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



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Contents (Volume - 20)

Syllabi for Common Courses

<u>No</u>		<u>Title</u>	<u>Pag</u>
1	Core Course		
		Artificial Intelligence	
2	Open Elective Co	urses	
		Aerospace Engineering	
	21AS <mark>O301T</mark>	Elements of Aeronautics	
	21ASO302T		
	21ASO303T	Aviation and Airline Maintenance Management	
	21ASO304T	Aircraft General Engineering and Maintenance Practices	
	21ASO305T	Flow Visualization Techniques	
	21ASO306T		
	21ASO307T	Molecular Gas Dynamics	
	ion l	Artificial Intelligence	
	21AIO351T	Introduction to Artificial Intelligence	
	21AIO352T	Machine Learning	
	21AIO353T	Python for Data Analytics	
	21AIO354T	Soft Computing	
	Autom	nation and Robotics & Electronics and Instrumentation Engineering	
	21EIO131J	Virtual Instrumentation	
	21EIO132T	Analytical Instrumentation	
	21EIO133T	Industrial Automation Systems	
	21EIO134T	Industrial Automation SystemsIntroduction to Sensors	
	21 <mark>EIO1</mark> 35T	Introduction to MEMS	
	21EIO136J	PLC for Industrial Automation	
	21EIO138T	Logical Foundation of Cyber Physical Systems	
		Automobile Engineering	
	21AUO101T	Hybrid and Electric Vehicles	
	21AUO102T	Renewable Sources of Energy	
	21AUO103T	Special Type of Vehicles	
	21AUO104T	Fuel Cells and Applications	
	21AUO105T	Transport Management	
	21AUO106T	Composite Materials for Automotive Applications	
	21AUO107T	Non-Destructive Testing and Evaluation	

21AUO1081	Advanced Engine Technology
21AUO109T	New Product Development
21AUO110T	Automotive Standards and Regulations
21AUO111T	Automotive Sciences.
21AUO112T	Intelligent Vehicle Technology
	Biotechnology
21BTO101T	Human Health and Diseases
21BTO105T	Animal Models for Biomedical Research
21BTO106T	Waste to Wealth to Wheels
21BTO107T	Fundamental Neurobiology
	Biomedical
21BMO121T	Fundamentals of Biomedical Engineering
21BMO122T	Health Information Systems
21BMO123T	Basics of Medical Imaging
21BMO124T	Rehabilitation Engineering
21BMO125T	Quality Control for Biomedical Devices
	Biomechanics of Human Movement
21BMO127T	Digital Healthcare Technology
13 .	Chemical Engineering
21CHO101T	Sustainable Energy Engineering
21CHO102T	Petroleum Engineering
21CHO103T	Fundamentals of Chemical Engineering
21CHO104T	Process Plant Safety
21CHO105T	Pollution Abatement
()	Civil Engineering
21CEO301T	Maintenance and Rehabilitation of Structures
21CEO302T	Disaster Resistant Structures
21CEO303T	Smart City and Infrastructure
21CEO304T	Real Estate Management
21CEO305T	Project Management
21CEO306T	Environmental Impact Assessment
21CEO307T	Municipal Solid Waste Management
21CEO308T	Disaster Mitigation and Management
21CEO309T	Water Pollution and its Management
21CEO310T	Global Warming and Climate Change
21CEO311T	Indoor and Ambient Air Quality Management
21CEO312T	Intelligent Transportation Systems
21CEO313T	Traffic Management Systems

21CEO3141	Traffic Flow Modeling and Simulation Techniques	129
21CEO315T	Viscoelasticity	13
21CEO316T	Soil Sciences.	133
21CEO317J	Rural Development and Technology	13
21CEO318T	Floods and Flood Management	137
21CEO319T	Climate Change and Water Resources Management	139
21CEO320T	Principles of Satellite Remote Sensing.	14
21CEO321T	Spatial Information System	143
21CEO322T	Remote Sensing and GIS Application in Engineering	14
21CEO323T	Spatial Technology in Engineering	147
21CEO324T	GIS and Spatial Analysis Web GIS	149
21CEO325T	Web GIS	15
21CEO401T	Building Materials	153
21CEO402T	Introduction to Environmental Studies	155
21CEO403T	Integrated Waste Management	157
21CEO404T	Principles of Sustainable Development	159
21CEO405T	Road Safety and Audit	161
21CEO406T	Transportation Systems	163
21CEO407T	Rheology of Complex Materials	165
21CEO408T	Water Conservation and Management	167
21CEO409T	Water Quantity and Quality	169
21CEO410T	Remote Sensing Surveying	17
21CEO411T	Introduction to GIS and Data	173
21CEO412T	Web and Mobile GIS	175
21CEO413T	Digital Mapping	17
· <	Computer Science and Engineering	
21CSO270T	Cyber Security	179
21CSO351T	Web Programming	18′
21CSO352T	Python Programming	183
21CSO353T	Mobile Application Development	18
21CSO354T	Data Analytics	187
21CSO355T	Machine Learning for All	189
21CSO356T	Convolutional Neural Networks Foundation	19 ⁻
21CSO357T	Data Visualization Basics	193
21CSO358T	Network Security	198
21CSO359T	Fundamentals of Information System Security	197
21CSO360T	Security Policy Implementation	199
21CSO451T	Deep Learning Foundation	201

