
216M02L401	Power Electronics Laboratory	-	-	-	50	50
216M02C501	Smart sensors and Industry 4.0	30	20	50	-	100
216M02L501	Smart sensors and Industry 4.0 Laboratory	-	-	-	50	50
216M02C601	Digital controllers in power electronics	30	20	50	-	100
216M02L601	Digital controllers in power electronics Laboratory	-	-	-	50	50
216M02P601	Mini Project	-	-	-	50	50
216M02C701	Industrial Drives	30	20	50	-	100
216M02L701	Industrial Drives Laboratory	-	-	-	50	50
Total		**120**	**80**	**200**	**250**	**650**

Course Code	Course Title			
216M02C401	Power Electronics			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

- **Course prerequisites:** Semiconductor diodes as a rectifier, behavior of inductor and capacitor, Electrical Networks, harmonics, Fourier analysis.

Course Objectives: This course introduces the basic concepts of switched-mode converter circuits for controlling and converting electrical power with high efficiency. Principles of converter circuit analysis are introduced and are developed for finding the steady state voltages, current, and efficiency of power converters. A basic understanding of electrical circuit analysis is an assumed prerequisite for this course.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Understand construction, principle of operation and V-I characteristics of various Power Electronics Devices.

CO2: Analyze, compare and design power circuit of AC to DC converters.

CO3: Analyze, compare and design power circuit of DC to AC converters.

CO4: Analyze and compare various topologies of DC to DC converters.

CO5: Analyze and compare various topologies of AC to AC converters.

Module No.	Unit No.	Details	Hrs.	CO
1	**Power Electronics Devices**		**09**	CO1
	1.1	Principle of operation of SCR, static and dynamic characteristics, gate characteristics. Methods of turning on (type of gate signal), UJT triggering circuit, Commutation circuits. **Self learning**: - Study of turn on and driver ICs for various devices.		
	1.2	Principle of operation, characteristics, rating and applications of: DIAC, TRIAC, MOSFET, IGBT and power BJT.		

2	**AC to DC Converters: Controlled Rectifiers**		10	CO2
	2.1	Single phase Half wave controlled rectifiers, Full wave controlled rectifiers, half controlled and fully controlled rectifiers with R, R-Land R-L-E load with and without feedback diodes. **(effect of source inductance not to be considered).** **D**ual converter. **P**erformance Parameters.		
	2.2	Three phase half controlled and fully controlled rectifiers with R load only. **P**erformance Parameters.		
3	**DC to AC Converters : Inverters**		12	CO3
	3.1	Principle of operation of Series and Parallel Inverters. Principles of operation of Single phase half / full bridge voltage source inverters with R and R-L load. McMurray-Bedford half bridge and full bridge inverter. Voltage control of single phase inverters using PWM techniques.		
	3.2	Three phase bridge inverters (120° and 180° conduction mode) with R and R-L load.		
4	**Dc to DC Converters : Choppers**		**09**	CO4
	4.1	Basic principle of step up and step down choppers. Type-A, Type-B, Type-C, Type-D and Type-E choppers		
	4.2	Buck, Boost, Buck-Boost converters, Derivation of Vo, Io, ΔVc and ΔIo under steady state condition.		
5	**AC to AC Voltage Controllers and Cycloconverters**		**5**	CO5
	5.1	Principle of On-Off control, principle of phase control, single phase bidirectional control with R and RL load, TRIAC as light dimmer/ single-phase induction motor speed controller.		
	5.2	Principle of cycloconverter operation, single phase to single phase step-up and step-down cycloconverter. Introduction to three phase Cycloconverter. Applications of cycloconverter.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Dr. P.S. Bimbhra	*Power Electronics*	Khanna Publications, India	4th Edition Reprint-2008
2.	M.D. Singh and K.B. Khanchandani	*Power Electronics*	Tata McGraw Hill Education, India	2nd Edition, 18th reprint 2013
3.	M. Rashid	*Power Electronics Circuits Devices and Applications*	Pearson Education	4th Edition, 2013

4	Ned Mohan	*Power Electronics: Converters, Applications and Design*	John Willey Publication	3rd Edition, 2002

Course Code	Course Title			
216M04L401	Power Electronics			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	-	2	-	2
Credits Assigned	-	1	-	1

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	-	-	-	50	50

Term-Work:
Term work will consist of experiments/ tutorials covering entire syllabus of the course '116m76C401'. Students will be graded based on continuous assessment of their term work

Course Code	Course Title			
216M02C501	Smart Sensors and Industry 4.0			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites:

- Instrumentation System
- Microcontroller and Application

Course Objectives:
This course aims to cover smart sensors and brief introduction to Industry 4.0

Course Outcomes:

At the end of successful completion of the course the student will be able to
CO1. Realize the role of sensors in IoT systems.
CO2. Interface the Sensors
CO3. Understand the evolution of Industry 4.0
CO4. Analyze privacy security and governance in Industry 4.0
CO5. Study applications of Industry 4.0

Module No.	Unit No.	Topics	Hrs.	CO
1	**Introduction to Industry 4.0**		06	CO1
	1.1	The Various Industrial Revolutions. Transition from robotics and automation to Industry 4.0		
	1.2	Industry 4.0 Architecture: Interface, Information Processing and Intelligence		
2	**Introduction to Smart Sensors**		08	CO2
	2.1	Role of Sensors in IoT systems, Criteria for selection of Sensors		
	2.2	Application Specific sensors: Healthcare, Inventory Management & Quality Control, Smart city, Plant Safety and Security.		
3	**Interfacing of Sensors**		12	CO3
	3.1	Setting up IoT work-flow, Microcontroller programming using Arduino, Building IoT Applications using Raspberry Pi, programming with Python.		
	3.2	IoT data transfer Protocols: HTTP, CoAP, MQTT, AMQP, 6LoWPAN.		
	3.3	IoT network layer Protocols: RFID, HART, MODBUS-Serial & Parallel, Ethernet, BACNet , Current, M2M		
	3.4	Introduction to IoT Cloud Infrastructure		
4	**Privacy, Security and Governance**		10	CO4
	4.1	Introduction to web security, Conventional web technology and relationship with IIoT		
	4.2	Vulnerabilities of IoT, Privacy, Security requirements, Threat analysis, Trust, IoT security tomography and layered attacker model.		
	4.3	Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT, Network security techniques Management aspects of cyber security.		
5	**Industry 4.0 Applications**		09	CO5
	5.1	Industrial IoT Case studies: Healthcare, Inventory Management & Quality Control, Smart city, Plant Safety and Security, Preventive maintenance case study		
	5.2	Introduction to VAPT, brief study of internal and external network VAPT.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Elena G. Popkova, Yulia V. Ragulina, Aleksei V. Bogoviz	Industry 4.0: Industrial Revolution of the 21st Century	Springer	1st Edition, 2010
2.	Alp Ustundag, Emre Cevikcan	Industry 4.0: Managing The Digital Transformation	Springer	1st Edition, 2011
3.	Cuno Pfister	Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud	Maker Media, Inc., India	1st Edition, 2010
4.	Alasdair Gilchrist	Industry 4.0: The Industrial Internet of Things	Apress, India	1st Edition, 2010

Course Code	Course Title						
216M02L501	Smart Sensors and Industry 4.0 Laboratory						
	TH			P		TUT	Total
Teaching Scheme(Hrs.)	-			2		-	2
Credits Assigned	-			1		-	1
Examination Scheme	Marks						
	CA		ESE	TW	LAB/TUT CA		Total
	ISE	IA					
	-	-	-	50	--		50

Term-Work:
Term work will consist of experiments/ tutorials covering entire syllabus of the course '116m76C501'. Students will be graded based on continuous assessment of their term work

<table>
<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td>216M02C601</td><td colspan="6">Digital Controllers in Power Electronics</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="3">03</td><td>--</td><td>--</td><td>03</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">03</td><td>--</td><td>--</td><td>03</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>50</td><td colspan="2">-</td><td>100</td></tr>
</table>

Course prerequisites:

- Digital Logic Design
- Microcontroller and Applications

Course Objectives:

- To study architecture and programming model of PIC18FXXX
- To analyze internal peripheral units of PIC18FXXX and use them for interfacing applications in power electronics.
- To be able to write assembly language and Embedded-C program for power electronics applications.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1. Compare microcontrollers and analyze features of microcontrollers.
CO2. Write Embedded-C programs to use on chip peripherals of microcontrollers.
CO3. Perform measurement of various parameters of a machine.
CO4. Control firing angles of different types of converters.
CO5. Design various controllers in the field of power electronics.

Module No.	Unit No.	Topics	Hrs.	CO
1	**Introduction to Microcontrollers**		06	CO1
	1.1	Evolution of microcontrollers: comparison between microprocessor and microcontroller.		
	1.2	Overview on 8051 and PIC33FX microcontrollers.		

	1.3	Architecture, register files, memory organization, addressing modes, instruction set of PIC33FX. Programming techniques and simple assembly language programs for PIC33FX.		
2	**On chip peripherals of PIC33FX**		**12**	**CO2**
	2.1	On chip peripherals like IO ports, timers, ADC, I^2C bus, UART, PWM control.		
	2.2	Interrupt structure, interrupt priority, initializing and servicing the interrupts.		
	2.3	Embedded-C programming to use on chip peripherals.		
3	**Microcontrollers in Closed Loop Control Schemes**		**09**	**CO3**
	3.1	Importance of measurement and sensing in closed loop control.		
	3.2	Measurement of supply voltage, current, frequency, power and power factor.		
	3.3	Voltage feedback sensing circuits, Hall effect sensors and CT based current sensing, interfacing of zero crossing detector, speed measurement, temperature measurement, and vibration measurement.		
4	**Microcontroller Based Firing Scheme for Converters**		**09**	**CO4**
	4.1	Low offset Op-Amps for signal conditioning, Single and dual supply op-amps, need for isolated drivers, optically isolated drivers.		
	4.2	Firing schemes for single phase and three phase rectifiers.		
	4.3	Firing scheme for DC choppers, inverters, types of pulse width modulation techniques, their implementation.		
5	**Applications of microcontroller in power electronics**		**09**	**CO5**
	5.1	Design for Buck Converter, voltage regulation of DC-DC converters using PWM technique.		
	5.2	Speed control of DC motor.		
	5.3	Stepper motor control.		
	5.4	Speed and Power Factor (PF) control of AC motor.		
		Total	**45**	

Recommended Books:

Sr. No.	**Name/s of Author/s**	**Title of Book**	**Name of Publisher with Country**	**Edition with Year of Publication**
1.	Ramesh S Gaonkar	Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family)	Thomson/Delmar Learning, NY, USA	1^{st} edition, 2007
2.	John B.Peatman	Design with PIC Microcontrollers	Pearson Education, India	1^{st} edition, 2004

3.	Muhammad Mazidi, Rolin Mckinlay, Danny Causey	PIC Microcontroller and Embedded Systems using Assembly and C for PIC18	Pearson Education, International, USA	1st edition, 2008
4.	Ajay Deshmukh	Microcontrollers: Theory and Applications	Tata McGraw-Hill Education, India	3rd edition, 2017

Course Code	**Course Title**					
216M02L601	**Digital Controllers in Power Electronics Laboratory**					
	TH			**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**-**			**2**	**-**	**2**
Credits Assigned	**-**			**1**	**-**	**1**
Examination Scheme	**Marks**					
	CA		**ESE**	**LAB/TUT CA**		**Total**
	ISE	**IA**				
	-	**-**		**50**		**50**

Term-Work:
Term work will consist of experiments/ tutorials covering entire syllabus of the course '116m76C601'. Students will be graded based on continuous assessment of their term work.

Course Code	Course Title			
216M02P601	**Mini Project on Power Electronics and Industrial Drives***			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	0	04	--	04
Credits Assigned	0	02	--	02

<table>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

Course Objectives:

Applications of Power Electronics and Industrial Drives in real world applications can be designed using various platforms and concepts studied in different courses. The student can design and develop the project individually or in a pair based on scope of the work approved by faculty mentor.

*An industrial application can be developed in the form of an internship of minimum 4 weeks approved by a faculty mentor.

Course Outcomes:
At the successful completion of this minor program an engineering graduates will be able to
CO1: Develop small Power Electronics and Drive based applications
CO2: Communicate the project work in the form of report, presentation/ demonstration.

Course Code	Course Title				
216M02C701	**Industrial drives**				
	TH		**P**	**TUT**	**Total**
Teaching Scheme (Hrs.)	03		--	--	03
Credits Assigned	03		--	--	03
Examination Scheme	**Marks**				
	CA		**ESE**	**LAB/TUT CA**	**Total**
	ISE	**IA**			
	30	20	50	--	100

Course prerequisites:

- Power Electronics

Course Objectives: This course aims to cover various motor drives used in Industries.

Course Outcomes:
At the end of successful completion of the course the student will be able to

CO1. Understand basics of electrical drives with selection of motor.
CO2. Control Speed of the DC motor by using different controllers.
CO3. Design and modeling of various closed loop control strategies and controllers.
CO4. Study Victor control of Induction Motor Drive.
CO5. Study and draw characteristics of synchronous motor using UPF and constant flux linkage control.

Module No.	Unit No.	Topics	Hrs.	CO
1	**Introduction to Electric Industrial Drives**		09	CO1

	1.1	Parts, advantages, parameters for choice and present status of Electric Drive. Dynamics of drives. Nature, classification and components of load torques on drive. Steady state stability and equalization of load.		
	1.2	Selection of motor power rating. Thermal model of motor and classes of motor duty.		
	1.3	Introduction to AC motor drives, torque production, Equivalent circuit analysis,		
	1.4	Speed Torque Characteristics with variable voltage operation, variable frequency operation, constant v/f operation, variable stator current operation, Induction motor characteristics in constant torque and field weakening regions.		
2	**Controlled Rectifier and Chopper fed DC Drives**		**09**	**CO2**
	2.1	Separately exited, Shunt and series DC motors with rectified supply. Single phase semi converter and single phase full converter for continuous and discontinuous modes of operation, power and power factor.		
	2.2	Three-phase semi converter and three phase full converter for continuous and discontinuous modes of operation. Power and power factor, addition of freewheeling diode, three-phase double converter.		
	2.3	Principles of operation of the chopper, four-quadrant chopper circuit, chopper for inversion, chopper with other power devices , model of the chopper, input to the chopper steady state analysis of chopper controlled DC motor drives, rating of the devices, pulsating torque		
3	**Control of DC Drives**		**09**	**CO3**
	3.1	Speed control of Drives. Closed loop current limit control, torque control, speed control, Closed loop speed control scheme of DC motors for control below and above base speed and multi-motor drives. PLL control. Speed sensing, current sensing.		
	3.2	Filter in the speed feedback loop speed controller, current reference generator, current controller and flow chart for simulation, harmonics and associated problems, Harmonic Mitigation.		
4	**Control of Induction Motor Drive at Rotor Side and Vector Control**		**09**	**CO4**
	4.1	Slip power recovery drives, Static Kramer Drive, phasor diagram, torque expression, speed control of a Kramer Drive.		
	4.2	Static Scherbius Drive, modes of operation.		

	4.3	Vector control of Induction Motor Drives: Principles of Vector control, vector control methods, direct methods of vector control, indirect methods of vector control, adaptive control principles, self-tuning regulator Model referencing control. Sensor based Control and Network Drives.		
5	**Control of Synchronous motor drives and Special Drives**		**09**	**CO5**
	5.1	Synchronous motor and its characteristics, control strategies, constant torque angle control, unity power factor control, constant mutual flux linkage control.		
	5.2	Controllers: Flux weakening operation, maximum speed, direct flux weakening algorithm, constant torque mode controller, flux weakening controller, indirect flux weakening, maximum permissible torque-speed control scheme, and implementation strategy speed controller design. Working of SRM and BLDC Drives used in Industry.		
	5.3	Miniature drives, Ethercat, SIC Drives.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Shepherd, Hulley, Liang	Power Electronic and motor control	Cambridge University Press.	2nd Edition
2.	R. Krishnan	Electronic Motor drives modeling, Analysis and control	Prentice Hall India.	1st Edition
3.	M. H. Rashid	Power Electronic circuits, Drives and Applications	Prentice Hall India.	1st Edition, 1995
4.	G.K. Dubey	Fundamentals of Electric Drives	Narosa Publications	1995
5.	S.B. Dewan and A. Straughen	Power Semiconductor drives	Wiley	1975
6.	B K Bose	Modern Power Electronics and AC Drives	Pearson Publications	1st edition
7.	MD Murthy and FG Turn Bull	Power Electronics and Control of AC Motors (For Chapters II, III, V)	Pergman Press	1st edition

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M02L701</td><td colspan="5">Industrial drives Laboratory</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="2">-</td><td>02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">-</td><td>01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

Term-Work:
Term work will consist of experiments/ tutorials covering entire syllabus of the course '116m76C701'. Students will be graded based on continuous assessment of their term work.

Somaiya Vidyavihar University

Syllabus
Minor Programme in
Robotics and Automation
Offered by the Department of Electronics and Computer Engineering
From
Academic Year 2024-25

K J Somaiya College of Engineering, Mumbai-77
(A Constituent College of Somaiya Vidyavihar University)

Minor Programme on Robotics and Automation
Offered by Department of Electronics and Computer Engineering

Introduction

Robotics and automation is the basic control process in the industry. The Fourth Industrial Revolution, or Industry 4.0, brings digital and physical technologies together to create responsive, interconnected operations. From the supply chain to the smart factory, enterprises are using AI, robotics, edge computing, and the cloud to make informed, timely decisions. In industrial control, a wide number of variables temperature, flow, level, pressure, and distance can be sensed simultaneously. The technological boom in recent years has seen a transformation in the field of sensor technology. Digital and internet of things era, with upcoming industry 4.0 sensors and actuators play a vital role in any system. Moreover, automation and other fields are also composed of numerous sensors or actuators.

Objective

This program is designed with an aim of educating students in the area of Robotics and automation. It gives due importance to collect, process, store, and analyse large volumes of sensor data. It aims to cover smart sensors and a brief introduction to Industry 4.0. This program incorporates applications of different controller modes in various industrial processes. This program aims to focus on different technologies for the design and development of products. Understand and develop a solid security approach to keep advisories from hacking an IIoT system Staff a project and then plan and execute a product schedule of what Industry 4.0 is and what factors have enabled the IIoT.

At the successful completion of this minor program an engineering graduates will be able to:

LO1. Understand the basics of Industrial Automation and Robotics to design and develop industrial applications.
LO2. Gain insights into IoT industrial applications and technologies like IIoT.

Eligibility Criteria:

Students who have passed the First Year of Engineering in any branch at K. J. Somaiya College of Engineering.

Assessment Methods: **P**rojects, Mini Project, Tests, Laboratory experiments, Presentation / Video making, Quiz, study of research papers etc.

Key Information
Duration: 3 Years
Total credits: 18
Programme Code: ______
Course Type: Minor Degree
Mode of study: Full time
Campus: Vidyavihar - Mumbai
Institute: KJSCE

Teaching and Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M07C301	Fundamentals of Automation	3 – 0 – 0	3	3-0-0	3	III
216M07L301	Fundamentals of Automation Laboratory	0 – 2 – 0	2	0-1-0	1	III
216M07C401	Smart Sensor and Industry 4.0	3 – 0 – 0	3	3-0-0	3	IV
216M07L401	Smart Sensor and Industry 4.0 laboratory	0 – 2 – 0	2	0-1-0	1	IV
216M07C501	Industrial Process Control	3 – 0 – 0	3	3-0-0	3	V
216M07L501	Industrial Process Control laboratory	0 – 2 – 0	2	0-1-0	1	V
216M07C601	Mini Project	0 – 4 – 0	4	0-2-0	2	VI
216M07L701	Industrial Robotics	3 – 0 – 0	3	3-0-0	3	VII
216M07P701	Industrial Robotics Laboratory	0 – 2 – 0	2	0-1-0	1	VII
Total		**12-12-0**	**24**	**12-06-1**	**18**	

Evaluation Scheme

Course Code	Course Name	Examination Scheme				
		Marks				
		CA		ESE	LAB/ CA	Total
		ISE	IA			
216M07C301	Fundamentals of Automation	30	20	50	--	100
216M07L301	Fundamentals of Automation Laboratory	--	--	--	50	50
216M07C401	Smart Sensor and Industry 4.0	30	20	50	--	100
216M07L401	Smart Sensor and Industry 4.0 laboratory	--	--	--	50	50
216M07C501	Industrial Process Control	30	20	50	--	100
216M07L501	Industrial Process Control Laboratory	--	--	--	50	50
216M07L601	Mini Project	--	--	--	50	50
216M07C701	Industrial Robotics	30	20	50	--	100
216M07L701	Industrial Robotics Laboratory	--	--	--	50	50
Total		120	80	200	250	650

Course Code	Course Title			
216M07C301	**Fundamentals of Automation**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**03**	**-**	**-**	**03**
Credits Assigned	**03**	**-**	**-**	**03**

Examination Scheme	Marks				
	CA		**ESE**	**LAB/CA TW**	**Total**
	ISE	**IA**			
	30	**20**	**50**	**-**	**100**

Course prerequisites: Basics of Control systems

Course Objectives: This course aims at providing an overview of PLCs, SCADA and HMI and making the students aware of the current industry trends. PLCs are at the heart of the automation system. It is a controller used to control the plant/ process/machine/system. SCADA is extensively used in the process industry for remote monitoring and control of the plant/system, which is geographically widespread. HMI is a device that acts as an interface between PLC and operator.

Course Outcomes

At the end of completing the course the student will be able to

- **CO1:** Understand Industrial Automation components
- **CO2:** Describe PLC and its architecture
- **CO3:** Select protocol based on different applications
- **CO4:** Interface PLC with HMI, SCADA

Module No.	Unit No.	Topics	Hrs.	CO
1		**Overview of industrial automation**	9	CO1
	1.1	Fundamentals of Industrial Automation, Basics of Process Instrumentation		
	1.2	Understanding different transducers and sensors - Pressure, Level, Flow, and Temperature in industrial environment		

2	**Programmable Logic Controllers (PLC)**		12	CO2
	2.1	Basic concepts of PLC and its block diagram, PLC scan cycle		
	2.2	PLC Architectures- Stand-alone, DCS, PLC-to-PLC, Redundant Systems		
	2.3	Programming Languages for PLC – Ladder, STL, IL, SFC, FBD, Interfacing of actuators and sensors with PLC		
3	**Communication Protocols**		12	CO3
	3.1	RS232, RS485/422, Ethernet, Ethercat, DF1, Control Net, DeviceNet, Profibus, Profinet, Modbus, CAN, IEC 61131		
	3.2	Understanding Industry 4.0 standards		
4	**Human Machine Interface (HMI) & Supervisory Control and Data Acquisition (SCADA)**		12	CO4
	4.1	Initialization of new Programme, Creating Screen, Creating Database of Tags, Navigation between Screens		
	4.2	Communicating between PLC and HMI, Uploading/Downloading Applications, Programming Exercises, Security Features		
	4.3	Understanding SCADA and its generations, - Introduction, Selection and Requirements of Components, Creating Database of Tags, Driver Configuration		
	4.4	Animation, Writing Logic through Script, Interfacing with PLC, Security Features, real life applications		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Frank D Petruzella	*Programmable Logic Controllers*	McGraw Hill, New York	5th edition, 2016
2.	Stamatios Manesis, George Nikolakopoulos	*Introduction to Industrial Automation*	CRC Press, UK	1st edition, 2018
3.	William Bolton	*Programmable Logic Controllers*	Elsevier Newnes	4th edition, 2006
4.	Kelvin Collins	*PLC programming for Industrial Automation*	McGraw Hill, New York	4th edition, 2005

Course Code	Course Title		
216M07L301	**Fundamentals of Automation laboratory**		
	TH	**P**	**Total**
Teaching Scheme(Hrs.)	-	02	02
Credits Assigned	-	01	01

Examination Scheme	**Marks**				
	CA		**ESE**	**LAB / CA TW**	**Total**
	ISE	**IA**			
	-	-	-	50	50

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Term work will consist of experiments covering the entire syllabus of "**Fundamentals of Automation**" (**216M07C301**). Students will be graded based on continuous assessment of their term work.
Practical and oral examinations will be based on laboratory work and the entire syllabus.

Course Code	Course Title			
216M07C401	**Smart Sensor and Industry 4.0**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**03**	**-**	**-**	**03**
Credits Assigned	**03**	**-**	**-**	**03**

Examination Scheme	Marks				
	CA		**ESE**	**LAB/CA TW**	**Total**
	ISE	**IA**			
	30	**20**	**50**	**-**	**100**

Course prerequisites: NIL
Course Objectives: This course aims to cover smart sensors and brief introduction to Industry 4.0
Course Outcomes
At the end of completing the course the student will be able to

CO1. Understand the evolution of Industry 4.0
CO2 . Realize the role of sensors in IoT systems.
CO3. Interface the Sensors
CO4. Analyze privacy security and governance in Industry 4.0
CO5. Study applications of Industry 4.0

Module No.	Unit No.	Topics	Hrs.	CO
1		**Introduction to Industry 4.0**	06	CO1
	1.1	The Various Industrial Revolutions. Transition from robotics and automation to Industry 4.0		
	1.2	Industry 4.0 Architecture: Interface, Information Processing and Intelligence		
2		**Introduction to Smart Sensors**	08	CO2
	2.1	Role of Sensors in IoT systems, Criteria for selection of Sensors		

	2.2	Application Specific sensors: Healthcare, Inventory Management & Quality Control, Smart city, Plant Safety and Security.		
3	**Interfacing of Sensors**		12	CO3
	3.1	Setting up IoT work-flow, Microcontroller programming using Arduino, Building IoT Applications using Raspberry Pi, programming with Python.		
	3.2	IoT data transfer Protocols: HTTP, CoAP, MQTT, AMQP, 6LoWPAN.		
	3.3	IoT network layer Protocols: RFID, HART, MODBUS Serial & Parallel, Ethernet, BACNet , Current, M2M		
	3.4	Introduction to IoT Cloud Infrastructure		
4	**Semiconductor Memories**		10	CO4
	4.1	Introduction to web security, Conventional web technology and relationship with IIoT		
	4.2	Vulnerabilities of IoT, Privacy, Security requirements, Threat analysis, Trust, IoT security tomography and layered attacker model.		
	4.3	Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT, Network and data security techniques Management aspects of cyber security.		
	Industry 4.0 Applications		09	CO5
5	5.1	Industrial IoT Case studies: Healthcare, Inventory Management & Quality Control, Smart city, Plant Safety and Security, Preventive maintenance case study		
	5.2	Introduction to VAPT, brief study of internal and external network VAPT.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Elena G. Popkova, Yulia V. Ragulina, Aleksei V. Bogoviz	*Industry 4.0: Industrial Revolution of the 21st Century*	Springer , India	1st Edition, 2010
2.	Alp Ustundag, Emre Cevikcan	*Industry 4.0: Managing The Digital Transformation*	Springer , India	1st Edition, 2011
3.	Cuno Pfister	*Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud*	Maker Media, Inc., India	1st Edition, 2010
4.	Alasdair Gilchrist	*Industry 4.0: The Industrial Internet of Things*	Apress , India	1st Edition, 2010

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M07L401</td><td colspan="5">Smart Sensor and Industry 4.0 Lab</td></tr>
<tr><td></td><td colspan="2">TH</td><td colspan="2">P</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="2">-</td><td colspan="2">2</td><td>2</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">-</td><td colspan="2">1</td><td>1</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB / CA TW</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>50</td><td>50</td></tr>
</table>

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Term work will consist of experiments covering the entire syllabus of "**Smart Sensor and Industry 4.0**" (**216M07C401**). Students will be graded based on continuous assessment of their term work.
Practical and oral examinations will be based on laboratory work and the entire syllabus.

Course Code	Course Title			
216M07C501	**Industrial Process Control**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	03	-	-	03
Credits Assigned	03	-	-	03

Examination Scheme	Marks				
	CA		ESE	LAB/CA TW	Total
	ISE	IA			
	30	20	50	-	100

Course prerequisites: Nil
Course Objectives: This course makes the students understand all the processes involved in the industries, the various unit operations and be able to apply control schemes to these processes to get the output with desired specifications.
Course Outcomes
At the end of successful completion of the course the student will be able to CO1. Get a complete overview of strategies for process control.
CO2. Understand PLC Programming and interfacing of various sensors
CO3. Understand applications of hydraulic and pneumatic system components
CO4. Understand process control methods in automation
CO5. To learn industrial safety standards

Module No.	Unit No.	Topics	Hrs.	CO
1	**Elements of Process Control**		8	CO1
	1.1	Introduction to Modern Automatic control system, and standard signal used in process control		
	1.2	Computers in process control: Data loggers, Data Acquisition Systems (DAS), Direct Digital Control (DDC). Supervisory Control and Data Acquisition Systems (SCADA), sampling considerations. Functional		

		block diagram of computer control systems. Alarms, interrupts. Characteristics of digital data, controller software, linearization.		
	1.3	Digital controller modes: Error, proportional, derivative and composite controller modes.		
2	**Programmable logic controller (PLC)**		**12**	**CO2**
	2.1	Definition, overview of PLC systems, input/output modules, power supplies, isolators. General PLC programming procedures, programming on-off inputs/ outputs. Auxiliary commands and functions: PLC Basic Functions: Register basics, timer functions, counter functions.		
	2.2	Development stages involved for PLC based automation systems. Basics of eplan , Example of soft PLC		
3	**Hydraulic and Pneumatic systems**		**09**	**CO3**
	3.1	Introduction and difference between hydraulic and pneumatic systems, construction and operations of pump, relief valve, non-return valve, pilot operated relief valve, series and parallel compensator of flow valve, pressure compensated pump, motor ,actuators, seals used in control system , Comparison with electrical actuators		
	3.2	Symbolic representation of hydraulic and pneumatic elements. Various types of pumps used in hydraulic systems. purpose of air filters and types in pneumatic system		
4	**SCADA / HMI System and DCS**		**11**	**CO4**
	4.1	SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems		
	4.2	SCADA Architecture and Application: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850		
	4.3	DCS fundamentals: DCS introduction, Various function Blocks, DCS components/block diagram , Interfacing of smart sensor with SCADA		
5	**Safety Instrumented System (SIS)**		**05**	**CO5**
	5.1	Need for safety instrumentation- risk and risk reduction		

		methods, hazards analysis. Process control systems and SIS. Safety Integrity Levels (SIL) and availability. Introduction to the International Functional Safety Standard IEC 61508		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Samuel M. Herb	*Understanding Distributed Processor Systems for Control*	Instrument Society of America	1st Edition, 1999
2.	Hackworth, Fredrik D , Hackworth Jr.	*Programmable Logic Controllers: Programming Methods and Applications*	Pearson Education, India	1st Edition, 2011
3.	S.K. Singh	*Computer Aided Process Control*	Prentice Hall of India	1st Edition, 2004
4.	Stuart A. Boyer	*SCADA: Supervisory Control and Data Acquisition*	International Society of Automation	4th Edition, 2010
5.	Andrew Parr	*Hydraulic & pneumatics*	A Technicians & Engineers Guide	3rd Edition, 2011
6.	Gruhn and Cheddie	*Safety Shutdown Systems*	International Society of Automation	2nd Edition, 2006

Course Code	Course Title				
216M07L501	**Industrial Process Control Laboratory**				
	TH		**P**		**Total**
Teaching Scheme(Hrs.)	-		02		02
Credits Assigned	-		01		01
Examination Scheme	**Marks**				
	CA		**ESE**	**LAB / CA TW**	**Total**
	ISE	**IA**			
	-	-	-	50	50

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Term work will consist of experiments covering the entire syllabus of "**Industrial Process Control**" (**216M07C501**). Students will be graded based on continuous assessment of their Term work.
Practical and oral examinations will be based on laboratory work and the entire syllabus.

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M05P701</td><td colspan="5">Mini Project</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">–</td><td>04</td><td>–</td><td>04</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">–</td><td>02</td><td>–</td><td>02</td></tr>
<tr><td rowspan="4">Evaluation Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA (TH)</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB CA TW</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td colspan="2">50</td><td>50</td></tr>
</table>

Distribution of LAB CA:

Criterion	**Marks**
Project demonstration 1	20
Project demonstration 2	20
Orals based on project	10

The student shall select projects related to Robotics and Automation. The topics may be from the course syllabus or broad areas in Robotics and Automation. Students will be graded based on continuous assessment of their project work.

Course Code	Course Title			
216M07C701	**Industrial Robotics**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	03	-	-	03
Credits Assigned	03	-	-	03

Examination Scheme	**Marks**				
	CA		**ESE**	**LAB/CA TW**	**Total**
	ISE	**IA**			
	30	20	50	–	100

Course prerequisites: Control System Engineering, Applied Mechanics, Matrix Algebra

Course Objectives: The course aims in discussing the requirements, kinematics involved in designing an industrial robot. It helps in making an appropriate choice of the robotic system for a particular application

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1. Understand basic principles of robot specifications, technology and configurations

CO2. Apply the theory of robotic arm kinematics for industrial robots

CO3. Describe various drive and control mechanism along with different types of end effectors

CO4. Implement the Machine vision system for a given application

CO5. Apply the theory and concepts to design real life application robots

Module No.	Unit No.	Details	Hrs.	CO
1	**Fundamentals of Robotics**		05	CO 1
	1.1	Robot definition, Robot anatomy – Coordinate systems, work envelope, types and classification, Specifications, Pitch, yaw, roll, joint notations, speed of motion and payload		
	1.2	Robot parts and their functions, Need for robots, Different applications		

2	**Direct Kinematics and Inverse Kinematics**		**10**	**CO 2**
	2.1	**Direct Kinematics:** Rotation Matrix, Homogeneous		
	2.2	**Inverse Kinematics:** General Properties of Solutions, Tool Configuration, Solutions for Four-Axis and Five Axis Robots, Robot Work Cell		
3	**Robot Drive Systems and Peripherals**		**10**	**CO 3**
	3.1	Control systems and components, Positional sensors, velocity sensors, Actuators, AC/DC motors, Tactile sensors, Proximity and range sensors		
	3.2	Design of planar robotic arm for workspace analysis., Design of planar robot for motion detection using joint sensors, types of end effectors, grippers: selection and design		
4	**Machine Vision**		**10**	**CO 4**
	4.1	Camera, frame grabber, sensing and digitizing image data, Signal conversion, Image Storage, Lighting techniques		
	4.2	Image processing and analysis, Data reduction, Segmentation, Feature extraction, Object recognition, Other algorithms, Applications, Inspection, identification, visual serving and navigation		
5	**Robot Programming and Industrial Applications**		**10**	**CO5**
	5.1	Robot programming methods, end effector commands, simple programs		
	5.2	Economic analysis of robot		
	5.3	**Applications:** manufacturing, loading/unloading, material transfer, processing operations, assembly and inspection		
		Total	**45**	

Recommended Books:

Sr. No.	**Name/s of Author/s**	**Title of Book**	**Name of Publisher with country**	**Edition and Year of Publication**
1.	Robert J Schilling	*Fundamentals of Robotics*	Prentice Hall India, Meerut	1st edition, 2009
2.	Fu, Lee and Gonzalez	*Robotics, control vision and intelligence*	McGraw Hill International, NewYork	1st edition, 2008
3.	M.P.Groover, M.Weiss, R.N.Nagel, N.G.Odrey	*Industrial Robotics Technology programming and Applications*	Tata McGraw Hill Publishing Company Limited	1st edition, 2008
4.	Yoram Koren	*Robotics for Engineers*	McGraw Hill International, NewYork	1st edition, 1987
5.	R.K. Mittal & I.J. Nagrath	*Robotics & Control*	TMH Publication	1st edition, 2003

Course Code	**Course Title**					
216M05L701	**Industrial Robotics Laboratory**					
	TH			**P**		**Total**
Teaching Scheme(Hrs.)	**-**			**02**		**02**
Credits Assigned	**-**			**01**		**01**
Examination Scheme	**Marks**					
	CA		**ESE**	**LAB / CA TW**		**Total**
	ISE	**IA**				
	-	**-**	**-**	**50**		**50**

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Term work will consist of experiments covering the entire syllabus of "**Industrial Robotics Laboratory**" (**216M07C701**). Students will be graded based on continuous assessment of their Term work.
Practical and oral examinations will be based on laboratory work and the entire syllabus.

Syllabus
Minor Programme in
Sound Engineering
Offered by the Department of Electronics and Computer Engineering

From
Academic Year 2024-25

(SVU-KJSCE 2.0)

(Approved by BOS dated 23-Apr-24)

Offered by the Department of Electronics and Computer Engineering

Introduction:

Sound engineering is a vast field that covers all the aspects of music and sound. Sound engineering, also often termed audio engineering, refers to the art of reproducing, mixing, and reinforcing sound. Other than that, audio engineering is also involved in producing music, live performances, and films. Audio engineers usually work on the technical side of sound recording, which involves setting levels, placing the microphones, and making sure the respective audience receives good sound. They handle the entire technical side involving performances and Audio Production.

