ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 20
(Syllabi for Common Courses)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

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ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21CSC206T	Course Name	ARTIFICIAL INTELLIGENCE	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*School of Computing*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*infer knowledge in problem formulation with AI*
CLR-2:	*exemplify the uninformed and informed search technique procedures for real world problems*
CLR-3:	*understand the adversarial search methods, constraint satisfaction problems and intelligent agents*
CLR-4:	*demonstrate various knowledge representation techniques*
CLR-5:	*infer knowledge about expert systems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*formulate a problem as a state space search method and its solution using various AI techniques*	*1*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*apply appropriate searching techniques to solve a real-world problem*	*1*	*2*	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*develop various game playing strategies to solve real world adversarial search problems*	-	*2*	*2*	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*represent various knowledge representation techniques to solve complex AI problems*	*1*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*design an expert system to implement advance techniques in Artificial Intelligence*	*3*	*2*	*3*	-	-	-	-	-	*2*	-	-	-	-	-	-

Unit-1- Introduction to AI	***9 Hour***
AI techniques, Problem solving with AI, AI Models, Data acquisition and learning aspects in AI, Problem solving- Problem solving process, formulating problems, Problem types and characteristics, Problem space and search, Toy Problems – Tic-tac-toe problems, Missionaries and Cannibals Problem, Real World Problem – Travelling Salesman Problem	
Unit-2- Basic Introduction to Data Structure and Search Algorithms	***9 Hour***
Basic introduction to stacks, queues, trees and graphs - General Search Algorithms – Searching for solutions – Problem-solving agents – Control Strategies – Uninformed Search Methods – Breadth First Search – Uniform Cost Search - Depth First Search -Depth Limited Search – Informed search - Generate and test - Best First search - A Algorithm*	
Unit-3 - Adversarial Search Problems and Intelligent Agent	***9 Hour***
Adversarial Search Methods (Game Theory) - Mini max algorithm - Alpha beta pruning - Constraint satisfactory problems – Constraints – Crypt Arithmetic Puzzles – Constraint Domain – CSP as a search problem (Room colouring). Intelligent Agent – Rationality and Rational Agent – Performance Measures – Rationality and Performance – Flexibility and Intelligent Agents – Task environment and its properties – Types of agents.	
Unit-4 - Knowledge Representation	***9 Hour***
Knowledge Representation -Knowledge based agents – The Wumpus world – Propositional Logic - syntax, semantics and knowledge base building - inferences – reasoning patterns in propositional logic – predicate logic – representing facts in logic: Syntax and semantics – Unification – Unification Algorithm - Knowledge representation using rules - Knowledge representation using semantic nets - Knowledge representation using frames inferences - Uncertain Knowledge and reasoning Methods.	
Unit-5 - Planning and Expert System	***9 Hour***
Planning – planning problem – Simple planning agent – Blocks world problem – Mean Ends analysis Learning - Machine learning - Learning concepts, methods and models Introduction to expert system – architecture of expert systems.	

Learning Resources	1. *Deepak Kemhani, First course in Artificial Intelligence, McGraw Hill Pvt Ltd, 2013* 2. *Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson Education, 2020.*	3. *Parag Kulkarni, Prachi Joshi, Artificial Intelligence –Building Intelligent Systems, 1st ed., PHI learning, 2015* 4. *Data Structures Schaum's Outlines Series, Seymour, Lipschutz, 2014.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*15%*	-	*15%*	-	*15%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*25%*	-	*25%*	-	*25%*	-
Level 5	*Evaluate*	*20%*	-	*20%*	-	*20%*	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Tejas Gowda, Co-Founder & Chief Data Scientist, tenzai*	1. *Dr. T. Senthilkumar, Associate Professor, Amrita School of Engineering, Amrita Vishwa Vidyapeetham*	1. *Dr. A. Alice Nithya, SRMIST*
		2. *Dr. K. Senthil Kumar, SRMIST*

ACADEMIC CURRICULA

Open Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21ASO301T	Course Name	ELEMENTS OF AERONAUTICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*describe the art of flying*
CLR-2:	*discuss the various types of aircraft configuration, control systems and instruments*
CLR-3:	*explain about the atmosphere and variation in properties, aircraft flight and different speed regimes*
CLR-4:	*explain the basics of aircraft structures and the aerospace materials*
CLR-5:	*describe about the various propulsion systems used in aerospace industry*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		engineering knowledge	problem analysis	design/development of solutions	conduct investigations of complex problems	modern tool usage	the engineer and society	environment & sustainability	ethics	individual & team work	communication	project mgt. & finance	life long learning	pso-1	pso-2	pso-3
CO-1:	*discuss the evolution of aircraft and their types*	*3*	-	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-2:	*describe the various types of aircraft configuration, control systems and instruments*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*describe about the atmosphere and variation in properties, aircraft flight and different speed regimes*	*3*	*1*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*explain the basics of aircraft structures and the aerospace materials*	*3*	-	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-5:	*demonstrate about the various propulsion systems used in aerospace industry*	*3*	-	-	-	-	-	-	-	-	-	-	*1*	-	-	-

Unit-1 - History of Flight	***9 Hour***
Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years	
Unit-2 - Aircraft Configurations and its Controls	***9 Hour***
Different types of flight vehicles, Classifications-Components of an airplane and their functions - Conventional control, powered control- Basic instruments for Flying -Typical systems for control actuation	
Unit-3 - Basics of Aerodynamics	***9 Hour***
Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Manoeuvres	
Unit-4 - Basics of Aircraft Structures	***9 Hour***
General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and Strains-Hooke's law- stress-strain diagrams - elastic Constants-Factor of Safety.	
Unit-5 - Basics of Propulsion	***9 Hour***
Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust Production – Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space	

Learning Resources	
	1. *Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015*
	2. *E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021*
	3. *Clancy L.J.., Aerodynamics, 2nd ed., Sterling book house 1975*
	4. *Sadhu Singh, "Internal Combustion Engines and Gas Turbine", SS Kataraia& Sons, 2015*
	5. *Kermode, "Flight without Formulae", Pitman; 4th revised edition 1989.*
	6. *McKinley, J.L., R.D. Bent, Aircraft Power Plants, McGraw Hill 1993*
	7. *Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.*

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	50%	-	50%	-
Level 2	Understand	50%	-	50%	-	50%	-
Level 3	Apply	-	-	-	-	-	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Wg.CdrK. Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	1. Dr. A. P. Haran, Park College of Engineering & Technology, ap_haran@rediffmail.com	1. Dr. T. Selvakumaran, SRMIST
2. Wg.Cdr R.Annamalai, Chief training co-ordinating officer IAF,Tambaram.annamalai.ramasamy2@gmail.com	2. Dr.S. Nadaraja Pillai, Sastra university Thanjavur, nadarajapillai@mech.sastra.edu	2. Mr. G. Mahendra Perumal, SRMIST

Course Code	21ASO302T	Course Name	CREATIVITY, INNOVATION AND NEW PRODUCT DEVELOPMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*explain the process of technological innovation, creativity and problem-solving methods*
CLR-2:	*discuss the ideas, criteria and techniques for project selection*
CLR-3:	*identify the project evaluation techniques and describe the factors for product screening*
CLR-4:	*discuss the importance of patent search and patent laws, as well as the role and classifications of IPR*
CLR-5:	*explain the steps involved in new product development process*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*describe the technological innovation process and identify the need for creativity & innovation in engineering*	*3*	*1*	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-2:	*explain the project selection ideas as well as the various criteria and measures adopted during project selection*	*3*	*1*	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-3:	*describe the factors for product screening and identify the project evaluation techniques*	*3*	*2*	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-4:	*explain IPR & its types and discuss the objective of patent laws, WIPO, TRIPS, WTO, PCT*	*3*	*1*	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-5:	*describe the process of new product development and discuss the need, purpose & methods of marketing research*	*3*	*2*	-	-	-	-	-	-	-	-	-	*1*	-	-	-

Unit-1 - Introduction	***9 Hour***
Introduction-The process of technological innovation-Factors contributing to successful technological innovation-Examples for the factors-Technological milestones-Technological evolution-The need for creativity for individual and nation-The need for innovation for individual and nation-Creativity -Obstacles-Problem solving-Obstacles-Creativity -keys and questions-Problem solving-keys and questions-Brain Storming-Examples-Different techniques for creative intelligence-Detailed explanation with examples-Case Study on technology innovation-Example	
Unit-2 - Project Selection	***9 Hour***
Collection of ideas-Categories of ideas-Different routes for collecting ideas-Examples-Taking different views, Combining the unusual-Examples-Adapt, adopt & improve - Breaking the rules - Challenge the assumptions - sking searching questions - Increasing the yield - Implementation methods - Purpose and types, Indian National Technology Missions-Detailed explanation-Project selection criteria -Analysis methods-Case Study- on project selection - Example	
Unit-3 - Project Evaluation	***9 Hour***
Introduction to project evaluation-Preliminary Methods-Screening Methods-Examples-Product life cycle-Different organizations-Product evaluation profile- Stability factors-Growth factors-Marketability factors-Research factors-Development factors-Position factors- Production factors-Value Engineering-Need for value engineering-Case Study on project evaluation - Example	
Unit-4 - New Product Developments	***9 Hour***
Evaluation of IPR-4 traditional forms-Definition of IPR-Development of 7 types of IPR-Need for IPR in India-Patentable Innovation-Obligations-Enforcement Measures-Patent search and its advantages-IP Council-International Treaties-Conventions-WIPO-TRIPS- WTO-PCT-Case Study-4 on IPR-Example	

Unit-5 - New Product Planning	***9 Hour***
Design of product prototype-Factors of design-Requirement of design-Design process-Functional design-Functional margins-Test and Qualification-Types of tests and their significance-Test plan-Issues in concluding a test-Quality standards-Product Strategy-Six-sigma Practice Procedure-Implementation-Marketing- methods-Marketing- research-Case Study -5 on product development-Example	