Electronics and Communication Engineering

21ECO101T	Short Range Wireless Communication	203
21ECO102J	Electronics Circuits and Systems	205
21ECO103T	Modern Wireless Communication System	207
21ECO104J	PCB Design and Manufacturing	209
21ECO105T	Fiber Optics and Optoelectronics	211
21ECO106J	Embedded System Design Using Arduino	213
21ECO107J	Embedded System Design Using Raspberry Pl	215
21ECO108J	3D Printing Hardware and Software	217
	Electrical and Electronics Engineering	
21EEO301T	E-Mobility	219
21EEO302T	Wearable Technology	221
21EEO303T	E-Waste Management	223
21EEO304T	Energy Efficient Practices	225
21EEO305T	Surveillance Technology	227
21EEO306T	Sustainable Development Practices	229
21EEO307T	Clean and Green Energy	231
21EEO308T	Smart Cities and Communities	233
21EEO309T	Electrical Trading	235
21EEO310T	는 것은 경험을 하는 것이 있다는 것이 되면 가장 보고 있다. 그는 사람들은 그리고 있다는 사람들이 되었다. 그런 그리고 있다면 보다 보다 보다 보다 되었다. 그리고 있다면 보다 보다 보다 보다 보다 보다 보다 되었다. 그리고 있다면 보다 보다 보다 보다 되었다. 그리고 있다면 보다 보다 되었다. 그리고 있다면 보다 보다 되었다. 그리고 있다면 보다 되었다면 보다 되었다. 그리고 있다면 보다 되었다면 보다	237
	Genetic Engineering	
21GEO101T	Behavioral Biology	239
21GEO102T	Microbes and Society	24 1
21GEO103T	Biofertilizers – An Entrepreneurial Perspective	243
21GEO104T	Computational Genomics	245
21GEO105T	Biology for Everyday Life	247
	Mechatronics Engineering	
2 <mark>1MHO301T</mark>	Smart Farming	249
	Mechanical Engineering	
21MEO101T	Fundamentals of Composite Materials	251
21MEO102T	Reverse Engineering and 3d Printing	253
21MEO103T	Fundamentals of Biomechanics	255
21MEO104T	TQM and Reliability Engineering	257
21MEO105T	Occupational Safety and Disaster Management	259
21MEO106T	Introduction to Robotics	261
21MEO107T	Fundamentals of Nano Engineering	263
21MEO108T	Computer Numerical Control Programming and Operation	265
21MEO109T	Resource Management Techniques	267

	21MEO110T	Energy Systems for Sustainable Buildings	26
	21MEO111T	Environmental Pollution and Abatement	27
	21MEO112T	Renewable Energy Sources and Applications	27
	21MEO113T	Electronics Thermal Management	27
	21MEO114T	Solar Energy for Societal Applications	2
	21MEO115T	Introduction to Drones	2
		Nanotechnology	
	21NTO301T	Applications of Nanotechnology	28
	21NTO302T	Solid State Electronic Devices	2
	21NTO30 <mark>3T</mark>	Micro and Nanoelectronics	2
	21N <mark>TO304T</mark>	Environmental Nanotechnology	2
	21 <mark>NTO30</mark> 5T	Medical Nanotechnology	2
	21NTO306T	Nanoscale Surface Engineering	2
	21NT0307T	Nanocomputing	2
	21NTO308T	Smart Sensor Systems	2
	21NTO309T	2D Materials and Applications	2
	21NTO310T	Nano and Micro Eletromechanical Systems	2
	21NTO401T	Scientific Research Principles	3
	21NTO402T	Micro and Nanofluidic Technology	3
	21NTO403T	Thin film Photovoltaics	3
	21NTO404T	Nanotechnology in Societal Development	3
	21NTO405T	Polymer Engineering	3
	21NTO406T	Industrial Nanotechnology	3
	21NTO407T	Quantum Computing	3
	21NTO311T	Nanomaterials in Cosmetics and Cosmeceuticals	3
	21NTO312T		3
	21NTO313T	Nanotechnology in Food Science and Packaging	3
	21PYO301T	Astrophysics	3
	21PYO302T	Photonics	3
	21PYO303T	Quantum Optics	3
3	Engineering Scien	nce Courses	3
	21DCS201P	Design Thinking and Methodology	3
	21CSS303T	Data Science	3
	21GNS502J	Research Methodology	3
4	Non-Credit Course	98	3
	21PDM201L	Verbal Reasoning	3
	21PDM202L	Critical and Creative Thinking Skills	3
		Analytical and Logical Thinking Skills	3