This minor program in Sound Engineering of KJSCE is designed to carve young professionals from UG students who will be able to process, record, edit and present sound, and their work is inarguably vital in the music industry. This minor program helps students to combine both art and a gamut of physics involved in Sound Engineering. Case studies, Internships in Industry and mini projects which are the essential components of this program will give opportunity for experiential learning on real life problems through well formulated curriculum that foster hands-on learning.

Objectives:

- Develop a theoretical and practical understanding of the fundamentals of sound engineering including recording, mixing, production and mastering.
- Extend artistic and technical outcomes in the sonic arts including sound recording, mixing and production.
- Understand the principles of editing and enhancing film sound
- Understand the workflow and roles in live sound environments
- Identify the different stages of film sound production
- Recognize the different roles and responsibilities in film sound departments
- Describe the procedure of recording film sound on location

Learning Outcomes:

On successful completion of Minor Programme in Sound Engineering, an engineering graduate will be able to:

- Identify, describe and explain sound engineering fundamentals associated with signal flow, microphones, recording, mixing, production and mastering.
- Develop and implement compositional and arrangement ideas for music productions

List of Courses:

1. Fundamentals of Sound Engineering
2. Digital Audio Processing
3. Audio and Music Engineering
4. Mini Project
5. Music production and Editing

Eligibility Criteria:
Students who have passed the First Year of Engineering in any branch at K. J. Somaiya College of Engineering.
Assessment Method:

- Laboratory performance evaluation- H/W +simulation
- Unit tests
- Mini project
- Internal assessment
- presentation/ report writing
- End semester examination

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M10C401	Fundamentals of Sound Engineering	3 –0– 0	03	3 – 0 – 0	03	IV
216M10L401	Fundamentals of Sound Engineering Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	IV
216M10C501	Digital Audio Processing	3 –0– 0	03	3 – 0 – 0	03	V
216M10L501	Digital Audio Processing Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	V
216M10C601	Audio and Music Engineering	3 –0– 0	03	3 – 0 – 0	03	VI
216M10L601	Audio and Music Engineering Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	VI
216M10P601	Mini Project	0 – 4 – 0	04	0 – 2 – 0	02	VI
216M10C701	Music production and Editing	3 – 0– 0	03	3 – 0 – 0	03	VII
216M10L701	Music production and Editing Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	VII
Total		**12—12 -- 0**	**24**	**12-06-0**	**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme					
		Marks					
		CA		ESE	LAB/TUT CA	Total
		ISE	IA			
216M10C401	Fundamentals of Sound Engineering	30	20	50	-	100
216M10L401	Fundamentals of Sound Engineering Laboratory	-	-	-	50	50
216M10C501	Digital Audio Processing	30	20	50	-	100
216M10L501	Digital Audio Processing Laboratory	-	-	-	50	50
216M10C601	Audio and Music Engineering	30	20	50	-	100
216M10L601	Audio and Music Engineering Laboratory	-	-	-	50	50
216M10P601	Mini Project	-	-	-	50	50
216M10C701	Music production and Editing	30	20	50	-	100
216M10L701	Music production and Editing Laboratory	-	-	-	50	50
Total		**120**	**80**	**200**	**250**	**650**

Course Code	Course Title			
216M10C401	**Fundamentals of Sound Engineering**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**03**	**--**	**--**	**03**
Credits Assigned	**03**	**--**	**--**	**03**
Examination Scheme	**Marks**			

	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites:
None

Course Objectives:
This course aims to provide a comprehensive understanding of the physics of sound, signal flow, audio processing techniques, and the use of sound engineering tools. It also emphasizes professional practices in sound engineering, including studio etiquette, health and safety considerations, and career development opportunities.

Course Outcomes

At the end of the successful completion of the course, the student will be able to

CO1: Understand the physics of sound.
CO2: Apply the concept of dynamics & compression to shape and enhance audio signals.
CO3: Demonstrate proficiency in using mixing consoles.
CO4: Apply systems engineering principles to design and understand the application of audio systems
CO5: Learn advanced topics and emerging technologies in music engineering.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Sound and Acoustics**		**10**	**CO1**
	1.1	Physics of Sound, Sound Perception, Room Acoustics, Sound Isolation and Treatment		
	1.2	Acoustic Measurement Tools, Sound Wave Properties, and Sound Propagation		
2	**Audio Signal Flow**		**10**	**CO2**
	2.1	Signal Path, Analog and Digital Signals, Microphones and Speakers,		
	2.2	Mixers and Interfaces, Signal Processing Equipment, Audio Cables and Connectors, Signal Routing		
3	**Audio Processing**		**10**	**CO3**
	3.1	Equalization, Dynamic Range Processing, Time-Based Effects, Modulation Effects,		
	3.2	Advanced Processing Techniques, Audio Compression, and Noise Reduction Techniques		
4	**Sound Engineering Tools and Equipment**		**10**	**CO4**
	4.1	Recording Equipment, Mixing Consoles, Digital Audio Workstations, Monitoring Systems,		
	4.2	Live Sound Equipment, Audio Software, Hardware vs Software Processing		
5	**Professional Practices in Sound Engineering**		**5**	**CO5**
	5.1	Studio Etiquette, Health and Safety with respect to Ear, Ethical Considerations in Sound Production,		
	5.2	Career Opportunities in sound engineering, Continuing Professional Development, Project Management in Sound Engineering		
		Total	**45**	

Reference Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Shyh-Yuan Lee	*Fundamental Physics of Sound*	World Scientific, Singapore	1st Edition 2020
2.	Dan Hosken	*An Introduction to Music Technology*	Taylor & Francis, United Kingdom	1st Edition 2014

3.	Mads Græsbøll Christensen	*Introduction to Audio Processing*	Springer International Publishing, Switzerland	1st Edition 2019
4.	Francis Rumsey	*Desktop Audio Technology: Digital Audio and MIDI Principles*	Taylor & Francis, United Kingdom	1st Edition 2003
5.	Lida Skoczylas	*Guide To Audio Engineer In A Recording: Sound Engineering*	Independently Published, United States	1st Edition 2021

Course Code	Course Title			
216M10L401	**Fundamentals of Sound Engineering**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	--	02	--	02
Credits Assigned	00	01	--	01

Examination Scheme	**Marks**				
	CA		**ESE**	**LAB/TUT CA**	**Total**
	ISE	**IA**			
	--	--	--	50	50

Term work will consist of experiments covering the entire syllabus of "Fundamentals of Sound Engineering" (116mxxC401). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Course Code	Course Title			
216M10C501	**Digital Audio Processing**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	**Marks**				
	CA		**ESE**	**LAB/TUT CA**	**Total**
	ISE	**IA**			
	30	20	50	--	100

Course prerequisites:
Knowledge of digital signal processing. Calculus, linear algebra and basic statistics.

Some programming (preferably MATLAB)

Course Objectives: This course focuses on digital audio processing techniques and their applications. This syllabus is designed to fill the gap between the hardcore theory of various digital signal processing techniques and their applications in various real-world digital audio products and services. Students are expected to be able to handle digital audio processing and design, and have a deep understanding of the topics in the field after completing this course successfully.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Understand the fundamentals of digital audio processing and associated techniques.
CO2: Solve practical problems associated with digital audio recording techniques.
CO3: Solve practical problems associated with digital audio compression techniques.
CO4: Design simple systems for digital audio reproduction with some basic audio processing techniques.
CO5: Design simple systems for digital audio restoration with some basic audio processing techniques.

Module No.	Unit No.	Details	Hrs.	CO
1	Fundamentals of DSP and Fundamentals of Digital Audio		**10**	CO1
	1.1	Fourier transform, Time-frequency analysis, Multirate systems, Filter bands etc.		
	1.2	Sampling, Dithering, Quantization, Dynamic Range, SNR, Technical terms in the field etc.		
	1.3	Basics of speech signals, Preprocessing, feature extraction techniques in Time and Frequency domain		
2	Digital Audio Recording		9	CO2
	2.1	Speech analysis and synthesis, Speech recognition		
	2.2	Recording process, Input lowpass filtering, Sample-and-hold circuit, Oversampling, Analog-to-digital conversion, Noise shaping, Post-processing.		

3	Digital Audio Compression		10	CO3
	3.1	Critical bands; threshold of hearing; Amplitude masking; Temporal masking; Waveform coding; PCM .		
	3.2	DPCM, Perceptual coding, Coding techniques: Subband coding and Transform coding; Codec examples		
4	Digital Audio Reproduction		**09**	CO4
	4.1	.Reproduction process, Model, Digital-to-audio Conversion, Sampling-and-hold circuit, Filtering, Oversampling		
	4.2	Noise shaping, Sigma-delta modulation, Equalization, Post-processing, Practical implementation issues.		
5	Digital Audio Restoration		**7**	CO5
	5.1	Detection of Pops/Clicks/Pulses; Estimation of corrupted samples; Techniques: Prediction-error detection, LS gap filling, Bayesian approaches etc.; Background noise reduction; Short-time spectral attenuation etc.		
	5.2	Case Study of System/Codecs: MP3, MP3-Pro, CD, DVD-Audio, AC-3, Dolby digital. SRS Surround system etc.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	K.C. Pohlmann	*Principles of Digital Audio*	McGraw-Hill	5th Edition., 2005.
2.	K.C. Pohlmann	*Advanced Digital Audio*	SAMS	1991
3.	S.J. Godsill and P.J.W. Rayner	*Digital Audio Restoration – A Statistical Model-Based Approac*	Springer-Verlag, London	1998
4.	U. Zolzer	*Digital Audio Signal Processing*	Wiley	1997

Course Code	Course Title			
216M10L501	**Digital Audio Processing Laboratory**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	--	02	--	02

Credits Assigned	00			01	--	01
Examination Scheme	Marks					
	CA		ESE	LAB/TUT CA		Total
	ISE	IA				
	--	--	--	50		50

Term work will consist of experiments covering the entire syllabus of "Digital Audio Processing" (116mxxC501). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Course Code	Course Title					
216M10C601	Audio and Music Engineering					
	TH			P	TUT	Total
Teaching Scheme(Hrs.)	03			--	--	03
Credits Assigned	03			--	--	03
Examination Scheme	Marks					
	CA		ESE	LAB/TUT CA		Total
	ISE	IA				
	30	20	50	--		100

Course prerequisites:
None

Course Objectives:
This course aims to provide a comprehensive understanding of the physics of sound, dynamics, mixing strategies, systems engineering, and advanced topics in audio technology. Students will learn about the fundamentals of sound waves, compression techniques, mixing console operations, PA system design, and emerging technologies such as surround sound, virtual reality audio, and live sound engineering. By the end of the course, students will be equipped with the knowledge and skills necessary to analyze, design, and implement sound systems across various applications.

Course Outcomes
At the end of successful completion of the course the student will be able to
CO1: Understand the physics of sound.
CO2: Apply the concept of dynamics & compression to shape and enhance audio signals.

CO3: Demonstrate proficiency in using mixing consoles. **CO4:** Apply systems engineering principles to design and understand the application of PA systems **CO5:** Learn advanced topics and emerging technologie in music engineering.

Module No.	Unit No.	Details	Hrs.	CO
1	**Physics of sound**		05	CO1
	1.1	What is sound, Longitudinal vs. transverse waves, Spherical vs. plane waves, Visualization as a waveform, Properties of wave, Inverse square law & inverse distance law, Basic definition: Decibel, Sound pressure level, Sound intensity level, Sound power level,		
	1.2	Visualization as a spectrum, Harmonic sounds & spectrum		
2	**Dynamics & compression**		10	CO2
	2.1	Dynamic range processors, Compressor, Limiter, Expander, Gate, Control parameters,		
	2.2	Threshold, ratio, knee, make-up gain, Attack time, release time, release delay		
	2.2	Compression techniques, compression recipe, Side chain manipulation, Multiband compression, Parallel compression,		
3	**Mixing consoles & strategies**		08	CO3
	3.1	Introduction, models, topology, Preamps & phantom power, inserts, Different Sections of mixer		
	3.2	Balance, DAW parameter automation		
4	**Systems Engineering**		12	CO4
	4.1	Role of a systems engineer, designing and understanding the application of a PA system design, Prediction softwares like Arraycalc and Soundvision, PA design exercise Introduction to SMAART.		
	4.2	Understanding FFT and it's concepts - spectrum analyser, transfer functions, impulse responses.		
	4.3	reading various data charts like phase trace, Live IR graph and magnitude chart. Comb filtering and basic sub to tops alignment		
5	**Advanced Topics and Emerging Technologies**		10	CO5
	5.1	Surround sound and immersive audio: Perception of Spatial Sound, 3D Sound, Binaural Audio Through Headphones & Loudspeakers		
	5.2	Virtual reality (VR) and augmented reality (AR) audio: Overview of VR, AR and MR technologies, Binaural audio for VR and AR, Implementation of audio in VR/AR applications		
	5.3	Live sound engineering: Front of House (FOH) and Monitor Mixing, Venue acoustics and sound reinforcement, Equipment setup and troubleshooting, Stage management and communication, Live		

		recording and broadcast considerations		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Bob McCarthy	*Sound Systems Design and Optimization : Modern Techniques and Tools for Sound System Design and Alignment*	Focal Press, United States	3rd Edition, 2016
2.	F. Alton Everest, Ken Pohlmann	*Master Handbook of Acoustics*	McGraw-Hill Education, United States	6th Edition, 2014
3.	Roey Izhaki	*Mixing Audio: Concepts, Practices, and Tools*	Taylor & Francis	3rd Edition, 2013
4.	Scott Hunter Stark	*Live Sound Reinforcement: A Comprehensive Guide to P.A. and Music Reinforcement Systems and Technology*	MixBooks, United States	1st Edition, 1996 Reprint - 2012

Course Code	Course Title				
216M10L601	**Audio and Music Engineering**				
	TH		**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	--		02	--	02
Credits Assigned	00		01	--	01
Examination Scheme	**Marks**				
	CA		**ESE**	**LAB/TUT CA**	**Total**
	ISE	**IA**			
	--	--	--	50	50

Term work will consist of experiments covering the entire syllabus of “Audio and Music Engineering” (116mxxC601). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Course Code	Course Title			
216M10P601	**Mini Project**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	--	04	--	04
Credits Assigned	--	02	--	02

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	--		--	50	50

Objectives:

Implementation of mini project aims to identify a clear and achievable goal, demonstrate personal abilities and skills to analyse, design, produce and present the work done. It will also inculcate qualities such as scheduling the work, meeting deadlines and following work plan.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Define the problem with analysis of need statement and literature surveyed.
CO2: Implement and test the hardware/ software algorithms to meet the desired specifications
CO3: Identify limitations of work done and scope for future development
CO4: Write technical report in proper format

Term Work and Oral:

The mini-project can be an individual or a group project. Each project will be assigned one faculty member as a guide/supervisor. There will be continuous assessment of the project and progress report of it needs to be maintained.

<table>
<tr><td>Course Code</td><td colspan="5">Course Title</td></tr>
<tr><td>216M10C701</td><td colspan="5">Music Production and Editing</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">03</td><td>--</td><td>--</td><td>03</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">03</td><td>--</td><td>--</td><td>03</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>50</td><td colspan="2">--</td><td>100</td></tr>
</table>

Course prerequisites:

None

Course Objectives:

The course is designed to provide a comprehensive understanding of music production. It starts with an introduction to the history and elements of music production, including the setup and configuration of Digital Audio Workstations (DAWs), audio interfaces, and recording basics. The course then delves into recording techniques for vocals, instruments, and samples, along with MIDI recording and editing. Students will also learn about editing tools and techniques, arranging and sequencing music, and audio editing effects. Advanced concepts such as sound design, synthesis, automation, and detailed mixing and mastering techniques are covered, with a focus on collaboration and communication in music production. The course concludes with applications and portfolio building, where students will learn about genre-specific production techniques, music production for specific platforms, music licensing, distribution strategies, and professional development opportunities in music production. The aim is to help students build a compelling production portfolio.

Course Outcomes

At the end of the successful completion of the course, the student will be able to

CO1: Demonstrate understanding of fundamental music production concepts and terminology.
CO2: Apply basic audio recording techniques using digital audio workstations (DAWs).
CO3: Utilize editing tools and techniques to manipulate audio recordings effectively.
CO4: Incorporate effects processing to enhance recordings and create desired sonic textures.
CO5: Prepare and export finished audio productions for various purposes.

Module No.	Unit No.	Details	Hrs.	CO
1		**Introduction to Music Production**	**10**	**CO1**
	1.1	Music production, History and evolution of music production, Elements of a music production studio,		
	1.2	Digital audio workstations (DAWs) overview, setting up and configuring your DAW, Audio interface basics, Microphones and microphone techniques, Recording basics		
2		**Recording Techniques**	**10**	**CO2**
	2.1	Recording vocals, instruments, and samples, Microphone placement and techniques for different instruments,		
	2.2	Multi-track recording, Monitoring and level control, Punch-in and comping techniques, MIDI recording and editing, Troubleshooting recording problems		
3		**Editing and Processing**	**10**	**CO3**
	3.1	Editing tools and techniques (cut, copy, paste, trim), Non-destructive editing, Arranging and sequencing music, Audio editing effects (EQ, compression, reverb, etc.),		
	3.2	Creative audio manipulation techniques, Mixing fundamentals (levels, panning, balancing), Introduction to mastering		
4		**Advanced Concepts and Projects**	**10**	**CO4**
	4.1	Sound design and synthesis, Working with loops and samples, Automation and editing automation, Creative effects processing,		
	4.2	Mixing and mastering techniques in detail, Collaboration and communication in music production, Copyright and legal considerations, Building a music production portfolio		
5		**Applications and Portfolio Building**	**5**	**CO5**
	5.1	Identifying target audience and purpose for music production,Genre-specific production techniques and trends, Music production for specific platforms (film, games, podcasts, etc.),		
	5.2	Music licensing and distribution strategies, Building a compelling production portfolio, Professional development and career opportunities in music production		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with	Edition and Year of

			country	Publication
1.	L. J. Howard, Tommy Gordon	*Music Production Tips, Tricks, and Secrets for all Producers, Musicians, Beat Makers, Songwriters, and Media Composers*	Fretboard Media Group, United States	1st Edition 2019
2.	Bill Gibson	*Instrument and Vocal Recording*	Hal Leonard, United States	1st Edition 2007
3.	Roger Derry	*PC Audio Editing: Broadcast, Desktop, and CD Audio Production*	Focal, United States	1st Edition 2003
4.	Meinard Müller, Stefania Serafin, Tapio Lokki, Vesa Välimäki	*Sound and Music Computing*	MDPI, Switzerland	1st Edition 2018
5.	Marshall McLuhan	*Understanding Media: The Extensions of Man*	CreateSpace Independent Publishing Platform, United States	*1st Edition 2016*

<table>
<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td></td><td colspan="6"></td></tr>
<tr><td>216M10L701</td><td colspan="6">Music Production and Editing</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">--</td><td>02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">00</td><td>01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2" colspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td colspan="2">50</td><td>50</td></tr>
</table>

Term work will consist of experiments covering the entire syllabus of "Music Production and Editing" (116mxxC701). Students will be graded based on a continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

SOMAIYA
VIDYAVIHAR UNIVERSITY
K J Somaiya College of Engineering

Syllabus
Minor in VLSI Design

(Programme commenced from AY 2024-25)

Offered by Department of Electronics and Computer Engineering

From

Academic Year 2024-25

(SVU-KJSCE 2.0)

(Approved by BOS dated 23-Apr-24)

Minor Programme on
VLSI Design

Offered by Department of Electronics and Computer Engineering and Electronics & Telecommunication Engineering

Introduction

VLSI Design or 'Very Large Scale Integration' Design is a course offered to create students who are academically and practically skilled in designing semiconductor devices and circuits and designing systems using embedded components utilizing small space.

VLSI is mainly used to design electronic components like microprocessors and memory chips, which require millions of transistors. The process of designing these chips is analogous to the above example, and the only difference is the number of components.

Objective

This course introduces students to the basic concepts of digital systems, including analysis and design. Both combinational and sequential logic will be covered. Students will gain experience with several levels of digital systems, from simple logic circuits to programmable logic devices and hardware description language.

Learning Outcomes

At the successful completion of this minor program an engineering graduates will be able to

LO1: Design CMOS logic circuits

LO2: simulate circuits within a CAD tool and compare to design specifications

Proposed Courses:

1. **Digital System Design**
2. **Basics of VLSI Design**
3. **Verilog HDL and FPGA**
4. **Analog VLSI**

Eligibility Criteria :

Students who have passed the First Year of Engineering in Electronics and Telecommunication Engineering/ Computer Engineering / Information Technology / Artificial Intelligence & Data Science/ Mechanical Engineering/ Computer and Communication Engineering/ Robotics & Artificial Intelligence.

Assessment Methods: Tests, Mini projects, Laboratory, Presentation, Quiz, Research paper analysis.

Key Information
Duration: 3 Years
Total credits: 18
Programme Code: ______

Course Type: Minor Degree
Mode of study: Full time
Campus: Vidyavihar - Mumbai
Institute: KJSCE

Course Code	Course Category	Course Name	LAB/TUT CA	CA		ESE	Total
				IA	ISE		
216M01C301	PC	Digital System Design	-	20	30	50	100

Teaching and Credit Scheme

Course Code	Course Category	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M01C301	PC	Digital System Design	3-0-0	03	3-0-0	03	III
216M01L301	PC	Digital System Design Laboratory	0-2-0	02	0-1-0	01	III
216M01C401	PC	Basics of VLSI	3-0-0	03	3-0-0	03	IV
216M01L401	PC	Basics of VLSI Laboratory	0-2-0	02	0-1-0	01	IV
216M01C501	PC	Verilog HDL and FPGA	3-0-0	03	3-0-0	03	V
216M01L501	PC	Verilog HDL and FPGA Laboratory	0-2-0	02	0-1-0	01	V
216M01C601	PC	Analog VLSI	3-0-0	03	3-0-0	03	VI
216M01L601	PC	Analog VLSI Laboratory	0-2-0	02	0-1-0	01	VI
216M01P701	PR	Project	0-2-0	02	0-2-0	02	VII
Total			**12-10-0**	**22**	**12-04-0**	**18**	

Evaluation Scheme

216M01L301	PC	Digital System Design Laboratory	50	-	-	-	50
216M01C401	PC	Basics of VLSI	-	20	30	50	100
216M01L401	PC	Basics of VLSI Laboratory	50	-	-	-	50
216M01C501	PC	Verilog HDL and FPGA	-	20	30	50	100
216M01L501	PC	Verilog HDL and FPGA Laboratory	50	-	-	-	50
216M01C601	PC	Analog VLSI	-	20	30	50	100
216M01L601	PC	Analog VLSI Laboratory	50	-	-	-	50
216M01P701	PR	Project	50	-	-	-	50
Total			**250**	**80**	**120**	**200**	**650**

Course Code	Course Title			
216M01C301	Digital System Design			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	03	–	–	03
Credits Assigned	03	–	–	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites: None

Course Objectives: This course introduces students to the basic concepts of digital systems, including analysis and design. Both combinational and sequential logic will be covered. Students will gain experience with several levels of digital systems, from simple logic circuits to programmable logic devices and hardware description language.

Course Outcomes

At the end of completing the course the student will be able to

CO1. Understand the logic family.

CO2. Analyze and design combinational circuits

CO3. Analyze and design sequential circuits

CO4. Analyze State Machines

Module No.	Unit No.	Topics	Hrs.	CO
1		**Fundamentals of Digital Design**	9	CO1
	1.1	Review of basic gates, Implementation of logic expression using gates.		
	1.2	Combinational logic representation using truth table, sum of products (SOP) and products of sum (POS)		
2		**Combinational Logic Circuits**	14	CO2
	2.1	Design of different combinational circuits, Adder, subtractor, controlled adder/ subtractor, BCD adder/subtractor, Use of MSI devices		
	2.2	Multiplexer, demultiplexer, decoder, encoder, comparator, multiplexer tree and decoder tree. Use of MSI devices		
3		**Sequential Logic Design**	10	CO3
	3.1	Latches and flip flops		
	3.2	synchronous counters, synchronous counter, up/down counter, mod counter, shift register		
4		**Finite State Machines Design**	12	CO4
	4.1	Mealy and Moore Machines, Clocked synchronous state machine analysis, Development of state diagram, State		

		reduction techniques and state assignment, Clocked synchronous state machine design.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Morris Mano and Michael D. Ciletti	*Digital Design: With an Introduction to Verilog*	HDL Pearson, India	5th Edition, 2013
2.	R.P.Jain	*Modern Digital Electronics*	McGraw Hill Education, India	4th Edition, 2015
3.	John M Yarbrough	*Digital logic: Applications and design*	Thomson Brooks/ Cole, India	India Edition, 2006
4.	David Patterson, John L Hennessy	*Computer Organization and Design: The hardware and software interface*	MK Publications	4^{th} Edition

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M01L301</td><td colspan="5">Digital System Design Laboratory</td></tr>
<tr><td></td><td colspan="4">TH</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="4">–</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="4">–</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td rowspan="2">LAB / TUT CA</td><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>50</td><td>–</td><td>–</td><td>-</td><td>50</td></tr>
</table>

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20

Total	50

Term work will consist of experiments covering the entire syllabus of "**Digital System Design**" (**216M01C301**). Students will be graded based on continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M01C401</td><td colspan="5">Basics of VLSI Design</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">03</td><td>–</td><td>–</td><td>03</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">03</td><td>–</td><td>–</td><td>03</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>50</td><td colspan="2">--</td><td>100</td></tr>
</table>

Course prerequisites: Basic Electronics Circuits

Course Objectives: The objective of the course is to impart fundamental knowledge of MOSFETs and to familiarize the student with fundamental principles of VLSI Design. It provides coverage of classical VLSI Design for both combinational and sequential digital circuits. Various design styles used for the design of such circuits have also been introduced.

Course Outcomes

At the end of completing the course the student will be able to

CO1. Understand the fundamentals of MOSFET

CO2. Understand the characteristics of different MOS inverters

CO3. Analyze and design combinational and sequential MOS-based circuits

CO4. Design and implement semiconductor memories

Module No.	Unit No.	Topics	Hrs.	CO
1		**Fundamentals of MOSFETs**	13	CO1
	1.1	N-channel MOSFET working in cutoff, saturation, and linear regions,		
	1.2	**Physics of MOS:** MOS capacitor, energy band diagrams, band bending, threshold voltage calculation, MOSFET capacitance, Drain current model for the linear region of operation, Pinch-off region condition, Drain current model for saturation region of operation, Channel length modulation, I-V characteristics of N-Channel MOSFET		
	1.3	**Technology Scaling:** Types of scaling and VLSI Design Flow		
2		**MOS Inverters and MOS Circuit Design Styles**	12	CO2

	2.1	**MOS inverter:** Resistive load inverter, Depletion load, Enhancement load inverter, CMOS Inverter (with analysis), VTC curve of CMOS inverter in the digital domain, the concept of Noise margins and its calculation for MOs inverters		
	2.2	**Design Styles:** Static CMOS, pass transistor logic, transmission gate, Pseudo NMOS, Domino, NORA, Zipper,C^2MOS		
3	**Combinational Logic Circuits and Data Path Design**		10	CO3
	3.1	**Circuit Realization:** SR Latch, JK FF, D FF, MUX, decoder using CMOS based design styles		
	3.2	**Data Path Design:** Bit adder circuits, Ripple carry adder, CLA adder, Partial-product generation, partial-product accumulation, final addition, barrel shifter		
4	**Semiconductor Memories**		10	CO4
	4.1	SRAM: ROM Array, SRAM (operation, design strategy, leakage currents, read/write circuits), 6 T SRAM cell with memory read/write operation, sense amplifier and decoder, DRAM operation		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim	*CMOS Digital Integrated Circuits – Analysis and Design*	McGraw Hill Education, India	4^{th} Edition, 2016
2.	Jan M Rabaey	*Digital Integrated Circuits – A Design Perspective*	Pearson Education, India	2^{nd} Edition, 2016
3.	John P. Uyemura	*Introduction to VLSI Circuits and Systems*	Wiley Publishers, India	1st Edition, 2006
4.	Behzad Razavi	*Fundamentals of Microelectronics*	Wiley India Pvt. Ltd	1^{st} Edition, 2013

<table>
<tr><td>Course Code</td><td colspan="5">Course Title</td></tr>
<tr><td>216M01L401</td><td colspan="5">Basics of VLSI Design Laboratory</td></tr>
<tr><td></td><td colspan="4">TH</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="4">–</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="4">–</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td rowspan="2">LAB / TUT CA</td><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>50</td><td>–</td><td>–</td><td>–</td><td>50</td></tr>
</table>

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Term work will consist of experiments covering the entire syllabus of "**Basics of VLSI Design**" (**216M01C401**). Students will be graded based on continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Course Code	Course Title			
216M01C501	Verilog HDL and FPGA			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	03	–	--	03
Credits Assigned	03	–	–	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Module No.	Unit No.	Topics	Hrs.	CO
1		**Introduction to Verilog**	8	CO1
	1.1	Introduction to Verilog,		
	1.2	Data Types: Physical and abstract, operators, Registers, Nets, Modules, Ports declaration and connection rules, always and Initial blocks		
2		**Modeling of combinational and Sequential circuits**	14	CO2
	2.1	Verilog variables, data types, operators, Registers, Nets, Modules, Ports declaration and connection rules, always and Initial blocks		
	2.2	Behavioral modeling, structural modeling, Gate level primitives, User defined primitives. Description styles in Verilog- continuous assignment, procedural assignment, blocking and non-blocking		
	2.3	Modeling combinational circuits using Verilog like Decoders and encoders, Multiplexers and Demultiplexers, Priority encoder, Priority decoder, Comparators, Adders, subtractors etc.		
3		**Modeling of Sequential circuits**	12	CO3
	3.1	Sequential Statements, If Statements, Case Statements, Loop Statements, Tasks and functions		
	3.2	Design of sequential circuits, flip flops, counters memories, shift registers, etc		
4		**Design for Synthesis**	11	CO4
	4.1	Design of FSM using Verilog, (Mealy and Moore type) Introduction to Datapath and controller design with simple examples		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Michael D.Celetti	*Digital Design with the Verilog*	Pearson Education, India	2nd edition, 2011
2.	J Bhasker	*A Verilog HDL Primer*	Primer BS Publication	1st edition, 1997
3.	Samir Palnitkar	*Verilog HDL, A Guide to Digital Design and Synthesis*	Pearson Education, India	2nd edition, 2010
4.	Zainalabedin Navabi,	*Verilog Digital System Design RT Level synthesis TestBench and verification*	Mc Graw Hill, India	2nd edition, 2017

Course Code	**Course Title**				
216M01L501	**Verilog HDL and FPGA Laboratory**				
	TH				**Total**
Teaching Scheme(Hrs.)	-				**02**
Credits Assigned	--				**01**
Examination Scheme	**Marks**				
	LAB / TUT CA	**CA**		**ESE**	**Total**
		ISE	**IA**		
	50	–	–	–	**50**

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Term work will consist of experiments covering the entire syllabus of "**Verilog HDL and FPGA**" (**216M01C501**). Students will be graded based on continuous assessment of their term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

Course Code	Course Title			
216M01C601	Analog VLSI			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	03	–	--	03
Credits Assigned	03	--	–	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites: Basics of VLSI

Course Objectives: The objective of the course is to expose the students to analog VLSI designing. The course discusses the basic building blocks of Analog circuits and their implementation in integrated circuits.

Course Outcomes

At the end of completing the course the student will be able to

CO1. Recognize and analyze tradeoffs in Analog VLSI

CO2. Design of basic building blocks of Analog VLSI Circuits.

CO3. Analyze and design MOSFET-based single-stage and differential amplifiers.

CO4. Analyze and design MOSFET-based operational amplifier

Module No.	Unit No.	Topics	Hrs.	CO
1		**CMOS Analog building blocks**	10	CO1
	1.1	**MOS Models:** Necessity of CMOS Analog design, Analog Design Octagon, MOS small signal model, body effect. **Active Current Mirror circuits:** Basic current mirrors, Cascode current mirrors, and Active current mirrors.		
2		**Single Stage Integrated Circuit Amplifiers**	12	CO2
	2.1	**Configurations:** Basic concepts, Common source stage with different loads, Source follower, and Common gate stage.		
	2.2	Cascode stage, Folded Cascode		
3		**Differential Amplifiers**	12	CO3
	3.1	Single-ended and differential operation, Basic differential pair, Common-mode response,		
	3.2	Differential pair with MOS loads, Gilbert cell		
4		**MOS Operational Amplifiers**	11	CO4
	4.1	Op-amp Design: General Considerations, performance parameters, One-stage OTA, Two stage OTA with single-ended output, Design of Two-stage op-amps, Gain		

		Boosting, Common-mode feedback, Input range limitations, Slew Rate, Power supply rejection		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	B Razavi	*Design of Analog CMOS Integrated Circuits*	McGraw Hill Education, India	2nd Edition, 2017
2.	R. Jacob Baker, Harry W. Li, David E. Boyce,	*CMOS Circuit Wiley Design, Layout, and Stimulation*	Wiley, India	Student Edition, 2018
3.	P. E. Allen and D. R. Holberg.	*CMOS Analog Circuit Design*	Oxford University Press, India	3rd Edition, 2012
4.	Gray, Meyer, Lewis, Hurst	*Analysis and design of Analog Integrated Circuits*	Wiley, India	5th Edition, 2009

Course Code	Course Title				
216M01L601	**Analog VLSI Laboratory**				
	TH				**Total**
Teaching Scheme(Hrs.)	_				**02**
Credits Assigned	_				**01**
Examination Scheme	**Marks**				
	LAB / TUT CA	**CA**		**ESE**	**Total**
		ISE	**IA**		
	50	–	--	--	**50**

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Term work will consist of experiments covering the entire syllabus of "**Analog VLSI**" (**216M01C601**). Students will be graded based on continuous assessment of their

term work.

Practical and oral examinations will be based on laboratory work and the entire syllabus.

<table>
<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td>216M01P701</td><td colspan="6">Project</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">–</td><td>4</td><td>–</td><td>4</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">–</td><td>2</td><td>–</td><td>2</td></tr>
<tr><td rowspan="4">Evaluation Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA (TH)</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td colspan="2">50</td><td>50</td></tr>
</table>

Distribution of LAB CA:

Criterion	Marks
Project demonstration 1	20
Project demonstration 2	20
Orals based on project	10

The student shall select projects related to VLSI Design. The topics may be from the course syllabus or broad areas in VLSI. Students will be graded based on continuous assessment of their project work.

Syllabus

Minor Programme in

Computer Networking and Security

Department of Electronics and Telecommunication Engineering

From

Academic Year 2024-25

Revision 2

(Approved in Academic Council meeting dated 30th April 2024)

K J Somaiya College of Engineering, Mumbai-77

(A Constituent College of Somaiya Vidyavihar University)

Minor Programme in Computer Networking and Security

(Offered by Department of Electronics and Telecommunication Engineering)

Introduction

The objective of the course is to impart knowledge of digital communication systems with emphasis on digital modulation techniques. It helps in understanding the basic building blocks of digital communication system. It provides the foundation for data networking core field to perceive a better career in the field of networking. It also includes the concepts of voice communication over IP and deals with RTP as the most important protocol for voice transmission. This course provides knowledge on network security threats, vulnerabilities and countermeasures. It elaborates on encryption mechanisms and network security protocols.

All courses in this certification are thoughtfully designed for the students to be equipped with skillset, as per needs of global standards of networking industry. The modules are developed in consultation with industry representatives and academicians. All courses blend theoretical concepts with hands-on experience, case studies and project based approach. Hence, even a working professional will also gain a lot in order to expand one's career opportunities.