Learning Resources	1. *Keleen A.L., New Product Planning and Development, International Correspondence Schools Division, Scraton, Pennsyvania, 1969* 2. *Paul Sloane, The Leader's Guide to Lateral Thinking Skills, 2nd ed., Kogan Page India, New Delhi, 2008, Department of Space: IPR Manual, Bangalore, 2007* 3. *Khandwalla, R.N., Fourth Eye (Excellence through creativity), Wheeler Publishing, Allahabad, 1992.*	4. *Osho,Creativity – Unleashing the Forces Within, St Martin's Griffin, New York, March, 2007* 5. *Abdul Kalam.A.P.J., Arun Tiwari, "Wings of Fire", Universities Press, Hyderabad,1999, Edward de Bono, How to have a beautiful mind, Vermilon, London, 2004* 6. *Rajiv.V.Dharaskar, Innovation-Growth Engine for Nation. Nice Buzzword but often Misunderstood, www.dharaskar.com Annamalai.N., www.creativitysphere*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*50%*	-	*50%*	-	*50%*	-
Level 2	*Understand*	*50%*	-	*50%*	-	*50%*	-
Level 3	*Apply*	-	-	-	-	-	-
Level 4	*Analyze*	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. D. Saji, National Aerospace Laboratories, Bangalore, saji@nal.res.in*	1. *Dr. V. Arumugam, Madras Institute of Technology, Chennai, arumugam.mitaero@gmail.com*	1. *Dr. S. Gurusideswar, SRMIST*
2. *Dr. Manoj Kumar Buragohain, Defense Research and Development Organization, Hyderabad,ragohainm@yahoo.com*	2. *Dr. K. Vadivuchezhian, National Institute of Technology Karnataka, Surathkal, vadivuchezhian_k@yahoo.co.in*	2. *Dr. K. Saravanakumar, SRMIST*

Course Code	21ASO303T	Course Name	AVIATION AND AIRLINE MAINTENANCE MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*explain the concepts of Air transportation and Airline management*
CLR-2:	*explain the concept of Airline forecasting and fleet planning*
CLR-3:	*discuss the significance of airline scheduling and equipment maintenance*
CLR-4:	*describe the concepts of Aircraft reliability and aging aircraft maintenance*
CLR-5:	*discuss the aviation supporting organization and state regulatory*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*describe the organization details in air-transportation*	*3*	-	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-2:	*describe the forecasting methods in airline*	*3*	-	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-3:	*summarize the scheduling process and maintenance of aircraft*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*explain the aging aircraft maintenance*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*summarize the aviation supporting organizations and state regulatory*	*3*	-	-	-	-	-	-	-	-	-	-	*1*	-	-	-

Unit-1 - Air Transportation	***9 Hour***
International Aviation Association - IATA – General Aviation Classification - Factors Affecting General Aviation Industry - Aircraft Uses - Airport classification - Airline Management Levels of Management Functions of management - Chart Line management	
Unit-2 - Airline Managerial Aspect	***9 Hour***
Airline Forecasting - Fleet Planning - Aircraft Selection Process - Passenger Capacity - Load Factor - Passenger Fare and Tariffs - Influence of Geographical, Economic and Political Factors on Routes and Route Selection - Fleet Commonality - Factors Affecting Fleet - Choice Valuation and Depreciation - Budgeting - Cost planning - Aircrew Analysis - Route Analysis - Aircraft evaluation	
Unit-3 - Airline Scheduling	***9 Hour***
Mission of Airline scheduling - Equipment maintenance - Maintenance system of a jet aircraft - Objective of ground service - Ground operations and facility limitations - Schedule planning and coordination - Traffic flow - Schedule salability - Schedule Adjustment - Chain reaction effect - Load factor leverage - Equipment's and types of schedule - Preparing flight plans - Aircraft scheduling in line with aircraft maintenance practice - Hub and spoke scheduling	
Unit-4 - Aircraft Reliability	***9 Hour***
Parameters to monitor Maintenance schedule - Maintenance program - Condition monitoring maintenance -ETOPS - Maintenance versus Conventional Maintenance - ETOPS for Non-ETOPS Airplanes - Aircraft depressurization - Aging Aircraft Maintenance in aging aircraft - Operating cost associated with maintenance - Helicopter maintenance - Maintenance schedule	
Unit-5 - Aviation Supporting Organizations	***9 Hour***
organization - State regulatory - Responsibilities and functions of FAA - DGCA - functions of DGCA - Turbine engine monitoring - On board maintenance system - Life usage monitoring - Technology in aircraft maintenance - Introduction and Functions of Technical Publications, Airline Libraries, Control of Publications, Document Distribution	

Learning Resources	1. *John G Wensveen, Air Transportation – A Management Perspective, Ashgate Publications, 8th ed., 2015* 2. *Friend C.H.,Aircraft Maintenance Management,Longman aviation technology.2nd ed.,1992*	3. *Indian Aircraft Manual, DGCA, sterling book House, Mumbai, reprint 2014* 4. *Aviation maintenance management Harry.A.Kinnison, Second edition McGraw-Hill 2013* 5. *PS Senguttuvan, Fundamentals of air transport management, excel books, reprint 2010*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*50%*	-	*50%*	-	*50%*	-
Level 2	*Understand*	*50%*	-	*50%*	-	*50%*	-
Level 3	*Apply*	-	-	-	-	-	-
Level 4	*Analyze*	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Wg.Cdr retd. Manoharan, Continuing Airworthiness Manager, Blue Dart Aviation. manoharank@bluedart.comS*	1. *Dr. V.Arumugam, Madras Institute Of Technology Campus, Anna University, Chennai, arumugam.mitaero@gmail.com*	1. *Dr. S. Sivakumar, SRMIST*
2. *Wg.cdr R.Annamalai, Chief training co-ordinating officer IAF,Tambaram anamalai.ramasamy2@gmail.com*	2. *Dr.S.Nadaraja pillai, Sastra university Thanjavur, adarajapillai@mech.sastra.edu*	2. *Mr. K. Iyenthezhuthon, SRMIST*

Course Code	21ASO304T	Course Name	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	identify ground handling tools and equipment's to perform ground handling operation of aircraft
CLR-2:	maintain the aircraft ground servicing units
CLR-3:	summarize the safety aspects and improve the human relations in working environment
CLR-4:	work in the planning process environment of maintenance industry
CLR-5:	maintain the tools, accessories and components

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	explain the operation of various ground handling equipment's and its procedures	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-2:	restate the utility of aircraft ground servicing units and their maintenance	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	describe the various aspects of human performance factors	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-4:	discuss about different maintenance operational procedures	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	explain the various precision instruments and special tools	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-

Unit-1 - Aircraft Ground Handling — **9 Hour**

Mooring, jacking, levelling and towing operations – Preparation – Equipment – precautions - Engine starting procedures – Piston engine, turboprops and turbojets - Engine fire extinguishing. - Ground Power Units.

Unit-2 - Maintenance and Handling of Ground Equipments — **9 Hour**

Air Starter Unit - Portable Hydraulic Test Stand - Electric power supply equipment - Air-conditioning Unit - Oil Pressure Unit - Jacks, Cranes, Ladders, Platforms, Trestles & Chocks.

Unit-3 - Human Performance and Limitations — **9 Hour**

The need to take human factors into account, Incidents attributable to human factors/human error, Murphy's law. Vision, Hearing, Information processing, Attention and perception, Memory, Claustrophobia and physical access.

Unit-4 – Inspection — **9 Hour**

Inspection Process, Purpose, Types - Inspection intervals – Techniques – Checklist - Special inspection – Publications, bulletins, various manuals – FAR Air worthiness directives. - Type certificate Data Sheets – ATA specifications.

Unit-5 - Aircraft Hardware and Materials — **9 Hour**

Hand tools – Precision instruments – Special tools and equipment in an airplane maintenance shop - Identification terminology – Specification and correct use of various aircraft hardware - American and British systems of specifications – Threads, gears, bearings – Drills, tapes & reamers.

Learning Resources

1. *Airframe and Power plant Mechanics, General Hand Book, Federal Aviation Administration, and AC65 - 9A.*
2. *Airframe and Power plant Mechanics, Airframe Hand Book, Federal Aviation Administration, and AC65- 15A.*
3. *Michael J.Kroes, William A.Watkins ad Frank Delp, Aircraft Maintenance and Repair, 7 th ed., Tata McGraw Hill, New Delhi, 2013.*
4. *CAP 715 – An Introduction to Aircraft Maintenance Engineering Human Factors for JAR 66, Civil Aviation Authority, UK.*

Learning Assessment							
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*50%*	-	*50%*	-	*50%*	-
Level 2	*Understand*	*50%*	-	*50%*	-	*50%*	-
Level 3	*Apply*	-	-	-	-	-	-
Level 4	*Analyze*	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Wg.Cdr retd. Manoharan, Continuing Airworthiness Manager,Blue Dart Aviation.manoharank@bluedart.com*	1. *Dr. V.Arumugam, Madras Institute Of Technology Campus, Anna University, Chennai, arumugam.mitaero@gmail.com*	1. *Dr. S. Sivakumar, SRMIST*
2. *Wg.cdr R.Annamalai,Chief training co-ordinating officer IAF, Tambaram annamalai.ramasamy2@gmail.com*	2. *Dr.S.Nadaraja Pillai, Sastra university Thanjavur, nadarajapillai@mech.sastra.edu*	2. *Mr. G. Mahendra Perumal, SRMIST*