	21PDM302L	Employability Skills and Practices
	21LEM201T	Professional Ethics
	21LEM202T	Universal Human Values-II: Understanding Harmony and Ethical Human Conduct
	21LEM301T	Indian Art Form
	21LEM302T	Indian Traditional Knowledge
5	Humanities Cours	ses
	21PDH201T	Social Engineering
	21GNH401T	Behavioral Psychology
6	Project Work, Ser	ninar, Internship in Industry / Higher Technical Institutions
	21GNP301L	
	21XXP302L	Project
	21XXP303T	Massive Open Online Course (MOOC)
	21XXP401L	Major Project
	21XXP402L	Major Project
	21XXP403L	Internship
	21XXP501L	Specialization Project
	21XXP502L	Specialization Project
	21XXP503L	Domain Internship
	R.M. IN	

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	21CCC20GT Course	ARTIFICIAL INTELLIGENCE	Course	PROFESSIONAL CORE	L	Т	Р	С	
Code	Name	ARTIFICIAL INTELLIGENCE	Category	PROFESSIONAL CORE	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 L	earning Rationale (CLR):	The purpose of learning this course is to:	11	4			Progi	am Ou	ıtcome	s (PO)					gram
CLR-1:	LR-1: infer knowledge in problem formulation with Al					4	5	6	7	8	9	10	11	12		cific comes
CLR-2:	exemplify the uninformed	d and informed search technique procedures for real world problems	agp		o	SL		. "	_ `\		Work		9			
CLR-3:	understand the adversar	ial search m <mark>ethods, co</mark> nstraint satisfaction problems and intelligent agents	owlec	S	elopment of	stigations roblems	Usage	ъ					nan	Б		
CLR-4:	demonstrate various kno	wledge re <mark>presentati</mark> on techniques	ering Kno	alysis	udoli	estig		r and	× ×	h.	Team	ţį	& Fir	arni		
CLR-5:	R-5: infer knowledge about expert sys <mark>tems</mark>				/deve	duct invi	n Tool	engineer sty	nment nability	١.	ual &	ımunication	t Mgt.	ng Le		
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	Engine	Problem	Design solutio	Condu of com	Moder	The er	Enviro Sustai	Ethics	Individual	Comm	Project	Life Lor	PSO-1	PSO-2 PSO-3
CO-1:	formulate a problem as a	sta <mark>te space</mark> search method and its solution using various AI techniques	1	- 2	-	-	-	/	-	-	-	-	-	-	-	
CO-2:	: apply appropriate searching techniques to solve a real-world problem			2	3	-19	-	4	-		-	-	-	-	-	
CO-3:	3: develop various game playing strategies to solve real world adversarial search problems				2	154	-	-	7 -		-	-	-	-	-	
CO-4:	represent various knowledge representation techniques to solve complex AI problems		1	2	100	1	-	-	-		-	-	-	-	-	
CO-5:	design an expert system to implement advance techniques in Artificial Intelligence		3	- 2	3	7-	-		-		2	-	-	-	-	

Unit-1- Introduction to AI 9 Hour

Al techniques, Problem solving with Al, Al Models, Data acquisition and learning aspects in Al, 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 – representation using 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. 2.	Deepak Kemhani, First course in Artificial Intelligence, McGraw Hill Pvt Ltd, 2013 Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson Education, 2020.	Parag Kulkarni, Prachi Joshi, Artificial Intelligence –Building Intelligent Systems, 1st ed., PHI learning, 2015 Data Structures Schaum's Outlines Series, Seymour, Lipschutz, 2014.
			a in the second

Learning Assessme	nt	, , , ,							
			Continuous Learning	Cum	matius.				
	Bloom's Level of Thinking	Form CLA-1 Avera (50		CL	g Learning LA-2 0%)	Summative Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice Practice	Theory	Practice		
Level 1	Remember	20%	-	20%		20%	-		
Level 2	Understand	15%		15%	7 2 - 1	15%	-		
Level 3	Apply	20%	A POST OF	20%	1 / Je 1	20%	-		
Level 4	Analyze	25%	70 TO 10	25%	400	25%	-		
Level 5	Evaluate	20%	A 3. 2. 276	20%		20%	-		
Level 6	Create				1 - 2	-	-		
	Tota <mark>l</mark>	100)%	10	00 %	10	0 %		