Differentiators:

- Aligned to industry-recognized skills: With support of Cisco Centre of Excellence setup from 2019.
- Experiential Learning-: All courses backed by laboratories or projects for practical exposure
- Foundation for Career

Objective

The objectives of this minor program are to produce graduates who:

- Understand architecture of digital communication systems
- Comprehend fundamentals of data networking communication networks
- Analyze different protocols for voice communication over IP.
- Analyze the threats and vulnerabilities in network
- Explore encryption mechanisms and network security protocols

Learning Outcomes:

At the successful completion of Networking Honours program, the student will be able to:

1. Demonstrate knowledge of networking using multiple media.
2. Gain in-sight to analyse issues related to Networking.
3. Configure inter-network connectivity

Minor Programme in Computer Networking and Security

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M16C301	Digital Communication and Networks	3 – 2 – 0	05	3 – 1 – 0	04	III
216M16C401	Computer Networking	3 – 2 – 0	05	3 – 1 – 0	04	IV
216M16C501	Internet and Wireless Networks	3 – 2 – 0	05	3 – 1 – 0	04	V
216M16C601	Network Security	3 – 2 – 0	05	3 – 1 – 0	04	VI
216M16P701	Project on Computer Networking or Network Security / Internship	0 – 4 – 0	04	0 – 2 – 0	02	VII
Total		**12—12 -- 0**	**24**	**12 – 6 – 0**	**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme							
		Marks							
		CA		ESE	TW	O	P	P& O	Total
		ISE	IA						
216M16C301	Digital Communication and Networks	30	20	50	50	-	-	-	150
216M16C401	Computer Networking	30	20	50	50	-	-	-	150
216M16C501	Internet and Wireless Networks	30	20	50	50	-	-	-	150
216M16C601	Network Security	30	20	50	50	-	-		150
216M16P701	Project on Computer Networking or Network Security / Internship	-	-	-	25	25	-	-	50
Total		**120**	**80**	**200**	**225**	**25**			**650**

Course Code	Course Title							
216M16C301	**Digital Communication and Networks**							
	TH			**P**		**TUT**		**Total**
Teaching Scheme(Hrs.)	**3**			**2**		**0**		**5**
Credits Assigned	**3**			**1**		**0**		**4**
Examination Scheme	**Marks**							
	CA		**ESE**	**TW**	**O**	**P**	**P&O**	**Total**
	ISE	**IA**						
	30	**20**	**50**	**50**	**--**	**--**	**--**	**150**

Course Prerequisites: Basics of digital signals

Course Objectives: The objective of the course is to impart knowledge of digital communication systems with emphasis on digital modulation techniques. It helps in understanding the basic building blocks of digital communication system. The course explains error performance of a digital communication system It introduces the concept of line coding and multiple access techniques.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Understand basics of analog and digital signals.
CO2: Compare digital modulation techniques.
CO3: Comprehend line codes.
CO4: Analyze error detection and correction schemes.
CO5: Understand multiple access techniques

Module No.	Unit No.	Details	Hrs.	CO
1	**Analog and Digital Signals**		**05**	**CO 1**
	1.1	Analog, digital, periodic and non-periodic signals		
	1.2	Periodic analog signals: sine wave, phase, wavelength, time and frequency domains, composite signals		
	1.3	Digital signals: Bit rate, bit length, bandwidth, throughout, latency , bandwidth-delay product		
2	**Digital Modulation Techniques**		**12**	**CO 2**
	2.1	Block diagram of digital communication system		
	2.2	Need and basics of modulation, Process of sampling, PCM		
	2.3	Generation, detection and signal space diagram of Phase Shift Keying: BPSK, QPSK, DPSK		
	2.4	Generation, detection and signal space diagram of Frequency Shift Keying: BFSK, Quadrature Amplitude Modulation (QAM), Minimum Shift Keying (MSK)		
3	**Line Coding**		**04**	**CO 3**
	3.1	Unipolar: Non Return to Zero		
	3.2	Polar: NRZ, RZ, Manchester and Differential Manchester		
	3.3	Bipolar: AMI and Pseudoternary		
4	**Error Detection and Correction**		**12**	**CO 4**
	4.1	Types of errors, redundancy, detection versus correction, forward error correction versus retransmission		
	4.2	Block coding: Error detection, error correction, hamming distance		
	4.3	Linear Block codes, Checksum: One’s complement, internet checksum		
	4.4	Cyclic Codes: CRC, polynomials		
5	**Multiple Access**		**12**	**CO5**
	5.1	Carrier Sense Multiple Access (CSMA), CSMA/CD, CSMA/CA, ALOHA and slotted ALOHA		
	5.2	Controlled Access: Reservation, polling, token passing		
	5.3	Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA)		

Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	B. Forouzan,	*Data Communication and Networking*	McGraw Hill Publication, India	4th Edition. 2007.
2.	Haykin Simon	*Digital Communication Systems*	John Wiley and Sons, India	1st Edition 2013
3.	Taub Schilling	*Principles of Communication systems*	Tata McGraw Hill, India	4th Edition 2013
4.	T L Singal	*Digital Communication*	McGraw Hill Education, India	1st Edition 2015
5.	Bernard Sklar and Pabitra Kumar Ray	*Digital Communications*	Pearson Education	2nd Edition 2014

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Course Code	Course Title								
216M16C401	**Computer Networking**								
	TH				P		TUT		Total
Teaching Scheme(Hrs.)	3				2		0		5
Credits Assigned	3				1		0		4
Examination Scheme	Marks								
	CA		ESE	TW	O	P	P&O	Total	
	ISE	IA							
	30	20	50	50	--	--	--	150	

Course Prerequisites: Digital Communication

Course Objectives: The objective of this course is designed to have an introduction to data networking technology for those pursuing careers as network professionals as well as those who need only an introduction to network technology for professional growth. It provides the foundation for data networking core field to perceive a better career in the field of networking.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Understand the basics of data networking.
CO2: Understand working of transmission media at physical layer
CO3: Implement the concept of LAN at the data link layer
CO4: Analyze various routing techniques and design complete network as per the given requirement
CO5: Understand the Transport layer protocol and apprehend various application layer protocols

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction**		10	CO 1
	1.1	**Data Communication :** Characteristics and Components		
	1.2	**Networks:** Network criteria, Physical structures, Categories of network, Interconnection of networks		
	1.3	Protocols and Standards		
	1.4	Network models and Types of addressing		
2	**Physical Layer**		07	CO 2
	2.1	Transmission Media		
	2.2	Switching: Circuit switched networks, Datagram Networks, Virtual Circuit Networks		
	2.3	Structure of a switch		
3	**Data Link Layer**		10	CO 3
	3.1	**Framing:** Fixed size and variable size, Noisy channels and Noiseless channels		
	3.2	Wired LANs: Ethernet		
	3.3	**Media Access Control:** CSMA-CD		
	3.4	**Connecting Devices:** Repeater, switch, router		
	3.5	Switched Local Area Networks: concept of VLAN		
4	**The Network Layer**		08	CO 4
	4.1	Internet Protocol: characteristics, IPv4 packet header IP v4 addressing, subnetting IP networks		
	4.2	Internet Control Message Protocol (ICMP) and Internet Group Management Protocol (IGMP)		
	4.3	Routing Algorithms : Dijkstra's and Bellman Ford Algorithm		
	4.4	**Network Layer :** Delivery, forwarding and routing		
5	**Transport and Application Layer**		10	CO5
	5.1	TCP and UDP, Congestion control		
	5.2	The Web, HTTP, DHCP, DNS,FTP, SSH, TELNET		
		Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	B. Forouzan,	*Data Communication and Networking*	McGraw Hill Publication, India	4th Edition. 2007.
2.	Behrouz Forouzan	*TCP/IP Protocol Suite*	McGraw Hill Publication, India	4th Edition. 2010
3.	L. Garcia et al	*Communication Networks*	McGraw Hill Publication, India	2nd Edition,2004.
4.	J. F. Kurose and K. W. Ross	*Computer Networking: A Top-Down Approach*	Pearson Publication, India	5th Edition, 2012.

Course Code	Course Title							
216M16C501	**Internet and Wireless Networks**							
	TH				P		TUT	Total
Teaching Scheme(Hrs.)	3				2		0	5
Credits Assigned	3				1		0	4
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	50	--	--	--	150

Course prerequisites: Basic Networking Concepts

Course Objectives: This course offers a detailed introduction into Voice over IP (VoIP). It includes the concepts of voice communication over IP and deals with RTP as the most important protocol for voice transmission as well as with the two signaling protocols SIP and H.323. Upon completion of the course, students will have a thorough understanding of the implementation and operation of VOIP technology. The objective of this course to learn about IP based wireless networks, protocol stack and standards, different wireless technologies. It also covers wireless sensor network basics and applications

Course Outcomes

After successful completion of the course the student will be able to :

CO1: Explain the basics of Voice over IP (VoIP)
CO2: Understand the H.245 protocol for the transmission of call management and control signals in packet-based networks using H.323 equipment.
CO3: Understand the application layer protocol like SIP that works in conjunction with other application layer protocols to control multimedia communication sessions over the Internet.
CO4: Understand IP based wireless networks, protocol stack and standards
CO5: Understand working principal of wireless technologies, wireless sensor network architecture and applications

Module No.	Unit No.	Details	Hrs.	CO
1	**VoIP Components**		**05**	**CO 1**
	1.1	Transport layer protocols: TCP, UDP, SCTP		
	1.2	IP version 6 (IP v6), Interworking IPv4 and IPv6		
2	**Real Time Transport Protocol**		**09**	**CO2**
	2.1	RTP Payload and RTP Header		
	2.2	RTCP: Sender report, Receiver report source description packet, Timing of packets, Calculating RTP and Jitter		
	2.3	The H.323 Architecture		
	2.4	H.245 Control Signaling Conference calls- The Decomposed Gateway		
3	**The Session Initiation Protocol (SIP)**		**09**	**CO3**
	3.1	SIP architecture		
	3.2	Overview of SIP Messaging Syntax. JSON to SIP communication		
	3.3	The Session Description Protocol (SDP)- Usage of SDP With SIP..		
	3.4	SS7 Protocol Suite, SS7 Network architecture		
4	**Wireless IP Network**		10	**CO 4**
	4.1	Introduction – Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation		
	4.2	Mobile ad-hoc network: Routing, Destination Sequence distance vector, Dynamic source routing		
	4.3	TCP enhancements for wireless protocols – Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility		
5	**Wireless technologies and Wireless Sensor Network**			
	5.1	Wireless technologies-Bluetooth, Zigbee and WLAN	12	**CO 5**
	5.2	Wireless Sensor Network for Smart City: Architecture, latency and bandwidth constraint improvisation using MQTT protocol		
	5.3	Applications of wireless sensor network, Category 1 and 2		

		WSN. Sensor node technology, hardware and software. Medium access control protocols		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Daniel Collins	*Carrier Grade Voice Over IP*	McGraw-Hill Education	2nd edition 2005
2.	Zheng Wang	*Internet QoS: Architectures and Mechanisms for Quality of Service*	The Morgan Kaufmann Series in Networking	Morgan Kaufmann Publishers 2001
3.	Behrouz Forouzan,	*TCP/IP Protocol Suite*	McGraw-Hill Education	4th edition 2017
4.	Jochen Schiller,	*Mobile Communications*	Pearson Education India	Second Edition, 2012.
5.	Kazem Sohraby, Daniel Minoli, and Taieb Znati	*Wireless Sensor Networks: Technology, Protocols, and Applications*	Wiley Eastern Limited, India	Wiley Student Edition

Course Code	Course Title							
216M16C601	**Network Security**							
	TH			**P**		**TUT**		**Total**
Teaching Scheme(Hrs.)	**3**			**2**		**0**		**5**
Credits Assigned	**3**			**1**		**0**		**4**
Examination Scheme	**Marks**							
	CA		**ESE**	**TW**	**O**	**P**	**P&O**	**Total**
	ISE	**IA**						
	30	**20**	**50**	**50**	**--**	**--**	**--**	**150**

Course prerequisites: Computer Networking, Internet and Wireless Networks

Course Objectives:

Security of data and network is very important in internet world. This course provides knowledge on network security threats, vulnerabilities and countermeasures. It elaborates on encryption mechanisms and network security protocols.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Understand the concept of security and learn the threats , vulnerabilities and security policies
CO2: Apply symmetric cryptographic techniques for data security
CO3: Apply asymmetric cryptographic techniques for secure data security
CO4: Understanding firewall mechanisms and IDS technologies to secure networks
CO5: Illustrate network security protocol at network, transport and application layer

Module No.	Unit No.	Details	Hrs.	CO
1	**Understanding Network Security Principles**		10	CO1
	1.1	Why Network Security is a Necessity, Threats, Vulnerabilities, CIA model		
	1.2	Potential Attackers (White hat, Black hat, Grey hat, Phreaker, Script Kiddy, Hobby hacker) , Active and Passive attacks, Confidentiality attacks: Packet Capture, Ping Sweep and port scan, Social Engineering Integrity attacks: Password attack (Packet Capture, Keylogger, Brute Force, Hijacking a session) Availability attacks: DoS, DDoS, TCP SYN flood, Smurf Attack		
	1.3	IP Spoofing, IP spoofing using Man-in the-Middle Attack		
	1.4	Planning and Enforcing Security Policies: Legal and Ethical laws , Planning Security Policies, Risk Analysis, Security Policies for an Organization, External Security		
2	**Symmetric Cryptography**		10	CO2
	2.1	Definition, Basic Elements of Cryptography, Modular Arithmetic, Classic Cryptography technique: Substitution and Transposition Cipher, Stream and Block Ciphers.		
	2.2	Cryptanalysis, Types of attacks: Chosen plain-text, Chosen ciphertext, Birthday attack, Cipher-text only, Known plain-text		
	2.3	Symmetric Encryption Algorithms: Feistel Cipher, DES, Triple DES, AES		
3	**Asymmetric Cryptography**		10	CO3
	3.1	Asymmetric Encryption Cryptography: Knapsack, RSA, Diffie-Hellman, Public Key Infrastructure		
	3.2	Hash Function: HMAC, MD5, SHA-1, RSA Digital Signature		
4	**Exploring Firewall and IPS Technologies**		8	CO4
	4.1	Role of Firewall in Defending Networks, Basic Firewall Services: Static Packet Filtering, Circuit level, Proxy server, Application server		
	4.2	Basics of ACLs, Types of ACL: Standard and Extended ACLs , Preventing IP spoofing with ACLS,		

	4.3	IDS vs IPS, Detection methods: Signature-based, Policy-based, Anomaly-based, Honey pot		
5	**Network Layer, Transport Layer and Application layer Security**		**7**	**CO5**
	5.1	Modes of IP security and the IP security protocols, Authentication Header Protocol and the Encapsulating security payload, IPsec site-to-site VPN		
	5.2	The SSL (Secure Sockets Layer) Protocol and its architecture, Introduction to TLS (Transport Layer Security) protocol and differences as compared to SSL		
	5.3	Electronic Mail Security: Threats to E-Mail, Requirements and Solutions, Encryption for Secure E-Mail, Secure E-Mail System.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Behrouz A. Forouzan and Debdeep Mukhopadhyay	*Cryptography and Network Security*	McGraw-Hill, India	2^{nd} edition, 2010
2.	William Stallings	*Cryptography and network security: principles and practice*	Pearson Education, India	5^{th} edition, 2011
3.	Deven N. Shah	*Mark Stamp's Information Security: Principles and Practice (WIND)*	Wiley-Interscience, India	1^{st} edition, 2009
4.	Douglas Stinson	*Cryptography Theory and Practice*	Chapman & Hall/CRC.	3^{rd} edition, 2006
5.	Arthur Salmon, Warun Levesque and Michael McLafferty	*Applied Network Security*	Packt Publishing Ltd., UK	1^{st} edition, 2017

<table>
<tr><th>Course Code</th><th colspan="8">Course Title</th></tr>
<tr><td>216M16P701</td><td colspan="8">Project</td></tr>
<tr><td></td><td colspan="3">TH</td><td colspan="2">P</td><td colspan="2">TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">0</td><td colspan="2">04</td><td colspan="2">--</td><td>04</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">0</td><td colspan="2">02</td><td colspan="2">--</td><td>02</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="8">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">TW</td><td rowspan="2">O</td><td rowspan="2">P</td><td rowspan="2">P&O</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>25</td><td>25</td><td>--</td><td>--</td><td>50</td></tr>
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Somaiya Vidyavihar University

Syllabus

Minor Programme in
IoT and Real Time Embedded Systems

(Programme commenced from AY 2024-25)
Jointly Offered by Department of Electronics and Computer Engineering and Electronics and Telecommunication Engineering

From
Academic Year 2024-25
(SVU-KJSCE 2.0)

(Approved by BOS dated 23-Apr-24)

Minor Programme on
IoT and Real Time Embedded Systems

Jointly offered by Department of Electronics and Computer Engineering and
Electronics and Telecommunication Engineering

Introduction

In today's world embedded systems are very important and have applications in almost all fields of engineering. With the addition of "Internet of Things" (IoT) the human world has changed significantly, finding its applications in the automotive industry, consumer electronics,medical devices, defence and many others.

It is necessary for any graduating engineer to know fundamental principles of designing embedded systems and the Internet of Things.

The programme emphasizes the key aspects of both hardware and software of microcontrollers and their integration for development of real time applications.It introduces students to understand the process of development of embedded systems, from specifications to final marketable products.It exposes students to fundamentals of controllers, sensors and actuators used in embedded systems, various aspects of the design and development of hardware and software in an embedded system, and basics of IoT. In the process they are expected to use knowledge and apply skills gained in their domain of engineering.

Objective

This course on "IoT and Real Time Embedded Systems" aims to provide the knowledge of microcontroller and its programming.It also develops an ability to use appropriate sensors and actuators for design and integrate hardware and software for microcontroller systems.

It provides the basics of real time embedded systems and the internet of things. This helps students to design and develop small IOT applications.

Learning Outcomes:

At the successful completion of this minor program an engineering graduates will be able to

LO1: Develop small embedded applications using microcontrollers, sensors and actuators.

LO2: Gain insights of IoT enabling technologies to design small IoT based applications

List of proposed courses

1. Microcontrollers and Embedded C Programming
2. Sensors and Actuators in embedded systems
3. Real time Embedded Systems
4. Internet of Things (IoT)
5. Project on Embedded systems or IoT

Eligibility Criteria :

Students who have passed the First Year of Engineering in Electronics and Computer Engineering/ Computer Engineering / Information Technology / Artificial Intelligence & Data

Science/ Mechanical Engineering/ Computer and Communication Engineering/ Robotics & Artificial Intelligence .

Assessment Methods: Tests, Mini projects, Laboratory ,Presentation/ Video making ,Quiz, study of research papers etc.

Key Information
Duration: 3 Years
Total credits: 18
Programme Code: ______
Course Type: Minor Degree
Mode of study: Full time
Campus: Vidyavihar - Mumbai
Institute: KJSCE

Teaching and Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M05C301	Microcontrollers and Embedded C Programming	3 – 0 – 0	03	3 – 0 – 0	03	III
216M05L301	Microcontrollers and Embedded C Programming Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	III
216M05C401	Sensors and Actuators in embedded systems	3 – 0 – 0	03	3 – 0 – 0	03	IV
216M05L401	Sensors and Actuators in embedded systems Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	IV
216M05C501	Real time Embedded Systems	3 – 0 – 0	03	3 – 0 – 0	03	V
216M05L501	Real time Embedded Systems Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	V
216M05C601	Internet of Things (IoT)	3 – 0 – 0	03	3 – 0 – 0	03	VI
216M05L601	Internet of Things (IoT) Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	VI
216M05P701	Project on Embedded systems or IoT / Internship *	0 – 4 – 0	04	0 – 2– 0	02	VII
Total		**12—12 -- 0**	**24**	**12 – 6 – 0**	**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme					
		Marks					
		CA		ESE	LAB/TUT CA	Total
		ISE	IA			
216M05C301	Microcontrollers and Embedded C Programming	30	20	50	-	100
216M05L301	Microcontrollers and Embedded C Programming Laboratory	-	-	-	50	50
216M05C401	Sensors and Actuators in embedded systems	30	20	50	-	100
216M05L401	Sensors and Actuators in embedded systems Laboratory	-	-	-	50	50
216M05C501	Real time Embedded Systems	30	20	50	-	100
216M05L501	Real time Embedded Systems Laboratory	-	-	-	50	50
216M05C601	Internet of Things (IoT)	30	20	50	-	100
216M05L501	Internet of Things (IoT) Laboratory	-	-	-	50	50
216M05P701	Project on Embedded systems or IoT / Internship	-	-	-	25	50
Total		**120**	**80**	**200**	**225**	**650**

Course Code	Course Title			
216M05C301	**Microcontrollers and Embedded C Programming**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**3**	**-**	**-**	**3**
Credits Assigned	**3**	**-**	**-**	**3**

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	**20**	**50**	**-**	**100**

Course prerequisites: **Number systems , Basic Digital Circuits, C programming**

Course Objectives: The course aims at creating awareness about powers of microcontrollers as controllers in embedded systems. It focuses on understanding features of microcontrollers and learning to write programs for using them in applications.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Understand working of Microcontrollers like 8051/ PIC to control simple tasks.

CO2: Write embedded C code for controlling I/O ports of a microcontroller

CO3: Write embedded C code for use of Timers, Serial communication, PWM features of Microcontrollers.

CO4: Interpret the specifications and write simple programs for microcontroller applications

CO5: Develop a small application using interfacing devices such as LCD, Keypad, ADC, DAC using microcontrollers

Module No.	Unit No.	Details	Hrs.	CO
1	**Basics of Microcontrollers : Architecture and Working**		06	CO1
	1.1	8051/PIC Microcontroller architecture, programming model		
	1.2	Flag bits and the PSW register, SFRs		
	1.3	Register banks and stack		
2	**Embedded C coding for application development**		09	CO2
	2.1	C data types for 8051/PIC Microcontroller		
	2.2	C program elements:Header and source files, preprocessor		

		directives		
	2.3	C program elements: Functions, data structures, modifiers, statements, loops, pointers		
3	**Basic Features of Microcontrollers and embedded C programming**		09	CO3
	3.1	I/O port structure and operation		
	3.2	I/O Handling and I/O bit manipulation programming		
	3.3	Timers/counter programming		
4	**More features of Microcontrollers**		**09**	CO4
	4.1	Serial Communication		
	4.2	Other communication Interfaces (I2C / CAN etc)		
	4.3	PWM and motor control		
5	**Application Development with Interfacing various devices with Microcontrollers**		**12**	**CO5**
	5.1	Seven Segment Displays, Keypads, LCD Interface		
	5.2	ADC, DAC Interface		
	5.3	Motor Interface and control		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Muhammad Ali Mazidi, Janice G. Mazidi, Rolin Mckinlay	The 8051 Microcontroller And Embedded Systems Using Assembly And C	Pearson India	*2nd* Edition, 2008
2.	MAZIDI and MA and MCKINLAY and R ETAL	Microcontroller And Embedded Systems Using Assembly And C For Pic 18	Pearson India	*1st* Edition, January 2015
3.	Kenneth J. Ayala	The 8051 Microcontroller	Cengage Learning,	*3rd* Edition, 2005
4.	Ramesh Gaonkar	Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family)	Penram International;	*1st*t edition January 2010
5.	Shibu K. V.	Introduction to Embedded Systems	McGraw Hill Education India Private Limited;	*2nd* edition, July 2017

Course Code	Course Title					
216M05L301	Microcontrollers and Embedded C Programming Laboratory					
	TH			P	TUT	Total
Teaching Scheme(Hrs.)	-			2	-	2
Credits Assigned	-			1	-	1
Examination Scheme	Marks					
	CA		ESE	LAB/TUT CA		Total
	ISE	IA				
	-	-	-	50		50

Term-Work:
Term work will consist of experiments/ tutorials covering the entire syllabus of the course '116M05C301'. Students will be graded based on continuous assessment of their term work

Course Code		Course Title					
216M05C401		Sensors and Actuators in Embedded systems					
		TH			P	TUT	Total
Teaching Scheme(Hrs.)		3			-	-	3
Credits Assigned		3			-	-	3
Examination Scheme		Marks					
		CA		ESE	LAB/CA/TUT		Total
		ISE	IA				
		30	20	50	-		100

Course prerequisites: Digital Circuits, Microcontrollers and Embedded C Programming
Course Objectives: Sensors and actuators are important and integral parts of any embedded and IoT applications. The course aims to introduce different sensors and their characteristics and applications used for embedded systems
At the end of successful completion of the course the student will be able to
CO1: Understand basic building blocks of embedded systems.
CO2: Describe real world sensors and actuators with their specifications
CO3: Write programs in embedded C for acquiring data from sensors and controlling actuators using Microcontrollers
CO4: Explain the scope, requirements, system architecture for simple embedded system applications case studies

Module No.	Unit No.	Details	Hrs.	CO
1		**Basic concepts of Embedded Systems**	06	CO1
	1.1	Introduction to Embedded systems, classification, major application, purpose		
	1.2	Core of embedded system, sensors, actuators, memory,Embedded firmware		
	1.3	Types of Communication interfaces		
2		**Sensors and Actuators in embedded systems**	15	CO2
	2.1	Sensor Specifications- Static, Dynamic, Characteristics		
	2.2	Electrical / Electro-Mechanical Sensors and Transducers: Principle of operation,characteristics, applications • Displacement / Level Sensors : Contact - non-contact type level sensors, capacitive level sensors, inductive level sensors, ultrasonic range sensors, radiation based level sensors, variable resistance sensors • Optical / Light Sensor :Optical displacement sensor, zone distance sensor, color sensors • Flow Sensors / Transducers • Proximity / Limit Sensors:Inductive and capacitive proximity sensors, photoelectric proximity switches, ultrasonic proximity switches • Temperature Sensors :RTD, thermocouple, thermistor, Non-contact temperature sensors, infra-red sensors • Environmental sensing- Gas sensors, soil moisture,Humidity,alcohol sensor • Biological sensors:Heart rate sensing, body temp sensing • Self study: Chemical sensors,		
	2.3	Actuators- Types of actuators and their characteristics linear, D.C motors, stepper motors, servo motors, Relays. Buzzers/ Sirens, displays		
	2.4	Standards for sensors & Actuators		
3		**Introduction to smart sensors**	06	CO2

	3.1	Smart sensors basics, MEMS sensors - Micromachining		
	3.2	Sensors for IoT applications		
	3.3	MEMS actuators- Microvalve, micromotors, micro dynamometer, MEMS relays		
	3.4	Standards for smart sensors		
4	**Interfacing sensors and actuators to Microcontrollers**		09	CO3
	4.1	Amplification and Signal conditioning		
	4.2	Introduction to to Raspberry Pi, Interfacing of Temp sensors with Raspberry Pi		
	4.3	Interfacing of proximity, ultrasonic sensors		
	4.4	Interfacing of D.C motors, stepper motors, servo motors, Relay using RASP / PIC microcontroller		
5	**Embedded Systems Case Studies**		09	CO4
	5.1	Digital clock, Battery operated smart card reader		
	5.2	Automated meter reading system, Elevator control		
	5.3	Digital camera, Vending Machines		
		Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Shibu K. V.	*Introduction to Embedded Systems*	McGraw Hill Education India Private Limited;	*2nd* edition, July 2017
2.	Jacob Fraden	*Handbook of Modern Sensors: Physics, Designs, and Applications*	Springer, USA	*5th* edition 2015
3.	Randy Frank	*Understanding Smart Sensors*	Artech House Publications	*3rd* edition
4.	Simon Monk	*Raspberry Pi Cookbook: Software and Hardware Problems and Solutions*	O'Reilly Media, Inc.Publication	*3rd* Edition October 2019

Course Code	Course Title				
216M05L401	**Sensors and Actuators in Embedded systems Laboratory**				
	TH		**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	-		2	-	2
Credits Assigned	-		1	-	1
Examination Scheme	**Marks**				
	CA		**ESE**	**LAB/TUT CA**	**Total**
	ISE	**IA**			

Course Code	Course Title				
	-	-	-	50	50

Term-Work:
Term work will consist of experiments/ tutorials covering the entire syllabus of the course '116M05C401'. Students will be graded based on continuous assessment of their term work

Course Code	Course Title				
216M05C501	**Real Time Embedded Systems**				
	TH		**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	3		-	-	3
Credits Assigned	3		-	-	3
Examination Scheme	**Marks**				
	CA		**ESE**		**Total**
	ISE	**IA**			
	30	20	50		100

Course prerequisites: Digital Circuits, Microcontrollers and Embedded C Programming
Course Objectives: This course aims at teaching concepts like the coexistence of a variety of real time tasks and timing correctness in embedded systems, which means to guarantee that the system reacts within the real-time requirements. The course teaches how to plan real-time systems in theory using established modeling and how to implement them in practice by using the most common scheduling methods. It also aims at teaching how to program the system in the C language using the FreeRTOS real-time kernel.

Course Outcomes
After successful completion of the course the student will be able to :
CO1. Get insight of the design metrics and trade offs of real time embedded system
CO2. Understand the basic concepts of real time operating systems like multitasking , scheduling etc.
CO3. Learn importance of Interprocess communication and synchronization tools
CO4 Apply open source operating system programming concepts for task management
CO5: Develop a small embedded application

Module No.	Unit No.	Details	Hrs.	CO
1		**Fundamentals of Embedded Systems**	**06**	**CO1**
	1.1	Introduction to Embedded Systems, Characteristics of Embedded System, Design Metrics and optimization of various parameters of embedded system. Real time Systems requirements, real time issues, interrupt latency		
	1.2	Embedded Product development lifecycle, Program Modeling concepts: , FSM, UML		

	1.3	Architecture of embedded systems		
2	**Real time Operating System Concepts**		**12**	**CO2**
	2.1	Real time concepts, hard real time and Soft Real time,difference between general purpose OS and real time OS		
	2.2	Tasks, Task states,Thread,Process, Types of Tasks, Multitasking		
	2.3	Task Scheduling algorithms: Preemptive ,non preemptive,FIFO,SJF/ SRT, priority based, Round Robin		
3	**Inter process communication and synchronization**		**12**	**CO3**
	3.1	Message Queue, Mailbox, Pipe Function, Mutex, RPC Function, Shared Resources ,context switching		
	3.2	Inter process Communication, Semaphore, Spinlock Semaphore, Blocking Semaphore, Mailbox		
4	**Open source RTOS programming**		**09**	CO4
	4.1	Introduction to FreeRTOs: Task creation, Task management		
	4.2	Heap Memory management, interrupt generation		
	4.3	Pipes, Semaphore, Message Queue, Sockets		
5	**Embedded Application Development with Interfacing various devices with Microcontrollers**		**09**	**CO5**
	5.1	Requirement analysis, Hardware blocks diagram, System model (like FSM, UML), Software architectures (modules, drivers), and Component/hardware selection, covering following cases: ● Hard real time/ Mission critical: Missile, Car cruise control, medical monitoring systems, process control system (temp, pressure) ● Soft real time: Automated vending machines, digital camera, media player. Communication: Embedded web servers, routers, Wireless (sensor) networks		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Shibu K V	*Introduction to Embedded Systems*	McGraw Hill Education	Tenth Edition 2013
2.	Sriram Iyer , Pankaj Gupta	*Embedded Realtime Systems Programming*	Tata McGraw-Hill Education	July 2017

3.	Richard Barry	*Mastering the FreeRTOS Real Time Kernel A Hands-On Tutorial Guide0*	Real Time Engineers Ltd	*Pre-release 161204 Edition, 2016*
4.	Raj Kamal	*Embedded Systems – Architecture, Programming and Design*	McGraw Hill Education Private Limited, India	Third Edition,2015

Course Code	Course Title				
216M05L501	**Real Time Embedded Systems Laboratory**				
	TH		P	TUT	Total
Teaching Scheme(Hrs.)	-		2	-	2
Credits Assigned	-		1	-	1
Examination Scheme	Marks				
	ISE	IA	ESE	LAB/TUT CA	Total
	-	-	-	50	50

Term-Work:
Term work will consist of experiments/ tutorials covering the entire syllabus of the course '116M05C401'. Students will be graded based on continuous assessment of their term work

Course Code	Course Title				
216M05C601	**Internet of Things**				
	TH		P	TUT	Total
Teaching Scheme(Hrs.)	03		-	–-	03
Credits Assigned	03		-	-	03
Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	-	100

Course prerequisites:
Embedded systems

Course Objectives:
Internet of thing is an emerging field. Different area such as agriculture, space, healthcare, manufacturing, construction, water and mining are going to have massive use of IoT. This course imparts the knowledge fundamental concepts of internet of Things. It includes IoT protocol, security aspects and designing of IoT based applications.

Course Outcomes

At the end of successful completion of the course the student will be able to
CO1. Describe IoT fundamentals
CO2. Understand IoT enabled technologies
CO3. Distinguish different IoT protocols
CO4. Elaborate various security aspects of IoT
CO5. Design application of IoT using any suitable platform

Module No.	Unit No.	Details	Hrs.	CO
1	**Fundamental overview on IoT**		05	CO 1
	1.1	IoT Architecture: History of IoT, Comparison between IoT and M2M, M2M, Web of Things		
	1.2	Design challenges, Development challenges, Security challenges		
	1.3	IoT reference model, simplified architecture		
2	**IoT enabled technologies**		10	CO 2
	2.1	IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT		
	2.2	Interoperability and its solution		
	2.3	Overview on Industrial IoT		
3	**IoT protocols**		10	CO 3
	3.1	**Data link protocols:** IEEE 802.15.4e, IEEE 802.11 ah, Wireless HART, Z-Wave, Bluetooth low energy, Zigbee		
	3.2	**Network layer routing protocols:** RPL, CORPL, CARP		
	3.3	**Session layer protocols:** MQTT, SMQTT, CoAP, XMPP, HTTP		
	3.4	**Management Protocol:** Interconnection of Heterogeneous data link, Smart transducer interface		
4	**Service layer protocols & security**		10	CO 4
	4.1	Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4 , 6LoWPAN, RPL, Application Layer		
	4.2	Authentication and authorization of smart devices		
	4.3	secure cloud, firmware, physical layer security		
5	**Design and development of IoT**		10	CO5
	5.1	Data acquisition using IoT platforms: Arduino, Raspberry –Pi, embedded microcontrollers		
	5.2	Developing sensor based application through embedded system platform,		
	5.3	Overview on IoT supporting technologies: Cloud computing, Big data analytics		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Arshdeep Bahga,			

	Vijay Madisetti	*Internet of Things: A hands-on Approach*	Universities Press, India	*1st* edition, 2015
2.	Honbo Zhou	*The Internet of Things in Cloud: A middleware perspective*	CRC Press, New York	2013
3.	Raj Kamal	*Internet of Things: Architecture and Design Principles*	McGraw Hill Education, India	2017
4.	Olivier Hersent, David Boswarthick, Omar Elloumi	*The Internet of Things: Key Applications and Protocols*	Wiley Publication, UK	*1st* edition, 2012
5.	Shanang Li,Li Da Xu	*Securing the Internet of Things*	Elsevier	2017

Course Code	**Course Title**					
216M05L601	**Internet of Things Laboratory**					
	TH			**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**-**			**2**	**-**	**2**
Credits Assigned	**-**			**1**	**-**	**1**
Examination Scheme	**Marks**					
	ISE	**IA**	**ESE**	**LAB/TUT CA**		**Total**
	-	**-**	**-**	**50**		**50**

Term-Work:
Term work will consist of experiments/ tutorials covering the entire syllabus of the course '116M05C401'. Students will be graded based on continuous assessment of their term work

Proposed List of Projects:

1. Speed control of motors in robotic applications
2. Monitoring of agricultural parameters of soil
3. Monitoring and control of biomedical system
4. Weather monitoring system
5. Home Automation system
6. Security systems

Alternative online courses

- Embedded Systems by NPTEL Prof Amit Patra IIT Kharagpur
- Embedded Systems by NPTEL by Prof Santanu Chaudhury IIT Delhi
- Embedded System Design NPTEL by Prof. Anupam Basu IIT Kharagpur
- Introduction of Internet of things , NPTEL by Prof Sudip Mishra, IIT Kharagpur
- Design of Internet of Things NPTEL by Prof T V Prabhakar , IISc bangalore
- Udemy , Coursera , CISCO courses

Syllabus

Minors in Intelligent Systems

Department of Electronics and Telecommunication Engineering

From
Academic Year 2024-25
Revision 2

(Approved by Academic Council meeting dated)

K J Somaiya College of Engineering, Mumbai-77

(A Constituent College of Somaiya Vidyavihar University)

Minor Degree Programme in Intelligent Systems

Offered by Department of Electronics and Telecommunication Engineering

Abstract: This Minor degree program focuses on computers and systems with intelligence. These systems can take many various forms; some examples include speech and facial recognition software, drones and driverless automobiles, as well as e-commerce.

Basically, an intelligent system is computer-based systems with the ability to collect, interprets, and makes decisions based on data. Rather than adhering to a rigid set of guidelines, the system has the ability to identify valuable patterns and acquire strategies and processes that optimize the final results. To put it another way, the system acquires artificial intelligence through training on large amounts of data using a range of mathematical/computational models.

Objectives:

- Understand signal acquisition techniques**.**
- Identify problems where intelligence techniques are applicable.
- Understand selected basic machine learning techniques; judge applicability of more advanced techniques

Learning Outcomes:

At the successful completion of Information and Intelligent Systems Minor Programme, an engineering graduate will be able to:

1. Acquire physical signals such as speech, image, biomedical signals and signals from sensors.
2. Process the acquired signals for feature extraction in specific applications.
3. Design intelligent systems in their subject area.
4. Integrate knowledge from various subject areas such as Statistics, Programming, Machine Learning and Artificial Intelligence.

Eligibility Criteria:

Student who has earned all credits of First Year of Engineering in Computer Engineering / Information Technology /Electronics Engineering / Mechanical Engineering.