Course Code	21ASO305T	Course Name	FLOW VISUALIZATION TECHNIQUES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*describe the flow visualization techniques in fluid flows*
CLR-2:	*select the appropriate equipment required for performing flow visualization experiment*
CLR-3:	*identify the techniques for performing flow visualization in air and water*
CLR-4:	*visualize the density gradients and shocks in compressible flows*
CLR-5:	*examine the lased based optical techniques for flow visualization applications*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply the principles of fluid flows for flow visualization application*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*list the equipment required for flow visualization experiments*	*3*	*2*	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-3:	*perform flow visualization in air and water*	*3*	*2*	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-4:	*illustrate the flow field in supersonic flows*	*3*	*2*	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-5:	*apply advanced flow visualization techniques to fluid flows*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fluid Flows	***9 Hour***
Brief history of fluid mechanics, Properties of fluids, fluid statics, flow kinematics, types of flows, Fluid Flow description, Conservation laws, Continuity and Navier-Stokes equation, Bernoullis equation and its applications, Boundary layer and separation, Reynolds number and Mach number	
Unit-2 - Flow Visualization Set-Ups and Equipments	***9 Hour***
Wind Tunnels and their classification - Subsonic and Supersonic Wind Tunnels, Smoke Tunnel, Hele-Shaw apparatus, Reynolds apparatus, Water Tunnel, Photographic equipment and techniques, Lab Demonstration of various set-ups	
Unit-3 - Flow Visualization in Incompressible Flows	***9 Hour***
Flow visualization in air – Smoke generator, Smoke rake technique, Smoke-wire technique, Surface oil flow visualization, Tufts Visualization, Flow Visualization in water – Conventional and Fluorescent dyes, Methods of dye injection, Hydrogen bubble technique, Lab Demonstration of visualizations	
Unit-4 - Flow Visualization in Compressible Flows	***9 Hour***
Optical Techniques, Gladstone-Dale Relation, Shadowgraph, Schlieren, Lab demonstration of Schlieren Technique, Background Oriented Schlieren (BOS)	
Unit-5 - Advanced Laser Based Optical Techniques	***9 Hour***
Particle Image Velocimetry (PIV) - PIV Setup components and procedure - Image Correlation and Post processing of PIV Data, Stereo PIV and Tomo PIV, Planar Laser Induced Fluorescence for combustion applications, Pressure Sensitive Paints, Temperature Sensitive Paints	

Learning Resources	1. *Rathakrishnan, Ethirajan. Instrumentation, measurements, and experiments in fluids. CRC press, 2007.* 2. *Smits, Alexander J. Flow visualization: techniques and examples. World Scientific, 2012.* 3. *Tropea, C., Yarin, A. L., & Foss, J. F. (Eds.). (2007). Springer handbook of experimental fluid mechanics. Berlin: Springer.*	4. *Barlow, Jewel B., William H. Rae, and Alan Pope. Low-speed wind tunnel testing. John wiley & sons, 1999.* 5. *Discetti, Stefano, and Andrea Ianiro, eds. Experimental aerodynamics. CRC Press, 2017.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*60%*	-	*60%*	-	*60%*	-
Level 4	*Analyze*	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Saurav Kumar Ghosh, CSIR-NAL, Bangalore skghosh@nal.res.in*	1. *Dr. Lakshmana Dora C, IIT Hyderabad lchandrala@mae.iith.ac.in*	1. *Dr. K K Bharadwaj, SRMIST*
2. *Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in*	2. *Dr. Arun Kumar Perumal, IIT Kanpurakp@iitk.ac.in*	2. *Dr. S Senthilkumar , SRMIST*

Course Code	21ASO306T	Course Name	AIRPORT ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*explain about airports and surveys*
CLR-2:	*describe about airport planning and forecasting*
CLR-3:	*contrast and design runway and taxiways*
CLR-4:	*explain air traffic control tower and terminal areas and Air cargo*
CLR-5:	*discuss about heliports, STOL ports and vertiports*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*describe airports and surveys involved*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*explain airport planning and forecasting*	*2*	-	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-3:	*differentiate interpret and design runway and taxiways*	*2*	-	-	-	-	-	-	-	-	-	-	*1*	-	-	-
CO-4:	*describe about air traffic control tower and terminal areas*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*differentiate interpret about heliports, STOL ports and vertiports*	*2*	-	-	-	-	-	-	-	-	-	-	*1*	-	-	-

Unit-1 - Airport Survey	***9 Hour***
National and International Organizations - Aircraft Characteristics - Civil and military aircrafts - Airport Definitions- Categories and Codes of airports - Flying Activities - Scheduled and non-scheduled flights - Airport Survey - Objectives and types of survey - Drawings to be Prepared - Types of plan	
Unit-2 - Airport Planning	***9 Hour***
Improvement of existing Airport - Airport site selection - Factors affecting size of airport - Aviation Forecasting - Airport obstructions - Imaginary surface - Objects with actual height - Airport zones - Zoning Laws- Environmental considerations - Factors influenced by airport activity - Pollution, Social factor	
Unit-3 - Runway and Taxiway Design	***9 Hour***
Runway orientation - Change in direction of runway - Basic runway length - Runway patterns - Comparison of runway patterns - Taxiway design - Layout of taxiways - Geometric standards for taxiway - Exit taxiways - Location of exit taxiway - Design of exit taxiways - Apron Types - Fillets - Separation Clearance - Bypass or turnaround taxiway	
Unit-4 - Terminal Area and ATC and Air Cargo	***9 Hour***
Terminal building - Passenger Flow- Apron - Hangars - Typical airport layout - Air Traffic Control - Flight Rules - ATC Network - ATC Aids - Automation in ATC- Factors affecting the size of cargo terminal - Apron cargo handling	
Unit-5 - Visual Aids, Heliport and STOL Ports, Vertiports	***9 Hour***
Requirements of pilot for visual aids - Airport Marking - Guidance to pilots during landing - elements of airport lighting- Heliport - Planning of heliport - Elevated heliport - Marking and lighting of heliport - STOL ports - Characteristics of STOL - Aircraft Planning of STOL Port - Runway and taxiway of STOL port - Lighting of STOL Port - Marking of STOL Port -Planning and design of Vertiports	

Learning Resources	1. *Rangwala. Airport Engineering, Charotar Publishing House Pvt. Ltd.; 17th Edition (1 January 2018)* 2. *FAA Advisory Circular - Airport Design 150/5300-13B - March 2022*	3. *Norman J. Ashford, Saleh A. Mumayiz, Paul H. Wright. Airport Engineering: Planning, Design and Development of 21St - Century Airports", 4th ed., CBS Publishers & Distributors. April 2011* 4. *Airport Engineering - planning and design- Saxena S.C.CBS Publishers & Distributors*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*50%*	-	*50%*	-	*50%*	-
Level 2	*Understand*	*50%*	-	*50%*	-	*50%*	-
Level 3	*Apply*	-	-	-	-	-	-
Level 4	*Analyze*	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Wg.Cdr retd. Manoharan, Continuing Airworthiness Manager,Blue Dart Aviation.manoharank@bluedart.com*	1. *Dr. V.Arumugam, Madras Institute Of Technology Campus, Anna University, Chennai, arumugam.mitaero@gmail.com*	1. *Dr. S. Sivakumar, SRMIST*
2. *Wg.cdr R.Annamalai,Chief training co-ordinating officer IAF, Tambaram annamalai.ramasamy2@gmail.com*	2. *Dr.S.Nadaraja pillai, Sastra university Thanjavur, nadarajapillai@mech.sastra.edu*	2. *Mr. K. Iyenthezhuthon, SRMIST*

Course Code	21ASO307T	Course Name	MOLECULAR GAS DYNAMICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*discuss need for molecular description of fluid flow, binary collision and the Boltzmann equation*
CLR-2:	*explain the significance of elastic and inelastic collision*
CLR-3:	*interpret the chemical reactions and thermal radiation with respect to engineering problem*
CLR-4:	*describe importance of collisionless flow*
CLR-5:	*explain the numerical technique for microscopic and mesoscopic method*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*define the importance of molecular perspective fluid flow, binary collision and need for Boltzmann equation*	*1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*explain the difference between inelastic and elastic collision and its significance*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*examine the role of bimolecular reactions and termolecular reactions in chemical reaction*	*2*	-	-	-	-	-	-	-	-	-	-	*2*	-	-	-
CO-4:	*describe the significance of collisionless flow*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*demonstrate the need for mesoscopic and microscopic numerical technique for fluid flow*	*3*	-	-	-	-	-	-	-	-	-	-	*2*	-	-	-

Unit-1 - Introduction to Kinetic Theory ***9 Hour***

Gaskinetic theory, Molecular model, the simple dilute gas, real gas effects, macroscopic properties in a simple gas. Equilibrium Kinetic theory: Distribution function, phase space distributions, macroscopic averages, the Maxwell-Boltzmann distribution

Unit-2 - Binary Collision ***9 Hour***

The Boltzmann Equation: The evaluation of the phase space distribution function, the Boltzmann collision integral, The H-theorem, BGK approximation. Elastic collision dynamics, collision models, Maxwell model. Inelastic collision models: Larsen-Borgnakke model, The general Lasren-Borgnakke distribution, vibrational and electronic energy, gas-surface interaction.

Unit-3 - Chemical Reaction and Thermal Radiation ***9 Hour***

Collision theory for bimolecular reactions, reaction cross-sections for given reaction rates. Extension to termolecular reactions, chemical equilibrium, The equilibrium collision theory. The dissociation reaction, recombination reaction, the exchange and ionization reactions. Classical model for rotation radiation, bound-bound thermal radiation

Unit-4 - Collisionless Flows ***9 Hour***

Bimodal distributions, molecular effusion and transpiration, one-dimensional flows, Transfer of normal, tangential momentum, transfer of translational energy, free molecular heat transfer, recovery temperature, Stanton number and thermal recovery factor. Thermophoresis, flows with multiple reflection, test-particle Monte Carlo method, variance reduction

Unit-5 - Computational Techniques for Mesoscopic and Microscopic Methods ***9 Hour***

Direct Simulation Monte Carlo, Lattice Boltzmann Method: Lattice gas automata (LGA), LGA to lattice Boltzmann equation, algorithm, boundary and initial conditions. Molecular Dynamics: the force calculation, integrating equations of motion, solutions methods.