Course Designers	F 5 A 1 H 1 2 W 6 C 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	3 //
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Tejas Gowda, Co-Founder & Chief Data Scientist, tenzai	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	ELEMENT	S OF AERONAUTICS	Course Category	0	OPEN ELECTIVE	3	T 0	P 0	C 3
Pre-requisi Courses		Nil	Co- requisite Courses	Nil	Progres Cours	_	Nil				

Data Book / Codes / Standards

Course L	earning Rationale (CLR): The purpose of learning this course is to:		Π,	4			Progr	am Oı	ıtcome	s (PO)					ogram
CLR-1:	describe the art of flyir	ng	1		2	3	4	5	6	7	8	9	10	11	12		pecific tcomes
CLR-2:	discuss the various typ	pes of aircraft con <mark>figuration,</mark> control systems and instruments	a	,		of	of		ciety			Ž					
CLR-3:	explain about the atmo	osphere and va <mark>riation in properties, aircraft flight and different speed regimes</mark>	- Pol	20			tigations lems	Φ	Soci		L	work		finance			
CLR-4:	explain the basics of a	nircraft struct <mark>ures and t</mark> he aerospace materials			ysis	bmdc	stiga	usage	and	ల	h.	team	드	& fins	ing		
CLR-5:	describe about the var	rious propu <mark>lsion syst</mark> ems used in aerospace industry	ering k	מ	analysis	n/development ons	inve	tool	engineer	environment sustainability		∞ర	ommunication	mgt. 8	learning		
			- 0	3	em	gn/de tions	uct Sex	ern	ngi	nvironn staina	S	enpi	unu	บู	ong	_	2 8
Course C	Outcomes (CO):	A <mark>t the en</mark> d of this course, learners will be able to:	- Julio	n o	problem	desig solut	puos	mod	the e	envir suste	ethics	individual		project	life lo	-osd	-osd
CO-1:	discuss the evolution of	of aircra <mark>ft and t</mark> heir types	3		2.1	150	- 1	-	7	-	-	-	-	-	1	-	
CO-2:	describe the various ty	rpes o <mark>f aircraft</mark> configuration, control systems and instruments	3		1	127	- 1	-	5	-		-	-	-	-	-	
CO-3:	describe about the atn	nosph <mark>ere and</mark> variation in properties, aircraft flight and different speed regimes	3	8/-1	1	7-	1	-	-	-	- :	-	-	-	-	-	
CO-4:	explain the basics of a	nircraf <mark>t structur</mark> es and the aerospace materials	3		-	142	3.5	-	-	-		-	-	-	1	-	
CO-5:	demonstrate about the	e vario <mark>us propu</mark> lsion systems used in aerospace industry	3		-1		ú -	_		-		-	-	-	1	-	

Unit-1 - History of Flight

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

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

Course Offering Department

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015 2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic

Aerospace Engineering

- 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.

Nil

9 Hour

9 Hour

			Continuous Learnin	g Assessment (CLA)		Cum	mative				
	Bloom's Level of Thinking	CLA-1 Avera	native ge of unit test 0%)	C	g Learning LA-2 10%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	50%	23 T. A.	50%		50%	-				
Level 2	Understand	50%		50%		50%	-				
Level 3	Apply			7-7-1		-	-				
Level 4	Analyze	- ())		- 1/		-	-				
Level 5	Evaluate	4	-		//	-	-				
Level 6	Create		-A - AA		7 - 1	<u>-</u>	-				
	Total	10	0 %	10	00 %	10	00 %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg.CdrK. Manoharan (Retd), Blue Da <mark>rt Aviatio</mark> n Ltd.,	1. Dr. A. P. Haran, Park College of Engineering & Technology,	1. Dr. T. Selvak <mark>umaran, S</mark> RMIST
manoharank@bluedart.com	ap_haran@rediffmail.com	
2. Wg.Cdr R.Annamalai, Chief training co-ordinating officer	2. Dr.S. Nadaraja Pillai, Sastra university Thanjavur,	2. Mr. G. Mahend <mark>ra Perum</mark> al, SRMIST
IAF,Tambaram.annamalai.ramasam <mark>y2@gm</mark> ail.com	nadarajapillai@mech.sastra.edu	

Course	21ASO302T	Course	CREATIVITY INNOVATION AND NEW PRODUCT DEVELOPMENT	Course	^	OPEN ELECTIVE	L	T	Р	С	
Code	21A3U3U21	Name	CREATIVITY, INNOVATION AND NEW PRODUCT DEVELOPMENT	Category	U	OPEN ELECTIVE	3	0	0	3	