Assessment Methods:

- Quiz
- Open book test
- Theory examination
- Mini project
- Laboratory experimentation

- Study of research paper

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M17C301	Signal Acquisition Techniques	3 – 0 – 0	03	3 – 0 – 0	03	III
216M17L301	Signal Acquisition Techniques Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	III
216M17C401	Information and Entropy	3 – 0 – 1	04	3 – 0 – 1	04	IV
216M17C501	Image and video processing / Audio Signal Processing	3 – 0 – 0	03	3 – 0 – 0	03	V
216M17L501	Image and video processing / Audio Signal Processing Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	V
216M17C601	Deep Learning/Online course (Credit) in following areas - Automation/ Machine Learning / Biomedical signal processing / Intelligent Systems: Techniques, Applications	3 – 0 – 1	04	3 – 0 – 1	04	VI
216M17P701	Project	0 – 4– 0	04	0 – 2– 0	02	VII
Total		**12—08 – 2**	**22**	**12 – 4 – 2**	**18**	

Examination Scheme

Course Code	Course Name	Marks							
		CA		ESE	TW	O*	P	P& O	Total
		ISE	IA						
216M17C301	Signal Acquisition Techniques	30	20	50	-	-	-	-	100
216M17L301	Signal Acquisition Techniques Laboratory	-	-	-	50	-	-	-	50
216M17C401	Information and Entropy	30	20	50	50	-	-	-	150
216M17C501	Image and video processing / Audio Signal Processing	30	20	50	-	-	-	-	100
216M17L501	Image and video processing / Audio Signal Processing Laboratory	-	-	-	50	-	-	-	50

216M17C601	Deep Learning/Online course (Credit) in following areas - Automation/ Machine Learning / Biomedical signal processing / Intelligent Systems: Techniques , Applications	30	20	50	50	-	-	-	150
216M17P701	Project	-	-	-	25	25	-	-	50
Total		**120**	**80**	**200**	**225**	**25**			**650**

Course Code	Course Title						
216M17C301	**Signal Acquisition Techniques**						
	TH		**P**		**TUT**		**Total**
Teaching Scheme (Hrs.)	**03**		**-**		**-**		**03**
Credits Assigned	**03**		**-**		**-**		**03**
Examination Scheme	**Marks**						
	CA		**ESE**	**TW**	**O**	**P&O**	**Total**
	ISE	**IA**					
	30	**20**	**50**	**-**	**-**	**-**	**100**

Course prerequisites: Basic concepts of electrical and electronics, basic programming

Course Objectives:

Understand fundamentals of signal, signal acquisition systems, different types of sensors, hardware and software for signal acquisition systems. Study concept of digital to analog and analog to digital signal conversion. Understand various communication systems/protocol used in signal acquisition.

Course Outcomes:

At the end of successful completion of the course, the student will be able to

CO1. Understand different elements of signal acquisition techniques.

CO2. Understand and use hardware components of signal acquisition circuits.

CO3. Use various software tools for signal acquire process, archive and display

CO4. Understand different method for signal transfer.

CO5. Implement signal acquisition system.

Module No.	Unit No.	Details	Hrs.	CO
1		**Introduction to Signal Acquisition Techniques**	08	CO1
	1.1	Signals, types, classification, sensors and transducer interface, signal acquisition system elements		
	1.2	Signal conditioning and processing overview		
2		**Signal Acquisition Hardware**	12	CO2
	2.1	Analog to Digital conversion and devices, types, accuracy, and resolution, multiplexing and sampling theory, cable types, shielding		
	2.2	Electrical Measurements: AC and DC voltage, current, resistance, wheatstone bridges, single-ended and differential measurements		
	2.2	Sensors for measuring temperature, accelerometer, strain, light, angular velocity, pressure, liquid-level, humidity		
3		**Fundamental Signal Conditioning and Processing**	08	CO3, CO5
	3.1	Amplification, instrumentation amplifiers, filtering, attenuation, isolation, linearization		
	3.2	Fourier transform, digital filters vs analog filters, compression, modulation		
4		**Communication protocols**	10	CO4
	4.1	Serial communications RS232, SPI, I2C, CAN, IEEE-488 (GPIB), converters, extenders, repeaters		
	4.2	Wireless: Bluetooth, Wi-Fi, GSM		
5		**Software for Signal Acquisition Systems**	07	CO3, CO5
	5.1	MATLAB for acquiring, plotting, storing and processing of signal (Case study: Audio Signal)		
	5.2	LabVIEW: Virtual instruments, indicators and controls, front panel and block diagram, data types and data flow programming; case and sequence structures, arrays, loops, and clusters, graphs and charts		
	5.2	Examples of signal acquisition implementation		

Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition and Year of Publication
1.	Kalsi, H.S.	*Electronic Instrumentation*	Tata McGraw Hill, India	3rd edition 1 July 2017
2.	A.K. Sawhney, Puneet Sawhney	*A Course in Electrical And Electronic Measurements and Instrumentation*	Dhanpat Rai, India	1st edition 2012
3.	Ramakant Gayakwad	*Op-Amp and Linear Integrated Circuits*	Pearson Education, India	4th edition 2002
4.	John Park, Steve Mackay, Edwin Wright	*Practical Data Communications for Instrumentation and Control*	Newnes, Boston	1st edition 11 June 2003

User Guides:

1. Data Acquisition Toolbox™ User's Guide by Mathworks (March 2020 Version 4.1)

Online resources:

1. LabVIEW: Measurement Fundamentals Main Page. https://www.ni.com/en-in/innovations/white-papers/06/measurement-fundamentals-main-page.html

Course Code	Course Title						
216M17L301	Signal Acquisition Techniques Laboratory						
	TH			P		TUT	Total
Teaching Scheme (Hrs.)	--			02		--	02
Credits Assigned	--			01		--	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	-	-	-	50	-	-	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course 'Signal Acquisition Techniques'**.** Students will be graded based on continuous assessment of their term work.

<table>
<tr><th>Course Code</th><th colspan="8">Course Title</th></tr>
<tr><td>216M17C401</td><td colspan="8">Information and Entropy</td></tr>
<tr><td></td><td colspan="2">TH</td><td colspan="2">P</td><td colspan="3">TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="2">03</td><td colspan="2">---</td><td colspan="3">01</td><td>04</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">03</td><td colspan="2">--</td><td colspan="3">01</td><td>04</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="8">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">TW</td><td rowspan="2">O</td><td rowspan="2">P</td><td rowspan="2">P&O</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>50</td><td>50</td><td>--</td><td>--</td><td>--</td><td>150</td></tr>
</table>

Course prerequisites: Basic knowledge of randomness and probability, Basic skills of Programming.

Course Objectives:

This course gives a general idea about information to a freshman –level. The course contents tell how information everybody deal with can be quantified, compressed and processed in communication and computation systems. The important term “Entropy”, which is generally taught in Thermodynamics to 12^{th} standard students, is a kind of information. The depth is extended to model communication systems with errors, approaches to detect and correct errors. The course also teaches limits to communication and computation of information. An attempt is made to give exposure to information handling and information estimation in practical systems. Thus, by doing this course, students should be able to develop intelligent systems that have growing number of applications in factory automation, service robotics, medical care, transportation, human identification, visual surveillance, entertainment and education.

Course Outcomes:

At the end of successful completion of the course, the students will be able to

CO1. Quantify information and entropy.
CO2. Design efficient codes for information.
CO3. Generate error detection and error correction codes.
CO4. Understand models of reliable communication system.
CO5. Understand models of reliable computation system.

Module No.	Unit No.	Details	Hrs.	CO
1		**Fundamentals of Information and Entropy of discrete source**	08	CO1, CO2
	1.1	**Information:** Significance, Illustration, Quantification, Unit of measurement, Reversible and Irreversible information, Self-information, Mutual information, conditional self-information		
	1.2	**Bits:** Boolean Bit, Circuit Bit, Control Bit, Physical Bit, Quantum Bit, Classical Bit		
	1.3	**Codes:** Significance of the term "Symbol", Symbol Space Size, Common Codes- Binary Coded Decimal (BCD), Telephone Area Code, ASCII, Fixed Length and Variable Length Codes, Integer Codes		
	1.4	**Compression-** Huffman coding algorithm, Lempel Ziv encoding and decoding algorithm, 2 D-Discrete Cosine Transformation (DCT) algorithm for image compression		
	1.5	**Entropy (Average information):** Significance, average self-information, average mutual information, average conditional self-information		
2		**Errors in communication**	08	CO3
	2.1	**Model of communication system with errors:** Basic system model, Extension of basic system model, how do errors happen? examples of practical systems having errors		
	2.2	**Approaches to dealing with errors**- Hamming Distance, detection and correction of single bit errors, detection and correction of multiple bit errors, Linear Block code, Hamming code, Convolutional code, Binary Cyclic code.		
3		**Probability concepts in modeling communication system**	05	CO4
	3.1	**Basic Concepts and Definitions**: Terms "Randomness" and "Probability", Definition of probability, Axioms.		
	3.2	**Brief review of probability theory**: Event, Outcome, Joint events, Conditional probability, Bayes theorem		
	3.3	**Discrete random variables**: Probability mass function, Probability distribution function, Expectation, Variance (mathematical equations and its significance to information) **Important distribution functions**: Bernoulli trials, Binomial, Negative Binomial, Geometric, Poisson Approximation to the Binomial Distribution, problem Solving in engineering.		

4	**Communication and Computation of information (speed and reliability)**		12	CO4, CO5
	4.1	**Source Model:** Prefix-condition code, Kraft inequality, Source entropy, Source coding theorem,		
	4.2	**Channel Model:** Channel capacity for noiseless channel , Channel capacity for noisy channel		
	4.3	**Communication System Requirements:** Measures of reasonable communication systems- throughput, latency, tolerance of errors, and tolerance of bursts, Measures of various communication systems like computer memory, hard disk, telephone, internet, email,		
	4.4	**Processes:** Significance of process in communication system and in computation system, Types – discrete, finite, memoryless, nondeterministic, lossy, definition of capacity of process		
	4.5	**Discrete, memoryless, nondeterministic and lossy process:** General model, Formulas for input information, loss, mutual information, noise, output information and information transfer		
	4.6	**Inference:** Estimation – Symmetric Binary Channel and Non -Symmetric Binary Channel, Inference strategy- Maximum likelihood Principle of maximum entropy- simple form, constraints, maximum entropy, analytic form		
5	**Implementation of modules 1 to 4**		12	CO1, CO2, CO3, CO4, CO5
	5.1	**Compression:** Image compression using 2D- DCT		
	5.2	**Source coding algorithm:** Generation of a codebook for a sequence of characters		
	5.3	**Error correction code**: Generation of error detection/ correction code for a test pattern		
	5.4	**Maximum entropy:** Inference in practical system		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	David J.C. Mackay	*Information Theory, Inference and Learning Algorithms*	Cambridge University Press, UK	1st edition, 2003.
2.	Robert G. Gallager	*Information Theory & Reliable Communication*	John Wiley & Sons INC., USA	1st edition 1968
3.	Mark Kelbert Yuri Suhov	*Information Theory & Coding by Example*	Cambridge University Press, UK	1st edition 2013
4.	Monica Borda	*Fundamentals in Information Theory & Coding*	Springer, India	1st edition 2011

Course Code	Course Title								
216M17C501	Image and Video Processing								
	TH			P		TUT		Total	
Teaching Scheme (Hrs.)	03			--		--		03	
Credits Assigned	03			--		--		03	
Examination Scheme	Marks								
	CA		ESE	TW	O	P	P&O	Total	
	ISE	IA							
	30	20	50	--	--	--	--	100	

Course prerequisites:

Matrix theory, Basics of signal processing and Digital Signal Processing

Course Objectives:

Image and Video Processing currently is one of the most widely investigated subjects in the industry. The objective of the course is to introduce students to both the fundamentals and emerging techniques in the area of image and video processing. The analysis of still images is considered first and then, it is extended to the case of image sequences (video). The topics covered in this course find wide scope in applications such as photographic image processing, satellite imaging, bio-medical image processing, video surveillance, video codecs, etc. The course also aims to prepare students for exploring further in this field.

Course Outcomes:

At the end of successful completion of the course, the students will be able to

CO1. Understand the fundamentals of image processing.
CO2. Interpret and analyze image enhancement algorithms in spatial domain Interpret.
CO3. Analyze image enhancement algorithms in frequency domain.
CO4. Implement binary image processing methods / techniques for various applications.
CO5. Understand theory and fundamentals of video processing.

Module No.	Unit No.	Details	Hrs	CO mapping
1		**Image Processing Basics**	10	CO1
	1.1	Components of a digital image processing system, light, color, and electromagnetic spectrum, image acquisition, image digitization, types and formats of images, properties of image such as spatial resolution, tonal resolution, aspect ratio, dots per inch and pixels per inch		
	1.2	Basic operations between images: arithmetic and logic operations, geometric operations such as translation, rotation, cropping, flipping, decimation, interpolation, zooming		
	1.3	Colour image processing: Basics of colour, additive and subtractive colour mixtures, chromaticity diagram, different colour models, RGB, CMY and CMYK, HSV and the YCbCr models.		
2		**Spatial domain Processing for Grey Scale Images**	10	CO2
	2.1	Point Transformations: Digital negative, contrast manipulation, power law and log transformations, piecewise linear transformations		
	2.2	Histogram Processing: Computing and interpreting Image Histograms, Histogram Equalization, Histogram Sliding, Histogram Stretching, Histogram Shrinking		
	2.3	Neighbourhood Processing: Convolution and correlation in two-dimensional domain, lowpass filters such as averaging, median, order – statistics filter, high pass filters, first derivative and second derivative operators, The Laplacian, Directional Difference Filters, Unsharp Masking, High-Boost filtering		
	2.4	Image restoration in spatial domain: Modeling of the image degradation and restoration, noise and noise models, noise reduction using mean filters, order statistic filters and adaptive filters		
3		**Frequency domain Processing**	08	CO3
	3.1	Frequency domain processing: 2D-Discrete Fourier Transform and plotting the spectrum, filtering in frequency domain (ideal, Butterworth and Gaussian filters), separable and non-separable filters and their applications.		
	3.2	Noise Reduction Using Frequency-domain Techniques: Periodic Noise, Band reject Filter, Bandpass Filter, Notch Filter		
4		**Binary Image Processing**	09	CO4
	4.1	Binarization, basic set theory (logical operations) and introduction to morphology		

	4.2	Morphological operations such as dilation, erosion, opening, closing, Hit-or Miss transform,		
	4.3	Morphological algorithms for boundary extraction, region filling, extraction, labelling of connected components and blob analysis.		
	4.4	Binary object features such as area, centroid, perimeter, Euler number, aspect ratio and moments, importance of invariant and robust features		
	4.5	Boundary descriptors such as chain code, shape number, signatures and Fourier descriptors.		
5		**Video Processing**	**08**	**CO5**
	5.1	Basic Concepts and terminology such as scanning (interlaced and progressive), aspect ratio, gamma correction.		
	5.2	Video sampling, advantages and parameters of a digital video sequence, Sampling of video sequence and deinterlacing of a video sequence.		
	5.3	Fundamentals of Motion estimation and compensation, Concept of optical flow, Exhaustive search block matching algorithm, 2D log search method and Hierarchical block matching algorithm.		
	5.4	The MPEG-4 video compression standard.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1	Jayaraman, Esakkirajan and Veerakumar	*Digital Image Processing*	Tata McGraw Hill Education Pvt. Ltd., India	2nd reprint, 2010
2	Gonzalez and Woods	*Digital Image Processing*	Pearson Education, India	3rd edition, 2008
3	Shengrong Gong, Chunping Liu, Yi Ji Baojiang Zhong, Yonggang Li and Husheng Dong	*Advanced Image and Video Processing Using MATLAB*	Springer International Publishing, Switzerland	1st edition, 2018
4	Murat Tekalp	*Digital Video Processing*	Prentice Hall, US	2nd edition, 2015
5	Oge Marques	*Practical Image and Video Processing using MATLAB*	John Wiley & Sons Inc., US	1st edition, 2011

<table>
<tr><th>Course Code</th><th colspan="8">Course Title</th></tr>
<tr><td>216M17C501</td><td colspan="8">Audio Signal Processing</td></tr>
<tr><td></td><td colspan="3">TH</td><td colspan="2">P</td><td colspan="2">TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">03</td><td colspan="2">--</td><td colspan="2">--</td><td>03</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">03</td><td colspan="2">--</td><td colspan="2">--</td><td>03</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="8">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">TW</td><td rowspan="2">O</td><td rowspan="2">P</td><td rowspan="2">P&O</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>50</td><td>--</td><td>--</td><td>--</td><td>--</td><td>100</td></tr>
</table>

Course prerequisites: Calculus, Digital Signal Processing

Course Objectives: The objective of this course is to learn audio signal processing methodologies useful in real applications. Focus of the course is on the use of basic engineering mathematics and spectral processing techniques for the description, generation and transformation of sound. The course includes programming exercises in Python for processing of sound.

Course Outcomes

At the end of successful completion of the course, the student will be able to

CO1. Understand applications of audio signal processing.
CO2. Understand spectral processing techniques for description and transformation of sounds.
CO3. Analyze sound signal.
CO4. Synthesize sound signal.
CO5. Learn skills of Python programming for sound signal.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction**		08	CO1
	1.1	Field of Audio Signal Processing and its applications		
	1.2	Basic mathematics required before the start of the course: Sinusoidal functions; Complex numbers; Euler's formula; Complex sinusoids; Scalar product of sequences; Even and odd functions; Convolution		
	1.3	Software applications and software tools		
2	**Analysis of sound using Discrete Fourier Transform (DFT)**		09	CO2, CO3
	2.1	The Discrete Fourier Transform equation; complex exponentials; scalar product in the DFT; DFT of complex sinusoids; DFT of real sinusoids; and inverse-DFT.		
	2.2	Analysis of a sound using the DFT; Data base of sound signals; Generating sinusoids and implementing the DFT in Python.		
	2.3	DFT properties: Linearity, shift, symmetry, convolution; Fast Fourier Transform (FFT): Analysis of simple periodic signals and of complex sounds. Computation of the spectrum of a sound fragment using Python		
3	**Analysis of sound using Short Time Fourier Transform (STFT)**		08	CO2,CO3
	3.1	STFT equation; analysis window; FFT size and hop size; time-frequency compromise; inverse STFT.		
	3.2	Spectrogram of a sound; Analysis of a sound using Spectrogram; Implementation of the windowing of sounds using Python		
4	**Sinusoidal Model, Harmonic Model, Sinusoidal plus residual model**		10	CO3,CO4
	4.1	Sinusoidal model equation; sinewaves in a spectrum; Sinewaves as spectral peaks; Time-varying sinewaves in spectrogram; Analysis and synthesis of sounds using Sinusoidal model; Detection of spectral peaks using Python		
	4.2	Harmonic model equation; Sinusoids-partials-harmonics; Polyphonic-monophonic signals; Harmonic detection; f0-detection in time and frequency domains. Pitch detection algorithm; Analysis and synthesis of sound; Detection of the fundamental frequency in the frequency domain using the TWM algorithm in Python		
	4.3	Stochastic signals; Stochastic model; Stochastic approximation of sounds; Sinusoidal/harmonic plus residual model; Residual subtraction; Stochastic model of		

		residual.		
5	**Activity – Sound Transformations**		10	CO5
	5.1	Filtering and morphing using the short-time Fourier transform; Frequency and time scaling using the sinusoidal model; Frequency transformations using the harmonic plus residual model; Time scaling and morphing using the harmonic plus stochastic model.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1	Julius O. Smith	*Mathematics Of The Discrete Fourier Transform (DFT) - With Audio Applications*	W3K, USA	2nd edition, 2007
2	Julius O. Smith	*Physical Audio Signal Processing*	W3K, USA	2nd edition, 2010
3	Julius O. Smith	*Spectral Audio Signal Processing*	W3K, USA	1st edition, 2011
4	Julius O. Smith	*Introduction to Digital Filters with Audio Applications*	W3K, USA	2nd edition, 2007

Course Code	Course Title						
216M17L501	Image and video processing / Audio Signal Processing Laboratory						
	TH			P		TUT	Total
Teaching Scheme (Hrs.)	-			02		-	02
Credits Assigned	-			01		-	01
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	-	-	-	50	-	-	50

Term-Work:

Term work will consist of experiments/ tutorials covering entire syllabus of the course 'Image and video processing / Audio Signal Processing'. Students will be graded based on continuous assessment of their term work.

<table>
<tr><th colspan="3">Course Code</th><th colspan="8">Course Title</th></tr>
<tr><td colspan="3">216M17C601</td><td colspan="8">Deep learning</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td colspan="3">TUT</td><td colspan="3">Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="3">03</td><td>--</td><td colspan="3">--</td><td colspan="3">03</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">03</td><td>--</td><td colspan="3">--</td><td colspan="3">03</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="10">Marks</td></tr>
<tr><td colspan="3">CA</td><td rowspan="2">ESE</td><td rowspan="2">TW</td><td rowspan="2">O</td><td rowspan="2">P</td><td rowspan="2">P&O</td><td rowspan="2" colspan="2">Total</td></tr>
<tr><td>T-1</td><td>T-2</td><td>IA</td></tr>
<tr><td>15</td><td>15</td><td>20</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td colspan="2">50</td></tr>
</table>

Course prerequisites: Calculus, Linear Algebra, Probability & Statistics

Course Objectives

Understand how human solve basic classification, recognition and sequential problem. Study selected topics of Deep Learning, discussing recent models from both supervised and unsupervised learning. Use of deep learning to solve different real-world problems.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1. Understand the fundamentals of deep learning.
CO2. Apply the fundamental principles of mathematics for learning deep neural Networks.
CO3. Understand concepts, issues and practices when training deep neural network
CO4. Understand deep learning algorithms and models.
CO5. Implement deep learning algorithms and solve real-world problems.

Module No.	Unit No.	Details	Hrs	CO
1	**Introduction to Neural Networks and its Basic Concepts:**		8	**CO1**
	1.1	Neuroscience inspiration, perceptron, cost functions, hypotheses, training data, activation functions, feed-forward networks, MLP, review of fundamental learning techniques.		
	1.2	Learning via gradient descent, backpropagation, output units: linear, SoftMax; hidden units: tanh, RELU		
	1.3	Reasons to go Deep		
2	**Neural Networks Learning and Algorithms**		9	**CO2, CO3**
	2.1	Forward and Backpropagation algorithms, Gradient Descent (GD), Momentum Based GD, Nesterov's Accelerated GD		
	2.2	Regularization: Bias variance tradeoff, L2 regularization, Early stopping, Dataset augmentation, Dropout		
3	**Deep learning algorithms and model**		12	**CO4**
	3.1	Convolutional Neural Networks (CNN), AlexNet, VGGNet, GoogLeNet, ResNet, hyper parameter learning, transfer learning, Visualizing Convolutional Neural Networks		
	3.2	Region-CNN (R-CNN), Fast R-CNN, Faster R-CNN, You Only Look Once (YOLO)		
	3.3	Sequence learning problems, recurrent neural networks, backpropagation through time, vanishing and exploding Gradients		
4	**Recent trends in Deep learning**		7	**CO4**
	4.1	Gated Recurrent Units (GRUs), Long Short-Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs		
	4.2	Encoder Decoder Models, Attention Mechanism, Attention over images		
5	**Applications of Deep learning**		9	**CO5**
	5.1	Character & face recognition, image segmentation, object detection, word embedding		
	5.2	Deep Dream, Generative Adversarial Networks (GANs)		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Jacek M. Zurada	*Introduction to Artificial Neural Systems*	Jaico Publishing House, India	1st edition 1992
2.	Ian Goodfellow, Yoshua Bengio, Aaron Courville	*Deep Learning*	MIT Press, USA	1st edition 3 January 2017
3.	Geron Aurelien	*Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*	O'Reilly, UK	4th edition, 2017
4.	Francois Chollet	*Deep Learning with Python*	Manning Publications, India	1st edition, 2017

Course Code	Course Title							
216M17P701	Project							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	0			08		--		08
Credits Assigned	0			04		--		04
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	-	-	-	25	25	--	--	50

Syllabus

Minor Degree Program in
Aerospace Engineering

(Offered by Department of Mechanical Engineering)

From

Academic Year 2024 – 25

(Revision 2)

(Approved by Expert Board meeting dated 19/04/2024)

K. J. Somaiya College of Engineering, Mumbai-77

(A Constituent College of Somaiya Vidyavihar University)

It is notified for information of all concerned that the FOET at its meeting held on ~~08/05/2021~~ the syllabus of **Minor Degree Program on Aerospace Engineering** and same be brought in to force from Academic ~~Year 2023-24~~ with immediate effect.

Date: **HOD MECH**

Introduction

The Program offers special challenges and opportunities to a academically talented and highly motivated undergraduate students. Minor program in Aerospace Engineering provides opportunity to students to enrich their knowledge in the Aerospace field along with their Major program for which they are admitted. Curriculum of this minor program is designed to impart fundamental knowledge of propulsion, aerodynamic, structure and control system used in Aerospace Engineering

Project Work: Proposed areas of project work are

1. Analysis of Jet and wake flow
2. Blade analysis of compressor and turbine
3. Acoustic analysis of aerospace vehicle
4. Aeromodelling
5. Structural analysis of composite material
6. Vibration analysis

Alternative Online Courses

Suitable online courses such as NPTEL/MOOC etc. may be considered as an alternative to maximum one of the mentioned stipulated courses. The permissible online courses will be announced at the appropriate time when this minor degree program will be in effect.

Eligibility Criteria:

Students who have passed first year of engineering in Computer Science, Electronics, Electronics & Telecommunication Engineering, Information Technology.

Assessment Methods:

Tests, quiz, mini-projects, presentations, study of research articles, etc.

Dr. Shailesh Nikam
Programme Coordinator

Dr. Ramesh Lekurwale
Head of the Department

Program Objectives:

The objectives of this minor program are to produce graduates who:

- Solve Aerospace engineering problems throughout their careers using the knowledge and skills developed during their minor degree program
- Make a positive contribution to society through advancing the state of the art in aerospace engineering, professional service, community service, and/or mentoring
- Advance their career by demonstrating leadership, teamwork, and communication skill in addition to technical knowledge

Learning Outcomes (LOs) of the minor Degree Program:

At the successful completion of this minor program in Aerospace engineering graduate will be able to

LO1: Design, analyse and review safe and efficient aerospace systems to meet industry requirements and regulatory environment.

LO2: Establish them as practicing professionals in aerospace engineering by acquiring knowledge of propulsion systems, aerodynamics and control of aerospace vehicles.

Acronyms used in syllabus document	
Acronym	**Definition**
CA	Continuous Assessment
ESE	End Semester Exam
IA	Internal Assessment
O	Oral
P	Practical
P&O	Practical and Oral
TH	Theory
TUT	Tutorial
TW	Term work
ISE	In-semester Examination
CO	Course Outcome

Acronyms used in Course code e.g. 116h49301

Position of Digit	Acronym	Definition
1	**2**	Second revision SUV KJSCE 2023
2	**16**	KJSCE
3	**h**	**Honour Degree Program**
4	**71**	**Aerospace Engineering**
5	**C**	Core Course
	L	Laboratory Course
	T	Tutorial
	P	Project Based Course
6	**1/2/3/4**	Semester Number
7	**01/02/03--**	Course Number

Table of Contents

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits
216M21C301	Introduction to Flight	3 – 0 – 0	3	3 – 0 – 0	3
216M21C401	Aircraft Propulsion	3 – 0 – 0	3	3 – 0 – 0	3
216M211C501	Flight Mechanics	3 – 0 – 0	3	3 – 0 – 0	3
216M21C601	Aerodynamics	3 – 0 – 0	3	3 – 0 – 0	3
216M21L601	Aerodynamics Laboratory	0 – 2 – 0	2	0 – 1 – 0	1
216M21P601	Mini Project	0 – 4 – 0	4	2	2
216M21C701	Computational Fluid Dynamics	2 – 0 – 0	2	2 – 0 – 0	2
216M21L701	Computational Fluid Dynamics Laboratory	0 – 2 – 0	2	0 – 1 – 0	1
Total		**14 – 08 – 00**	**22**	**14 – 04 – 00**	**18**

Examination Scheme

Course Code	Course Name	Examination Scheme Marks					
		CA		ESE	LAB/TUT CA#	O	Total
		ISE	IA				
216M71C301	Introduction to Flight	30	20	50	--	--	100
216M71C401	Aircraft Propulsion	30	20	50	--	--	100
216M71C501	Flight Mechanics	30	20	50	--	--	100
216M71C601	Aerodynamics	30	20	50	--	--	100
216M71L601	Aerodynamics Laboratory	--	--	--	50	--	50
216M71P601	Mini Project	--	--	--	50	50	100
216M71C701	Computational Fluid Dynamics	30	20	--	--	--	50
216M71L701	Computational Fluid Dynamics Laboratory	--	--	--	50	--	50
Total		**150**	**100**	**200**	**150**	**50**	**650**

#Lab/Tut CA will comprise of a variety of components such as quizzes, onscreen exam, viva-voce, journal, GDs etc. throughout the semester. Details will be shared by course teachers at the beginning of every semester

Course Code	Course Title						
216M71C301	**Introduction to Flight**						
	TH			P	TUT		Total
Teaching Scheme (Hrs.)	03			--	--		03
Credits Assigned	03			--	--		03
Examination Scheme	Marks						
	CA		ESE	TW	LAB/TUT CA		Total
	ISE	IA					
	30	20	50	--	--		100

Course prerequisites:

- **Basic Thermodynamics**
- **Basic Heat Transfer**
- **Fluid Mechanics**

Course Objectives:

1. To gain a foundational understanding of all the aspects of flight.
2. To Understand and apply methods for estimating performance of aircraft.
3. To gain a broad knowledge of multiple aviation career pathways

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand history and development of aviation and basic aircraft nomenclature

CO2: Demonstrate basic aerodynamics necessary for understanding mechanics of flight

CO3: Understand and analyse important aspect of aircraft performance

CO4: Identify technology for aircraft stability and control

CO5: Rationalize the selection of different forms of propulsion used by aircraft

Module No.	Unit No.	Topics	Hrs.	CO
1	**Anatomy of Airplane**		**05**	**CO1**
	1.1	Historical development of airplane		
	1.2	Nomenclature of aircraft components		
	1.3	The standard atmosphere, Relation Between Geopotential and Geometric Altitudes		
2	**Basic Aerodynamics**		**12**	**CO2**
	2.1	Streamlines, steady fluid motion, incompressible flow, Bernoulli's equation, Mach number, Pressure and air speed measurement, Boundary layer, Reynolds number, Laminar and Turbulent flow.		
	2.2	Airfoils and Wings: Pressure coefficient and lift calculation, Critical Match number, Wave drag, Finite wings, Included drag, Swept wings,		
3	**Elements of Airplane Performance**		**12**	**CO3**
	3.1	Equations of Motion, Thrust Required for Level, Unaccelerated Flight, Steady level flight, Altitude effects, Absolute ceiling, Steady climbing flight, Energy methods, Range and Endurance		
	3.2	Take-off Performance, Landing Performance, Turning Flight and the $V - n$ Diagram, Uninhabited Aerial Vehicles (UAVs), Micro Air Vehicles		
4	**Principles of Stability and Control**		**08**	**CO4**
	4.1	Definition of Stability and Control, Criteria for Longitudinal Static Stability		
	4.2	The Development of Flight Controls		
5	**Aircraft Propulsion**		**08**	**CO5**
	5.1	Propeller, Reciprocating Engine, Jet Propulsion, Turbojet Engine, Turbofan Engine		
	5.2	Ramjet Engine, Rocket Engine, Rocket Propellants		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	J. D. Anderson	*Introduction to Flight*	Mc Graw Hill	6th Edition , 2015
2.	J. D. Anderson	*Fundamentals of Aerodynamics*	Mc Graw Hill	5th Edition, 2010
3.	Ronald D. Flack	*Fundamentals of Jet Propulsion with Applications*	Cambridge	1st Edition, 2011
4.	J. D. Anderson	*Aircraft Performance and Design*	Mc Graw Hill	5th Edition, 2012
5.	Robert C. Nelson	*Flight Stability and Automatic Control*	Mc Graw Hill	2nd Edition, 2017

Course Code	Course Title			
216M71C402	Aircraft Propulsion			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites:

- **Thermodynamics, Fluid Mechanics, Heat Transfer**

Course Objectives:

This course deals with the gas power cycles for aircraft propulsion. Different types of aircraft engines, their parts and their performance parameters are discussed. Further, different parts of aircraft engines like compressor, turbines, combustor and nozzle are discussed in detail.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand history and working of different aircraft propulsion system

CO2: Analyse performance of gas turbine engine using thermodynamic cycles

CO3: Design inlet duct and nozzles for aircraft engine

CO4: Analyse performance of compressor , turbine and combustion system used in aircraft engine

CO5: Understand sizing and matching of aircraft engine components

Module No.	Unit No.	Topics	Hrs.	CO
1	**Introduction to aircraft Propulsion:**		04	CO1
	1.1	History of air breathing jet engine, Gas turbine engine development for aircraft propulsion, How jet engine makes thrust: conceptual basis.		
	1.2	Jet engine performance parameters: Thrust, SFC, efficiencies.		
	1.3	Simple turbojet engine, turbojet engine with afterburner, turbofan engine, turboprop engine, single and multi-spool gas turbine based propulsive devices		
2	**Gas Turbine Engine thermodynamic analysis**		10	CO2
	2.1	Ideal and real Brayton cycle, jet engine cycles for aircraft propulsion, cycle component and component performance: intake, compressor, combustion chamber turbine, afterburner and nozzle		
	2.2	Analysis of turbojet cycle with afterburner, Analysis of turbofan engine cycle, Analysis of turboprop engine		
3	**Aircraft engine Inlets & Nozzles**		08	CO3
	3.1	Requirements of an Intake for Transport and Military Aircraft. Subsonic Intakes, Transonic and Supersonic Intakes. Axi-symmetric and Asymmetric Intakes. Aircraft Intake design considerations.		
	3.2	Theory of isentropic flow through nozzles, Nozzle design considerations: fixed and variable geometry nozzle, nozzle efficiency, nozzle pressure ratio, convergent nozzle and convergent divergent nozzle, Nozzle cooling, thrust reverser and thrust vectoring		
4	**Compressor, turbine and Combustion system**		12	CO4
	4.1	**Axial and centrifugal Compressors:** A simple two dimensional analytical model, 2-D (cascade) analysis; Loss and Blade performance estimation, Simple Free Vortex theory, Single and Multi-stage Axial compressor characteristics. Elements of centrifugal compressor, Inlet Duct; Impeller; Slip factor, Centrifugal Compressor Characteristics: Surging and Choking. Efficiency and performance.		
	4.2	**Axial and Radial flow turbines** Introduction, Turbine stage : Turbine Blade 2-D (cascade) analysis; Work Done, Degree of Reaction, Losses and		

Module No.	Unit No.	Topics	Hrs.	CO
		Efficiency, Multi-staging of Turbine, Turbine Cooling Technology, Radial Turbine Aerodynamics and Thermodynamics, Losses in radial turbine and efficiency		
	4.3	Introduction: Various types of combustion chambers in aircraft engines, Combustion Mechanism and Important Combustion parameters, Development of a practical combustion system and design parameters, Pressure losses ; Combustion efficiency; Combustion intensity, Combustion Stability limits and Instability, Fuels and their properties and Fuel injection systems, afterburner.		
5	**Engine Installed Performance, Sizing & Matching and Ramjets, Pulsejets and Scramjets**		**10**	**CO5**
	5.1	Introduction to engine component sizing, Installed Performance of Engine, Engine - Design Point Operations, Engine Off Design Operations, Single Shaft Engine, Two-Shaft: Turbojet & Turboprop, Turbo-shaft Engines. The Engine Operating Lines, Operational details of multiple shaft engines, Aircraft Engine component matching; Intake-Compressor matching, Turbine-Nozzle matching, Compressor-Turbine matching: Single and Multi-spool. Free Turbine and Unducted Fan / Propeller matching		
	5.2	**Ramjets, Pulsejets and Scramjets** Use of Ramjets and Pulsejets in Aircraft propulsion, Operating Principles, Thermodynamic Cycle, Performance Parameters, Design and Performance of a Ramjet, Flow in Diffusers, Combustors and Nozzles, Principles of Scramjet Engines		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Ronald D. Flack	*Fundamentals of Jet Propulsion with Applications*	Cambridge	1st Edition, 2011
2.	Saeed Farokhi	*Aircraft Propulsion*	John Willey & Sons, USA	2nd Edition, 2014
3.	Bhaskar Roy	*Aircraft propulsion*	Elsevier	2011
4.	V. Ganesan	*Gas Turbines*	Tata McGraw-Hill	3rd Edition, 2010
5.	Nicholas Cumpsty and Andrew Heyes	*Jet Propulsion: A Simple Guide to the Aerodynamics and Thermodynamic Design and Performance of Jet Engines*	Cambridge University press	3rd Edition, 2015

Course Code	Course Title			
216M71C501	Flight Mechanics			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites:

- Fluid Mechanics
- Basic Aerodynamics

Course Objectives:

1. To gain a fundamentals understanding of all the aspects of flight mechanics.
2. To understand basics of stability and controls of flight.
3. To apply Dynamics equation to flight.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Summaries the history and development of flight, as well as future trends in technology, and contemporary issues