Learning Resources	1. *Gombosi, Tamas I., and Atmo Gombosi. Gaskinetic theory. No. 9. Cambridge University Press, 1994.* 2. *Bird, Graeme A., and J. M. Brady. Molecular gas dynamics and the direct simulation of gas flow Vol. 5. Oxford: Clarendon press, 1994* 3. *Kruger, Ch H., and W. G. Vincenti. "Introduction to physical gas dynamics." John Wlley & Sons (1965).*	4. *Frenkel, Daan, et al. "Understanding molecular simulation." Computers in Physics 11.4 (1997): 351-354.* 5. *Anderson, John David. Modern compressible flow: with historical perspective. Vol. 12. New York: McGraw-Hill, 1990.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	20%	-	20%	-	20%	-
Level 2	*Understand*	20%	-	20%	-	20%	-
Level 3	*Apply*	60%	-	60%	-	60%	-
Level 4	*Analyze*	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mrs. Smrutisudha Sahoo, DRDO s.sahoo.pxe@gov.in*	1. *Dr. Rakesh Kumar, Indian Institute of Technology Kanpur rkm@iitk.ac.in*	1. *Dr. Malaikannan G, SRMIST*
2. *Mr. Dhanabal K, S & I Engineering Solutions Pv.t. Ltd. dhanabal@sandi.co.in*	2. *Dr. Arun Kumar P, Indian Institute of Technology Kanpur akp@iitk.ac.in*	2. *Dr. Aravindh Kumar S M, SRMIST*

Course Code	21AIO351T	Course Name	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Computational Intelligence*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*analyze the various characteristics of Intelligent agents*
CLR-2:	*organize different search strategies in AI*
CLR-3:	*incorporate knowledge in solving AI problems*
CLR-4:	*construct in different ways of designing software agents*
CLR-5:	*plan various applications of AI*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*use appropriate search algorithms for any AI problem*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*represent a problem using first order and predicate logic*	*3*	*3*	*3*	-	*2*	*3*	-	-	-	-	-	-	-	-	-
CO-3:	*provide the apt agent strategy to solve a given problem*	*3*	*3*	*2*	-	*2*	-	-	-	-	-	-	-	-	-	-
CO-4:	*design software agents to solve a problem*	*3*	*1*	*3*	-	*2*	*3*	-	-	-	-	-	-	-	-	-
CO-5:	*develop application that uses Artificial Intelligence*	*3*	*1*	*3*	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction	***9 Hour***
Introduction, Definition, Future of Artificial Intelligence, Characteristics, Typical Intelligent agents, Problem solving approach, Search strategies, Uniformed and informed, Heuristics, Local search, Algorithm and optimization problems, Constraint satisfactory problems, Constraint propagation, Back tracking search, Game playing, Optimal decision	
Unit-2 – Predicate Logic and Knowledge Representation	***9 Hour***
Alpha beta pruning, First order predicate logic, Porlog programming, Unification, Forward Chaining, backward chiming Resolution, Knowledge Representation, Events, Mental Events, Mental Objects, Reasoning Systems, Reasoning with default information, Typical AI Problems	
Unit-3 – Intelligent Agents	***9 Hour***
Architecture for intelligent agents, Agent communication, Negotiation, Bargaining, Argumentation, Agents, Trust, Reputation, Multi agent systems, AI applications, Language Models, Information Retrieval, Information extraction, Natural language processing, Machine translation, Speech recognition, Robot Hardware, Perception	
Unit-4 – Inference Engine	***9 Hour***
Planning, Moving, Frames, Scripts, Goals, Plans, Inheritance in Taxonomies, Description logics, Formal concept analysis, Conceptual graphs, Hierarchies in domain, Knowledge based reasoning, Agents, Facts of knowledge, Logic and inference, Formal logic, Propositional logic	
Unit-5 – Optimization Techniques	***9 Hour***
Resolution method, first order logic, second order logic, Genetic algorithms, Travelling salesman problem, Neural networks, Ant colony optimization, Generate and search, Depth first search – Breadth First Search, Quality of Solution, Depth bounded DFS, Hill climbing, Beam search	

Learning Resources	1. *S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach‖, Prentice Hall, Third Edition, 2009.* 2. *Bratko, —Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison- Wesley Educational Publishers Inc., 2011* 3. *M. Tim Jones, —Artificial Intelligence: A Systems Approach (Computer Science) ‖, Jones and Bartlett Publishers, Inc.; First Edition, 2008* 4. *Nils J. Nilsson, —The Quest for Artificial Intelligence‖, Cambridge University Press, 2009.*	5. *William F. Clocksin and Christopher S. Mellish, Programming in Prolog: Using the ISO Standard‖, Fifth Edition, Springer, 2003.* 6. *Gerhard Weiss, —Multi Agent Systems‖, Second Edition, MIT Press, 2013.* 7. *David L. Poole and Alan K. Mackworth, —Artificial Intelligence: Foundations of Computational Agents‖, Cambridge University Press, 2010.* 8. *"A First Course in Artificial Intelligence", Deepak Khemani, McGraw Hill Education, 2013.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Marriappan Vaithilingam, Senior Director of Engineering, Fresh works*	1. *Dr. Udendran, Dept. of CSE., Bharathidasan University, Tiruchirappalli*	1. *Dr. A. Alice Nithya, SRMIST*
		2. *Mr. Joseph James, SRMIST*

Course Code	21AIO352T	Course Name	MACHINE LEARNING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Computational Intelligence*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*explore the fundamentals of Machine Learning along with its Mathematical concepts*
CLR-2:	*provide deeper understanding of various tools and techniques for Machine Learning Algorithms and outputs*
CLR-3:	*apply linear learning models to perform classification in Machine Learning*
CLR-4:	*understand the various Clustering Methods*
CLR-5:	*learn and understand the Tree based Machine Learning Algorithms*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*understand the concepts of machine learning*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*learn and understand tools and libraries of machine learning*	*3*	*3*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-
CO-3:	*implement machine learning models using supervised learning algorithms*	*3*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	-
CO-4:	*implement machine learning models using unsupervised learning algorithms*	*3*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	-
CO-5:	*implement the tree-based machine learning techniques and to appreciate their capability*	*3*	*3*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-

Unit-1 - Machine Learning	***9 Hour***
Introduction - Types of Machine Learning, Supervised Learning, Unsupervised Learning, Reinforcement learning, The Curse of dimensionality, Over fitting and under fitting, Linear Regression, Bias and Variance tradeoff, Testing – cross validation, Regularization, Learning Curve, Classification - Error and noise, Parametric vs. non-parametric models	
Unit-2 – Regression Methods	***9 Hour***
Platform for machine learning, Machine learning python libraries, training data – testing data – validation data, k-fold cross validation Features, Performance metrics, MSE, accuracy, confusion matrix, precision, recall, F- score, Linear Regression with multiple variables, Logistic Regression	
Unit-3 – Classification	***9 Hour***
Ridge Regression, Maximum likelihood estimation (least squares), principal component analysis, Bayesian classifier, Support vector machine, Support vector machine and kernels, Multi class classification, K nearest neighbour classification, K nearest neighbour classification	
Unit-4 – Clustering	***9 Hour***
Measuring (dis)similarity, Evaluating output of clustering methods, Spectral clustering, Hierarchical clustering, Agglomerative clustering, Divisive clustering, Choosing the number of clusters - Clustering datapoints and features, Bi-clustering, Multi-view clustering, K-Means clustering, K-medoids clustering	
Unit-5 - Decision Trees	***9 Hour***
Decision tree representation, Basic decision tree learning algorithm, Inductive bias in decision tree, Decision tree construction, Issues in decision tree, Classification and regression trees (CART), Random Forest, Multivariate adaptive regression trees (MART).	

Learning Resources	1. *Kevin P. Murphy, —Machine learning: A Probabilistic Perspective‖, MIT Press, 2012.* 2. *Ethem Alpaydin, —Introduction to Machine Learning‖, Prentice Hall of India, 2005* 3. *Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.* 4. *Gavin Hackeling, ‖ Machine Learning with scikit-learn‖, Packet publishing, O'Reily, 2018.*	5. *Carol Quadros, ‖Machine Learning with python, scikit-learn and Tensorflow‖, Packet Publishing, 2018.* 6. *Sebastian Raschka, Vahid Mirjilili,‖Python Machine Learning and deep learning‖, 2nd edition, kindle book, 2018*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Marriappan Vaithilingam, Senior Director of Engineering, Fresh works*	1. *Dr. Udendran, Dept. of CSE., Bharathidasan University, Tiruchirappalli*	1. *Mr. C. Arun, SRMIST*
		2. *Mr. Joseph James, SRMIST*

Course Code	21AIO353T	Course Name	PYTHON FOR DATA ANALYTICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Computational Intelligence*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*introduce a range of topics and concepts related to data and data analysis process*
CLR-2:	*understand the basic data structures involved in python to perform exploratory data analysis*
CLR-3:	*apply EDA for different file formats*
CLR-4:	*understands data visualization using python*
CLR-5:	*provides an exposure to basic machine learning techniques to solve real world problems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*understand different types of data and starts working in python environment*	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*understand various data structures involved in python and perform exploratory data analysis*	3	3	2	-	-	2	-	-	-	-	-	-	-	-	-
CO-3:	*apply the concepts of EDA in various datasets*	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*formulate and use appropriate visualization techniques for their data*	2	3	2	-	-	2	-	-	-	-	-	-	-	-	-
CO-5:	*formulate and use appropriate models of data analysis to solve hidden solutions to business-related challenges*	-	-	-	3	2	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Python ***9 Hour***