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

THE RESERVE

Course L	earning Rationale (CLR): The purpose of learning this course is to:	11	4			Progr	am Oı	ıtcome	s (PO)					rogram
CLR-1:	explain the process of technological innovation, creativity and problem-solving methods	1	2	3	4	5	6	7	8	9	10	11	12	_	pecific utcomes
CLR-2:	discuss the ideas, criteria and techniques for project selection	dge		of	SI		. "			Work		9			
CLR-3:	identify the project evaluation techniques and describe the factors for product screening	45	S	evelopment of	restigations problems	Usage	ъ	· ·				Finan	Вu		
CLR-4:	discuss the importance of patent search and patent laws, as well as the role and classifications of IPR	Knowle	alysis	ldol	estig	ı Us	r and	∞ ∞ >	h.	Team	ion	∞ ∃	arning		
CLR-5:	explain the steps involved in new product development process	eering	em Ana	/deve	duct inve	n Tool	engineer a	nment nability		lual &	Sommunication	t Mgt.	Long Le		0
Course O	utcomes (CO): At the end of this course, learners will be able to:	Engine	Proble	Design	Condu of con	Modern	The en	Enviro S <mark>ustai</mark>	Ethics	Individual	Comm	Project	Life Lo	PS0-1	PSO-2 PSO-3
CO-1:	describe the technological innovation process and identify the need for creativity & innovation in engineering	3	1	15		-	7	-		-	-	-	1	-	
CO-2:	explain the project selection ideas as well as the various criteria and measures adopted during project selection	3	1	. J.	4	-	(=) -	- 1	-	-	-	1	-	
CO-3:	describe the factors for prod <mark>uct scre</mark> ening and identify the project evaluation techniques	3	2	125	-	-	-	. -		-	-	-	1	-	
CO-4:	explain IPR & its types and discuss the objective of patent laws, WIPO, TRIPS, WTO, PCT	3	- 1		7 -	-		-	-	-	-	-	1	-	
CO-5:	describe the process of new product development and discuss the need, purpose & methods of marketing research	3	2	-	-	-	I	-		-	-	-	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

- Keleen A.L., New Product Planning and Development, International Correspondence Schools Division, Scraton, Pennsyvania, 1969
 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

arning Assessme		AYA	Continuous Learnin	g Assessment (CLA)		0	
	Bloom's Level of Thi <mark>nking</mark>	CLA-1 Avera	native ge of unit test 0%)	Life-Long CL/ (10	4-2	Final Ex	mative amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	Carlotte Carlotte	50%		50%	-
Level 2	Understand	50%	A 15 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	50%	. 1.7	50%	-
Level 3	Apply		188 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	8.4 1 30 77		-	-
Level 4	Analyze	S	MARK 1997 TO 1	7 1 2 2 2 2 2 2 2		-	-
Level 5	Evaluate	2.3 (7/3)		"一根"也为"从表现"。			-
Level 6	Create		20 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 July 200	E	-	-
	Total	100	0%	100) %	10	0 %

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

Course	21ASO303T Course	AVIATION AND AIRLINE MAINTENANCE MANAGEMENT	Course	0	OPEN ELECTIVE	L	Τ	Р	С	
Code	Name	AVIATION AND AIRLINE MAINTENANCE MANAGEMENT	Category	U	OPEN ELECTIVE	3	0	0	3	

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

Course L	earning Rationale (CLR):	The purpose of learning this course is to:		1			Prog	am Ou	ıtcome	s (PO))					rogram
CLR-1:	explain the concepts of A	ir transportation a <mark>nd Airline m</mark> anagement	1	2	3	4	5	6	7	8	9	10	11	12		pecific itcomes
CLR-2:	explain the concept of Air	line forecastin <mark>g and fleet</mark> planning	ge)	of	SI					Work		8			
CLR-3:	discuss the significance of	f airline sch <mark>eduling a</mark> nd equipment maintenance	Knowledge	w	Jent	vestigations x problems	Usage	ъ			۸ ۸		Finance	guir		
CLR-4:	describe the concepts of	Aircraft re <mark>liability a</mark> nd aging aircraft maintenance			lobi	estig	l Us	r and	∞ × >	l.	Team	ion	∞ర	<u>=</u>		
CLR-5:	discuss the aviation supp	orting o <mark>rganizati</mark> on and state regulatory	ering	, A	n/development of	t inve	T ₀₀	engineer ety	nment		<u>∞</u>	ommunication	Mgt.	g Le		
	•		9	<u>a</u>	/ugi	nduct in	dern	enç etv	ron Rain	SS	jg /	l III	roject	Long	7)-2)-3
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	L E	. 설	Desi	of Con	Mod	The	Envi	Ethics	Individual	Con	Proj	Life	PSO-1	PSO-2 PSO-3
CO-1:	describe the organization	details in air-transportation	3		3	-	-	/	-	-	-	-	-	1	-	
CO-2:	describe the forecasting r	net <mark>hods in</mark> airline	3	14-	40.5	17-19	-	4	-		-	-	-	1	-	
CO-3:	summarize the scheduling	g p <mark>rocess a</mark> nd maintenance of aircraft	.3	Mily.	4	15	-	_	- 1		-	-	-	-	-	
CO-4:	explain the aging aircraft	m <mark>aintenan</mark> ce	3	4.4	100		-	-	-		-	-	-	-	-	
CO-5:	summarize the aviation so	upp <mark>orting o</mark> rganizations 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	1.	John G Wensveen, Air Transportation – A Management Perspective, Ashgate Publications,	3.	Indian Aircraft Manual, DGCA, sterling book House, Mumbai, reprint 2014
		8th ed., 2015	4.	Aviation maintenance management Harry.A.Kinnison, Second edition McGraw-Hill 2013
Resources	2.	Friend C.H., Aircraft Maintenance Management, Longman aviation technology. 2nd ed., 1992	5.	PS Senguttuvan, Fundamentals of air transport management, excel books, reprint 2010