CO2: Identify basic longitudinal stability and controls in flight

CO3: Identify basic lateral-direction stability and controls in flight

CO4: Apply Dynamics equation for flight stability

CO5: Understand different air motions modes in flight

Module No.	Unit No.	Topic	Hrs.	CO
1	**Introduction to Flight Mechanics**		**06**	**CO1**
	1.1	History of Flight		
	1.2	Equilibrium in Flight Mechanics, static stability in Flight		
	1.3	Introduction to Controls in Flight Mechanics		
2	**Longitudinal Stability and Control:**		**10**	**CO2**
	2.1	Definition of Stability and Control, Criteria for Longitudinal Static Stability, Longitudinal equilibrium and static stability, stick fixed neutral point, all moving horizontal tail OR elevator as longitudinal control.		
	2.2	Trimmed lift curve slope and advantages of reduced/negative longitudinal static stability. Hinge moments, reversible control, stick force, and trim tab. Stick free static stability, stick-free neutral point.		
3	**Lateral-directional Stability and Control**		**09**	**CO3**
	3.1	Directional equilibrium, stability and rudder as control.		
	3.2	Lateral stability, dihedral angle, aileron control.		
4	**Dynamical Equations**		**10**	**CO4**
	4.1	Euler angles. Body angular velocity and Euler angle rates. Body-fixed axis, wind axis, stability axes. Equations of motion of rigid aircraft in body fixed axes.		
	4.2	Stability derivatives. Steady flight and perturbed flight leading to linearised equations of motion.		
5	**Aircraft Motion Modes:**		**10**	**CO5**
	5.1	Decoupling of longitudinal dynamics and lateral-directional dynamics. Short period and phugoid modes of longitudinal dynamics.		
	5.2	Dutch roll, spiral and roll subsidence modes of lateral-directional dynamics. Effect of winds. Flight simulation.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	J. D. Anderson	*Introduction to Flight*	Mc Graw Hill, India	6th Edition, 2015
2.	J. D. Anderson	*Fundamentals of Aerodynamics*	Mc Graw Hill, India	5th Edition, 2010
3.	Ronald D. Flack	*Fundamentals of Jet Propulsion with Applications*	Cambridge, India	1st Edition, 2011
4.	Nelson, R. C.	*Flight Stability and Automatic Control,*	Mc Graw Hill Indian edition, India	2nd Edition, 2017
5.	Nandan K. Sinha N. AnanthKrishnana	*Elementary Flight Dynamics*	CRC Press, India	Edition, 2015

Course Code	Course Title			
216M71C601	Aerodynamics			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	50	--	100

Course prerequisites:

- **Basic Thermodynamics**
- **Fluid Mechanics**

Course Objectives:

This course builds on the student's background in Fluid Mechanics to deal primarily with internal and external flows (low-speed and high speed) relevant to aerospace applications. Course enables to analyse flows past airfoils, wings as well as nozzles and diffusers which form the basic building blocks of an air plane.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand basic equations and aerodynamic forces used in aerodynamics

CO2: Analyse aerodynamic forces on body for Inviscid incompressible flow

CO3: Understand wing theory

CO4: Explain different theories and equations of compressible flow

CO5: Analyse aerodynamic forces on airfoil in high speed flow

Module No.	Unit No.	Topics	Hrs.	CO
1	**Introduction**		07	CO1
	1.1	Aerodynamic forces, moments and related coefficient, center of pressure, types of flow, Introduction to boundary layer, laminar and turbulent boundary layer.		
	1.2	conservation equations (mass, momentum and energy);		
	1.3	Streamlines, streak lines and path lines; angular velocity, vorticity and strain, Velocity potential and stream function		
2	**Inviscid Incompressible flow**		10	CO2
	2.1	Bernoulli's equation, low-speed wind tunnel flows; Governing equations and boundary conditions; Elementary flows (uniform, sources, sinks and vortex); ideal lifting flow past a circular cylinder, Kutta-Joukowski theorem and lift generation; source panel method for non-lifting flows; d'Alembert's paradox.		
	2.2	Incompressible flow over airfoils: Introduction; Kutta Condition; Thin airfoil theory (symmetric, cambered); Aerodynamic center; vortex panel method for lifting flows; qualitative aspects of viscous flow.		
3	**Finite wing theory**		06	CO3
	3.1	Introduction; Downwash and induced drag; Biot-Savart Law and Helmholtz's Theorems; Prandtl's lifting line theory; Numerical lifting-line method		
4	**Inviscid compressible flow**		12	CO4
	4.1	Introduction to Compressible flows (Inviscid): Thermodynamics review; Governing equations; Compressibility		
	4.2	Normal Shock, Oblique Shock and Expansion Waves: Basic relations; flow over wedges and cones; shock interactions; blunt body flow; Prandtl-Meyer expansion waves; qualitative picture of shock wave-boundary layer interaction		
	4.3	Quasi-one-dimensional flow through nozzles and diffusers.		
5	**Flow over subsonic and Supersonic airfoil**		10	CO5
	5.1	Introduction; Velocity potential equation and linearized form; Prandtl-Glauert correction; Improved corrections; Critical Mach number; Drag divergence Mach number		
	5.2	Supercritical airfoils and area rule, Linearized supersonic flow application to supersonic airfoil		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	J. D. Anderson	*Introduction to Flight*	Mc Graw Hill, India	6th Edition, 2015
2.	J. D. Anderson	*Fundamentals of Aerodynamics*	Mc Graw Hill, India	5th Edition, 2010
3.	Houghton E L & Carpenter E W	*Aerodynamics for Engineering students*	Butterworth Heinemann, UK	5th Edition, 2001
4.	John J. Bertin	*Aerodynamics for Engineers*	Pearson, India	6th Edition, 2013
5.	Mark Drela	*Flight vehicle Aerodynamics*	MIT Press, USA	2014

<table>
<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td>216M71L601</td><td colspan="6">Aerodynamics Laboratory</td></tr>
<tr><td></td><td colspan="2">TH</td><td colspan="2">P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="2">--</td><td colspan="2">02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">--</td><td colspan="2">01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">TW</td><td rowspan="2">O</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>50</td><td>50</td><td>100</td></tr>
</table>

Term work will consist of laboratory experiment based on syllabus of course aerodynamics. Evaluation will be based on continuous assessment of their term work. Oral examination will be based on laboratory experiments.

List of experiments: Tentative topics for experiment is given bellow

1. Wind tunnel and their characteristics
2. Flow visualization over bluff and streamline body
3. Flow past bluff and streamlined body and measurement of pressure drag
4. Effect of shape on aerodynamic drag
5. Airfoil drag from a wake traverse
6. Boundary layer study on flat plate
7. Flow through nozzle subsonic incompressible flow (2D and 3D)
8. Flow through nozzle subsonic compressible flow (2D and 3D)

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M71P601</td><td colspan="5">Mini Project</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="3">--</td><td>04</td><td>--</td><td>04</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">--</td><td>02</td><td>--</td><td>02</td></tr>
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<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td colspan="2">100</td><td>100</td></tr>
</table>

Course Prerequisites:
All the courses offered under minor program

Course Outcomes:
At the end of successful completion of the course the student will be able to

CO1: Define the problem statement and develop a solution to solve real life problems in Aerospace Engineering

CO2: Implement and test the hardware/ software for defined problem

CO3: Analyse, interpret results, correspondingly modify the system to get the desired results

CO4: Demonstrate oral and written communication skills.

Term Work and Oral:

The mini project can be individual or a group project. Interdisciplinary projects are also permitted. Each project will be assigned one faculty member as a supervisor. There will be a continuous assessment and progress report of the project that needs to be maintained.

Course Code	Course Title			
216M71C701	Computational Fluid Dynamics			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	02	--	--	02
Credits Assigned	02	--	--	02

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	--	--	50

Course prerequisites:

- **Heat Transfer, Fluid dynamics, Numerical method.**

Course Objectives:

Earlier the study and practice of fluid dynamics involved the use of pure theory on one hand and pure experiment on the other hand. Computational fluid Dynamics is a new third approach in the study and development of the whole discipline of fluid dynamics. Objective is to study governing equation of fluid flow and boundary condition. Objective is also to study the grid generation and discretization methods to apply finite volume and finite difference methods to solve heat transfer and fluid flow problems.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand the application of CFD and working of commercial software.

CO2: Apply basics of fluid mechanics to derive the mathematical behaviors of fluid flow and boundary conditions.

CO3: Analyze the grid generation and discretization methods for CFD analysis.

CO4: Evaluate and solve the fluid flow and heat transfer problems using FVM method.

CO5: Apply modeling for turbulent flow and algorithm for pressure velocity coupling.

Module No.	Unit No.	Topics	Hrs.	CO
1	**Introduction:**		02	CO1
	1.1	Definition and overview of CFD, need, Advantages of CFD, Numerical vs Analytical vs Experimental		
	1.2	Applications of CFD, CFD methodology, grid independence, Verification and validation		
2	**Governing equations of mass, momentum and energy**		05	CO2
	2.1	Derivation, Discussion of physical meanings and presentation of forms particularly suitable to CFD		
	2.2	Boundary Conditions – Dirichlet, Neuman, Robbins, initial conditions, mathematical behavior of partial differential equations – Elliptic, parabolic & hyperbolic equations, impact on CFD		
3	**Discretization methods& Grid Formation**		08	CO3
	3.1	**Introduction to Discretization**- Finite Difference Method, Finite Volume Method, Finite Element Method. Consistency, stability, and numerical error in discritization.		
	3.2	**Finite Difference method** – Introduction to finite differences, difference equation, Solution of discretized equations, Direct methods and iterative methods, Tri Diagonal Matrix Algorithm, iterative convergence		
	3.3	**Introduction to Grid Generation**-Structured and Unstructured Grids, Structured and unstructured Grids: O-type, H-type, C-type of Structured Grid Generation, Mesh Adaptation.		
4	**FVM method**		10	CO4
	4.1	Finite volume method for diffusion problems (Conduction): **Steady state one dimensional** heat conduction with or without heat generation, types of boundary conditions. **Unsteady heat conduction**- Explicit, Crank-Nicolson, implicit schemes, One dimensional steady and unsteady heat conduction. **Fluid flow**-Method for discretization of compressible and incompressible Navier Stroke equations.		
	4.2	**Finite volume method for Advection-diffusion problems(Convection-conduction)**- One dimensional convection-diffusion problem. Central, first order upwind, hybrid etc.		
	4.3	**Properties of advection schemes-** Conservativeness, boundedness, transportiveness		

Module No.	Unit No.	Topics	Hrs.	CO
5	Turbulent modelling and algorithm		05	CO5
	5.1	**Turbulence Modelling** -Turbulence, its effect on governing equations, introduction to turbulence modelling –RANS, DNS, LES, k-ε, k-ω models.		
	5.2	**Solution algorithms**-Solution algorithms for pressure velocity coupling in steady flows: Staggered grids, SIMPLE, SIMPLER, SIMPLEC Algorithm		
		Total	30	

***This course is listed as one of the Departmental Elective course in T.Y. B. Tech. Semester-Vth under the category of Choice Based Courses. Hence those students who will be opting for Honor degree in Aerospace Engineering are not allowed to take this course as a departmental elective in Semester-Vth under the category of Choice Based Courses**

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition with Year of Publication
1.	Versteeg.H.K. , Malalasekera.W	*An introduction to computational fluid dynamics-The finite volume method*	Prentice Hall, US	2nd Edition, 2007
2.	Anderson, D.A., Tannehill, I.I., and Pletcher, R.H.	*Computational Fluid Mechanics and Heat Transfer*	Hemishphere Publishing Corporation, US	3rd Edition, 2012
3.	Niyogi P. ,Laha M.K., Chakrabarty S.K.	*Introduction to Computational Fluid Dynamics*	Pineridge Press Ltd. U.K.	1st Edition, 2005
4.	Patankar, S. V.	*Numerical Heat Transfer and Fluid Flow*	Special Indian Edition, Hemisphere, UK	1st Edition, 2017
5.	Ghoshdasdidar P. S.	*Computer Simulation of flow and heat transfer*	Tata McGraw-Hill Publishing Company Ltd., US	1st Edition, 1998

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M71L701</td><td colspan="5">Computational Fluid Dynamics Laboratory</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
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<tr><td>Credits Assigned</td><td colspan="2">--</td><td>01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>50</td><td>50</td></tr>
</table>

Term work will consist of tutorials (04)/simulated experiments (minimum 04) covering entire syllabus. Students will be graded based on continuous assessment of their term work. Practical examination will be based on laboratory experiments and entire syllabus of Computational Fluid Dynamics.

Assessment of these experiments will be done continuously based on designed rubrics

List of Experiments/tutorials:

1. Steady state heat transfer problems solutions (by using finite difference methods) of a discretized equation using direct/iterative method
2. Unsteady steady explicit/implicit method heat transfer problems solutions (by using finite difference methods) of a discretized equation using direct/iterative method.
3. Steady state convection diffusion problems solutions (by using finite volume method) of a discretized equation using direct/iterative method.
4. Unsteady steady state convection diffusion problems solutions (by using finite volume method) of a discretized equation using direct/iterative method.
5. Compressible/incompressible fluid flow problems solutions (by using finite volume method) using simulation software for internal flow (Laminar Pipe Flow, Modeling a mixing Elbow (2-D), Compressible Flow in a Nozzle).
6. Compressible/incompressible fluid flow problems solutions (by using finite volume method) using simulation software for external flow (Flat Plate Boundary Layer, Forced Convection over a Flat Plate, Steady Flow past a Cylinder, Unsteady Flow past a Cylinder, Flow Over an Airfoil, Flow past a Sphere).
7. Turbulent flow problem simulation using simulation software (Turbulent pipe flow).
8. Flow simulation over a rocket.
9. Supersonic Flow over a Wedge.
10. MATLAB Exercises.

Syllabus

Minor Programme in

Entrepreneurship

(Programme commenced from AY 2024-25)
Jointly Offered by Department of Electronics and Computer Engineering and Department of Mechanical Engineering

From
Academic Year 2024-25
(SVU-KJSCE 2.0)

(Approved by BOS dated 23-Apr-24)

Introduction:

Somaiya Vidyavihar University is introducing a Minor Degree programme in Entrepreneurship along with an engineering degree. Students pursuing a Major Degree in any Engineering programme can earn extra credits by choosing a Minor programme that complements the Major Degree he/she is pursuing. Minor Degree programmes in Entrepreneurship Develop an entrepreneurial mindset in student for a business and potential to identify the opportunities for growth in an organization.

This program will explore the various facets of entrepreneurship and small business ownership. Courses in this program will cover the logical steps that are part of organizing, managing and assuming the risks of starting a new business enterprise. Entrepreneurship program include various inputs to generate real value for customers. Operations and financial aspects for starting a new business will be addressed via planning and development of strategic business. This program develops the knowledge, skills and confidence to create opportunities from ideas and to evaluate them.

This program focuses on:

- Project based learning,
- Feasibility study of an opportunity
- Market/ industry attractiveness and customer segment analysis.

Trends towards globalization, crafting prototypes and manufacturing of product with rapid technological innovations create an even greater need for the Entrepreneurship program.

Program Objectives:

The objectives of this minor program are to produce graduates who:

- Understand the process of entrepreneurship
- Create framework for business idea and identify the business opportunities
- Capitalize the opportunity by feasible idea and strategic / operational plan
- Drive change with innovation in business operations and project management teams.
- Explore the business plan and focus on the entrepreneurial process and resources

Learning Outcomes (LOs) of the Minor Degree Program:

At the successful completion of this minor program an engineering graduate will be able to

LO1: Understand the basics of entrepreneurship and lean start-up with various managerial functions for successful business operations.

LO2: Design and develop the integrated systems that identify the opportunity, assess the opportunity and create the prototype.

LO3: Cultivate an entrepreneurial Mindset and skills necessary for change in societal, technological, and global environments

Eligibility Criteria:

- Students who have passed first year of engineering in Computer Science, Electronics, Electronics & Telecommunication Engineering, Information Technology and Mechanical Engineering.
- Students of other constituent colleges of SVU passed First Year of their degree program and having background of engineering skill and manufacturing processes.

Assessment Methods:

Tests, Mini projects, Case-Studies, Presentation/ Video making, Quiz, internships, study of research papers, Customer Interviews & surveys, Role play, etc.

Alternative Online Courses

- Suitable online courses such as NPTEL/MOOC etc. may be considered as an alternative to maximum one of the above mentioned stipulated courses. The permissible online courses will be announced at the appropriate time when this minor degree program will be in effect.

Minor Program: Entrepreneurship

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH–P–TUT	Total (Hrs.)	Credits Assigned TH–P–TUT	Total Credits	Semester of Major Degree
216M04C301	**Introduction to Entrepreneurship**	**3-0-2**	**5**	**3-0-1**	4	III
216M04C401	**Entrepreneurship Development – I** Ideation and Design Thinking	**3-0-2**	**5**	**3-0-1**	4	IV
216M04C501	**Entrepreneurship Development – II** Innovation and Rapid Prototyping	**3-0-2**	**5**	**3-0-1**	4	V
216M04C601	**Entrepreneurship Business Essentials**	**3-0-2**	**5**	**3-0-1**	4	VI
216M04P701	**Building business model** : design and Prototyping : New venture creation	**0-0-4**	**4**	**0-0-2**	2	VII
		Total Hours	**24**	**Credits**	**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme							
		Marks							
		CA		ESE	TW	O	P	P&O	Total
		ISE	IA						
216M04C301	**Introduction to Entrepreneurship**	30	20	-	50	25	--	--	125
216M04C401	**Entrepreneurship Development – I** Ideation and Design Thinking	30	20	-	50	25	--	--	125
216M04C501	**Entrepreneurship Development – II** Innovation and Rapid Prototyping	30	20	-	50	25	--	--	125
216M04C601	**Entrepreneurship Business Essentials**	30	20	-	50	25	--	--	125
216M04P701	**Building business model** : design and Prototyping : New venture creation	-	-	-	50	50	--	--	100
Total		**120**	**80**	**-**	**250**	**150**	**--**	**--**	**600**

<table>
<tr><th>Course Code</th><th colspan="8">Course Title</th></tr>
<tr><td>216M04C301</td><td colspan="8">Introduction to Entrepreneurship</td></tr>
<tr><td></td><td colspan="3">TH</td><td colspan="2">P</td><td colspan="2">TUT*</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="3">03</td><td colspan="2">--</td><td colspan="2">02</td><td>05</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">03</td><td colspan="2">--</td><td colspan="2">01</td><td>04</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="8">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">TW</td><td rowspan="2">O</td><td rowspan="2">P</td><td rowspan="2">P&O</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>-</td><td>50</td><td>25</td><td>--</td><td>--</td><td>125</td></tr>
</table>

Course prerequisites:

- **None**

Course Objectives:

The objectives of the course '**Introduction to Entrepreneurship**' are to provide knowledge on various aspects of the entrepreneurial venture creation process. It has been designed to address multidisciplinary audiences keeping following aim -

- Introduce basic concepts of entrepreneurship
- Explain the importance of entrepreneurs for economic growth
- Cultivate creativity and entrepreneurial initiatives
- Promoting the ideas for the expansion of business
- Focused on the entrepreneurial process and resources

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand the entrepreneurship scenario in India for entrepreneurial mindset
CO2: Learn how to start a start-up.
CO3: Pitch their ideas for business development
CO4: Create awareness to take their ideas to the prototype stage
CO5: Connect with Entrepreneurs from Interdisciplinary fields of engineering.

Module No.	Unit No.	Details	Hrs.	CO
1	**Evolution of Entrepreneurship**		**09**	**CO1**
	1.1	Macro ('wide-scale' perspective), social cultural and business, entrepreneurial venture (start-up or acquisition), Ecological entrepreneurship		
	1.2	Micro ('small-scale' perspective), entrepreneurial trait, pathways principle, strategic planning (market and resources), Self-efficacy, Elements of Entrepreneurial Expertise (Effectuation)		
	1.3	Interdisciplinary, Stage of economic development,		
2	**Entrepreneurial Mind-set**		**09**	**CO2**
	2.1	Entrepreneurial Mind-set and motivation, Necessity-driven, Opportunity-driven, Entrepreneurial cognition		
	2.2	Essentials of Entrepreneurship/Self-employment, Dark side of entrepreneurship, Entrepreneurial stress		
	2.3	Factor-driven, Efficiency-driven and Innovation-driven economies Entrepreneurial capabilities, Entrepreneurial life cycle		
3	**Entrepreneurship and Sustainable Development**		**09**	**CO3**
	3.1	Classification of entrepreneurship, Industrial entrepreneurship, sustainable entrepreneurship, De-growth entrepreneurship		
	3.2	Entrepreneurial ecology, Down-cycling and Up-cycling Opportunity in crisis		
	3.3	Specific risks, Reputation risks, Competition risks, Regulatory risks		
4	**Social and Ethical Entrepreneurship**		**09**	**CO4**
	4.1	Social (non-profit) innovators, Social Venture Network		
	4.2	Corporate social responsibility (CSR), Ecopreneurship, Triple bottom line (TBL): profit, people, and the planet		
	4.3	Entrepreneurial ethics, Ethical processes		
5	**Connect with Entrepreneurs**		**09**	**CO5**
	5.1	Introduction to Startup incubators and accelerators, Pathways into an entrepreneurial career		
	5.2	Invited Expert talks/guest sessions from multidisciplinary fields.		
	5.3	Orientation of campus companies and entrepreneurship related activities of Entrepreneurship-cell, Social entrepreneurship activities of E-Cell with Enactus		
		Total	**45**	

Term Work:
Term-Work will consist of Tutorials/Numerical, Presentations, Mini-projects and/or case studies. Students will be graded based on problem identification, entrepreneurial mindset and awareness from the course syllabus or any other pertinent area. Assessment will be done continuously based on designed rubrics:

Internal Assessment based on following assessment techniques

a. Creating a Website: The final exam in the class will consist of a website you have created for your business idea. This needs to be at least 5 pages and can be made free at Wix.com or weebly.com. The business idea and product or service needs to be clearly identified and created.
b. Create a business plan i.e. Business Model Canvas including Value Proposition Model
c. Customer Identification: interviewing and surveying
d. Pitching an idea: Video submission
   - The Elevator Pitch
   - Testing your Idea: Customer Interviews
   - Testing your Idea: Surveys
   - Finding your own personal entrepreneurial ecosystem
   - Understanding your beliefs about successful entrepreneurs
   - Interviewing an entrepreneur
e. Networking events for entrepreneurs
   - Who is it within your own personal circle who respects entrepreneurship
   - Business plan competitions
   - Entrepreneurship activities centre
   - Experiencing Entrepreneurship

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Robert D. Hisrich & V. Ramadani	Effective Entrepreneurial Management Strategy, Planning, Risk Management, and Organization	Springer International Publishing AG, Switzerland	2017
2.	Rajeev Roy	Entrepreneurship	OUP India;	3rd edition 2020
3.	Raj Shankar	Entrepreneurship: Theory And Practice	McGraw-Hill (TMH)	2016
4.	Prateek Jain	Start Your Own Enterprise: The Must Know-How Guide for an Entrepreneur	Cloudtail, India	2020
5.	Eric Ries	The Lean Startup: How Constant Innovation Creates Radically Successful	Cengage Learning Australia Pty Limited	4^{th} edition, 2016

Course Code	Course Title						
216M04C401	Entrepreneurship Development – I Ideation and Design Thinking						
	TH		P		TUT		Total
Teaching Scheme (Hrs.)	03		--		02		05
Credits Assigned	03		--		01		04
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	-	50	25	--	--	125

Course prerequisites:

- **None**

Course Objectives:

- Understanding basic concepts in the area of entrepreneurship,
- Understanding the role and importance of entrepreneurship for economic development,
- Developing personal creativity and entrepreneurial initiative,
- Adopting of the key steps in the elaboration of business idea,
- Understanding the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand the Pathways to experience entrepreneurship and how a franchise works
CO2: Identify the market opportunity
CO3: Evaluate the effectiveness of different entrepreneurial strategies
CO4: Examine the importance of creativity in process of developing business
CO5: Describe the change for building business model and creating start-up

Module No.	Unit No.	Topics	Hrs.	CO
1	**Entrepreneurship Pathways**		**09**	**CO1**
	1.1	Bootstrapping : Bootstrapping options for product development, business development, minimize the need for capital, meet the need for capital		
	1.2	Business Ownership: Advantages and disadvantages of: sole proprietorship, partnership, and corporation. Types of franchising: how a franchise works, advantages and disadvantages of franchising		
	1.3	Social enterprises: models of social enterprises, development cycle, entrepreneur model, market intermediary model, employment model		
2	**Design Thinking and opportunity**		**09**	**CO2**
	2.1	Introduction to design thinking, examples of design thinking process, Inspiration- Identify a problem, practice observing, identifying extremes, interviewing process, immersive empathy, Human-cantered ideas. Understanding how to get effective customer feedback (using Lean Launchpad method)		
	2.2	Opportunity identification: Learn proven techniques for identifying the opportunity, assessing the opportunity, opportunities and uncertainty, opportunities as a source of innovation.		
	2.3	Importance of the idea, assessing opportunities, idea to opportunity. Design thinking in action – Case study, Generating Concepts: Basic methods of concept generation, Advanced methods of concept generation, Inventive problem solving, Concept variants		
3	**Ideation and creativity**		**09**	**CO3**
	3.1	Ideation- Desirability (human), Viability (Business), Feasibility (Technical) Sources of innovative ideas : Trends, Unexpected occurrences, Incongruities, Process needs, Industry and market changes		
	3.2	Market-based opportunity : competition model, innovation model, alertness model and social need model		
	3.3	Entrepreneurial imagination and creativity: Lateral thinking, vertical thinking, arenas of creativity		
4	**Process of Entrepreneurship - Inspiration**		**09**	**CO4**
	4.1	Defining the Project Challenge: Ideation process - Process of Developing Entrepreneur, - Measuring entrepreneurship quotient, - Enterprise Launching & Resources, - Steps of setting new Enterprise, - Sensing Business opportunity & Identifying Product		
	4.2	Ideation Examples: Practicing Ideation tools - Disciplined entrepreneurship – step by step approach to		

Module No.	Unit No.	Topics	Hrs.	CO
		create successful start-up		
	4.3	Understanding User Needs: - Who is your customer? - What can you do for your customer? - How does your customer acquire your product? Generating Ideas with Individuals and Groups - How do you make money off your product? - How do you design and build your product? - How do you scale your business? Planning: - Consumer Centric Decisions - Talent Management and Development - Competitive Analysis		
5	**Analysis and Business Plan**		**09**	**CO4**
	5.1	Life Cycle Analysis: product life cycles, life cycle of a manufacturing system, reduce, reuse, recycle; waste vs value approach, remanufacture and disposal , tools for LCA		
	5.2	Pitch an idea – Identify the problem to be solved - The Lean Approach - Minimum Viable Products (MVPs) - Hypothesis and Preliminary Experiments - The Pivot - The Art of the Pitch- Venture perspective		
	5.3	Building the business plan : - Business Canvas model: Contents, Unique selling features, preparation and guidelines; Elevator pitch, Iterate using lean start-up Case studies		
		Total	**45**	

Term Work: Term-Work will consist of Tutorials/Numerical, Presentations, Mini-projects and/or case studies. Students will be graded based on problem identification, personal creativity and entrepreneurial initiative from the course syllabus or any other pertinent area. Assessment will be done continuously based on designed rubrics:

- Case study on Entrepreneurship Pathways
- Case study on successful Entrepreneurs from India/ Global
- Case study of Failure in entrepreneurship/business development
- Visit to E cell/ Incubation centres
- Interview and report on meeting with an Entrepreneur
- Development of Business canvas model for a start-up idea
- Internship/Case study on Ideation process (Experiential Learning) : Every year a new theme can be given (agriculture/ rural development/ medical/ water resource and management / defence/ surveillance/ transportation Disaster Management, Metropolitan Development, Sustainable Development for Rural Areas, etc.)

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Ramadani, Veland (et al.)	Organizational Mindset of Entrepreneurship	Springer Nature Switzerland	2020
2.	Marc Dollinger	Entrepreneurship: Strategies and Resources	Prentice Hall	3rd Edition, 2015
3.	Khanka. S.S	Entrepreneurship Development	Institute of India, Ahmadabad	1986.
4.	Peter Thiel	Zero to One: Notes on Start Ups, or How to Build the Future	Cloudtail, India	2014.
5.	Mathew J Manimala	Entreprenuership theory at cross roads: paradigms and praxis	Dream tech	2nd Edition, 2005.

Course Code	Course Title							
216M04C501	Entrepreneurship Development – II Innovation and Rapid Prototyping							
	TH			P		TUT		Total
Teaching Scheme (Hrs.)	03			--		02		05
Credits Assigned	03			--		01		04
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	-	50	25	--	--	125

Course prerequisites:

- **None**

Course Objectives:

- Understanding basic concepts in the area of entrepreneurship,
- Understanding the role and importance of entrepreneurship for economic development,
- Developing personal creativity and entrepreneurial initiative,
- Adopting of the key steps in the elaboration of business idea,
- Understanding the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand the process to test, validate and prototype the idea
CO2: Know the process of material selection and prototyping tools
CO3: Evaluate the effectiveness of entrepreneurial strategies and eco system
CO4: Understand the importance of rapid prototyping
CO5: Describe the process for business plan and marketing

Module No.	Unit No.	Topics	Hrs.	CO
1	**Design prototyping**		**09**	**CO1**
	1.1	Physical prototypes and experimentation: Opportunity evaluation, Innovation by Design, Prototyping essentials, Types of prototypes, Rapid prototyping techniques, Design of experiments, Statistical analysis of experiments.		
	1.2	Know how to test, validate and prototype your idea Prototyping Phases: Understand/observe; Visualize/Realize (Storyboarding of characters using potential idea; Brainstorming) Evaluating/Refining (Concurrent engineering, Design aesthetics) Implement - (detailed engineering; manufacturing liaison; Regulatory approvals), • Paper Prototype • Story board • Mock-up - Creating a Prototype: Physical Goods - Creating a Prototype: Software - Creating a Prototype: Services - Implementation- prototype into practice Control, Compare, Evaluate		
	1.3	The Importance of the Founding Team - Goals and Motivations - Founder's Agreements - Hiring Key Management - Finding Technical Resources - Allocating Equity among Team Members		
2	**Process of Testing**		**09**	**CO2**
	2.1	**Creativity in Design and Materials selection** - Mechanism and Visualization - Material Selection and Its Behavioral Analysis. - Product Modeling and Product Assembly		
	2.2	- Prototyping tools - Gathering Feedback - Iteration process		
	2.3	- DFM (Design for Manufacture) / testing / clinical trials, Deconstruction of system (Re-Engineering)		
3	**Information Design**		**09**	**CO3**
	3.1	- Wireframes & Mock-ups		
	3.2	- Building business model, Entrepreneurial eco system,		
	3.3	- Timing/Market analysis with reference to the timing, Customer discovery, Validation		
4	**Form to thinking (Rapid Prototyping)**		**09**	**CO4**
	4.1	- Functional Prototype - Experience Prototype		
	4.2	Desirability, Business viability and Feasibility analysis and Final presentations by teams		

Module No.	Unit No.	Topics	Hrs.	CO
	4.3	Designing Experiments		
5	**Process of creating a Start-up: Prototype**		**09**	**CO5**
	5.1	- Create the minimum value product (MVP) and prototype		
	5.2	- Interface Prototyping Techniques, Universal Design, Design for Different Contexts, Interaction Design, Heuristic Evaluation		
	5.3	- Entrepreneurial Marketing: Market segmentation		
		Total	**45**	

Term Work: Term-Work will consist of Tutorials/Numerical, Presentations, Mini-projects and/or case studies. Students will be graded based on problem identification, prototyping phases, material selection and creating functional Prototype from the course syllabus or any other pertinent area. Assessment will be done continuously based on designed rubrics:

- Innovative ideas, Product Development
- Initiating entrepreneurial ventures
- Basic protocols of industrial design
- Design thinking and innovation
- Brain Storming, Generic Phases of the Design
- Configuration Design
- Product Assembly and PLC
- Concurrent Engineering
- Growth, Modernization & Expansion of Enterprise,

Recommended Book:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Kathryn McElroy	Prototyping for Designers	O'Reilly Media, Inc	2016
2.	Manoj Kumar Lal	Knowledge Driven Development: Bridging Waterfall and Agile Methodologies	Cambridge IISc Series	2018
3.	Helen Sharp, Jennifer Preece, Yvonne Rogers	Interaction Design	Wiley Student Edition	5th Edition, 2019
4.	Clive L. Dym, Patrick Little	“Engineering Design: A Project-based Introduction”	John Wiley & Sons	3rd Edition, 2009
5.	Paul Degarmo, Black and Kohsher	Materials and processes in Manufacturing	Wiley Student Edition	9th Edition- 2005

Course Code	Course Title							
216M04C601	Entrepreneurship Business Essentials							
	TH				P		TUT	Total
Teaching Scheme (Hrs.)	03				--		02	05
Credits Assigned	03				--		01	04
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	-	50	25	--	--	125

Course Prerequisite:

- **None**

Course Objectives:

The objective of this course is: To introduce the basic concepts in finance, supply chain management as well as strategies and practice, and examines important managerial issues. To introduces the analysis, design, control, and operation of entrepreneurship program

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Know the government incentives and policy for entrepreneurship development
CO2: Identifying the sources of finance and manage the cash flow
CO3: Analyse the importance of facility planning , supply chain operations and Networks
CO4: Understand the role of functional planning and inventory management
CO5: Maintain the business relations and know the legal aspects of business

Module No.	Unit No.	Topics	Hrs.	CO
1	**Strategic planning and Finance management**		**09**	**CO1**
	1.1	**-** Importance of strategic management to a (small) business; - Understanding competitive advantages; Funding new ventures - bootstrapping, crowd sourcing,		
	1.2	Steps in the strategic planning process; - Basic strategies: low-cost, differentiation, and focus; - Balanced scorecard in the planning process.		
	1.3	Government incentives for entrepreneurship: Incubation, acceleration, Start-up policies, Leadership Roles for Making and Implementing Strategic Plans,		
2	**Accounting and Finance**		**09**	**CO2**
	2.1	- Understanding capital requirements; - identifying the sources of finance; - angel investing and venture finance;		
	2.2	- managing cash flow; - preparation of financial reports, - cost benefit analysis, discounted cash flow, internal rate of return and net present value methods.		
	2.3	- Working capital management, - Preparation of balance sheets and assessment of economic viability, role of NABARD, SIDBI and SEBI in finance, tax incentives, GST and taxation.		
3	**Facility Planning**		**09**	**CO3**
	3.1	**Network design**: Supply chain design frame work, global supply chain design, Regional facility location		
	3.2	**Transportation and warehousing**: Drivers of Transportation decision, Forms of transport, Modes of transport and their performance measure. Trade based transportation network design, Genetic transportation structure, realization of Economies of scale in transportation Warehouse management system, 3PL and 4PL.		
4	**Functional Planning**		**09**	**CO4**
	4.1	**Inventory Management:** Role, function and types of inventory, Material classification, Inventory models- Deterministic and Stochastic, Inventory policies and Aggregate planning.		
	4.2	**Demand forecasting**: Roles, characteristics, components of forecast and forecasting methods and their Comparative studies, measure of forecast error.		
5	**Management of Business Relations**		**09**	**CO5**
	5.1	Business relations: Need, Importance, BRM competencies Business Relations: Principles, steps, Trends, impact of		

Module No.	Unit No.	Topics	Hrs.	CO
		communication.		
	5.2	Marketing concept and evolution: Market Survey & Demand Analysis, Problems in the world of business- Technology shifts, Shifting demographics, Market shifts , Supplier, Investors and Community Relationship Management		
	5.3	Legal Challenges for Entrepreneurial Ventures: Legal aspects of business (IPR, GST, Labour law), HR Management		
		Total	**45**	

Term Work:

Term-Work will consist of Tutorials/Numerical, Presentations, Mini-projects and/or case studies. Students will be graded based on finance management, strategic planning, and facility planning and functional planning from the course syllabus or any other pertinent area. Assessment will be done continuously based on designed rubrics:

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Prasanna Chandra	Projects: Planning, Analysis, Selection, Financing, Implementation and Review	Tata McGraw-Hill, India	9th Edition, 2019
2.	Panneer Selvam, R	Engineering Economics	Prentice Hall of India Ltd, New Delhi	2001
3.	David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi	Designing and Managing the Supply Chain: Concepts, Strategies, and Cases	Tata McGraw-Hill, India	First Edition, 2005
4.	Truett & Truett	Managerial economics- Analysis, problems & cases	Wiley India	Eighth Edition, 2004
5.	Robbie Wheeler	business relation management	Independently Published	2019

Course Code	Course Title

<table>
<tr><td>216M04P701</td><td colspan="8">Building Business Model
: Design and Prototyping
: New Venture Creation</td></tr>
<tr><td></td><td colspan="3">TH</td><td colspan="2">P</td><td colspan="2">TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="3">00</td><td colspan="2">--</td><td colspan="2">04</td><td>04</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">00</td><td colspan="2">--</td><td colspan="2">02</td><td>02</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="8">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">TW</td><td rowspan="2">O</td><td rowspan="2">P</td><td rowspan="2">P&O</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>50</td><td>50</td><td>--</td><td>--</td><td>100</td></tr>
</table>

Term Work:

The term work shall comprise of mini projects, internship and/or case studies. Mini-projects are an important part of content delivery in the program of Entrepreneurship.

- Internship/ Case study on Ideation process (Experiential Learning)
- Mini-Project topics may be from the course syllabus or any other pertinent area
- The. Students will be graded based on continuous assessment of their work of Internship/ Case study/ Mini-Project based on New Venture Creation (Experiential Learning).