Python Data Structures and Functions, Basic Python Programs, Introduction to Data Analysis, Understanding the nature of Data, Types of Data, Data – Information; Information - Knowledge, Types of Data, Application using Python Data structures and libraries, Quantitative Data Analysis, Qualitative Data Analysis, Scipy: Numpy, Pandas, Matplotlib, Applications using Python libraries

Unit-2 - Numpy Library ***9 Hour***

Numpy Installation, Ndarray, Create an array and Types of data, Basic Operations: Arithmetic Operators, Matrix Product, Increment and Decrement Operators, Operations on Numpy array, Application using Numpy and its functions, Shape and array manipulation, Vectorization, structured arrays, Pandas library: Installation, Introduction to Pandas data structures, Application using Python Panda library, Function application and mapping, Sorting and ranking, Correlation and covariance, Hierarchical Indexing and leveling.Applications using Panda library functions

Unit-3 - Pandas ***9 Hour***

Reading data from csv, xml, text and html files, Writing data in CSV, Html, Excel, files, Json data, Data preparation - Concatenating, Applications illustration of loading external data using Panda, Data transformation- Removing duplicates, Mapping Discretization and binning: Detecting and filtering outliers, Permutation – random sampling - String manipulation, Application using Panda library, Data Aggregation- Group by, Hierarchical grouping, Advanced data aggregation, Application illustrating data aggregation function using Panda

Unit-4 - Data Visualization with Matplotlib Library ***9 Hour***

Matplotlib – Installation and architecture, Pyplot, plotting window, Using Kwargs and adding elements to the chart, Application using different plotting techniques, Line charts, Bar charts- Pie charts, Application using different plotting techniques, Histograms - Polar charts, Mplot 3D toolkit: 3D surfaces, Scatter plots and bar charts in 3D, Multi-panel plot, Application using different plotting techniques

Unit-5 - Machine Learning with Sci-Kit Learn ***9 Hour***

Sci-kit learn library, Machine Learning - Supervised learning with sci-kit learn, Application of Supervised learning, Linear Regression, Logistic Regression, Application using regression techniques, Support Vector Machines, Support Vector Classification, Support Vector Regression, Application using Support Vector machine

Learning Resources	1. *Fabio Nelli, Python Data Analytics with Pandas, Numpy and matplotlib (Second edition), Apress* 2. *Wes McKinney, Python for Data Analysis, 2nd Edition, O'Reilly Media, Inc. (https://learning.oreilly.com/library/view/python-for-data/9781491957653/)*	3. *Jake vaderplas, Python Data Science Handbook: Essential tools for Working with Data, O'Reily Media, 2016* 4. *Charles R. Severance, "Python for Everybody Exploring Data Using Python", Charles Severance, 2016.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Senthilnathan, Co-founder, Tenzai, Bangalore*	1. *Dr. E. Sivasankar, Assistant Professor, Department of CSE, NIT, Trichy*	1. *Mr.C.Arun, SRMIST*
		2. *Mr. Joseph James, SRMIST*

Course Code	21AIO354T	Course Name	SOFT COMPUTING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Computational Intelligence*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience*
CLR-2:	*gain knowledge on neural networks with examples*
CLR-3:	*gain knowledge on the mathematical background for carrying out the optimization associated with neural network learning*
CLR-4:	*gain knowledge on genetic algorithms and other random search procedures useful while seeking global optimum in self-learning situations*
CLR-5:	*introduce case studies utilizing the above and illustrate the intelligent behavior of programs based on soft computing*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*analyze a given computational task to recognize the appropriateness through fuzzy sets*	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*design a fuzzy based soft computing system to address the computational task*	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*analyze a given computational task to solve it through neural network*	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*apply Genetic Algorithm operations for solving a computational task*	3	2	2	-	-	2	-	-	-	-	-	-	-	-	-
CO-5:	*design and implement a soft computing system to achieve a computational solution*	3	2	2	3	-	-	2	-	-	-	-	2	-	-	-

Unit-1 - Introduction to Soft Computing ***9 Hour***

Evolution from Conventional AI to Computational intelligence, Evolutionary Search Strategies Fuzzy Sets, Fuzzy Membership Functions, Operations, Relations, Fuzzy Extension Principle Basics of Fuzzy Logic, Problem solving using Fuzzy Rules, Fuzzy Reasoning, Mamdani's Representation.

Unit-2 - Fuzzy Inference Systems ***9 Hour***

Fuzzification, Application of Fuzzy Operators on Antecedent part of Rules, Evaluation of Fuzzy Rules, Defuzzification, and Problems associated to Fuzzy controller, Cruise Controller and Air Conditioner Controller, Convergence of efficiency parameter, Boltzmann's Machine Learning Algorithm, Back Propagation Algorithm.

Unit-3 - Neural Networks ***9 Hour***

Neural Networks in Computer Science, Biological model, McCulloch-Pitts Model, The Perceptron Model, Widrow-Hoff's Delta Rule, XOR Problem, Curse of Dimensionality, Dimensionality Reduction, Activation Functions, Learning by Neural Nets.

Unit-4 - Advanced Search Strategies ***9 Hour***

Natural Evolution, Chromosomes, Systematic approach of Elitism (Selection- Crossover- Mutation), Development of Genetic Algorithm, Fitness Function, Population, GA operators, Parameters, Convergence, Pattern Classifiers, Layered Feed Forward Neural Networks, Solution for XOR Problem, Hebb's Rule, Competitive Learning Methods (Kohonen's Self Organizing Maps and Learning Vector Quantization), Pattern Associators (Hopfield nets),Back Propagation Networks, Generalized Delta Rule

Unit-5 - Hybrid Systems ***9 Hour***

Neuro-Fuzzy Modelling, Control, Feedback control, Neuro fuzzy control, Neuro-fuzzy Reinforcement Learning, Gradient Free Optimization (GA operators), Gain Scheduling , Case study: Color Recipe Prediction,

Learning Resources	1. *Sandhya Bansal & Rajiv Goel "Fundamentals of Soft Computing", 1st Edition, Notion Press Publication, 2020* 2. *Saroj koushik & Sunita Tiwari "Soft Computing, Fundamentals, Techniques and Applications" 1st Edition, McGraw Hill Publication, 2018* 3. *Samir Roy and Udit Chakraborthy, "Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms" Pearson Education, 2013.* 4. *J.S.R. Jang, C.T.sun and E. Mizutani, "Neuro-fuzzy and Soft Computing: A computational Approach to Learning and Machine Intelligence, Pearson Education, 2004.*	5. *D.E.GoldBerg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2013.* 6. *S.N.Sivanandam, S.N.Deepa, "Priciples of Soft Computing", 2nd Edition, John-Wiley India, 2011.* 7. *G.J.Klir and B.Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Second Reprint, PHI, 2000.* 8. *J.A.Freeman and D.M.Skapura, "Neural Networks: Algorithms, Applications and Programming Techniques", Pearson Education, 2011*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Senthilnathan, Co-founder, Tenzai, Bangalore*	1. *Dr. E. Sivasankar, Assistant Professor, Department of CSE, NIT, Trichy*	1. *Dr. C.Lakshmi, SRMIST*

Course Code	21EIO131J	Course Name	VIRTUAL INSTRUMENTATION	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Instrumentation Engineering*	**Data Book / Codes / Standards**	*Nil*		

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand various building elements of virtual instrumentation*
CLR-2:	*know the basics of creating VI programs*
CLR-3:	*impart knowledge on usage of arrays and clusters*
CLR-4:	*introduce various graphs and structures used in developing VI program*
CLR-5:	*understand the concepts of data acquisition by interfacing modules*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	**Program Outcomes (PO)**												**Program Specific Outcomes**		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*explain the procedure for creating virtual instrumentation program*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*select the appropriate condition loops for the given application*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*examine the usage of arrays and clusters*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*compare the data from graphs and charts*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*use different DAQ for data acquisition*	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Virtual Instrumentation ***12 Hour***

Introduction to graphical system design (GSD) model - Virtual instrument and traditional instrument - Hardware and software in virtual instrumentation - Design and virtual instrumentation advantages - Comparison of graphical programming with textual programming - Creating and saving a VI - Front panel toolbar, palettes, controls, and indicators - Block diagram, terminals, nodes, functions, wires, data types and data flow program.

Practice:

1. Creating Virtual Instrumentation for simple applications

2. Programming exercises for loops and charts

Unit-2 - Modular Programming and Loops ***12 Hour***

Creating an Icon - Building a connector pane - Displaying SUBVIs - Creating SUBVIs - Editing SUBVIs - Repetition and Loops - Shift Registers - Feedback nodes - Local and global variables.