Learning Assessm	ent	0.0								
				g Assessment (CLA)	** \	Sumi	mative			
	Bloom's Level of Thinking	Form CLA-1 Averaç (50		CI	<mark>g Learning</mark> LA-2 10%)	Final Examination (40% weightage)				
	_	Theory	Practice	Theory	Practice Practice	Theory	Practice			
Level 1	Remember	50%	-	50%		50%	-			
Level 2	Understand	- 50%		50%	A - V	50%	-			
Level 3	Apply	7			·	-	-			
Level 4	Analyze	7 / 7	2000		(P)	-	-			
Level 5	Evaluate	_	- 1 S. A. S. J. W.			-	-			
Level 6	Create			- TATE 1	1-2	-	-			
	Tota <mark>l</mark>	100)%	10	00 %	10	0 %			

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

Course 21ASO30	→ Course	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE	Course	0	OPEN ELECTIVE	L	Т	Р	С
Code	Name	PRACTICES	Category	U	OPEN ELECTIVE	3	0	0	3

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

THE PARTY OF THE P

Course L	Learning Rationale (CLR): The purpose of learning this course is to:		- 4			Prog	am Ou	ıtcome	s (PO))					rogram
CLR-1:	identify ground handling tools and equipment's to perform ground handling operation of aircraft	1	2	3	4	5	6	7	8	9	10	11	12		pecific Itcomes
CLR-2:	maintain the aircraft ground servicing units	dae		of	SI					Work		e			
CLR-3:	summarize the safety aspects and improve the human relations in working environment	11 0		velopment of	estigations roblems	Usage	ъ	٠, ١		N K		inan	ning		
CLR-4:	work in the planning process environment of maintenance industry		alysis	udoli	/estig probl		r and	ج ج ک		Team	ig	& ∃	ä		
CLR-5:	maintain the tools, accessories and components	ering	٩	Jn/deve	.≦ ×	n Tool	engineer ety	nment nability		ual &	mmunication	t Mgt.	ong Le		
Course C	Outcomes (CO): At the end of this course, learners will be able to:	Engii	Problem	Design	Conduct of comple	Moder	The en society	Enviro S <mark>ustai</mark>	Ethics	Individual	Comm	Project	Life Lo	PSO-1	PSO-2 PSO-3
CO-1:	explain the operation of various ground handling equipment's and its procedures	3	- 1	1.0	, Ten.	-	-7	-		-	-	-	1	-	
CO-2:	restate the utility of aircraft ground servicing units and their maintenance	3	14-	40.50	-11	-	4	-		-	-	-	-	-	
CO-3:	describe the various aspects of human performance factors	3	el ri		13	-	_) -		-	-	-	1	-	
CO-4:	discuss about different main <mark>tenance</mark> operational procedures	3	1.1	125	-	-	-	- 1		-	-	-	-	-	
CO-5:	explain the various precision instruments and special tools	3	1	-	7.	-		-		-	-	-	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 Hou

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.
- 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, 7th ed., Tata McGraw Hill, New Delhi, 2013.
- CAP 715 An Introduction to Aircraft Maintenance Engineering Human Factors for JAR 66, Civil Aviation Authority. UK.