Every year a new theme can be given i.e.

- Agriculture and Rural Development
- Medical and Health Care
- Water resource and management
- Supply Chain Management
- Transportation
- Disaster Management
- Metropolitan (Urban) Development,
- Sustainable Development etc.

A few examples of mini-projects are as under:

1. Planning and designing of physical facilities
2. Designing of scheme for a rural development
3. Family business and entrepreneurship
4. Designing a supply chain for a given product or service
5. Preparing feasibility report to start a firm
6. Green supply chain initiatives and challenges (Industry case study)
7. Technology and innovation for transparency in organization (IoT, Blockchain)
8. Sectors like; Beverages, Luxury goods and services, power & energy, retail services, sports goods, healthy food, wellness products and services, transportation and logistics, travel and tourism, climate change. Social welfare etc.

Some area of case study and venture creation:

- Product design and Prototyping,
- Basic prototype of innovative product
- Create a your website to sell your idea/product/service
- In Start-up Incubator to facilitates ideas / projects / start-ups and helps to move fast
- New venture creation, Start selling the idea and negotiation exercises
- Business plan and pitch presentation, Create the Business Model Canvas
- Minimum viable product
- Register a business, launch your business

Recommended Books:

Sr. No.	**Name/s of Author/s**	**Title of Book**	**Name of Publisher with country**	**Edition and Year of Publication**
1.	Tom Kelley and Jonathan Littman	*The Ten Faces of Innovation*	Profile Books;	2016
2.	Tim Brown	Change by Design	Harper Business	2009
3.	Ken Colwell	Starting a Business Quick Start Guide	ClydeBank Media LLC;	2019
4.	Ries, Trout, Kotler	*Positioning: the battle for your mind*	Tata Mcgraw Hill, India	2011
5.	Don Norman	*The Design of Everyday Things*	Ingram Publisher services us	2013

Syllabus

Minor Program on

Industrial Engineering and Management

(Offered by Department of Mechanical Engineering)

From

Academic Year 2024 – 25

(Revision 2)

(Approved by Expert Board Meeting dated April 19, 2024)

K. J. Somaiya College of Engineering, Mumbai-77

(A Constituent College of Somaiya Vidyavihar University)

It is notified for information of all concerned that the Expert Board at its meeting held on April 19, 2024 the syllabus of **Minor Degree Program in Industrial Engineering and Management** and the same be brought into force from Academic Year 2024-25 with immediate effect.

Date: ______________ HOD Mech

Introduction

Industrial engineering and management is a combination of the physical, mathematical and social sciences to design efficient manufacturing and service systems that integrate people, equipment and the information. Advancements in the areas of automation, management information systems and the process quality over the past century have revolutionized the field of manufacturing. This has greatly improved the quality of life. Trends towards globalization, increased complexity and rapid technological innovations create an even greater need for the discipline of industrial engineering and management. Some of the sub-specialties in this field are operations research, systems engineering, manufacturing engineering, supply chain management, ergonomics or human factors engineering, safety engineering and the management science etc.

Project Work

Mini-projects are an important part of content delivery in the field of Industrial Engineering and Management. A few examples of mini-projects are as under:

1. Planning and designing of physical facilities
2. Designing of incentive scheme for a production shop
3. Family business and entrepreneurship
4. Designing a supply chain for a given product or service
5. Preparing feasibility report to start a firm
6. Use of hybrid MCDM methods for performance improvement of a system
7. Analysis of enablers and barriers to Industry 4.0
8. MCDM techniques for decision making in medium size enterprises
9. Supply Chain Analytics (Supply Chain 4.0)
10. Supply chain analysis (Barriers/Models/SME challenges)
11. Green supply chain initiatives and challenges (Industry case study)
12. Technology and innovation for transparency in organization (IoT, Blockchain)

Alternative Online Courses

Suitable online courses such as NPTEL/MOOC etc. may be considered as an alternative to maximum one of the abovementioned stipulated courses. The permissible online courses will be announced at the appropriate time when this minor degree program will be in effect.

Eligibility Criteria:

Students who have passed first year of engineering in Electronics & Telecommunication Engineering, Computer Science, Information Technology and Electronics Engineering.

Assessment Methods:

Tests, quiz, mini-projects, presentations, study of research articles, etc.

Prof. Prashant Jain
Programme Coordinator

Dr. Ramesh Lekurwale
Head of the Department

Program Objectives:

The objectives of this minor program are to produce graduates who:

- Have knowledge on theories and principles of modern management and application of the same in private and public sector.
- Endeavour to design, develop and implement the integrated systems that include people, equipment, material, information and the environment.
- Undertake the challenges for contemporary professional practices and be able to adapt and solve the increasingly complex problems faced by industry.
- Understand the process of entrepreneurship development and effectively manage business operations and project management teams.

Vision

To become a program of world repute in the field of Mechanical Engineering, known for an ambience conducive to value based multifarious development of students, enabling them face technological challenges for service of the mankind.

Mission

- To impart skills and expertise in design, manufacturing and thermal areas of mechanical engineering that is the backbone of industry, so that the students thrive as successful engineers.
- To provide an opportunity to create, interpret, apply and disseminate knowledge to improve the quality of life.

Learning Outcomes (LOs) of the Minor Degree Program:

At the successful completion of this minor program an engineering graduate will be able to

LO1: Understand the basics of management and the various managerial functions for successful business operations.

LO2: Design and develop the integrated systems that include the various organizational resources.

LO3: Develop skills necessary to adapt to change in societal, technological, and global environments.

Acronyms used in syllabus document	
Acronym	**Definition**
CA	Continuous Assessment
ESE	End Semester Exam
IA	Internal Assessment
O	Oral
P	Practical
P&O	Practical and Oral
TH	Theory
TUT	Tutorial
TW	Term work
ISE	In-semester Examination
CO	Course Outcome

Acronyms used in Course code e.g. 216M14C301

Position of Digit	Acronym	Definition
1	**2**	Second revision SUV KJSCE 2023
2	**16**	KJSCE
3	**M**	Minor Degree Program
4	**14**	Industrial Engineering and Management
5	**C**	Core Course
	L	Laboratory Course
	T	Tutorial
	P	Project Based Course
6	**1/2/3/4**	Semester Number
7	**01/02/03--**	Course Number

Table of Contents:

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH–P–TUT	Total (Hrs.)	Credits Assigned TH–P–TUT	Total Credits	Semester of Major Degree
216M14C301	Industrial Engineering and Management	3-0-2	5	3-0-1	4	III
216M14C401	Organizational Behaviour	3-0-2	5	3-0-1	4	IV
216M14C501	Supply Chain Management	3-0-2	5	3-0-1	4	V
216M14C601	Operations Research	3-0-2	5	3-0-1	4	VI
216M14C701	Entrepreneurship Development	0-0-4	4	0-0-2	2	VII
		Total Hours	**24**	**Credits**	**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme				
		Marks				
		CA		ESE	LAB/TUT CA	Total
		ISE	IA			
216M14C301	Industrial Engineering and Management	30	20	-	75	125
216M14C401	Organizational Behaviour	30	20	-	75	125
216M14C501	Supply Chain Management	30	20	-	75	125
216M14C601	Operations Research	30	20	-	75	125
216M14C701	Entrepreneurship Development	-	-	-	100	100
Total		**120**	**80**	**-**	**400**	**600**

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M14C301</td><td colspan="5">Industrial Engineering and Management</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT*</td><td>Total</td></tr>
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<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>-</td><td>75</td><td>125</td></tr>
</table>

Course prerequisites:

- **None**

Course Objectives:

The objectives of the course 'Industrial Engineering and Management' are to produce graduates who:

- Design, develop, implement, and improve integrated systems that include people, material, information, equipment, and environment.
- Endeavour to meet the challenges for contemporary professional practices and be able to adapt and solve the increasingly complex problems faced by industry.
- Effectively manage business operations and projects through necessary analysis and synthesis.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand the basics of management science.
CO2: Understand the organization and its process.
CO3: Understand the basics of industrial engineering.
CO4: Comprehend the importance of work study and design of work systems.
CO5: Apply the principles of facility design and production planning.

Module No.	Unit No.	Topics	Hrs.	CO
1	**Management and Managerial Planning**		**09**	**CO1**
	1.1	**Basics of Management** Definition, characteristics, scope and functional areas, evolution of management thoughts, managerial roles and skills, management and administration, manager vs entrepreneur, levels of management.		
	1.2	**Managerial Planning** Nature and purpose of planning, planning process, types of planning, objectives, setting objectives, policies, planning premises, planning tools and techniques, decision making steps and process, strategic management		
2	**Organizing Function**		**09**	**CO2**
	2.1	**Introduction to Organization** Nature and purpose, formal and informal organization, organization chart, organization structure, types, line and staff authority, departmentalization, dual reporting system.		
	2.2	**Process of Organization** Delegation of authority, centralization and decentralization of authority and responsibility, span of control, management by objectives (MBO) and management by exception (MBE)		
3	**Industrial and Productivity Engineering**		**09**	**CO3**
	3.1	**Industrial Engineering** Definition, multidisciplinary nature of industrial engineering, history and contribution, objectives and techniques of industrial engineering, recent developments in industrial engineering, TQM, 5S, BPR, JIT, Kaizen etc.		
	3.2	**Productivity Engineering** Definition and concept of productivity, productivity, efficiency and effectiveness, types of productivity, productivity measurement, factors influencing productivity and productivity improvement techniques.		
4	**Work System Design**		**09**	**CO4**
	4.1	**Work Study** Work content, method study, charts and diagrams, principles of motion economy, micro-motion and memo-motion study. Work measurement - stop watch time study, work sampling, standard data, PMTS and MOST.		
	4.2	**Ergonomics** Definition and scope, ergonomics and the disciplines of anatomy, physiology and psychology. Building blocks of ergonomics such as anthropometry and biomechanics,		

Module No.	Unit No.	Topics	Hrs.	CO
		workplace design.		
5	**Facility Design and Production Planning**		**09**	**CO5**
	5.1	**Facility Design** Decisive factors for facility location, types of plant layout, computer aided layout design techniques, materials handling systems, group technology and cellular manufacturing.		
	5.2	**Production Planning** Jobs/projects, batch, mass/flow and continuous/process production methods. Capacity planning, aggregate planning, master production schedule, MRP, CRP, ERP and JIT.		
		Total	**45**	

Term Work:

Term-Work will consist of Tutorials covering the entire syllabus shall comprise of mini projects and/or case studies. The topics may be from the course syllabus or any other pertinent area. Students will be graded based on continuous assessment of their work.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	P.C.Tripathi, P.N.Reddy	*Principles of Management*	Tata McGraw Hill	1999
2.	Stephen P. Robbins & Mary Coulter	*Management,*	Prentice Hall (India) Pvt. Ltd.,	2009
3.	Harold Koontz & Heinz Weihrich	*Essentials of Management*	Tata McGraw Hill	1998
4.	O.P. Khanna	*Industrial Engineering and Management*	Dhanpat Rai Publications, New Delhi, India	1999
5.	Elwood S. Buffa, Rakesh K. Sarin,	*Modern Production & Operations Management*	John Wiley & Sons, India	8th edition, 2007
6.	ILO Geneva	*Introduction to Work Study.*	Oxford & IBH Publishing Co. Pvt. Ltd., England	2008
7.	James M. Apple	*Plant Layout and Material Handling*	John Wiley & Sons, New York	1978

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<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M14C401</td><td colspan="5">Organizational Behaviour</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="2">03</td><td>--</td><td>02</td><td>05</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">03</td><td>--</td><td>01</td><td>04</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>-</td><td>75</td><td>125</td></tr>
</table>

Course Prerequisites:

- **None**

Course Objectives:

The objectives of the course ‘Organizational Behaviour’ are to produce graduates who:

1. Are aware of the importance of human attitudes and behaviour in an organizational context.
2. Recognize the impact that the individuals, groups and the structure have on human behaviour.
3. Endeavour to use the organizational behaviour frame works, tools, and concepts in enhancing individual, group, and organizational effectiveness.
4. Enhance their abilities as a manager and a leader with the knowledge of organizational behaviour.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand organizational behaviour and its importance.
CO2: Comprehend individual behaviour in organization.
CO3: Comprehend personality traits and its various aspects.
CO4: Recognise the role of group dynamics in organizational effectiveness.
CO5: Appreciate the importance of organizational culture and change management.

Module No.	Unit No.	Topics	Hrs.	CO
1	**Overview of Organizational Behaviour**		**06**	**CO1**
	1.1	**Introduction to Organization** Concept of organization, importance of organization, organization as a process of management, types of organization, steps in the organization process, principles of organization, features of modern organization.		
	1.2	**Organizational Behaviour** Concept of organizational behaviour, genesis of organizational behaviour, needs for study of organizational behaviour, individual perspective, small and large group perspective, organizational perspective.		
2	**Organizational Behaviour and Individual Perspective-I**		**08**	**CO2**
	2.1	**Learning** Individual behaviour, concept of learning, the learning curve, learning and performance, theories of learning, strategies for change of behaviour.		
	2.2	**Perception** Concept and process of perception, factors influencing perception, barriers to accurate perception, managerial uses of perception.		
	2.3	**Attitudes** Process of formation of attitude, methods of effecting attitude change, relationship between attitude and behaviour, work related attitudes.		
	2.4	**Values** Concept of value, meaning and importance of value, types of values, designing value-based organization.		
3	**Organizational Behaviour and Individual Perspective-II**		**08**	**CO2**
	3.1	**Personality and Emotions** Determinants of personality, personality attributes influencing organizational behaviour, concept of emotions, applications of emotion.		
	3.2	**Stress Management** Stress Management, definition of stress, causes and consequences of stress, techniques of managing stress, creating		

Module No.	Unit No.	Topics	Hrs.	CO
		a stress free environment.		
	3.3	**Motivation,** Concept of motivation, motivators, theories of motivation, managerial approaches to motivating employees.		
	3.4	**Job Design and Job Satisfaction** Job design, factors of job design, job re-design, job satisfaction, determinants of job satisfaction, measurement of job satisfaction.		
4	**Organizational Behaviour and Group Perspective**		**08**	**CO3**
	4.1	**Group Formation and Structure** Concept of group, significance of group behaviour, factors of group formation, types of work groups, group dynamics, group decision making.		
	4.2	**Communication** Process of communication, principles of good communication, barriers to communication, communication network, effective communication.		
	4.3	**Team Building and Leadership** Types of team, team building, leadership, theories of leadership, leadership styles, functions of leadership, qualities of an effective leader.		
	4.4	**Conflict Management** Concept of conflict, sources of conflict, dynamics of organizational conflict. Methods of managing conflict.		
5	**Organizational Change and Culture**		**05**	**CO4**
	5.1	**Organizational Change** Introduction, forces of change, resistance to change, overcoming resistance to change, managing change, targets of change, strategies of change, building effective organization.		
	5.2	**Emerging Trends in Organizational Behaviour** Introduction, emerging trends, culture and organizational behaviour, cross-cultural management, managing multinational organization		
		Total	**45**	

Term Work:

The term work shall comprise of mini projects and/or case studies. The topics may be from the course syllabus or any other pertinent area. Students will be graded based on continuous assessment of their work.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	V.S.P.Rao & P.S. Narayana	*Organisational Theory & Behaviour*	Konark Publishers Pvt Ltd, India	2008
2.	Hellrigel, Solcum, Woodman	*Organisational Behaviour*	South-Western College Pub., USA	1998
3.	Luthans, Fred,	*Organisational Behaviour –*	McGraw Hill Publication, India	2005
4.	Stephen Robbins	*Organizational Behaviour*	Pearson Education, Australia	2004
5.	John W. Newstrom, Keith Davis	*Human Behaviour at Work Front Cover*	McGraw-Hill, India	2002
6	K. Aswathappa	*Organizational Behaviour - K.Aswathappa*	Himalaya Publishing House, India	2007

Course Code	Course Title					
216M14C501	**Supply Chain Management**					
	TH			**P**	**TUT**	**Total**
Teaching Scheme (Hrs.)	**03**			**--**	**02**	**05**
Credits Assigned	**03**			**--**	**01**	**04**
Examination Scheme	**Marks**					
	CA		**ESE**	**LAB/TUT CA**		**Total**
	ISE	**IA**				
	30	**20**	**-**	**75**		**125**

Course Prerequisite:

- **None**

Course Objectives:

The objective of this course is:

- To introduce the basic concepts in supply chain management fundamentals as well as strategies and practice, and examines important managerial issues.
- To introduces the analysis, design, control, and operation of supply chain management systems.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand Supply chain management for Products and Services.
CO2: Analyze the importance of supply chain operations and Networks.
CO3: Understand the role of cross-functional driver supply chain.
CO4: Understand the role of logical drivers in supply chain and.
CO5: Understand advancements in supply chain.

Module No.	Unit No.	Topics	Hrs.	CO
1	**Basics of Supply Chain Management**		**08**	**CO1**
	1.1	**Introduction**: Definitions of supply chain, evolution of supply chain management, objective of supply chain, decision phases in a supply chain and future challenges in supply chain management. Examples of supply chains in manufacturing, services, e-commerce.		
	1.2	**SCM drivers**: Framework of the SCM drivers and their metric. **Supply chain performance measures -** SCOR model, strategic profit model and impact of supply chain initiatives on ROA, critical success factors for SCM		
2	**Designing of Supply Chain Operations and Network**		**09**	**CO2**
	2.1	**Operations and supply chain strategies**- Value added and cost, operation strategy, supply chain strategy, strategic fit and expanding strategic scope, obstacles to achieve strategic fit. **Supply chain coordination**- Bullwhip effect, VMI, CPFR.		
	2.2	**Designing Supply Chain Network**: Regional facility location, distribution network, network design in supply chain, global supply chain design. **Production strategy**: Postponement and modularization, Process view- cycle view, Push-Pull view, OPP/CODP, Selection of production strategy.		
3	**Managing Cross- functional Drivers of Supply Chain**		**09**	**CO3**
	3.1	**Sourcing strategy**: Sourcing Process and Principles, Sourcing Strategies, Supplier Relationship Management (SRM), Supplier selection and rating, negotiations, supplier evaluation.		
	3.2	**Inventory Management:** Role, function and types of inventory, Material classification, Inventory models-Deterministic and Stochastic, Inventory policies and Aggregate planning.		
4	**Managing Logical Drivers in a Supply Chain**		**09**	**CO4**
	4.1	**Information Technology as a driver** :The role and function of IT in SCM, Enabling SCM through IT, Strategic management framework of IT adoption in SCM		

Module No.	Unit No.	Topics	Hrs.	CO
	4.2	**Transportation and warehousing**: Drivers of Transportation decision, Forms of transport, Modes of transport and their performance measure. Trade based transportation network design, Genetic transportation structure, realization of Economies of scale in transportation. Warehouse management system, 3PL and 4PL.		
5	**Advance Topics in Supply Chain**		09	CO5
	5.1	**Supply Chain Risk, Resilience, and Sustainable Management**: Supply Chain Risk Management-Introduction, Risk management in supply chain, Operational and Disruption risk and Ripple effect in supply chain. Supply Chain Resilience: Its Frame work and cost and KPIs for SC risk. Sustainable Supply chain, Green supply chain.		
	5.2	**Digital Supply Chain, Smart Operations and Industry 4.0:** Digitalization as New Driver in SCOM Excellence. Development of Technology in SC- Industry 4.0, Internet of Things, Cyber Physical Systems, Smart Connected Products, Smart Supply Chains and Smart Value Adding Networks. Digital SCOM Framework-Plan, Source, Make and Delivery processes , Big data Analytics in SC.		
		Total	**45**	

Term Work:

The term work shall comprise of mini-projects and/or case studies. The topics may be from the course syllabus or any other pertinent area. Students will be graded based on continuous assessment of their work.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Dmitry Ivanov Alexander, Tsipoulanidis, Jörn Schönberger	*Global Supply Chain and Operations Management: A decision-orientation Introduction to creation of value*	Springer	Second Edition, 2019
2.	Michael Hugos	*Essentials of Supply Chain Management*	John Wiley & Sons, Inc.	Second Edition, 2006
3.	Sunil chopra, Peter Meindl, D V Kalra	*Supply Chain Management-strategy, planning and operation*	Pearson, India.	Sixth Edition, 2016
4.	Joel Wisner, G. Keong, Keah-Choon Tan	*Principles of Supply Chain Management*	Cengage Learning, India.	First Edition, 2011
5.	David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi	*Designing and Managing the Supply Chain: Concepts, Strategies, and Cases*	Tata McGraw-Hill, India	First Edition, 2005
6.	Janat Shah	*Supply Chain Management*	Pearson, India.	First Edition, 2009

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M14C601</td><td colspan="5">Operations Research</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="2">03</td><td>--</td><td>02</td><td>05</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">03</td><td>--</td><td>01</td><td>04</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>=</td><td>75</td><td>125</td></tr>
</table>

Course prerequisites:

- **None**

Course Objectives:

The objective of the course is to understand the mathematical method for determining a way to achieve the best outcome (such as maximum profit or lowest cost) in a given mathematical model for some list of requirements represented as linear equations.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Formulate and solve Linear Programming problems.
CO2: Solve problems on Transportation and Assignment model.
CO3: Apply the techniques of network analysis in project management.
CO4: Decide strategy to be adopted by using Game theory.
CO5: Apply multi-criteria decision making techniques in engineering environment.

Module No.	Unit No.	Topics	Hrs.	CO
1	**Linear Programming**		**10**	**CO1**
	1.1	**Linear Programming:** Linear Programming Problem Formulation, Graphical solution, Simplex method, Two phase method, Big M method, Principle of Duality.		
2	**Transportation and Assignment problem**		**10**	**CO2**
	2.1	**Transportation problem:** Introduction, Formulation, Optimal solution, Degeneracy in Transportation.		
	2.2	**Assignment problem:** Introduction, Formulation, Optimal solution, Traveling Salesman problem		
3	**Project Management**		**07**	**CO3**
	3.1	Concepts of project planning, monitoring and control, Construction of Network – Rules & Precautions. C.P.M. & P.E.R.T. Networks. Obtaining a Critical Path. Time estimates for activities. Probability of completion of project. Determination of floats (total, free, independent & interfering) Crashing of Simple Networks.		
4	**Game Theory**		**06**	**CO4**
	4.1	**Game Theory:** Introduction, Minimax (Maximin), Criterion and optimal strategy, Solution of games with saddle points, Rectangular games without saddle points, 2 X 2 games, dominance principle, mx2 & 2xn game, Solution by Graphical Method.		
5	**Introduction to Decision Making**		**12**	**CO5**
	5.1	Introduction to decision making methods, multi-criteria decision making, Simple additive weighing method (SAW), Weighted Product method (WPM), Analytical Hierarchy Process (AHP) method.		
	5.2	**Advance Decision Making Methods:** DEMATEL method, TOPSIS method, VIKOR method, PROMETHEE method, Group decision making (GDM)		
		Total	**45**	

Term Work: Term-Work will consist of Tutorials/ Numericals covering entire syllabus. Students will be graded based on continuous assessment of their term work. Assessment of these assignments will be done continuously based on designed rubrics

Recommended Book:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	J K Sharma	*Operations Research Theory and Applications*	Macmillan Publishers India Ltd.	5th Edition, 2015
2.	Hamdy A Taha	*Operations Research - An introduction*	Prentice Hall of India	8th Edition, 2014
3.	Hira, Gupta	*Operations Research*	S. Chand & Sons	7th Edition, 2014
4.	A. M. Natarajan, P. Blasubramanie, A. Tamilarasi,	*Operations Research*	Pearson Education	2nd Edition, 2014
5.	V.K. Kapoor, Sumant Kapoor	*Operations Research*	S. Chand & Sons	8th Edition, 2012

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M14C701</td><td colspan="5">Entrepreneurship Development</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td colspan="2">00</td><td>-</td><td>04</td><td>04</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">00</td><td>-</td><td>02</td><td>02</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>100</td><td>100</td></tr>
</table>

Term Work:

- The term work shall comprise of mini-projects, case studies, or internship pertinent to the field of Entrepreneurship.
- The. Students will be graded based on continuous assessment of their work.

A few examples of mini-projects are as under:

1. Planning and designing of physical facilities
2. Designing of incentive scheme for a production shop
3. Family business and entrepreneurship
4. Designing a supply chain for a given product or service
5. Preparing feasibility report to start a firm
6. Use of hybrid MCDM methods for performance improvement of a system
7. Analysis of enablers and barriers to Industry 4.0
8. MCDM techniques for decision making in medium size enterprises
9. Supply Chain Analytics (Supply Chain 4.0)
10. Supply chain analysis (Barriers/Models/SME challenges)
11. Green supply chain initiatives and challenges (Industry case study)
12. Technology and innovation for transparency in organization (IoT, Blockchain)

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition with Year of Publication
1.	Hisrich R D, Peters M P	*Entrepreneurship*	Tata McGraw-Hill	10th Edition, 2017
2.	Marc Dollinger	*Entrepreneurship: Strategies and Resources*	Prentice Hall	3rd Edition, 2015
3.	Khanka. S.S	*Entrepreneurship Development*	Institute of India, Ahmadabad	1986.
4.	Donald F Kuratko	*Entreprenuership – Theory, Process and Practice*	Cengage Learning	9th Edition, 2014.
5.	Mathew J Manimala	*Enterprenuership theory at cross roads: paradigms and praxis*	Dream tech	2nd Edition, 2005.

Syllabus

Minor Program on
Mechatronics
(Offered by Department of Mechanical Engineering)

From

Academic Year 2024 – 25

(Revision 2)

(Approved by Expert Board meeting dated 19th April 2024)

K J Somaiya College of Engineering, Mumbai-77

(A Constituent College of Somaiya Vidyavihar University)

Introduction

The Programme designed gives an insight of sensors, actuators, PLC, System Interfacing, Data Acquisition, Robotics and Industry 4.0 that will help the students to have a good understanding and designing a Mechatronic system.

Program Objectives:

The objectives of this minor program are to produce graduates who:

- Have knowledge of all aspects of Mechatronics
- Will Understand industrial and societal needs in developing a Mechatronic product
- Can undertake challenge of developing a complete turn key Mechatronic product

Learning Outcomes (LOs) of the Minor Degree Program:

At the successful completion of this minor program an engineering graduate will be able to

LO1: Design and develop a Mechatronic system for a given real life application

LO2: Acquatain knowledge of various facets of Industry 4.0 and apply it in designing and developing a Mechatronic system

Eligibility Criteria:

Students who have passed first year of engineering in Electronics & Telecommunication Engineering, Computer Science, Information Technology and Electronics Engineering.

Assessment Methods:

Tests, quiz, mini-projects, presentations, study of research articles, etc.

Project Work

1. Agricultural Automation
2. Medical Automation
3. Automation in Automobile industry
4. Process industries
5. Smart factory

Alternative Online Courses

Suitable online courses such as NPTEL/MOOC etc. may be considered as an alternative to maximum one of the abovementioned stipulated courses. The permissible online courses will be announced at the appropriate time when this minor degree program will be in effect.

Vision

To become a program of world repute in the field of Mechanical Engineering, known for an ambience conducive to value based multifarious development of students, enabling them face technological challenges for service of the mankind.

Mission

- To impart skills and expertise in design, manufacturing and thermal areas of mechanical engineering that is the backbone of industry, so that the students thrive as successful engineers.
- To provide an opportunity to create, interpret, apply and disseminate knowledge to improve the quality of life.

Acronyms used in syllabus document	
Acronym	**Definition**
CA	Continuous Assessment
ESE	End Semester Exam
IA	Internal Assessment
O	Oral
P	Practical
P&O	Practical and Oral
TH	Theory
TUT	Tutorial
TW	Term work
ISE	In-semester Examination
CO	Course Outcome

Acronyms used in Course code e.g. 216M15C301

Position of Digit	Acronym	Definition
1	**2**	Second revision SUV KJSCE 2023
2	**16**	KJSCE
3	**M**	Minor Degree Program
4	**14**	Industrial Engineering and Management
5	**C**	Core Course
	L	Laboratory Course
	T	Tutorial
	P	Project Based Course
6	**1/2/3/4**	Semester Number
7	**01/02/03--**	Course Number

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH–P–TUT	Total (Hrs.)	Credits Assigned TH–P–TUT	Total Credits	Semester of Major Degree
216M15C301	Sensors and transducers	3-2-0	5	3-1-0	4	III
216M15C401	Actuators and Controllers	3-2-0	5	3-1-0	4	IV
216M15C501	Mechatronics system design	3-0-2	5	3-0-1	4	V
216M15C601	Robotics and Artificial intelligence	3-2-0	5	3-1-0	4	VI
216M15P601	Minor Project	0-4-0	4	0-2-0	2	VII
Total Hours			24		18	

Examination Scheme

Course Code	Course Name	Marks				
		CA		ESE	LAB/TUT CA	Total
		ISE	IA			
216M15C301	Sensors and transducers	30	20	--	75	125
216M15C401	Actuators and Controllers	30	20	--	75	125
216M15C501	Mechatronics system design	30	20	--	75	125
216M15C601	Robotics and Artificial intelligence	30	20	--	75	125
216M15P601	Minor Project	--	--	--	100	100
Total		**120**	**80**		**400**	**600**

Course Code	Course Title			
216M15C301	Sensors & Transducers			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	03	02	--	05
Credits Assigned	03	01	--	04

Examination Scheme	Marks			
	CA		LAB/TUT CA	Total
	ISE	IA		
	30	20	75	125

Course prerequisites: None

Course Objectives

The objective is to understand the importance of sensors & transducers in mechatronics systems and to effectively select sensors & transducers while designing a mechatronic system.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Understand mechatronics and sensor based measurement systems
CO2: Select appropriate sensor for required application
CO3: Understand working of flow, temperature, pressure, force and position measurements devices
CO4: Select non-contact type sensor suitable for specific application

Module	Unit	Content	Hrs.	CO

No.	No.			
1	**Introduction to Mechatronics**		04	CO1
	1.1	Introduction to mechatronics and mechatronics system, components of mechatronics system, objectives, advantages, disadvantages and applications of mechatronics.		
2	**Basics of Sensor-based measurement system**		08	CO1
	2.1	General concepts and terminology, sensor classification, general Input-Output configuration, static characteristics of measurement systems, dynamic characteristics, other sensor characteristics, Primary sensors, Materials for sensors, Micro-sensor technology.		
3	**Transducers/Sensors for Motion and Dimensional measurements:**		10	CO2
	3.1	Relative displacement, translation and rotational resistive potentiometers, resistance strain gauges, LVDT, capacitance pickups. Piezo-electric transducers, Relative acceleration measurements, seismic acceleration pickups, calibration of vibration pickups, Gyroscopic sensors.		
4	**Force, Pressure, Temperature and Flow measurements:**		15	CO3
	4.1	**Force Measurement:** Bonded strain gauge transducers, photoelectric transducers, variable reluctance pickup, torque measurement dynamometers.		
	4.2	**Pressure Measurement:** Manometers, elastic transducers, liquid systems, gas systems, very high pressure transducers, thermal conductivity gauges, ionisation gauges, microphone.		
	4.3	**Temperature Measurement:** Resistance thermometers, Thermistors, Thermocouples and Pyrometers		
	4.4	**Flow Measurement:** Hot-wire and hot-film anemometers, electromagnetic flow meters, laser Doppler velocity meter		
5	**Non-contact type Sensors**		08	CO4
	5.1	Proximity Sensors: Typical Sensor Characteristics, Technologies for Proximity Sensing, Electro-Optical Sensors, Capacitive Sensors, Inductive/Magnetic Sensors.		
		Total	45	

- Term work will consist of experiments covering the entire syllabus of course '116m49C301 Sensors and Transducers'. Students will be graded based on continuous assessment of their term work.
- Oral Examination will be based on laboratory work and the entire syllabus of '116m49C301 Sensors and Transducers'

Reference Books

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Doebelin Ernest O	*Measurement Systems: Application and Design*	Tata McGraw Hill Ltd	Fourth Edition, 2010
2.	Sawhney A K	*Mechanical Measurements and Instrumentation & Control*	Dhanpat Rai and Sons,	Twelveth Edition, 2015
3.	M. P. Groover	*Industrial Robotics*	McGraw-Hill Publishing Company Limited	First Edition, 2007
4.	Patranabis D	*"Sensors and Transducers*	Prentice-Hall India	Second Edition, 2012
5.	Nakra, B.C. and Chaudhry, K.K	*Instrumentation, Measurement and Analysis*	Tata McGraw Hill	First Edition, 2005

Course Code	Course Title					
216M15C401	Actuators and Controllers					
	TH		P	TUT	Total	
Teaching Scheme(Hrs.)	03		02	--	05	
Credits Assigned	03		01	--	04	
Examination Scheme	Marks					
	CA		ESE	LAB/TUT CA	Total	
	ISE	IA				
	30	20	--	75	125	

Course prerequisites: Sensors and transducers

Course Objectives

The objective is to select suitable actuators and program controllers for designing a stable control system

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Select appropriate actuator required for building a Mechatronic system
CO2: Select suitable drive required for building Mechatronic system
CO3: Design and develop a Pneumatic system for a given application
CO4: Design and develop a hydraulic system for a given application
CO5: Develop ladder logic program for PLC, understand concepts of Programmable Automatic Controller and PID

Module No.	Unit No.	Details	Hrs.	CO
1	**Electric Actuators**		**08**	**CO1**
	1.1	Linear Electric Actuators, Rotary Electric Actuators, Servo motors, Stepper Motors		
	1.2	Piezo electric actuator, Thermal actuators, Fluidic actuators, Solenoids and voice coil motors, MEMS actuators, Brushless DC Motor		
2	**Drives**		**07**	**CO2**
	2.1	Mechanical drives: -Conveyor belt, power screws, Pulley and belt, Sprocket and chain, Rack and pinion, Sheave and rope, Gear box		
	2.2	Electrical drives: - Constant speed, Variable speed, Ac drive, Dc drive, Stable torque, Variable Frequency Drive, Variable Voltage Frequency Drive, Thyristor, IGBT		
3	**Pneumatic Actuators**		**10**	**CO3**
	3.1	Basic principles and layout of Pneumatics systems, Design and development of Pneumatic and Electro Pneumatic circuit for single and multi-cylinder. Design of Pneumatic system for a given application		
4	**Hydraulic Actuators**		**10**	**CO4**
	4.1	Basic principles and lay out of hydraulic systems, Design and Development of hydraulic and Electro hydraulic circuits for single and Multi-cylinders. Introduction of hydro pneumatics, Design of hydraulic system for a given application.		
5	**Programmable Controllers**		**10**	**CO5**
	5.1	Programmable logic controllers Over view and applications of programmable logic controllers in manufacturing, Relay logic, programming a PLC using ladder logic Diagram. SCADA, HMI, Distributed control system: -Architecture and application		
	5.2	Programmable Automation Controller- Architecture and application, Proportional integral and derivative controller: - P, I and D Controller, PID Controller Communication protocols in Automation Selection of Controller and Communication protocol for a given Automation system		
		Total	**45**	

- Term work will consist of experiments covering entire syllabus of course '116m49C401 Actuators and Controllers'.
- Students will be graded based on continuous assessment of their term work.
- Oral Examination will be based on laboratory work and the entire syllabus of '116m49C401 Actuators and Controllers'.

Books recommended

Sr. No.	Name/s of Author/s	Title	Name of Publisher	Edition and Year of Publication
1.	W. Bolton	*Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*	Pearson Education,	3rd Edition, Published Year 2003
2.	Festo Series	*Fundamentals of Electro Hydraulics:*	Ebelf	First Edition,2003
3.	Festo Series	*Fundamentals of Electro pneumatics:*	Ebelf	First Edition,2003
4.	Frank Lamb	*"Industrial Automation: Hands On"*	(McGraw Hill Professional).	First Edition June 24, 2013
5.	Norman S. Nise	*Control Systems Engineering*	Wiley India Pvt. Ltd	Fifth Edition, 2009.