Practice:

1. Programming exercises for clusters and graphs

2. Programming exercises on case and sequence structures, file Input / Output.

Unit-3 - Arrays and Cluster ***12 Hour***

Creating one-dimensional array – Deleting - Inserting and replacing into arrays - Array functions - Auto indexing - Creating clusters control and constant - Cluster operations - Assembling and disassembling clusters - Conversion between arrays and clusters

Practice:

1. Data acquisition through Virtual Instrumentation.

2. Developing voltmeter using DAQ cards. 3. Developing signal generator using DAQ cards.

Unit-4 - Plotting Data and Structures	***12 Hour***
Types of graphs and charts - Customizing graphs and charts - Types of structures sequence, flat sequence, stacked sequence, event, timed, diagram disable - Basic of file I/O format ***Practice:*** *1. Simulating reactor control using Virtual Instrumentation.* *2. Real time temperature control using Virtual Instrumentation* *3. Real time sequential control of any batch process.*	
Unit-5 - Data Acquisition	***12 Hour***
Introduction to analog and digital signals - DAQ hardware - Analog and digital inputs and outputs - DAQ software architecture - DAQ assistant - Selecting and configuring a data acquisition device - Case study. ***Practice:*** *1. Data Acquisition using DAQs.* *2. Data Acquisition using NIELVIS* *3. Mini project*	

Learning Resources	*1. Jerome, Jovitha, "Virtual Instrumentation and LABVIEW", PHI Learning, New Delhi, 1st ed., 2010.* *2. Sanjay Gupta and Joseph John, " Virtual Instrumentation using LabVIEW", Tata Mc Graw – Hill Publishing Company Limited, New Delhi, 1st ed., 2005.* *3. Kevin James, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes, 2000.*	*4. Gary Johnson, "LABVIEW Graphical Programming", McGraw Hill, 2nd ed., 1997.* *5. Lisa K. Wells and Jeffrey Travis, "LABVIEW for Everyone", PHI, 1997.* *6. 6. S. Gupta, J.P. Gupta," PC Interfacing for Data Acquisition and Process Control", ISA, 2nd ed., 1994.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	-	*20%*	*20%*	-
Level 2	*Understand*	*20%*	-	-	*20%*	*20%*	-
Level 3	*Apply*	*30%*	-	-	*30%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*30%*	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com	*1. Dr.K.Srinivasan, NIT, Trichy, srinikkn@nitt.edu*	*1. Dr. C. Likith Kumar, SRMIST*
2. Mr. Gautham, Schneider Electric, gautham.r@se.com	*2. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	

Course Code	21EIO132T	Course Name	ANALYTICAL INSTRUMENTATION	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Instrumentation Engineering*	Data Book / Codes / Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the principle and theory of analytical instruments*
CLR-2:	*know the quantitative analysis of dissolved components*
CLR-3:	*provide the concept of separation science and its applications*
CLR-4:	*impart the knowledge on various spectroscopic techniques and its instrumentation*
CLR-5:	*identify the engineering problems associated with Radiation Techniques*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*summarize the principles and theory of instrumental analysis*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*apply the principles of various chemical analysis instruments in industries*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*analyze and understand the operation of various radio chemical methods of analysis*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*illustrate the operation of instruments based on optical properties*	*3*	*1*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*outline the engineering problems associated with Radiation Techniques*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Chemical Instrumental Analysis	***9 Hour***
Introduction to chemical instrumental analysis - Sampling systems - pH measurement - Reference electrodes and secondary electrodes and types - Indicator electrodes - pH meters - Direct reading type pH meter - Null detector type pH meter - Ion selective in chemical industries - Types of conductivity meters - Air pollution monitoring instruments	
Unit-2 - Gas Analyser	***9 Hour***
Dissolved oxygen analyzer - Silica analyzer - Moisture measurement - Oxygen analyzer - Methods of oxygen analyzers - Paramagnetic oxygen analyzer - Electro analytical method – CO monitor, types of CO monitor - NO2 analyzer, H2S analyzer - Dust and smoke measurement - Thermal analyzer, importance of thermal analyzers	
Unit-3 - Chromatography	***9 Hour***
Chromatography, basic working of chromatography - Gas chromatography - Chromatographic column - Detection system, recording system - Liquid chromatography - High pressure liquid chromatography - Liquid chromatographic column working -Types of recording system - Detector types, factors influencing the selection of detectors	
Unit-4 - Spectrophotometer	***9 Hour***
Spectral methods of analysis - Electromagnetic spectrum – UV visible spectrophotometers - Beer's law - Derivations of beer's law - Single beam and double beam instruments - IR spectrophotometers - IR radiation sources – Monochromators - FTIR spectrometers - atomic absorption spectrophotometer	
Unit-5 - Magnetic Resonance Techniques	***9 Hour***
NMR spectrometers - Mass spectrometers - Double focusing spectrometers - Time of flight analyzers - Quadrupole mass analyzers - Nuclear radiation detectors - GM counter - Proportional counter - Solid state detectors- Scintillation counter	

Learning Resources	1. *Khandpur. R.S, "Handbook of Analytical Instruments", Tata McGraw Hill publishing Co. Ltd., 2006* 2. *Bella. G, Liptak, "Process Measurement and analysis", CRC press LLC. 2003.* 3. *Francis Rousseau and Annick Rouesac, "Chemical analysis Modern Instrumentation Methods and Techniques", John wiley & sons Ltd.2007.*	4. *James W.Robinson, "Undergraduate Instrumental Analysis", Marcel Dekker, 2005* 5. *Dwayne Heard, "Analytical Techniques for atmospheric measurement", Blackwell Publishing, 2006.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 2	*Understand*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 3	*Apply*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*-*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*-*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com*	1. *Dr.K.Srinivasan, NIT, Trichy, srinikkn@nitt.edu*	1. *Dr. Vibha.K, SRMIST*
2. *Mr. Gautham, Schneider Electric,gautham.r@se.com*	2. *Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	

Course Code	21EIO133T	Course Name	INDUSTRIAL AUTOMATION SYSTEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Instrumentation Engineering*	**Data Book / Codes / Standards**	*Nil*		

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*introduce the hardware components of programmable logic controller*
CLR-2:	*provide knowledge on PLC programming using various function blocks*
CLR-3:	*understand distributed control system in process automation*
CLR-4:	*impart basic information on operator interface in distributed control system*
CLR-5:	*understand the hardware components and communication in SCADA*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	**Program Outcomes (PO)**												**Program Specific Outcomes**		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*summarize the working of programmable logic controller*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*write basic ladder logic program for control application*	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*outline the various local control unit architecture in distributed control system*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*analyze the various operator displays used in distributed control system*	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*describe the various elements of SCADA system*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - PLC Hardware Components — ***9 Hour***

Parts of a PLC - PLCs versus computers - PLC size and application - Fixed and modular I/O - Discrete I/O, analog I/O, special I/O modules - Electromagnetic control relays - Contactors - Motor starters - Manually operated switches - Mechanically operated switches - Sensors - Output control devices - Seal-In circuits - Electrical interlocking circuits

Unit-2 - PLC Programming — ***9 Hour***

PLC programming language - Wiring diagram - Ladder logic program -On-delay timer instruction - Off-delay timer instruction - Retentive timer - Cascading timer - Up-counter - Down-counter - Cascading counters - Combining counter and timer functions - Math operation - Data compare instructions.

Unit-3 - Distributed Control System — ***9 Hour***

Evolution of DCS - DCS architecture - Local control unit architecture - Comparison of different LCU architectures – LCU language requirements - LCU process interfacing issues - Security requirements - Security design approach - Redundant controller design.

Unit-4 - Operator Interface — ***9 Hour***

Operator Interfaces - Requirements - Low level operator interface - High level operator interface - Hardware elements in the operator interface - Operator displays - Engineering interface requirements - Low level engineering interface, high level engineering interfaces

Unit-5 - SCADA Elements — ***9 Hour***

SCADA basics introduction - Elements of SCADA - Functionality of SCADA - Key features - Remote terminal unit - Analog and discrete control - Monitoring signals - Master terminal unit - RTU/MTU communication - System components - Communication protocols.

Learning Resources	1. *Frank D. Petruzella, "Programmable Logic Controller", Tata McGraw Hill 5thed. 2017.* 2. *Bolton. W, "Programmable Logic Controllers", 6th ed., Elsevier Newnes, 2016.* 3. *Krishna Kant, "Computer-based Industrial Control", Prentice Hall, NewDelhi, 2nd ed., 2011.* 4. *Lukcas M.P, "Distributed Control Systems", Van Nostrand Reinhold Co., New York,1986*	5. *Stuart Boyer A, "SCADA : Supervisory control and data Acquisition", ISA-The Instrumentation, Systems, and Automation Society, 4th ed. 2016* 6. *NPTEL Video Lecture series on "Industrial Automation and Control "by Prof. S. Mukhapadhyay, IIT Kharagpur.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 2	*Understand*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 3	*Apply*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*-*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*-*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com*	1. *Dr.K.Srinivasan, NIT, Trichy, srinikkn@nitt.edu*	1. *Dr. J. Sam Jeba Kumar, SRMIST*
2. *Mr. Gautham, Schneider Electric,gautham.r@se.com*	2. *Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	

Course Code	21EIO134T	Course Name	INTRODUCTION TO SENSORS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Instrumentation Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*introduce different types of Sensing physical quantity and their basic principle and sensing characteristics*
CLR-2:	*gain knowledge on the construction and principle of motion, proximity and ranging sensors*
CLR-3:	*impart the knowledge of basic principles of force, magnetic and heading sensors*
CLR-4:	*understand the concepts of optical, pressure and temperature sensors*
CLR-5:	*provide the different types of sensors employed in various applications*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*familiarize the transduction principles and label their characteristics of the measurement system*	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*describe the principle of motion, proximity and ranging sensors*	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*recall the performance of force, magnetic and heading sensors*	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*outline the working principles optical, pressure and temperature sensors*	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*select the type of sensors used in various real time applications*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fundamentals and Sensor Characteristics ***9 Hour***

Introduction on Sensor - General concepts and terminology of measuring systems, transducer classification, general input-output configuration, static and dynamic characteristics of a measuring system, and statistical analysis of measurement data, classification of sensors

Unit-2 - Motion, Proximity and Ranging Sensors ***9 Hour***

Motion Sensors – Potentiometers – Resolver - Encoders – Optical, magnetic, inductive, capacitive, LVDT – RVDT – Synchro – Microsyn, accelerometer – GPS - Bluetooth, range sensors – RF beacons - Ultrasonic ranging - Reflective beacons - Laser Range Sensor (LIDAR).