			Continuous Learning Assessment (CLA)							
	Bloom's Level of Thinking	CLA-1 Ave	rmative rage of unit test (50%)	C	g Learning LA-2 10%)	Summative Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	50%	2011 T.N.	50%	· · · · · ·	50%	-			
Level 2	Understand	50%		50%		50%	-			
Level 3	Apply		4 7	**************************************		-	-			
Level 4	Analyze			- 1/		-	-			
Level 5	Evaluate		-	- 1		-	-			
Level 6	Create				X - \ .	-	-			
	Total	1	100 %	10	00 %	10	00 %			

Course Designers	A SALES STANDARD OF THE SALES O	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg.Cdr retd. Manoharan, Continuing Airworthiness Manager, Blue	1. Dr. V.Arumugam, Madras Institute Of Technology Campus, Anna	1. Dr. S. Sivakumar, SRMIST
Dart Aviation.manoharank@bluedart. <mark>com</mark>	University, Chennai, arumugam.mitaero@gmail.com	
Wg.cdr R.Annamalai, Chief training co-ordinating officer	2. Dr.S.Nadaraja Pillai, Sastra university Thanjavur,	2. Mr. G. Mahendra Perumal, SRMIST
IAF, Tambaram annamalai.ramasam <mark>y2@gm</mark> ail.com	nadarajapillai@mech.sastra.edu	

Course	21ASO305T	Course	FLOW VISUALIZATION TECHNIQUES	Course	0	OPEN ELECTIVE	L	Т	Р	С
Code	21A3U3U31	Name	FLOW VISUALIZATION TECHNIQUES	Category)	OPEN ELECTIVE	3	0	0	3

Pre-requisite Courses	Ni	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offerin	ng Department	Aerospace Enginee <mark>ring</mark>	Data Book / Codes / Standards		Nil

THE PROPERTY OF THE PARTY OF TH

Course L	earning Rationale (CLR):	The purpose of learning this course is to:	₹.	11	4			Prog	ram Oı	ıtcome	s (PO)					gram
CLR-1:	describe the flow visualiza	ation techniques i <mark>n fluid flows</mark>		1	2	3	4	5	6	7	8	9	10	11	12		cific omes
CLR-2:	select the appropriate equ	ipment requir <mark>ed for perf</mark> orming flow visualization experiment		dge		of	SL					Work		8			
CLR-3:	identify the techniques for performin <mark>g flow visu</mark> alization in air and water				alysis	nent	ation	Usage	ъ	. 1				Finance	bu		
CLR-4:						velopment	vestigations x problems		r and	∞ >	h.	Team	tion	∞ర	arni		
CLR-5:	examine the lased based	optical <mark>techniqu</mark> es for flow visualization applications	\$1.7 P	ering	٩	deve	_ <u>-</u>	Tool	engineer sty	ronment tainability		al &	mmunication	Mgt.	ng Le		
		The State of the S	7/10	Je .	roblem	ign/	nduct	dern	er et	io <mark>taj</mark>	S	ndividual	l E	Project	Long	<u>-</u>	7 5
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	1	Eng	Pag	Des	of G	Mo	The	Sus	Ethics	lpd	Con	Proj	Life	PSC	PSO-2 PSO-3
CO-1:	apply the principles of flui	d flo <mark>ws for f</mark> low visualization application	-17	3	- 2	1	-	-	-7	-		-	-	-	-	-	- -
CO-2:	list the equipment require	d f <mark>or flow v</mark> isualization experiments	8.4	3	2	40	- 19	-	4	-	-	-	-	-	1	-	- -
CO-3:	perform flow visualization	in <mark>air and</mark> water		3	2	1	13	-	_	-		-	-	-	1	-	
CO-4:	illustrate the flow field in s	rup <mark>ersonic</mark> flows	. 1	3	2	1.5	-	-	-	-		-	-	-	1	-	
CO-5:	apply advanced flow visua	aliz <mark>ation te</mark> chniques to fluid flows	F 11	3	2		7-	-		-		-	-	-	-	-	

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

	1.	Rathakrishnan, Ethirajan. Instrumentation, measurements, and experiments in fluids. CRC press, 2007.
Learning	2.	Smits, Alexander J. Flow visualization: techniques and examples. World Scientific, 2012.
Resources	3.	Tropea, C., Yarin, A. L., & Foss, J. F. (Eds.). (2007). Springer handbook of experimental fluid mechanics.
		Berlin: Springer.

- Barlow, Jewel B., William H. Rae, and Alan Pope. Low-speed wind tunnel testing. John wiley & sons, 1999.
 Discetti, Stefano, and Andrea laniro, eds. Experimental aerodynamics. CRC
 - Press, 2017.