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M15C501</td><td colspan="5">Mechatronic System Design</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">03</td><td>--</td><td>02</td><td>05</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">03</td><td>--</td><td>01</td><td>04</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB/TUT CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>---</td><td colspan="2">75</td><td>125</td></tr>
</table>

Course prerequisites: Sensors and transducers & Actuators and Controllers

Course Objective: The objective is to imbibe knowledge of Complete Life cycle right from Concept of need, material selection, Manufacturing methods till deployment of product.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Understand life cycle of Mechatronic Product from Concept to Deployment
CO2: Understand various latest Materials used in Manufacturing of Mechatronic Products
CO3: Understand Concept of Micro Electro Mechanical systems, Fabrication Techniques and Transducers
CO4: Understand various manufacturing methods for production of Mechatronic Products
CO5: Design a Complete Mechatronic Product for a given application

Module No.	Unit No.	Details	Hrs.	CO
1	**Design Process in Mechatronics**		09	CO1
	1.1	Recognition of the Need, Conceptual Design and Functional Specification, Control System Design, Design Optimization, Prototyping Hardware-in-the-loop Simulation, Deployment/Life Cycle, Deployment of Embedded Software, Life Cycle Optimization.		
2	**Materials for Mechatronic systems**		08	CO2
	2.1	Introduction to different types of materials - Overview of smart materials - Piezoelectric Ceramics - Piezo-polymers - Magnetostrictive Materials - Electroactive Polymers - Shape Memory Alloys -Shape Memory polymers - Electro and Magneto Rheological Fluids		
3	**Micro Electrical Mechanical systems (MEMS)**		08	CO3
	3.1	Micro Electrical Mechanical systems: - Introduction, Fabrication techniques and MEMS transducers		
4	**Manufacturing in Mechatronic systems**		10	CO4
	4.1	**Process selection**: Various manufacturing process and their classification for manufacturing Mechatronic products. Process and material selection,		
	4.2	**Design for Manufacturing** (DFM) and Design for Assembly (DFA), Ergonomics approach		
	4.3	**Value Engineering:** Value Analysis., Economic analysis: Qualitative & Quantitative., Legal and social issues		
5	**Design of Mechatronics System**		10	CO5
	5.1	Live Case studies - Development of a Complete mechatronic systems		
		Total	45	

- Term work will consist of experiments covering entire syllabus of course '116m49C501 Actuators and Controllers'.
- Students will be graded based on continuous assessment of their term work.
- Oral Examination will be based on laboratory work and the entire syllabus of '116m49C501 Actuators and Controllers'.

Reference Books

Sr. No.	Name/s of Author/s	Title	Name of Publisher With Country	Edition and Year of Publication
1.	Devidas shetty, Richard kolk	*Mechatronics system design*	Cengage Learning	India Edition
2.	A. Smaili and F. Mrad	*Applied Mechatronics*	OXFORD university press	Second Edition 2009
3.	Alciatore and Histand	. *Introduction to Mechatronics and Measurement Systems*	Tata McGraw-Hill	ThirdEdition 2011
4.	Necsulescu,	*Mechatronics*	Pearson education	ThirdEdition 2014
5	Electronic Control Systems in Mechanical Engineering	*Mechatronics*	Bolton Pearson education	Fouth Edition 2017

Course Code	Course Title			
216M15C601	Robotics and Artificial Intelligence			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	03	02	--	05
Credits Assigned	03	01	--	04

Examination Scheme	Marks				
	CA		ESE	LAB/TUT CA	Total
	ISE	IA			
	30	20	--	75	125

Course prerequisites: Fundamentals of Mathematics, Basics of sensors and actuators

Course Objectives: By the end of the course students should understand the concept of robots and its use in industry. Artificial Intelligence (AI) is an integral part of current robotic systems. This course also introduces students to various applications of robotics and AI for a wide range of applications in manufacturing.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Identify different actuators, sensors, grippers and find specific application in robotics. (Comprehension)

CO2: Apply knowledge of mathematics and engineering to derive and solve robot kinematics and dynamics problems. (Analysis)

CO3: Study modern techniques such as image processing tools and robot programming in decision making. (Application)

CO4: Understand Expert system, Fuzzy Logic, Neural networks, and Genetic algorithm techniques. (Comprehension)

CO5: Understand applications of robotics and AI in various domains through research case studies. (Comprehension)

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Robotics**		07	CO1
	1.1	Types of robot: Mobile robot, Quadruped robot, Humanoid robot. Stationary Robot Specification, Robot Applications, Robot Configuration, Social and Economic Issues, AI and Robotics, Role of robotics in Industry-4.0		
2	**Robot Kinematics**		12	CO2
	2.1	Basics of Kinematics, Co-ordinate System, Screw Transformation, D-H Algorithm, Forward Kinematics of SCARA and planer robots, Inverse Kinematics of SCARA and planer robots, Trajectory Planning, Robot dynamics (introduction)		
3	**Robot Vision and Programming**		08	CO3
	3.1	**Robot Vision:** Template Matching, Grey scale, Binary images, Noises in image, Shrink and swell operators		
	3.2	**Robot Programming:** Pick and place, Palletizing, De-palletising, Welding etc.		
4	**Artificial Intelligence**		11	CO4
	4.1	History of AI, Predicate Logic, Heuristic search techniques, State space search, Fuzzy logic, Neural networks, Genetic algorithm, Swarm intelligence		
5	**Applications of AI Techniques**		07	CO5
	5.1	Robot path planning to avoid static obstacles and dynamic obstacles, Travelling Salesman Problem, Trajectory Planning of Robot, Cellular Manufacturing Problem		
		Total	45	

Term work will consist of experiments covering entire syllabus of 'Robotics and Artificial Intelligence. Students will be graded based on continuous assessment of their term work.

List of Experiments

1. Robot programming using MATLAB - 3 program: DK, IK, Trajectory planning
2. Assembly of robot using Lego kit - 3 Kits
3. Robot dynamics using ADAMS - 1 robot tutorial
4. Robot demo and programme on Pick and place robot - 2 practical / demo
5. Path following robot: using obstacle sensor, voice sensor - 2 practical assembly of robot.

Reference Books

Sr. No.	Name/s of Author/s	Title	Name of Publisher With Country	Edition and Year of Publication
1.	Robert Schilling	*Fundamental of Robotics analysis and Control*	PrenticeHall India Eastern economy	2006
2.	Groover, Weiss, Nagel, Odrey	*"Industrial Robotics: technology, programming and applications*	MC Graw Hill international	Second edition
3.	Chmielewski, Klafter , Michael	*"Robotics Engineering: An integrated approach*	PHI learning	2009
4.	Amit Konar	*"Artificial Intelligence and Soft Computing"*	CRC Publication	Second edition
5.	Dilip K. Pratihar	*Soft Computing fundamentals and applications*	Narosa Publication	2011
6	Roland Siegwart and Illah R. Nourbakhsh	*Introduction to Autonomous Mobile Robots*	A Bradford Book The MIT Press Cambridge, Massachusetts, London, England	2004

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M15P601</td><td colspan="5">Mini Project</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
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<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>100</td><td>100</td></tr>
</table>

Term Work and Oral: The mini project can be an individual or a group project. Interdisciplinary projects are also permitted. Each project will be assigned one faculty member as a supervisor. There will be a continuous assessment and progress report of the project that needs to be maintained. The final oral will be a presentation based on a demonstration of the project in front of a committee of examiners

Syllabus

Minor Programme in

Robotics and Artificial Intelligence

Jointly offered by Department of Mechanical Engineering and Department of Information Technology

From

Academic Year 2024-25

Revision 2

(Approved in Academic Council meeting dated 19th April 2024)

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M13C401	Fundamentals of Robotics	3 – 0 – 0	03	3 – 0 – 0	03	IV
216M13L401	Fundamentals of Robotics	0 – 2 – 0	02	0 – 1 – 0	01	IV
216M13C501	Advanced Robotics	3 – 0 – 0	03	3 – 0 – 0	03	V
216M13L501	Advanced Robotics	0 – 2 – 0	02	0 – 1 – 0	01	V
216M13C601	AI for Robotics	3 – 0 – 0	03	3 – 0 – 0	03	VI
216M13L601	AI for Robotics	0 – 2 – 0	02	0 – 1 – 0	01	VI
216M13P601	Mini Project	0 – 4 – 0	04	0 – 4 – 0	02	VI
216M13C701	Deep Learning for Robotics	3 – 0 – 0	03	3 – 0 – 0	03	VII
216M13L701	Deep Learning for Robotics	0 – 2 – 0	02	0 – 1 – 0	01	VII
Total			**24**		**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme				
		Marks				
		CA		ESE	LAB/TUT CA	Total
		ISE	IA			
216M13C401	Fundamentals of Robotics	30	20	--	--	50
216M13L401	Fundamentals of Robotics	--	--	--	50	50
216M13C501	Advanced Robotics	30	20	--	--	50
216M13L501	Advanced Robotics	--	--	--	50	50
216M13C601	AI for Robotics	30	20	--	--	50
216M13L601	AI for Robotics	--	--	--	50	50
216M13P601	Mini Project	--	--	--	100	100
216M13C701	Deep Learning for Robotics	30	20	--	--	50
216M13L701	Deep Learning for Robotics	--	--	--	50	50
Total		**120**	**80**	**--**	**300**	**500**

Course Code	Course Title				
216M13C401	Fundamentals of Robotics				
	TH		P	TUT	Total
Teaching Scheme(Hrs.)	03		--	--	03
Credits Assigned	03		--	--	03
Examination Scheme	Marks				
	CA		LAB/TUT/CA	ESE	Total
	ISE	IA			
	30	20	--	--	50

Course prerequisites: None

Course Objectives

The objective is to understand fundamentals of industrial and mobile robots

Course Outcomes

At the end of successful completion of the course the student will be able to

1. identify different actuators, sensors, grippers and mechanisms used in robotics and find specific applications in robotics.
2. apply knowledge of mathematics and engineering to derive and solve robot kinematics and dynamics problems.
3. apply techniques such as image processing, robot trajectory planning and workspace analysis for industrial robots.
4. understand fundamentals of mobile robotics for specific /innovative application

Module No.	Unit No.	Topics	Hrs.	CO
1	**Introduction to Robotics**		**6**	**CO1**
	1.1	Types of robot: Mobile robot, Quadruped robot, Humanoid robot. Stationary robot.		
	1.2	Types of Robot locomotion		
	1.3	Robot Specification and material selection		
	1.4	Robot Applications		
	1.5	Robot Configuration		
	1.6	Social and Economic Issues		
	1.7	Design considerations, selection and performance evaluation		
	1.8	Safety and protection standards		
2	**Robot Kinematics**		**7**	**CO2**
	2.1	Basics of Kinematics and Mechanisms		
	2.2	Homogeneous Coordinate System & Transformations		
	2.3	Screw Transformation		
	2.4	D-H Algorithm		
3	**Forward and Inverse Kinematics and Dynamics of Robot**		**11**	**CO2**
	3.1	Forward Kinematics of planer robots and SCARA		
	3.2	Inverse Kinematics of planer robots and SCARA		
	3.3	Robot dynamics for planer robot		
4	**Robot Vision, Workspace Analysis and Trajectory Planning**		**11**	**CO3**
	4.1	Robot Vision: Template Matching, Grey scale, Binary images, Noises in image, Shrink and swell operators		
	4.2	Robot Workspace Analysis: Box, Cylindrical, Spherical workspaces		
	4.3	Robot Trajectory Planning: Linear, Quadratic and Cubic interpolation for robot trajectory		

Module No.	Unit No.	Topics	Hrs.	CO
5	**Case studies**		**10**	**CO4**
	5.1	Role of Robots in advanced manufacturing		
	5.2	Case study on applications Fuzzy Logic in Robot path planning		
	5.3	Case study on Mobile Robotics, Mechanics and Locomotion		
	5.4	Case study on Flying Robot		
	5.5	Case study on Surgical Robots		
	5.6	Case study on role of robots in Industry-4.0/Smart Manufacturing		
Total			**45**	

Books Recommended

Sr. No.	Name/s of Author/	Title	Name of Publisher with Country	Edition and Year of Publication
1.	Robert Schilling	*Fundamental of Robotics analysis and Control*	Prentice Hall India	2006
2.	Groover, Weiss, Nagel, Odrey	*"Industrial Robotics: technology, programming and applications*	MC Graw Hill international	Second edition
3.	Chmielewski, Klafter , Michael	*"Robotics Engineering: An integrated approach*	PHI learning	2009
4.	John Craig	*Introduction to Robotics : Mechanics and control –*	Pearson education	Second edition
5.	SR Deb and S Deb	*Robot technology and flexible automation –*	Tata MC Graw Hill edu. PVT Ltd	Second 2009
6	Roland Siegwart and Illah R. Nourbakhsh	*Introduction to Autonomous Mobile Robots*	A Bradford Book The MIT Press Cambridge, Massachusetts	2004

			London, England	

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<tr><td>216M13L401</td><td colspan="5">Fundamentals of Robotics</td></tr>
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<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>50</td><td>--</td><td>50</td></tr>
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Term work will consist of experiments covering entire syllabus of course '216m52C401 Fundamentals of Robotics'. Students will be graded based on continuous assessment of their term work.

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M13L501</td><td colspan="5">Advanced Robotics</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
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<tr><td>Credits Assigned</td><td colspan="2">03</td><td>--</td><td>--</td><td>03</td></tr>
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<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>--</td><td>--</td><td>50</td></tr>
</table>

Course prerequisites: **Fundamentals of Robotics**

Course Objectives

The objective is to understand robot design, motion planning, and implement robot programming.

Course Outcomes

At the end of successful completion of the course the student will be able to

1. Understand Robot design for the given application
2. Understand fundamentls of Robot Programming and write progrms for different tasks
3. Implement motion planning for mobile robots
4. Implement Robot Operating Systms (ROS) for the given application
5. Investigate role of Artificila Intelligence (AI) in robotics

Module No.	Unit No.	Topics	Hrs.	CO
1	**Robot Design**		**06**	**CO1**
	1.1	Selection of applications		
	1.2	Robotnconfiguration decision, specification,		
	1.3	Selection of actuators		
	1.4	Microcontroller interfacing		
	1.5	Forward and inverse kinematics of designed robot		
	1.6	Ardino programming		
2	**Robot programming**		**11**	**CO2**
	2.1	Methods of programming		
	2.2	Robot Languages		
	2.3	Data object commands, Motion commands		
	2.4	Gripper commands, Tool commands		
	2.5	Sensor commands, Other commands		
	2.6	Writing programs for different tasks such as machine loading, machine unloading, palletizing, depalletizing, etc.		
3	**Motion Planning of Mobile Robots**		**11**	**CO3**
	3.1	Introduction		
	3.2	Bug Algorithm		
	3.3	Cell Decomposition		
	3.4	Exact Roadmaps		
	3.5	Configuration Space and Prbabilistic Roadmaps		
4	**Robot Operating Systems (ROS)**		**09**	**CO4**
	4.1	Introduction to ROS		
	4.2	Features of ROS		

Module No.	Unit No.	Topics	Hrs.	CO
	4.2	Programming for Sensing and Perception		
	4.3	Programming for Sensing and Perception		
	4.4	Programming for Path Planning and Decision		
	4.5	Programming for Control		
	4.6	Interfacing ROS with other packages such as Gazebo, SIMULINK, MATLAB etc.		
	4.7	ROS2		
5	**Robot Intellegence**		**08**	**CO5**
	5.1	Role of AI in Robotics		
	5.2	State space search, Problem Reduction		
	5.3	Use of predicate logic, Problem solving		
	5.4	Robot learning, Robot task planning		
	5.5	Case studies on Intelligent Robots		
Total			**45**	

Books Recommended

Sr. No.	Name/s of Author/	Title	Name of Publisher with Country	Edition and Year of Publication
1.	John Craig	*Introduction to Robotics : Mechanics and control –*	Pearson education	Second edition
2.	SR Deb and S Deb	*Robot technology and flexible automation –*	Tata MC Graw Hill edu. PVT Ltd	Second 2009
3.	Roland Siegwart and Illah R. Nourbakhsh	*Introduction to Autonomous Mobile Robots*	A Bradford Book The MIT Press Cambridge, Massachusetts London, England	2004

4.	Francesco Bullo and Stephen L. Smith	*Lectures on Robotic Planning and Kinematics*	Github, https://fbullo.github.io/lrpk/	2022
5.	Howie Choset	*Principles of Robot Motion: Theory, Algorithms, and Implementations*	MIT Press	May 2005
6	Lentin Joseph and Jonathan C	*Mastering ROS for Robotics Programming*	Packt Publication	2^{nd} Edition

Course Code	Course Title				
216M13L501	Advanced Robotics				
	TH		P	TUT	Total
Teaching Scheme(Hrs.)	--		02	--	02
Credits Assigned	--		01	--	01
Examination Scheme	Marks				
	CA		LAB/TUT/CA	ESE	Total
	ISE	IA			
	--	--	50	--	50

Term work will consist of experiments covering entire syllabus of course '216m52C501 Fundamentals of Robotics'. Students will be graded based on continuous assessment of their term work.

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M13C601</td><td colspan="5">AI For Robotics</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="2">--</td><td>02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">--</td><td>01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">LAB/TUT/CA</td><td rowspan="2">ESE</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>--</td><td>--</td><td>50</td></tr>
</table>

Course Prerequisites: Probability Theory

Course Objectives:
The main objective of course is to introduce fundamentals required to understand and apply Artificial Intelligence (AI). The core concepts of AI include to attempt problem solving, to represent knowledge and to learn uncertainty. The concepts of AI, if applied, would aid in developing intelligent and efficient task handling robot. The course aims to lead students by imparting knowledge of artificial intelligence to apply the acquired concepts of AI in the field of Robotics.

Course Outcomes:
At the end of successful completion of the course the student will be able to
CO1: Comprehend concept of artificial intelligence along with Problem solving and Knowledge representation, Uncertainty
CO2: Realize different AI based algorithms
CO3: Acknowledge concepts of machine learning
CO4: Understand concepts of probabilistic Robotics
CO5: Gain Knowledge about Design and Ethics of intelligent Robot

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Artificial Intelligence**		**06**	**CO1**
	1.1	AI problems and AI techniques		
	1.2	Types of Agent and Agent Environment		
	1.3	History of AI Robotics		
	1.4	Automation and Autonomy		
2	**Problem Solving , Knowledge Representation, Uncertainty**		**15**	**CO1**
	2.1	State Space Search, Uninformed search techniques- Breadth First Search, Depth First Search, Uniform cost search, Depth Limited Search, Iterative Deepening, Bidirectional search, Comparing different techniques		
	2.2	Informed search techniques - Heuristic functions, Best First Search, Greedy BFS, A*, Hill Climbing		
	2.3	Adversarial search techniques - Min-Max Search, Alpha Beta pruning		
	2.4	A Knowledge Based Agent, WUMPUS WORLD Environment, Propositional Logic, First Order Predicate Logic		
	2.5	Forward and Backward Chaining, Resolution		
	2.6	Uncertainty and Representing knowledge in Uncertain domain		
	2.7	Conditional Probability, Joint Probability		
	2.8	Bay's theorem, Belief Networks, Simple Inference in belief networks		
3	**Introduction to Machine Learning**		**12**	**CO2**
	3.1	Introduction: well posed learning problem, designing a learning system, training experience, target function, final Design, Issues in machine learning		
	3.2	Instance Based Learning: introduction, K-nearest neighbor learning, locally weighted regression, case		

Module No.	Unit No.	Details	Hrs.	CO
		based Reasoning		
	3.3	Analytical learning: introduction, perfect domain theory, explanation based learning. Inductive analytical approaches to learning		
	3.4	Reinforcement learning and adaptive control,		
	3.5	Genetic Algorithms: Representation of Hypothesis as GA, Genetic Operators, Fitness function and Selection, Hypothesis Space search, Genetic Programming, Models of Evolution and Learning, Parallelizing GA, Different search methods for induction		
	3.6	Robot Learning From Demonstration		
4	**Introduction to Probabilistic Robot**		**08**	**CO2**
	4.1	Recursive State Estimation – Robot Environments Interaction		
	4.2	Bays Filter algorithm and Example		
	4.3	Gaussian Filters – Kalman Filer – Algorithm, illustration		
	4.4	Non Parametric Filters – Basic algorithm of Histogram Filters, Particle Filters		
5	**Intelligent Robot Design Process and Ethics**		**04**	**CO3**
	5.1	Case Study – Cleaning up the Playroom		
	5.2	Case Study – Location Navigator Robot		
	5.3	Case Study – Robot Speech Recognition		
	5.4	Ethics of Building intelligent Robot		
Total			**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	*Title of Book*	Name of Publisher with Country	Edition and Year of Publication
1.	Stuart Russell and Peter Norvig	*Artificial Intelligence: A Modern Approach*	Pearson Education	5th Edition, ,2004
2.	Elaine Rich, Kevin Knight, Shivshankar B Nair	*Artificial Intelligence*	McGraw Hill, 2012	3rd Edition
3.	Robin Murphy	*Introduction to AI Robotics*	MIT Press, England	Second Edition, 2019
4.	Sebastian Thrun, Wolfram Burgard, Dieter Fox	*Probabilistic Robotics*	MIT Press, England	2006
5.	Francis X. Govers	*Artificial Intelligence for Robotics*	Packt Publishing	August 2018

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M13L601</td><td colspan="5">AI For Robotics Laboratory</td></tr>
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<tr><td>Credits Assigned</td><td colspan="2">--</td><td>01</td><td>--</td><td>01</td></tr>
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<tr><td colspan="2">CA</td><td rowspan="2">LAB/TUT/CA</td><td rowspan="2">ESE</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>50</td><td>--</td><td>50</td></tr>
</table>

Term work will consist of experiments covering entire syllabus of course '216m52C601 AI for Robotics'. Students will be graded based on continuous assessment of their term work. Practical Examination will be based on laboratory work and the entire syllabus of '216m52C601 AI for Robotics'.

Course Code	Course Title			
216M13P601	**Mini Project**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	--	04	--	04
Credits Assigned	--	02	--	02

Examination Scheme	**Marks**				
	CA		**LAB/TUT/CA**	**ESE**	**Total**
	ISE	**IA**			
	--	--	100	--	100

Course Prerequisites: **Fundamentals of Machine Learning and Robotics**
Course Outcomes:
At the end of successful completion of the course the student will be able to

- CO1 - Define the problem statement and develop a solution to solve real life problems in robotics and AI .
- CO2 - Implement and test the hardware/ software algorithms to meet the desired specifications for robotics and AI applications
- CO3 - Analyze, interpret results, correspondingly modify the robotic system to get the desired results
- CO4 - Demonstrate oral and written communication skills.

Term Work and Oral:

Students will implement robots based on concepts learnt in earlier subjects. Projects should be involving social and other domains issues.

The mini project can be individual or a group project. Interdisciplinary projects are also permitted. Each project will be assigned one faculty member as a supervisor. There will be a continuous assessment and progress report of the project that needs to be maintained.

Course Code	Course Title				
216M13C601	**Deep Learning For Robotics**				
	TH		**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**03**		**--**	**--**	**03**
Credits Assigned	**03**		**--**	**--**	**03**
Examination Scheme	**Marks**				
	CA		**LAB/TUT/CA**	**ESE**	**Total**
	ISE	**IA**			
	30	20	**--**	**--**	**50**

Course Prerequisites: Fundamentals of Machine Learning

Course Objectives: Deep Learning is an advanced technique which is able to learn non-linear features directly from data, making them an excellent choice for many real time robotic applications. The course aims to introduce the concepts of Neural network and progresses towards deep learning models like Convolution Neural Network and Recurrent Neural Network. The course suffices applications of deep learning in the domain of Robotics with the help of case studies.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Comprehend basics of Neural network and Deep learning

CO2: Appreciate Artificial Neural Network (ANN)

CO3: Discuss concept of Convolution Neural Network (CNN)

CO4: Understand Recurrent Neural Network (RNN), its limitation and LSTM RNN

CO5: Realize role of Deep learning in Robotic Operation

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Neural Networks & Deep Learning**		**06**	**CO1**
	1.1	Neural Networks Vs Deep Learning		
	1.2	Biological Neurons and their artificial models		
	1.3	Basic models of Artificial Neural Networks, Neural Processing, Learning and adaptation, Neural Network Learning Rules and comparison.		
2	**Artificial Neural Networks**		**10**	**CO1**
	2.1	Single layer Perceptron classifiers: Single Discrete Perceptron Learning Algorithm, Single layer Continuous Perceptron Networks for linearly separable classifiers, Multicategory Single- Layer Perceptron Networks		
	2.2	Multilayer Feedforward Networks: Linearly Nonseparable Pattern Classification, Delta learning rule for Multiperceptron layer, Generalized Delta Learning Rule, Feedforward Recall and Error back-propagation algorithm, vanishing gradient, learning factors		
3	**Convolutional Neural Networks (CNN)**		**12**	**CO2**
	3.1	CNN Architecture, MLP versus CNN, Introduction to Popular CNN Architectures: LeNet, AlexNet, VGG16		
	3.2	Building blocks: Convolutional layer, Pooling layer, ReLU , layer, Fully connected layer, Loss layer		
	3.3	Choice of hyperparameters		
	3.4	Regularization methods		
	3.5	Applications		
4	**Recurrent Neural Networks(RNN)**		**10**	**CO2**
	4.1	Introduction to RNN, Limitations of RNN		
	4.2	Long Short Term Memory (LSTM)		

Module No.	Unit No.	Details	Hrs.	CO
	4.3	Architecture of LSTM: Forget Gate, Input Gate, Output Gate		
	4.4	LSTM models, Introduction to Univariate LSTM Models like Vanilla LSTM, Stacked LSTM, Bidirectional LSTM, CNN LSTM, ConvLSTM		
	4.5	Multivariate LSTM Models, Multi-Step LSTM Models, Multivariate Multi-Step LSTM Models		
5	**Case Studies on Deep Learning for Robotics**		**07**	**CO3**
	5.1	Object detection using Neural Network approach		
	5.2	Deep Learning based Latent feature for Model Predictive control		
Total			**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	*Title of Book*	Name of Publisher with Country	Edition and Year of Publication
1.	Jacek M. Zurada	*Introduction to Artificial Neural Systems*	Jaico Publishing House	First edition January 1994
2.	Ian Goodfellow, Yoshua Bengio , Aaron Courville	*Deep Learning*	MIT Press	2017 Adaptive computation and Machine learning Series
3.	Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun	*A Guide to Convolutional Neural Networks for Computer Vision*	Morgan & Claypool Publishers	February 2018
4.	Umberto Michelucci	*Advanced Applied Deep Learning: Convolutional Neural Networks and Object Detection*	Apress	1st edition September 2019
5.	Francis X. Govers	*Artificial Intelligence for Robotics*	Packt Publishing	August 2018

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<tr><td>216M13L701</td><td colspan="5">Deep Learning for Robotics Laboratory</td></tr>
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<tr><td colspan="2">CA</td><td rowspan="2">LAB/TUT/CA</td><td rowspan="2">ESE</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>50</td><td>--</td><td>50</td></tr>
</table>

Term work will consist of experiments covering entire syllabus of course '216m52C701 Deep Learning for Robotics'. Students will be graded based on continuous assessment of their term work.

Syllabus

Minor Programme in Computer Engineering

(Offered by Department of Computer Engineering)

From Academic Year 2024-25
Revision 2

(Approved in Academic Council meeting dated April 22,2024)

K J Somaiya College of Engineering, Mumbai-77

Minor Programme in Computer Engineering

Offered by Department of Computer Engineering

Introduction:

Computer Engineering is the study of the theory and practices needed to design computer based systems that solve a wide range of problems. Computer Science teaches students problem solving techniques to create cutting-edge technology in domains ranging from mobile devices to healthcare to knowledge sharing. The goal of this Minor programme in Computer Engineering is to provide students with the knowledge and tools that will help them to design and implement effective, economical, and creative solutions for the needs of individuals, society, and the high-tech economy.

The programme will focus on basics of Computer Engineering with respect to both the software and hardware aspects of computing, as well as the mathematics and science that are required in the discipline.

Objective:

- Identify, formulate, and solve engineering problems
- Analyze a problem, and identify and define the computing requirements appropriate to its solution
- Design, implement, and evaluate a computer-based system, process, or program to meet desired needs within realistic constraints.
- Apply design and development principles in the construction of software systems of varying complexity
- Apply knowledge and skills to solve problems effectively and efficiently that advances computer science in applied areas.

Learning Outcomes:

At the successful completion of this minor program, an Engineering Graduate will be able to:
LO1 : Design and develop computer based solutions to problems in their application domain.
LO2 : Apply principles in the construction of software systems of varying complexity.
LO3 : Analyze a problem, and identify and define the computing requirements appropriate to its solution.

Eligibility Criteria:

Students of UG, B. Tech. Programmes in Electronics Engineering / Mechanical Engineering / Electronics and Telecommunication Engineering who have cleared their first year.

Assessment Methods:

Evaluation is done by a variety of tools including Open Book tests, MCQ (multiple choice questions), Study of research papers, Internal Assessment tools and End Semester examinations etc. Mini-Projects are offered in courses also to encourage project based learning among students.

Acronyms used in syllabus document	
Acronym	**Definition**

CA	Continuous Assessment
ESE	End Semester Exam
IA	Internal Assessment
O	Oral
P	Practical
P&O	Practical and Oral
TH	Theory
TUT	Tutorial
TW	Term work
ISE	In-semester Examination
CO	Course Outcome

Acronyms used in Course code e.g. 216m54C301

Position of Digit	Acronym	Definition
1	**2**	First revision SUV KJSCE 2020
2	**16**	KJSCE
3	**m**	**Minor Degree Program**
4	**54**	**Computer Engineering**
5	**C**	Core Course
	L	Laboratory Course
	T	Tutorial
	P	Project Based Course
	E	Elective
6	**1/2/3/4**	Semester Number
7	**01/02/03--**	Course Number

Credit Scheme (for students of Mechanical Engineering programmes)

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M19C301	Data Structures and Algorithms	3 – 0 – 0	03	3 – 0 – 0	03	III
216M19L301	Data Structures and Algorithms Lab.	0 – 2 - 0	02	0 – 1 – 0	01	III
216M19C401	Object Oriented Programming	3 – 0 – 0	03	3 – 0 – 0	03	IV
216M19L401	Object Oriented Programming Lab.	0 – 2 - 0	02	0 – 1 – 0	01	IV
216M19C501	Operating System	3 – 0 – 0	03	3 – 0 – 0	03	V
216M19L501	Operating System Lab.	0 – 2 - 0	02	0 – 1 – 0	01	V
216M19E6XX	Elective – 1	3 – 0 – 0	03	3 – 0 – 0	03	VI
216M19L6XX	Elective-1 Lab	0 – 2 – 0	02	0 – 1 – 0	01	VI
216M19P701	Mini Project	0 – 4 – 0	04	0 – 2 – 0	02	VII
Total		**12—12 – 0**	**24**	**12 – 6 – 0**	**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme				
		Marks				
		CA		ESE	LAB/CA	Total
		ISE	IA			
216M19C301	Data Structures and Algorithms	30	20	50		100
216M19L301	Data Structures and Algorithms Lab.	-	-	-	50	50
216M19C401	Object Oriented Programming	30	20	50		100
216M19L401	Object Oriented Programming Lab.	-	-	-	50	50
216M19C501	Operating Systems	30	20	50		100
216M19L501	Operating Systems Lab.	-	-	-	50	50
216M19E6XX	Elective – I	30	20	50		100
216M19E6XX	Elective – I Lab	-	-	-	50	50
216M19P701	Mini Project / Internship	-	-	-	50	50
Total		**120**	**80**	**200**	**250**	**650**

Credit Scheme (for students of ETRX and EXTC Engineering programmes)

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Semester of Major Degree
216M19C301	Database Management Systems	3 – 0 – 0	03	3 – 0 – 0	03	III
216M19L301	Database Management Systems Lab.	0 – 2 - 0	02	0 – 1 – 0	01	III
216M19C401	Object Oriented Programming	3 – 0 – 0	03	3 – 0 – 0	03	IV
216M19L401	Object Oriented Programming Lab.	0 – 2 - 0	02	0 – 1 – 0	01	IV
216M19C501	Operating System	3 – 0 – 0	03	3 – 0 – 0	03	V
216M19L501	Operating System Lab.	0 – 2 - 0	02	0 – 1 – 0	01	V
216M19E6XX	Elective – 1	3 – 0 – 0	03	3 – 0 – 0	03	VI
216M19L6XX	Elective – lab 1	0 – 2 – 0	02	0-1-0	01	VI
216M19P701	Mini Project	0 – 4 – 0	04	0 – 2 – 0	02	VII
Total		**12—12 – 0**	**24**	**12 – 6 – 0**	**18**	

Examination Scheme

Course Code	Course Name	Examination Scheme				
		Marks				
		CA		ESE	LAB/CA	Total
		ISE	IA			
216M19C301	Database Management Systems	30	20	50		100
216M19L301	Database Management Systems Lab.	-	-	-	50	50
216M19C401	Object Oriented Programming	30	20	50		100
216M19L401	Object Oriented Programming Lab.	-	-	-	50	50
216M19C501	Operating Systems	30	20	50		100
216M19L501	Operating Systems Lab.	-	-	-	50	50
216M19E6XX	Elective – I	30	20	50		100
216M19E6XX	Elective – I Lab	-	-	-	50	50
216M19P701	Mini Project / Internship	-	-	-	50	50
Total		**120**	**80**	**200**	**250**	**650**

List of Elective – I

Sr No	Course Code	Course Name
01	216 M19E601	Computer Networks
02	216 M19E602	Data Mining
03	216 M19E603	Big Data Analytics
04	216 M19E604	Cloud Computing
05	216 M19E605	Web Programming
06	216 M19E606	Software Engineering

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<tr><th>Course Code</th><th colspan="6">Course Title</th></tr>
<tr><td>216M19C301</td><td colspan="6">Data Structures and Algorithms</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="3">03</td><td>-</td><td>-</td><td>03</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">03</td><td>-</td><td>-</td><td>03</td></tr>
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<tr><td>ISE</td><td>IA</td></tr>
<tr><td>30</td><td>20</td><td>50</td><td colspan="2">-</td><td>100</td></tr>
</table>

Course prerequisites: Programming Language

Course Objectives:

The objective of this course is to introduce different types of data structure and how user can use data structure in software development. The course also familiarizes students with the concepts of advanced data structures such as balanced search trees, hash tables, priority queues, sorting and searching. Students will be master in the implementation of linked data structures such as linked lists and binary trees using any preferable language. Course mainly focuses on choosing the appropriate data structure for a specified application.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1. Explain the different data structures used in problem solving.
CO2. Apply linear and non-linear data structure in application development.
CO3: Describe concepts of advance data structures like set, map & dictionary.
CO4. Demonstrate sorting and searching methods.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Data Structures**		**04**	**CO 1**
	1.1	Defining Data structure, Types of Data Structures, Abstract Data Type (ADT), Static and Dynamic Implementations		
	1.2	Applications of data structures.		
2	**Linear data structures: Linked List, Stack and Queue**		**16**	**CO 2**
	2.1	Introduction and Representation of Linked List, Linked List v/s Array, Implementation of Linked List, Circular Linked List, Doubly Linked List, Application – Polynomial Representation and Addition, Other additional applications/Case study.		
		#Self-learning - Sparse matrix addition		
	2.2	The Stack as an ADT, Stack operations, Array Representation of Stack, Linked Representation of Stack, Application of stack – Polish Notation, Recursion and other applications/Case study.		
		#Self-learning - Application of stack in evaluation of postfix and prefix expression.		
	2.3	The Queue as an ADT, Queue operation, Array Representation of Queue, Linked Representation of Queue, Circular Queue, Priority Queue, and Double ended queue, Application of Queues – Simulation and other applications/Case study.		
		#Self-learning - Application of queue in Josephus's Problem.		
3	**Non-linear data structures: Tree and Graph**		**10**	**CO 2**
	3.1	Basic tree terminologies, Types of trees, Binary tree representation, Binary tree operation, Binary tree traversal, Binary search tree implementation, Threaded binary trees. Different Search Trees -AVL tree, Multiway Search Tree, B Tree, B+ Tree, and Trie, Applications/Case study of trees.		
		#Self-learning Learning – Red-Black and Splay Trees.		
	3.2	Introduction to graph as a data structure, Terminologies, Representation, Traversals – Depth First Search (DFS) and Breadth First Search (BFS). Applications/Case study of Graphs.		
4	**Set, Map and Dictionary**		**7**	**CO 3**
	4.1	Set ADT, Set Implementation, and Partitions with Union-Find operations, Tree based partition implementation.		
	4.2	Map ADT, Implementation, Hash Tables Application of Maps		
	4.3	Dictionary ADT, Implementation, Application of		

		Dictionaries		
	#Self-earning - Exploring case studies on use of set, map and dictionary			
5	**Searching and Sorting**		**8**	**CO 4**
	5.1	Sort Concept, Sort Stability , Bubble Sort, Insertion Sort, Counting Sort		
		#Self-learning - Bucket and Radix sort		
	5.2	Search concept, Linear Search, Binary Search, Hashed List Search, Comparison of searching Techniques		
		Total	**45**	

 # Self-learning topics will be evaluated through IA and/or Lab.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed	*Fundamentals Of Data Structures In C*	University Press	Second Edition 2008
2.	Michael T Goodrich Roberto Tamassia David Mount	*Data Structure and Algorithm in C++*	Wiley	Second Edition 2011
3.	Richard F. Gilberg & Behrouz A. Forouzan	*Data Structures A Pseudocode Approach with C*	CENGAGE Learning	Second Edition 2005
4.	Aaron M Tanenbaum Yedidyah Langsam Moshe J Augentstein	*Data structure Using C*	Pearson	Twelfth Impression 2013
5.	Jean Paul Tremblay, Paul G. Sorenson	*An introduction to data structures with applications*	Tata McGraw-Hill Education	Second Edition 1984

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<tr><td>216M19L301</td><td colspan="5">Data Structures and Algorithms Lab.</td></tr>
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<tr><td>Credits Assigned</td><td colspan="3">-</td><td>01</td><td>-</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
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Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course “Data Structures and Algorithms”. Students will be graded based on continuous assessment of their term work.