Unit-3 - Force, Magnetic and Heading Sensors ***9 Hour***

Strain Gage - Load Cell - Magnetic Sensors - Types, principle, requirement and advantages - Magneto resistive – Hall effect – Current sensor heading sensors – Compass, gyroscope, inclinometers

Unit-4 - Optical, Pressure and Temperature Sensors ***9 Hour***

Photo conductive cell, photo voltaic, photo resistive - LDR – Fiber optic sensors – Pressure – Diaphragm – Bellows - Piezoelectric – Tactile sensors, Temperature – IC, Thermistor - RTD – Thermocouple - Acoustic sensors – Flow and level measurement - Radiation sensors - Smart sensors - Film sensor - MEMS & Nano Sensors - LASER sensors

Unit-5 - Miscellaneous ***9 Hour***

Moisture, humidity, wind chill indicator, radioactive count rate, smoke sensor, infrared, microwave, air purity, fire detector - Imaging sensors - Non-destructive monitoring - Pressure sensitive paint (PSP) measurements for aerodynamic applications

Learning Resources	1. *Patranabis D, "Sensors and Transducers" 2nd ed., PHI Publications,2021* 2. *Ian Slinchar, "Sensors and Transducers", 3rd ed., Newnes (an imprint of Butterworth-Heinemann Ltd), 2000* 3. *S. J. Prosser, E. Lewis,"Sensors and Their Applications XII", 1st ed., CRC Press, 2014.*	4. *Murthy DVS, "Transducers & Instrumentation", 2nd ed., Prentice Hall of India, 2008* 5. *Ernest O. Doebelin , Dhanesh N. Manik,Doebelin's Measurement Systems: 7th ed., Tata McGraw Hill , 2019* 6. *NPTEL Lecture notes on "Sensors and Actuators" by Prof Hardick J Pandiya, IISc Bangalore*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 2	*Understand*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 3	*Apply*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*-*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*-*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com*	1. *Dr.K.Srinivasan, NIT, Trichy, srinikkn@nitt.edu*	1. *Dr.A.Vimala Juliet, SRMIST*
2. *Mr. Gautham, Schneider Electric, gautham.r@se.com*	2. *Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	

Course Code	21EIO135T	Course Name	INTRODUCTION TO MEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Instrumentation Engineering*	Data Book / Codes / Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*know the importance of microsystem technology and the operating principle of various micro sensors and actuators*
CLR-2:	*impart knowledge of MEMS materials and their properties*
CLR-3:	*introduce different MEMS fabrications steps and procedures*
CLR-4:	*explore packaging process and solutions*
CLR-5:	*gain knowledge on the implementation of MEMS and microsystems in various industries*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*summarize the fundamental concepts in MEMS technology*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*familiarize the various MEMS material and their properties*	*2*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*understand the fabrication and machining tools needed for MEMS structure development*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*explain the various process involved in packaging*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*apply MEMS and microsystem concepts to real-time challenges*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Overview of Mems and Micro Systems ***9 Hour***

Evolution of MEMS - Microsystems Vs MEMS – Microsystem and miniaturization – Scaling laws in MEMS – Engineering sciences for Microsystem Design and Fabrication - MEMS products - Working principle of MEMS and microsystems.

Unit-2 - Materials for Mems ***9 Hour***

Substrate and Wafers- Active substrate Materials-Silicon as a substrate – Silicon Compounds : Silicon dioxide, Silicon carbide , Silicon nitride polycrystalline silicon, Silicon Piezo resistors, Gallium Arsenide, Piezoelectric crystals, Polymers

Unit-3 - Process of Micro Machining ***9 Hour***

Introduction, basic tools, photolithography – Light sources, photoresist development, ion implantation, diffusion, oxidation - CVD – PVD - Sputtering – Deposition by epitaxy – Etching - Bulk micro manufacturing - Surface micromachining LIGA process.

Unit-4 - Packaging in Mems ***9 Hour***

Key Design and packaging considerations - Die-attach process – Wiring and interconnects – Types of packaging solutions - Quality control, reliability, and failure analysis.

Unit-5 - Applications of Mems and Micro Systems ***9 Hour***

In automotive Industry - Aerospace industry - Biomedical Industry - Consumer products - Telecommunication industry - Pressure sensors – Acceleration sensor and gyroscopes – Gas Sensor - In photonics application - Projection display with the digital Micro mirror device - Fibre–optic communication devices - In life sciences –Microfluidics lap-on–chip components - Micro- needles, micro –electrode array - In RF-Applications Resonator, switches.

Learning Resources	1. *H. Tai-ran," Designs, Manufacture and Nanoscale engineering" John Wiely Publications, 2008* 2. *Williams. K, Maluf.N "An Introduction to Microelectromechanical Systems Engineering", second edition Artech House Publishers; 2nd ed., 2004.*	3. *V. Choudary, K Iniewskwi," MEMS – Fundamental Technology and Application",ISBN 9781138072305,2013* 4. *Stephen D. Senturia, " Microsystem Designs" Kulwer academic publisher , 2001*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com*	1. *Dr.K.Srinivasan, NIT, Trichy, srinikkn@nitt.edu*	1. *Dr.A.Vimala Juliet, SRMIST*
2. *Mr. Gautham, Schneider Electric, gautham.r@se.com*	2. *Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	

Course Code	21EIO136J	Course Name	PLC FOR INDUSTRIAL AUTOMATION	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Instrumentation Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*introduce the need for process automation technologies*
CLR-2:	*provide the fundamental knowledge for ladder logic programming*
CLR-3:	*identify applications of timers and counters in process automation*
CLR-4:	*understand the various math and data manipulation instructions used in PLC*
CLR-5:	*provide the knowledge of commissioning, maintenance and their importance in industries*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*summarize the need for process automation technologies*	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*apply logical principle in ladder logic program for control applications*	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*use timer and counter function blocks in PLC programming for process automation*	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*use data manipulation instructions in PLC programming*	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*summarize the troubleshooting techniques of PLC*	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to PLC — ***12 Hour***

Evolution of PLCs - Architecture of PLC – PLC vs PC - PLC size and applications - PLC wiring - Discrete and analog I/O, Field I/O devices - Sinking and sourcing - Electrical interlocks

Practice:

1. Basics of PLC ladder logic programming

2. Implementation of code converters

Unit-2 - PLC Programming — ***12 Hour***

PLC programming languages - Ladder logic, function block diagram, instruction list - Instruction addressing - Branch instructions – Relays – Contactors - Manually operated switches - Mechanically operated switches – Proximity sensor, magnetic reed switch, light sensors, velocity and position sensors

Practice:

1. Implementation of MUX and DEMUX Automatic control of bottle filling system using PLC

2. Water level control system

Unit-3 - Timers and Counters — ***12 Hour***

Timer instructions - On-delay, off-delay timer instruction - Retentive timers - Cascading timers - Counter instructions - Up and down counters - Cascading counters - Combining timers and counters - Simple exercises

Practice:

1. Traffic light control system

2. Sequential operation of stepper motor

Unit-4 - Data Manipulation and Math Instructions	**12 Hour**
Data manipulation - Data transfer operations - Data compare instructions - Data manipulation programs - Numerical data I/O interfaces - Math Instructions - Addition, subtraction, multiplication and division instructions - Other word-level math instructions ***Practice:*** *1. Bottle filling system* *2. Material handling system*	
Unit-5 - Troubleshooting of PLC	**12 Hour**
Electrical noise - Leaky inputs and outputs – Grounding - Voltage variations and surges - Program editing and commissioning - Preventive maintenance – Troubleshooting - Input and output malfunctions - Comparative study of industrial PLCs - Case studies ***Practice:*** *1. Program for lighting sequence (using timers and counters)* *2. Design of smart room*	

Learning Resources	
1. *Frank D. Petruzella, "Programmable Logic Controller", Tata McGraw Hill,5th ed., 2017* 2. *M.P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 5th ed., 2009*	3. *Bolton. W, "Programmable Logic Controllers", Elsevier Newnes, 6th ed., 2016* 4. *NPTEL Video Lecture Notes on "Industrial Automation and Control "by Prof. S. Mukhapadhyay, IIT*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	-	*20%*	*20%*	-
Level 2	*Understand*	*20%*	-	-	*20%*	*20%*	-
Level 3	*Apply*	*30%*	-	-	*30%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*30%*	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com*	1. *Dr.K.Srinivasan, NIT, Trichy, srinikkn@nitt.edu*	1. *Dr. R. Bakiya Lakshmi, SRMIST*
2. *Mr. Gautham, Schneider Electric, gautham.r@se.com*	2. *Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	

Course Code	21EIO138T	Course Name	LOGICAL FOUNDATION OF CYBER PHYSICAL SYSTEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Instrumentation Engineering*	Data Book / Codes / Standards	*Nil*		

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*provide the basic concepts of cyber-physical system and modeling of a continuous system*
CLR-2:	*understand the basic concepts of discrete modeling of a system*
CLR-3:	*impart the adequate information about hybrid system and state machines*
CLR-4:	*know the sensor networks in CPS*
CLR-5:	*explore the knowledge about security issues in CPS*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*summarize the basic concepts of cyber physical systems and modeling in continuous domain*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*illustrate the discrete model of continuous system*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*analyze the hybrid system and its interactions*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*select the sensor networks for CPS*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*examine the CPS design for specific applications*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Continuous Dynamics Modeling ***9 Hour***

Structure of cyber-physical systems - Design process - Modeling design – Analysis - Newtonian mechanics - Actor models - Properties of systems, causal systems - Memoryless systems - Linear-time invariant – Stability - Feedback control - Proportional control systems - Tracking error - Transformation to equivalent model, physical dynamics, Modeling and simulation tools - Multiple models - Uncertainty quantification - Problems stabilization using proportional control – Problems - BIBO stability analysis

Unit-2 - Discrete Dynamics Modeling ***9 Hour***

Discrete systems - Discrete signals - Event triggered - Modeling actors as function - Notion of state - Finite-state machines, transitions, reaction – Hysteresis - Time scale variance - Update functions - Software tools for FSM, determinacy - Receptiveness, extended state machines, moore and mealy machines - Traffic light controller - Non-determinism - Formal model - Uses of non-determinism, - Environmental modeling, specifications