Course Code	Course Title			
216M19C301	**Database Management Systems**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme (Hrs./Week)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB CA	Total
	ISE	IA			
	30	20	50	-	100

Course prerequisites:

Data Structure and programming knowledge

Course Objectives:

The objective of the course is to design and program database systems. It covers ER (Entity-Relationship) approach to data modeling, the relational model of Database systems (DBMS) and efficient database design using normalization. It covers Relational Algebra and use of Query Languages such as SQL. This course also introduces Transaction Management, Concurrency Control and Recovery Techniques. The course achieves balance between firm theoretical foundation to designing moderate size databases and creating, querying and implementing realistic databases.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand the features of Relational database management systems.

CO2: Develop relational database design using the designed Entity-Relationship model.

CO3: Use SQL for Relational database creation, maintenance and query processing

CO4: Understand and analyze indexing, hashing, Query processing, query optimization, and Normalization of relational database.

CO5: Apply the transaction, concurrency and recovery techniques

Module No.	Unit No.	Details of Topic	Hrs.	CO
1		**Introduction**	**05**	CO1
	1.1	Introduction, Characteristics of databases, Comparison of File system and Database approach, Users of Database system, Concerns when using an enterprise database		
	1.2	Data Independence, DBMS system architecture, Database Administrator		
2		**Data Modeling: Enhanced-Entity-Relationship Model and Relational Data Model**	**10**	CO2
	2.1	Introduction, Benefits of Data Modeling, Types of Models, Phases of Database Modeling, The Entity-Relationship (ER) Model		
	2.2	Enhanced -Entity-Relationship (EER)- Model Generalization, Specialization and Aggregation		
	2.3	Relational Model:Introduction, Data Manipulation, Data Integrity, Advantages of the Relational Model		
	2.4	Mapping EER Model to Relational Model		
3.		**Relational Algebra and Structured Query Language (SQL),**	**08**	CO2
	3.1	Relational Algebra, Relational Algebra Queries		
	3.2	Overview of SQL, Data Definition Commands, Domain Constraints, Referential integrity		
	3.3	Set operations, aggregate function, null values, Data Manipulation Commands		
	3.4	Data Control commands, Views in SQL, Nested and complex queries, Assertions, Trigger, Security and authorization in SQL		
4		**Query Processing and optimization**	**08**	CO4
	4.1	**Indexing**: Basic concepts, ordered indices: dense and sparse, multilevel indices, secondary indices		
	4.2	**Hashing**: Static hashing, dynamic hashing, comparison of ordered indexing and hashing		
	4.3	**Query processing**: Steps involved in query processing, measures of query cost, algorithms for SELECT and PROJECT operations.		

		4.4	**Optimization**: Overview, Transformation of relational expressions, Estimating statistics, Choice of evaluation plan		
	5	**Relational–Database Design**		**07**	CO4
		5.1	First Normal Form, Pitfalls in Relational-Database designs		
		5.2	Function Dependencies, Armstrong Axioms		
		5.3	2nd, 3rd, BCNF and 4th normal form		
		5.4	Decomposition, desirable properties of decomposition		
		5.5	Overall database design process		
	6	**Transaction Management, Concurrency control and Recovery protocols**		**07**	CO5
		6.1	Transaction concept, Transaction states, ACID properties		
		6.2	Characterizing schedule based on recoverability and serializability		
		6.3	Concurrency Control: Two-Phase Lock-based ,Timestamp-based, Multi-version Concurrency Control, Validation-based protocols, Deadlock Handling-Wait for graph		
		6.4	Recovery System: Recovery concept, Log based recovery, Shadow paging		
			Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1	Elmasri and Navathe	*"Fundamentals of Database Systems"*	Pearson Education	6th Edition
2	Korth, Silberchatz, Sudarshan	*"Database System Concepts"*	McGraw Hill	6th Edition
3	Raghu Ramakrishnan, Johannes Gerhke	*"Database Management Systems"*	McGraw Hill	6th Edition
4	G. K. Gupta	*"Database Management Systems"*	McGraw Hill.	6th Edition

Course Code	Course Title			
216M19L301	**Database Management Systems Lab.**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	-	02	-	02
Credits Assigned	-	01	-	01

Examination Scheme	**Marks**				
	CA		**ESE**	LAB CA	**Total**
	ISE	**IA**			
	--	--	--	50	50

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Database Management Systems". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title			
216M19C401	**Object Oriented Programming**			
	TH	P	TUT	Total
Teaching Scheme (Hrs./Week)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB CA	Total
	ISE	IA			
	30	20	50	-	100

* Batch wise Tutorial

Course prerequisites:

- Basics of Programming concepts

Course Objectives:

This course will provide the concept of object oriented designing and programming using JAVA and C++. These courses also provide differences in Object oriented programming approach in Java and C++. Students will learn about exception handling, Interfaces, file handling, Inheritance and Multithreading.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1. Understand the features of object oriented programming compared with procedural approach with C++ and Java

CO2. Explore arrays, vectors, classes and objects in C++ and Java.

CO3. Implement scenarios using object oriented concepts (Drawing class diagram, relationship between classes).

CO4. Explore the interface, exceptions, multithreading, packages

Module No.	Unit No.	Details	Hrs.	CO
1	**Fundamentals of Object oriented Programming**		04	CO1
	1.1	Introduction, Procedural Programming Approach, Structured Programming Approach, Modular Programming Approach, OOP Approach		
	1.2	Objects and classes, Data abstraction and Encapsulation, Inheritance and Polymorphism, Runtime polymorphism, Static and Dynamic Binding, Exceptions, Reuse, Coupling and Cohesion, Object Oriented Features of Java and C++. Comparing Object Oriented Concepts with Java and C++		
2	**Class, Object, Method and Constructor**		08	CO1, CO2
	2.1	Class Object and Method: member, method, Modifier, Selector, iterator, State of an object, instanceof operator, Memory allocation of object using new operator.		
	2.2	Method overloading & overriding, constructor, destructor, Types of constructor (Default, Parameterized, copy constructor with object), Constructor overloading, this, final, super keyword, Garbage collection.		
3	**Arrays String and vectors**		09	CO2
	3.1	Arrays: Arrays: 1D, 2D, Variable Length array, for-each with Array, Array of objects, Vectors: Vector, ArrayList, Wrapper class. Command line Arguments.		
	3.2	Immutable string ,Methods of String class, String comparison, concatenation, substring, toString method		
	3.3	String-Buffer class, StringBuilder class		
4	**Inheritance and Interface**		08	CO1, CO4
	4.1	Inheritance Types of Inheritance, Final class, abstract class with constructor, abstract and non-abstract methods, super keyword, Method Overriding.		
	4.2	Interface, final keyword Implementing interfaces, extending interfaces Difference between an Abstract class and an Interface		

5	**Class Diagram**		**06**	**CO1, CO 3**
	5.1	Class Diagram		
	5.2	Implementing Aggregation and Association ,composition ,multiplicity ,Generalization		
6	**Exception Handling & Packages, Multithreading**		**10**	**CO4**
	6.1	Packages: Creating Packages, Using Packages, Access Protection, Predefined packages		
	6.2	Exception handling: Exception as objects, Exception hierarchy, Try catch finally Throw, throws		
	6 .3	Multithreading: Thread life cycle, Multithreading advantages and issues, Simple thread program, Thread synchronization.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Herbert schildt	*The complete Reference JAVA7*	Tata McGraw-Hill	7th Edition 2017
2.	Kathy Sierra	*Sun Certified Programmer for JAVA*	McGraw-Hill Edition	6th Edition, 2013
3.	Sachin Malhotra,Saurabh Chaudhary	*Programming in JAVA*	Oxford University	2nd Edition, 2013
4.	E Balagurusamy	*Object Oriented Programming in C++*	Tata McGraw Hill	5th Edition, 2011
5.	Grady Booch,James Rumbaugh,Ivar Jacobson	*Unified Modeling Language*	Pearson Education	3rd Edition
6.	Yashwant Kanetkar	*Let us C++*	BPB publications	16th Edition, 2020
7.	Ralph Bravaco,Shai simoson	*Java Programming from the Group up*	Tata McGraw-Hill	McGraw-Hill Edition

Course Code	Course Title				
216M19L401	**Object Oriented Programming Lab.**				
	TH		**P**	**TUT**	**Total**
Teaching Scheme (Hrs./Week)	--		02	--	02
Credits Assigned	--		01	--	01

Examination Scheme	Marks				
	CA		**ESE**	**LAB CA**	**Total**
	ISE	**IA**			
	--	--	--	50	50

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Object Oriented Programming". Students will be graded based on continuous assessment of their term work.

Module No.	Unit	Details	Hrs	CO

Course Code	Course Title			
216M19C501	Operating System			
	TH	P	TUT	Total
Teaching Scheme (Hrs./Week)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB CA	Total
	ISE	IA			
	30	20	50	-	100

Course prerequisites (if any):
Basics of Computer Organization and architecture

Course Objectives:
1. To introduce basic concepts and functions of operating systems.
2. To understand the concept of process, thread and resource management.
3. To understand the concepts of process synchronization and deadlock.
4. To understand various Memory, I/O and File management techniques.
5. To understand the designing and implementation of system software like Assembler. Macro preprocessor and linker loader**.**

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1: Identify the different system programs and their utility and Explain the fundamental concepts of operating system with extension to Unix and Mobile OS
CO2: Illustrate and analyze the Process, threads, process scheduling and thread scheduling
CO3: Describe the problems related to process concurrency and the different synchronization mechanisms available to solve them.
CO4: Explain disk organization and file system structure with illustration of disk scheduling algorithms
CO5: Understand Storage management with allocation, segmentation & virtual memory concepts

	No.		.	
1	**Introduction to System software**		**7**	
	1.1 1.2 1.3 1.4 1.5 1.5 1.7	Concept, introduction to various system programs such as assemblers, loaders, linkers, macro processors, compilers, interpreters, operating systems, device drivers Operating System Objectives and Functions, The Evolution of Operating Systems OS Design Considerations for Multiprocessor and Multicore architectures Operating system structures, System Calls Linux Kernel and Shell System boot		**CO1**
2	**Process Concept and scheduling**		**8**	
	2..1 2.2 2.3 2.4	Process: Concept of a Process, Process States, Process Description, Process Control Block, Operations on Processes. Threads: Definition and Types, Concept of Multithreading Multicore processors and threads. Scheduling: Uniprocessor Scheduling - Types of Scheduling: Preemptive and, Non-preemptive, Scheduling Algorithms: FCFS, SJF, SRTN, Priority based, Round Robin, Multilevel Queue scheduling. Introduction to Thread Scheduling Linux Scheduling.		**CO2**
3	**Process Concurrency**		**10**	
	3.1 3.2 3.3 3.4	Concurrency: Principles of Concurrency, InterProcess Communication, Process/Thread Synchronization. Mutual Exclusion: Requirements, Hardware Support, Operating System Support (Semaphores and Mutex), Programming Language Support (Monitors) Classical synchronization problems: Readers/Writers Problem, Producer and Consumer problem. Principles of Deadlock: Conditions and Resource Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker"s Algorithm for Single & Multiple Resources, Deadlock Detection and Recovery. Dining Philosophers Problem		**CO3**
4	**Input output and file management**		**8**	
	4.1 4.2	File Management: Overview, File Organization and Access, File Directories, File Sharing, Secondary Storage Management, Linux Virtual File System. I/O Management and Disk Scheduling: I/O Devices, Organization of the I/O Function, Operating System Design Issues, I/O Buffering, Disk Scheduling algorithm: FCFS, SSTF, SCAN, CSCAN, LOOK, CLOOK. Disk Management, Linux I/O.		**CO4**
5	**Storage management**		**12**	
	5.1 5.2	Main Memory: Background, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Segmentation with paging, 32 and 64 bit architecture Examples Virtual Memory: Background, Demand Paging, Page Replacement, Allocation, Thrashing; Allocating Kernel Memory, OS Examples.		**CO5**
Self Learning Component: Androind OS, Cloud OS				
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	William Stallings	Operating System: Internals and Design Principles	Prentice Hall	8th Edition, 2014
2.	Abraham Silberschatz, Peter Baer Galvin and Greg Gagne	Operating System Concepts	John Wiley & Sons , Inc.	9th Edition, 2016
3.	Andrew Tannenbaum	Operating System Design and Implementation	Pearson	3rd Edition
4.	D.M Dhamdhere	Systems programming	Tata Mc-Graw Hill	2^{nd} Edition
5.	Maurice J. Bach	Design of UNIX Operating System	PHI	2^{nd} Edition
6.	J.J Donovan	Systems Programming	Tata McGraw Hill Publishing Company	--
7.	William Stallings	Computer organization and Architecture	Pearson Education	10th edition

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M19L501</td><td colspan="5">Operating System Lab.</td></tr>
<tr><td></td><td colspan="3">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs./Week)</td><td colspan="3">--</td><td>02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="3">--</td><td>01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="6">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td colspan="2" rowspan="2">LAB CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td colspan="2">50</td><td>50</td></tr>
</table>

Distribution of Lab CA:

Criteria	Marks
Experiments performed, journal completion and viva	30
Quiz based on experiments conducted	20
Total	50

Lab CA:

Term work will consist of experiments/ tutorials covering entire syllabus of the course "Operating System". Students will be graded based on continuous assessment of their term work.

Course Code	Course Title			
216M19E601	**Computer Networks**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB CA	Total
	ISE	IA			
	30	20	50	-	100

Course Objectives

1. To introduce concepts and fundamentals of data communication and computer networks.
2. To explore the inter-working of various layers of OSI.
3. To understand and apply IP addressing concepts in network design.
4. To assess the strengths and weaknesses of various routing algorithms.
5. To understand the transport layer and various application layer protocols.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Explain the fundamentals of the data communication networks, reference models, topologies, physical media, devices, simulators and identify their use in day to day networks.
CO2: Demonstrate Data Link Layer, MAC layer technologies & protocols and implement the functionalities like error control, flow control.
CO3: Demonstrate various network layer protocols and network design using IP addressing concepts.
CO4: Demonstrate Transport layer concepts like flow control, error control, congestion, sockets, QoS in wired technology.
CO5: Describe various features and operations of application layer protocols such as Telnet, HTTP, DNS, SMTP.

Module No.	Unit No.	Details	Hrs.	CO
1		**Introduction to networking**	10	CO1
	1.1	Types of Networks: LAN, WAN, MAN. Network Topology (types)		
	1.2	Network Software: Protocol hierarchy, Design Issues for layers, Connection oriented and connectionless services, Reliable and Un-reliable services		
	1.3	OSI and TCP/IP reference model, Comparison of OSI and TCP/IP reference model		
	1.4	Overview of connecting devices, NIC, Repeater, Hub, Bridge, Router, Gateway		
		# Self-Learning: Guided and Un-guided transmission media		
2		**Data Link and MAC Layer**	10	CO2
	2.1	Error Control: Types of Errors; Redundancy, Checksum, Hamming Code and CRC.		
	2.2	Framing, and Flow Control; Flow control Protocols: Stop-and-wait, Go-Back-N, Selective-Repeat, Piggybacking		
	2.3	MAC address; Random Access: ALOHA, slotted ALOHA, Efficiency; CSMA, CSMA/CD, CSMA/CA.		
	2.4	Controlled Access, Channelization, IEEE standards, different Ethernets		
		# Self-Learning: Modular Arithmetic		
3		**Network Layer**	10	CO3
	3.1	Network layer services, IPv4, strategies to bridge the limitations (IP sub netting, CIDR, NAT, Addressing, Options, Extension headers, Packet forwarding, Congestion Control)		
	3.2	ARP, RARP, DHCP and ICMP		
	3.3	IPV6 Addressing		
	3.4	Shortest Path routing, DV, Link state Routing. Unicast protocols:, OSPF, BGP.		
	3.5	Multicast routing protocols: IGMP; Hierarchical Routing , DVMRP		
		# Self Learning: RIP, MOSPF		
4		**Transport Layer: Protocols**	10	CO4
	4.1	Services, Transport layer protocols, UDP, TCP: State Transition diagram, flow control, error control, TCP Timers, Queuing disciplines		

	4.2	TCP Congestion control, SCTP		
	4.3	Quality of Service		
5	**Application Protocols**		**05**	**CO**
	5.1	HTTP, WWW		
	5.2	DNS		
	5.3	FTP, Telnet		
	5.4	SMTP		
		# Self Learning: POP and IMAP		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216M19L601</td><td colspan="5">Computer Networks</td></tr>
<tr><td></td><td colspan="2">TH</td><td>P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme(Hrs.)</td><td colspan="2">-</td><td>02</td><td>-</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td colspan="2">-</td><td>01</td><td>-</td><td>01</td></tr>
<tr><td rowspan="4">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td colspan="2">CA</td><td rowspan="2">ESE</td><td rowspan="2">LAB CA</td><td rowspan="2">Total</td></tr>
<tr><td>ISE</td><td>IA</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>50</td><td>50</td></tr>
</table>

Course Code	Course Title			
216M19E602	**Data Mining**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	**03**	**--**	**--**	**03**
Credits Assigned	**03**	**--**	**--**	**03**

	Marks				
Examination Scheme	**CA**		**ESE**	LAB CA	**Total**
	ISE	**IA**			
	30	**20**	**50**	-	**100**

Course prerequisites (if any): Understanding of basic concepts of Database Management System and algorithms and Data structures**.**

Course Objectives:

1. To introduce the concept of data mining as an important tool for enterprise data management.
2. To enable students to effectively identify sources of data and process it for data mining.
3. To make students well versed in all data mining algorithms like classification clustering and association rule mining and their method of evaluation.
4. To approach business problems analytically by identifying opportunities to derive business values from data.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: To understand the concepts of data mining and its applications in business intelligence.
CO2: Organize and Prepare the data needed for data mining using pre preprocessing techniques.
CO3: Apply & implement appropriate data mining algorithms like classification, clustering on larger data sets.
CO4: Discover interesting patterns from large amounts of data to analyse and extract patterns to solve problems.
CO5: Apply and analyze data mining for Business Intelligence Application.

Module No.	Unit No.	Details	Hrs.	CO
1		**Introduction to data mining (DM)**	03	CO1
	1.1	What is Data Mining; Knowledge Discovery in Database (KDD), What can be Data to be Mined, Related Concept to Data Mining, Data Mining Technique, Application and Issues in Data Mining		
2		**Data Exploration and Data Preprocessing**	06	CO2
	2.1	Types of Attributes; Statistical Description of Data; Data Visualization; Measuring similarity and dissimilarity.		
	2.2	Why Preprocessing? Data Cleaning; Data Integration; Data Reduction: Attribute subset selection, Histograms, Clustering and Sampling; Data Transformation & Data Discretization: Normalization, Binning, Histogram Analysis and Concept hierarchy generation.		
3		**Classification and Prediction**	09	CO3
	3.1	Basic concepts, what is supervised and unsupervised methods, difference between classification and prediction tasks. Decision Tree Induction: Attribute Selection Measures, Tree pruning. Bayesian Classification: Naïve Bayes' Classifier		
	3.2	Prediction methods: Linear and nonlinear regression, Logistic Regression		
	3.3	Accuracy and Error measures, Precision, Recall, Holdout, Random Sampling, Cross Validation.		
4		**Clustering**	08	CO3
	4.1	Cluster Analysis: Basic Concepts Partitioning Methods: K-Means, KMediods; Hierarchical Methods: Agglomerative, Divisive, BIRCH; Density-Based Methods: DBSCAN		
5		**Frequent pattern mining**	09	CO4
	5.1	Market Basket Analysis, Frequent Itemsets, Closed Itemsets, and Association Rules; Frequent Pattern Mining, The Apriori Algorithm for finding Frequent Itemsets, pattern growth approach for mining Frequent Itemsets; Mining Frequent Itemsets using vertical data formats; Introduction to Mining Multilevel Association Rules and Multidimensional Association Rules, Correlation Analysis, lift.		
6		**Business Intelligence**	10	CO5
	5.1	What is Business intelligence? Business intelligence architectures; Definition of decision support system; Development of a business intelligence system using Data Mining for business Applications like Fraud Detection, Clickstream Mining, Market Segmentation, retail industry, telecommunications industry, banking & finance CRM etc.		
		#Self-learning: Business intelligence tools.		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Galit Shmueli, Nitin Patel, Peter Bruce	Data mining For Business intelligence	Wiley Student Edition	
2.	Han, Kamber	Data Mining Concepts and Techniques	Elsevier	2nd edition
3.	Alex berson & Stephen J Smith	Data Warehousing, Data Mining & OLAP	Tata McGraw Hill	
4.	M.H. Dunham	Data Mining Introductory and Advanced Topics	Pearson Education	
5.	Rajiv Sabherwal, Irma Becerra-Fernandez	Business Intelligence: Practices, Technologies and Management	Wiley	1 edition

Course Code	Course Title			
216M19L602	Data Mining			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	-	02	-	02
Credits Assigned	-	01	-	01

Examination Scheme	Marks				
	CA		ESE	LAB CA	Total
	ISE	IA			
	--	--	--	50	50

Course Code	Course Title			
216M19E603	Big Data Analytics			
	TH	P	TUT	Total
Teaching Scheme(Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	CA		ESE	LAB CA	Total
	ISE	IA			
	30	20	50	-	100

Course prerequisites (if any):
Database management system

Course Objectives
Students will try to learn:
1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems in for decision support.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1	Understand the fundamental enabling techniques like Hadoop, MapReduce in achieving Big data analytics
CO2	Associate appropriate technique for finding similarity and dimensionality reduction
CO3	Demonstrate the statistical analysis techniques for decision making

CO4	Interpret business models and scientific computing paradigm for solving real world problems.

Module No.	Unit No.	Details	Hrs.	CO
1		**Introduction to Big Data and mining large scale system**	11	CO1
	1.1	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions.		
	1.2	Introduction to Hadoop and its components		
	1.3	Distributed File Systems: Physical Organization of Compute Nodes, Large-Scale File-System Organization MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.		
	1.4	Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step.		
2		**Finding Similar Items and Dimensionality Reduction**	08	CO2
	2.1	Applications of Near-Neighbor Search- Jaccard Similarity of Sets, Similarity of Documents, Collaborative Filtering as a Similar-Sets Problem.		
	2.2	Distance Measures: Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.		
	2.3	Shingling of Documents, Similarity-Preserving Summaries of Sets, Locality-Sensitive Hashing for Documents, Applications of Locality-Sensitive Hashing		
	2.4	Dimensionality Reduction: Eigenvalues and Eigenvectors of Symmetric Matrices, Principal-Component Analysis, Singular-Value Decomposition CUR Decomposition		
		#Self-learning : Latent factor models, Methods of High degree of similarity		
3		**Mining Data Streams**	06	CO3
	3.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Query, Issues in Stream Processing.		
	3.2	Sampling Data in a Stream: Obtaining a Representative Sample, The General Sampling Problem, Varying the Sample Size.		
	3.3	Filtering Streams: The Bloom Filter, Analysis		
	3.4	Counting Distinct Elements in a Stream: The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements. Estimating Moments Counting Ones in a Window: The Cost of Exact Counts,		

		The Datar-Gionis-Indyk-Motwani Algorithm.		
		Self-learning: Query Answering in the DGIM Algorithm, Decaying Windows.		
4	**Link Analysis And Frequent Itemsets**		**08**	**CO3**
	4.1	PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. Topic sensitive Page Rank,Hubs and Authorities		
	4.2	Handling Larger Datasets in Main Memory Algorithm of Park, Chen, and Yu, All or Most frequent itemsets in two passes.		
		The SON Algorithm and MapReduce, Toivonen's Algorithm		
		Self-learning: link spam, The Multistage Algorithm, The Multihash Algorithm. Counting Frequent Items in a Stream Sampling Methods for Streams, Frequent Item sets in Decaying Windows		
5	**Clustering and Mining Social Network and graphs**		**12**	**CO4**
	5.1	CURE Algorithm, Clustering in Non-Euclidean Spaces Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries		
	5.2	Recommendation Systems – A model for Recommendation systems, Content based recommendation, Collaborative Filtering		
	5.3	Mining Social-Network Graphs – Social networks as graphs, Clustering, Direct discovery of communities, Partitioning of Graphs, Finding overlapping of communities, SimRank, Counting Traingles,		
		#Self-learning : Counting Traingles, Neighborhood properties of graph, Adversting on Web		
Total			**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Anand Rajaraman and Jeff Ullman	Mining of Massive Datasets	Cambridge University Press	Second Edition , 2014
2.	Alex Holmes	Hadoop in Practice	Manning Press, Dreamtech Press.	Second Edition , 2015
3.	Bill Franks	Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics	Wiley	2012
4.	Chuck Lam	Hadoop in Action	Dreamtech Press	2011
5.	Radha Shankarmani M. Vijaylakshmi	Big Data Analytics	Wiley	2st edition, 2018

Course Code	Course Title				
216M19L603	**Big Data Analytics**				
	TH		**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	-		02	-	02
Credits Assigned	-		01	-	01
Examination Scheme	**Marks**				
	CA		**ESE**	LAB CA	**Total**
	ISE	**IA**			
	--	--	--	50	50

Course Code	Course Title					
216M19E604	**Cloud Computing**					
	TH			**P**	**TUT**	**Total**
Teaching Scheme (Hrs.)	**03**			**--**	**--**	**03**
Credits Assigned	**03**			**--**	**--**	**03**
Examination Scheme	**Marks**					
	CA		**ESE**	LAB CA		**Total**
	ISE	**IA**				
	30	**20**	**50**	-		**100**

Course prerequisites:

- Fundamental knowledge on Operating system.
- Basics of client/server programming and network protocols.

Course Objectives:

Cloud computing has evolved as a very important computing model, which enables information, software, and other shared resources to be provisioned over the network as services in an on-demand manner. Students will be exposed to the current practices in cloud computing. Topics may include distributed computing models and technologies, Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), virtualization, performance and systems issues, capacity planning, federated clouds, challenges in implementing clouds, data centers, hypervisor CPU and memory management, cloud hosted applications, and other advanced and research topics in cloud computing.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1 : Describe fundamental and core concepts of cloud computing
CO2: Investigate the system virtualization and outline its role in enabling the cloud computing system model.
CO3 : Develop cloud applications using Aneka platform
CO4 : Analyze and apply cloud programming models to solve problems
CO5 : Configure and experiment with advanced cloud technologies

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction**		8	
	1.1	Cloud Computing at a Glance, Historical Developments, Building Cloud Computing Environments, Computing Platforms and Technologies - Microsoft Azure, Hadoop, Force.com and Salesforce.com, Manjrasoft Aneka		CO1
2	**Virtualization**		12	
	2.1	Introduction, Characteristics of Virtualized Environments , Taxonomy of Virtualization Techniques, Virtualization and Cloud Computing, Pros and Cons of Virtualization,		CO2
	2.2	Technology Examples: Xen: Para virtualization, VMware: Full Virtualization, Microsoft Hyper-V		
	2.3	Cloud Computing Architecture : Cloud Reference Model, Types of Clouds, Economics of the Cloud, Open Challenges,		
		#Self-Learning – Virtual Machine Provisioning and Migration services		
3	**Aneka: Cloud Application Platform**		10	
	3.1	Framework Overview, Anatomy of the Aneka Container, Building Aneka Clouds : Infrastructure Organization, Logical Organization, Private Cloud Deployment Mode, Public Cloud Deployment Mode, Hybrid Cloud Deployment Mode		CO3
	3.2	Cloud Programming and Management - Aneka SDK, Management Tools		
		#Self-Learning - CometCloud: An Autonomic Cloud Engine		
4	**Cloud Infrastructure and Platforms in Industry.**		7	
	4.1	Open Stack: Introduction to open stack, Components of open stack, Amazon Web Services: Compute Services; Storage Services;		CO4
	4.2	Google Cloud Platform, Google AppEngine: Architecture and Core concepts; Application Life Cycle		
		#Self-Learning - The MapReduce Programming Model and Implementation		
5	**Advanced Topics in Cloud Computing**		8	
	5.1	Energy Efficiency in Clouds, Market Based Management of Clouds, Federated Clouds / Inter Cloud, Third Party Cloud Services: MetaCDN, SpotCloud		CO5
	5.2	Dockers and Containers, Micro Services, Cloud automation tools and DevOps concepts		
	5.3	Mobility as a Service (MAAS), JUJU, MBASS		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi	Mastering Cloud Computing	McGraw Hill Education Private Limited	2013
2.	Judith Hurwitz, R.Bloor,M.Kanfman, F.Halper	OpenStack Cloud Computing Cookbook	PACKT Publishing BIRMINGHAM - MUMBAI	Third Edition
3.	J.Vette, Toby J. Vette, Robert Elsenpeter	Cloud Computing: A Practical Approach	Tata McGraw Hill)	1st, 2009
4.	Rajkumar Buyya, James Broberg, Andrzej Goscinski	Cloud Computing, Principles and Paradigms	Wiley	1st ,2013
5.	Tim Mathar, S. Kumaraswammy, S.Latif	Cloud Security & Privacy	O'REILLY	1st , 2009

Course Code	Course Title			
216M19L604	**Cloud Computing**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	-	02	-	02
Credits Assigned	-	01	-	01

Examination Scheme	Marks				
	CA		ESE	LAB CA	Total
	ISE	IA			
	--	--	--	50	50

Course Code	Course Title			
216M19E605	**Web Programming**			
	TH	**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	03	-	-	03
Credits Assigned	03	-	--	03

Examination Scheme	Marks				
	CA		ESE	LAB CA	Total
	ISE	IA			
	30	20	50	-	100

Course prerequisites:

Basic Programming skills.

Course Objectives

Objective of this course is to provide students an overview of the concepts required for development of application based on Web Technologies.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1. Design dynamic web pages using various HTML tags.

CO2. Use CSS to prepare the layout of web pages.

CO3. Apply JavaScript for validation in client side programming.

CO4. Integrate server side pages using php.

CO5. Apply database operations by integrating SQL queries and session variables.

Module No.	Unit No.	Details	Hrs.	CO
1	**HTML,DHTML**			
	1.1	Designing of effective web site, Introduction to different Web Technologies. HTML Tag Reference, Global Attributes, Event Handlers, Document Structure Tags, Formatting Tags, Text Level formatting, Block Level formatting, List Tags, Hyperlink tags, Image and Image maps,	4	1
	1.2	Table tags, Form Tags, Frame Tags, Executable content tags.		
2	**CSS and Bootstrap**		4	2
	2.1	What are style sheets?, Why are style sheets valuable? Different approaches to style sheets, Using Multiple approaches, Linking to style information in separate file, Setting up style information, Using the <LINK> tag, embedded style information, Using <STYLE> tag, Inline style formation		
	2.2	Introduction to Bootstrap, Bootstrap grids, layouts, bootstrap components like iconography, dropdowns, input groups, navigation, alerts. and plugins		
3	**JavaScript**		6	3
	3.1	Introduction to JavaScript, Data Types, Operators, Control Flow, Arrays, and Functions		
	3.2	Making Decisions / Repeating Code; Debugging and Error Handling; Working with DOM and DHTML		
	3.3	Enhancing and Validating Forms		
4	**PHP Programming**		7	4
	4.2	PHP : Why PHP and MySQL?, Server-side web scripting, Installing PHP, Adding PHP to HTML, Syntax and Variables, Passing information between pages, Strings, Arrays and Array Functions, Numbers, Handling basic PHP errors / problems.		
5	**PHP and MySQL**		9	5
	5.1	PHP/MySQL Functions, Displaying queries in tables, Building Forms from queries, String and Regular Expressions, Sessions, Cookies, Integration of complete web application and deployment.		
	5.2	#self learning topic: Study of Laravel framework		

Total	**30**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Thomas Powell	Web Design The complete Reference	Tata McGrawHill	5th edition 2010
2.	Thomas Powell	HTML and XHTML The complete Reference	Tata McGrawHill	5th edition 2010
3.	Thomas Powell and Fritz Schneider	JavaScript 2.0 : The Complete Reference,	Tata McGrawHill	3rd Edition,2013
4.	Steven Holzner	PHP : The Complete Reference	Tata McGrawHill	2nd edition 2008

Course Code	Course Title					
216M19L605	**Web Programming**					
	TH			**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	-			02	-	02
Credits Assigned	-			01	-	01
Examination Scheme	**Marks**					
	CA		**ESE**	LAB CA		**Total**
	ISE	**IA**				
	--	--	--	50		50

Course Code	Course Title					
216M19E606	**Software Engineering**					
	TH			**P**	**TUT**	**Total**
Teaching Scheme(Hrs.)	03			--	--	03
Credits Assigned	03			--	--	03
Examination Scheme	**Marks**					
	CA		**ESE**	**LAB CA**		**Total**
	ISE	**IA**				
	30	20	50	-		100

Course prerequisites (if any):
-

Course Objectives

The Course focusses at developing an understanding of software process models such as the waterfall and evolutionary models. It Further provides, an understanding of software requirements and the SRS documents. The course aims at enabling the students to prepare the system design and test cases for proper testing of the software.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Understand the software development process and Estimate different types of resources for the given project..
CO2: Analyze the software requirements and Model the defined problem with the help of UML diagram.
CO3: Prepare the System Design and Model
CO4: Identify and manage configuration items and risks for the software.
CO5: Test the given software for different test cases with proper test planning

Module No.	Unit No.	Details	Hrs.	CO
1	**The Product and the Process:**		08	CO 1
	1.1	Software life cycle models: Waterfall, RAD, Spiral, Agile process.		
	1.2	Understanding software process, Process metric, CMM levels		
	1.3	Planning & Estimation: Product metrics Estimation- LOC, FP, COCOMO models.		
	1.4	Project Management activities : Planning, Scheduling and Tracking		
2	**Requirement Engineering**		08	CO 2
	2.1	Introduction to OO Methodologies :Booch,Rambaug and Jacobson		
	2.2	Requirements Engineering Tasks, Requirement Elicitation Techniques, Software Requirements: Functional, Non- Functional		
	2.3	Requirements Characteristics, Requirement qualities, Requirement Specification, Requirement Traceability, System Analysis Model Generation, Documentation : Use Case Diagram, Acitvity Diagram		
	2.4	Categorizing classes: entity, boundary and control ,Modeling associations and collections-Class Diagram		
	2.5	Dynamic Analysis - Identifying Interaction – Sequence and Collaboration diagrams, State chart diagram		
3	**System Design Engineering**		7	CO 3
	3.1	Design quality, Classification of Design Activities, Design Concepts: Modularity and Layering, Introduction to Pattern-Based Software Design,		
	3.2	Software Architecture, Data Design, Object-Oriented versus Function-Oriented Design, Design of Software Objects, Methods, Cohesion and Coupling between Objects,		
	3.3	User Interface Design: Rules, User Interface Analysis and Steps in Interface Design, Design Evaluation		
	3.5	Software Reuse, Component-Based Software Engineering		
4	**System Implementation, Configuration Management & Risk Management**		14	CO 4
	4.1	Packages and interfaces: Distinguishing between classes/interfaces, Exposing class and package interfaces		
	4.2	Mapping model to code , Mapping Object Model to Database Schema		
	4.3	Component and deployment diagrams: Describing dependencies		

	4.4	Managing and controlling Changes, Managing and controlling version		
	4.5	Categories of Risks, Nature Of Risk, Types of Risk, Risk Identification, Risk Assessment, Risk planning and control, Risk management, Evaluating risk to schedule, PERT technique.		
5	**Testing and Maintenance**		**8**	**CO 5**
	5.1	Testing Concepts: Purpose of Software Testing, Testing Principles, Goals of Testing, Testing aspects: Requirements, Test Scenarios, Test cases, Test scripts/procedures,		
	5.2	Strategies for Software Testing, Testing Activities: Planning Verification and Validation, Software Inspections,FTR		
	5.3	Levels of Testing : unit testing, integration testing, regression testing, product testing, acceptance testing and White-Box Testing		
	5.4	Black-Box Testing: Test Case Design Criteria, Requirement Based Testing, Boundary Value Analysis, Equivalence Partitioning		
	5.5	Object Oriented Testing: Review of OOA and OOD models, class testing, integration testing, validation testing		
	5.6	Reverse and re-engineering, types of maintenance		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Roger Pressman	Software Engineering	Tata McGraw Hill.	Sixth edition, 2010
2.	Bernd Bruegge	Object oriented software engineering	Pearson Education.	Third Edition, 2009
3.	Ian Sommerville	Software Engineering	Pearson Education	Sixth edition, 2001
4.	John Nicholas, Herman Steyn	Project Management for Business Engineering and Technology	Routledge	5th Edition, 2017
5.	Bob Hughes, Mike cotterell, Rajib Mall	Software Project Management	Tata McGraw Hill	fifth Edition, 2012

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<tr><th>216M19L606</th><th colspan="6">Software Engineering</th></tr>
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<tr><th>Credits Assigned</th><td colspan="3">-</td><td>01</td><td>-</td><td>01</td></tr>
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<tr><th colspan="2">CA</th><th rowspan="2">ESE</th><td colspan="2" rowspan="2">LAB CA</td><th rowspan="2">Total</th></tr>
<tr><th>ISE</th><th>IA</th></tr>
<tr><td>--</td><td>--</td><td>--</td><td colspan="2">50</td><td>50</td></tr>
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