Unit-3 - Hybrid Systems and State Machines ***9 Hour***

Modal models combining discrete and continuous dynamics - Actor model for state machines - Actor representation of FSM - Continuous inputs- Thermostat example - State refinements, Notations of hybrid systems, - Classes of hybrid systems - Timed automata - Higher order dynamics - Timed automation variant of traffic light controller - Hybrid system model for mass system - Supervisory control - Automated guided vehicle, Composition of state machines, Concurrent composition - Side-by-side synchronous composition - Side-by-side asynchronous composition - Shared variables - Cascade composition, General composition - Hierarchical state machines

Unit-4 - Sensor Networks in CPS	***9 Hour***
Traditional sensor networks vs WSNs - Sensors employed by CPS - Types of sensors - Smart sensors - Wireless sensor networks(WSNs) - Distributed WSNs - Sensor networks for Internet of Things (IoT) - Architecture of WSNs for CPS applications - Sensor network as Service-Oriented Architecture (SOA) - Semantic modeling of sensor network and sensor attributes, sensing resource management and task scheduling - Design of WSNs for CPS applications, sensing capacity of sensor networks - Optimum deployment of wireless sensor nodes for CPS applications - Routing techniques, WSNs for CPS applications, transforming WSNs to cyber-physical systems - emerging cyber-physical systems - Intelligent health care cyber system - Heath care monitoring and tracking - Intelligent rescue cyber system - Position–navigation–timing monitoring and tracking - Intelligent transportation cyber system- Transportation - Monitoring and tracking	
Unit-5 - Security Issues in CPS	***9 Hour***
Workflow of CPS - Monitoring, networking - Computing, actuation - Case studies on CPS security breaches - Stuxnet, maroochy water breach - Slammer worm, automobile attacks -health care, manufacturing sector, smart grid - Security objective for CPS - Challenges in CPS security - Real-time requirements - Intrusion detection techniques - Requirement for security in CPS - Sensing security, storage security, communication security, actuation security - Feedback security - Prominent attacks on security for CPS - Denial-of-service attack - Man-in-the-middle attack - Defensive mechanism against attack in CPS	

Learning Resources	1. *AncaMolnos, "Model Implementation Fidelity in Cyber-Physical System Design", Springer,2017* 2. *Gaddadevara Matt Siddesh et.al, "Cyber-Physical Systems – A Computational Perspective", CRC Press, 2016.* 3. *Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press,2015*	4. *E.A.Lee, S.A.Sashia, "Introduction to Embedded Sytems : A Cyber-Physical Systems Appproach", 2011* 5. *NPTEL Video Lecture series on "Foundations of cyber-physical systems" by Prof. Soumyajit Dey, IIT Kharagpur*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *T.A.Balaji, Robert Bosch, Coimbatore, Balaji.TAnanthanpillai@in.bosch.com*	1. *Dr.K.Srinivasan, NIT, Trichy, srinikkn@nitt.edu*	1. *Dr.G.Y. Rajaa Vikhram, SRMIST*
2. *Mr. Vijayarajeswaran, MD, Vi micro Pvt.Ltd, vijay@vimicrosystems.com*	2. *Dr.S.Latha, TCE, Madurai, sleee@tce.edu*	

Course Code	21AUO101T	Course Name	HYBRID AND ELECTRIC VEHICLES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Automobile Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*provide an insight into how electric vehicle operate*
CLR-2:	*demonstrate the functional requirements of Battery management system in detail*
CLR-3:	*demonstrate how Electric and Hybrid Vehicle vary as per design requirements*
CLR-4:	*perform the detailed analysis on the drives and driveline*
CLR-5:	*selection of the appropriate drive and driveline system for the different cases*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*learn the basic concepts of electric vehicle technology and electric vehicles*	*3*	-	-	-	-	-	*2*	-	-	-	-	-	-	-	-
CO-2:	*develop and analyze hybrid and electric drive trains*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*interpret various vehicle power sources in hybrid vehicle technology*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*analyze data to determine appropriate design calculation for hybrid system under study*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*apply the concepts in sizing the electric motors*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Electric Vehicle Propulsion and Energy Sources ***9 Hour***

Basic concepts and problems concerning the electrification in Mobility- Functional components in an electric and hybrid vehicle- Vehicle Mechanics – Kinetics - Dynamics & Roadway Fundamentals- Propulsion System Design - Force Velocity Characteristics, Calculation Of Tractive Power And Energy Required- Electric Vehicle Power Source - Battery Capacity - Battery Construction and Types- State of Charge and Discharge- Calculation of Specific Energy and Specific Power & Ragone Plot Relationship- Battery Modeling - Run Time Battery Model, First Principle Model- Battery Management System- SOC Measurement, Battery Cell Balancing- Traction Batteries - Nickel Metal Hydride Battery, Li-Ion, Li-Polymer Battery.

Unit-2 - Electric Vehicle Powerplant and Drives ***9 Hour***

Basic concepts of electric vehicle power plant- Power and Torque plot- Construction of Induction Machines, Operating cycle and application in traction- Construction of Permanent Magnet Machines - Construction of Switch Reluctance Machines- Role of Power Electronic Converters-DC/DC Converters- Description of Buck Boost Converter- Isolated DC/DC Converter- Functional Requirements and Operating limits- Two Quadrant Chopper – Switching Modes- AC Drives- PWM- Current Control Method - Role of Switch Reluctance Machine Drives- Voltage Control- Current Control.

Unit-3 - Hybrid and Electric Drivetrains ***9 Hour***

Functional requirements of Hybrid Vehicle- Operational difference between the Fully Electric, Hybrid, and Mild Hybrid- Topological Phenomena and Social Importance of e-mobility Role of modern drivetrain and the conversion efficiency and power consumption- Description of Hybrid Traction- Description of Electric Traction.- Topological Optimization for Hybrid Traction- Topological Optimization for Electric Traction- Power Flow Control & Energy Efficiency Analysis- Configuration and Control of DC Motor Drives- Induction Motor Drive.- Permanent Magnet Motor Drives, Switch Reluctance Motor Drives, Drive System Efficiency

Unit-4 - Electric and Hybrid Vehicle Design ***9 Hour***

Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmissionefficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refueling Systems, Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles. Steering and Suspension system. Choice of Tires.

Unit-5 - Electric and Hybrid Vehicles –Case Studies	***9 Hour***
Parallel Hybrid, Series Hybrid -Charge Sustaining- Parallel Hybrid, Series Hybrid –Charge Depleting- Hybrid Vehicle Case Study –Toyota Prius, HondaInsight, Chevrolet Volt- 42 V System for Traction Applications- Lightly Hybridized Vehicles and Low Voltage System- Electric Vehicle Case Study - GM EV1, Nissan Leaf, Mitsubishi Miev- Hybrid Electric Heavy-Duty Vehicles, Fuel Cell Heavy Duty Vehicles	

Learning Resources	*1. Iqbal Husain, "Eclectic and Hybrid vehicles Design Fundamentals,"* *2. CRC Press, second edition 2013, ISBN 9781439811757*	*3. James Larminie, John Lowry, "Electric vehicle technology Explained"Second Edition, Wiley 2012, ISBN-13: 978-1119942733*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*25%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*-*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*-*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Mr.G.Giri, Managing Director, Atalon ,giri@atalon.co.in	*1. Dr.S.Jeevananthan, Professor, Electrical and Electronics Engineering, PTU, drsj_eee@pec.edu.in*	*1. Mr S. Madhan Kumar, SRMIST*
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Course Code	21AUO102T	Course Name	RENEWABLE SOURCES OF ENERGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Automobile Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*explain the concept of wind energy*
CLR-2:	*create insight on solar energy and its application*
CLR-3:	*evaluate the use of geothermal and hydro power for power generation*
CLR-4:	*analyze the biomass energy and ocean energy*
CLR-5:	*develop knowledge on various energy conversion devices*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply the knowledge of using wind energy for power production*	*3*	*3*	-	-	-	-	*2*	-	-	-	-	-	-	-	-
CO-2:	*analyze the economy of using solar power*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*rationalize geo thermal and hydro power plants*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*perceive the concept of biomass and ocean energy for power production*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*demonstrate the working of various energy conversion devices*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Wind Energy — ***9 Hour***

Introduction- Renewable energy sources- statistics and technologies- Wind Energy – Introduction - Application of wind energy- Transformation of wind energy - Wind Turbines - Operating characteristics- Wind power plant- Utilization of wind power- Trends in wind energy utilization

Unit-2 - Solar Energy — ***9 Hour***

Basic properties of solar energy- Application of solar energy- Transformation of solar energy - Solar heat collectors- Solar photovoltaic collectors- Application of solar collectors- Solar power plant- Economic study- Trends in solar energy utilization

Unit-3 - Geothermal and Hydro Power — ***9 Hour***

Geothermal – Resources, Types of wells- Method of harnessing power and its potential in India- Hydropower – Properties and availability- Transformation of water energy- Hydro power plants- Applications of hydro power plants- Special hydropower plants- Economic study- Trends in hydro power utilization

Unit-4 - Ocean Energy and Biomass Based Energy — ***9 Hour***

Ocean Energy – Principle, Utilization- Setting of power plants- Thermodynamic cycles- Tidal and wave energy- Biomass - Principle of biomass conversion- Anaerobic/aerobic digestion- Biogas digestors, gas yield and combustion characteristics- Utilization for cooking and economic aspects- Utilization in IC engine

Unit-5 - Energy Conversions — ***9 Hour***

Need for direct energy conversion (DEC), carnot cycle- Limitations and principle of DEC- Thermo electric generators- Seebeck, peltier and joule Thompson effect and application- Magneto hydrodynamic generator (MHD) – Working principle- MHD accelerator, MHD engine- Electron gasdynamic conversion- Fuel cell – basic principle- Hybrid vehicle – Basic principle.