Learning Assessment		/ .** /			•,						
	Bloom's Level of Thinking	Form CLA-1 Avera	ative ge of unit test	CL	g Leaming A-2 0%)	— Summative Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	20%		20%	7 - 7	20%	-				
Level 2	Understand	20%	A CONTRACTOR	20%	- A-	20%	-				
Level 3	Apply	60%	77 - 17 - 14	60%	A 100	60%	-				
Level 4	Analyze	~~ ·	30 July 1777	27.4		-	-				
Level 5	Evaluate				- C- Z	-	-				
Level 6	Create			1 14424		-	-				
	Tot <mark>al</mark>	100)%	100	0 %	100	0 %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Inter <mark>nal Exp</mark> erts
1. Dr. Saurav Kumar Ghosh, CSIR-NA <mark>L, Bang</mark> alore skghosh@nal.res.in	Dr. Lakshmana Dora C, IIT Hyderabad Ichandrala@mae.iith.ac.in	1. Dr. K K Bharadwaj, SRMIST
2. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	Dr. Arun Kumar Perumal, IIT Kanpurakp@iitk.ac.in	2. Dr. S Senthilkumar , SRMIST



Course	21ASO306T	Course	AIRPORT ENGINEERING	Course	0	ODEN ELECTIVE	L	Т	Р	С
Code	2 IA303001	Name	AIRFORT ENGINEERING	Category	0	OF EN ELECTIVE	3	0	0	3

Pre-requisite Courses	N	Co- requisite Courses	NII	rogressive Courses	Nil
Course Offerin	ng Department	Aerospace Engineering	Data Book / Codes / Standards		Nil
·			- 1 TO 1 1 2 2 2 2		

Course L	earning Rationale (CLR):	The purpose of learning this course is to:	1	1			Prog	am O	ıtcome	s (PO)					gram	
CLR-1:	explain about airports and	surveys	1	2	3	4	5	6	7	8	9	10	11	12		ecific come	
CLR-2:	describe about airport plai	nning and for <mark>ecasting</mark>	ge		of	SL					Work		9				
CLR-3:	contrast and design runwa	Knowledge	S	sign/development of	stigations roblems	Usage	ъ					inance	Вu				
CLR-4:	explain air traffic control to			ldol	estig		er and	× ×		Team	tion	∞ π	arni				
CLR-5:	discuss about heliports, S	erina	Ä	deve	t inve	Tool	engineer	Environment Sustainability	1	रू ज	Sommunication	Mgt.	g Le				
						onduct i	lern		La La	S	/ign	<u> </u>	roject	Long	7	72	က္
Course C	outcomes (CO):	At the end of this course, learners will be able to:	i B	Problem	Des	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Modern	The	Sust	Ethics	Individual	Con	Proj	Life	PS0-1	PSO-2	PSO-3
CO-1:	describe airports and surv	eys <mark> involve</mark> d	2		17:	-	-		-		-	-	-	-	-	-	-
CO-2:	explain airport planning and forecasting			100	40 70	- 1	-	4	-	-	-	-	-	1	-	-	-
CO-3:	differentiate interpret and design runway and taxiways			n kiriya		1	-	-	- 1		-	-	-	1	-	-	-
CO-4:	D-4: describe about air traffic control tower and terminal areas				100	-	-	-	-		-	-	-	-	-	-	-
CO-5:	CO-5: differentiate interpret about heliports, STOL ports and vertiports				-		_		-		-	-	-	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

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	1.	Rangwala. Airport Engineering, Charotar Publishing House Pvt. Ltd.; 17th Edition (1 January 2018)	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
Resources	2.	FAA Advisory Circular - Airport Design 150/5300-13B - March 2022	4.	Airport Engineering - planning and design- Saxena S.C.CBS Publishers & Distributors

		7	Continuous Learning Assessment (CLA)								
	Bloom's Level of Thinking	CLA-1 Avera		CL	g <mark>Learning</mark> _A-2 0%)	Summative Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice Practice	Theory	Practice				
Level 1	Remember	50%		50%		50%	-				
Level 2	Understand	50%	- 4 - 4	50%	7) - 1	50%	-				
Level 3	Apply				1 / Jan 1 1	-	-				
Level 4	Analyze	7.		-	(P)	-	-				
Level 5	Evaluate	/~/	- 18 A. S. J. S. W.			• •	-				
Level 6	Create						-				
	Tota <mark>l</mark>	100)%	10	00 %	10	0 %				

Course Designers		3 /
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg.Cdr retd. Manoharan, Continuing Airworthiness Manager, Bl	le 1. Dr. V.Arumugam, Madras Institute Of Technology Campus, Anna	1. Dr. S. Sivaku <mark>mar, SR</mark> MIST
Dart Aviation.manoharank@bluedar <mark>t.com</mark>	University, Chennai, arumugam.mitaero@gmail.com	
Wg.cdr R.Annamalai, Chief training co-ordinating officer	2. Dr.S.Nadaraja pillai, Sastra university Thanjavur,	2. Mr. K. Iyenthe <mark>zhuthon</mark> , SRMIST
IAF, Tambaram annamalai.ramasam <mark>y2@gm</mark> ail.com	nadarajapillai@mech.sastra.edu	

Course	21ASO307T	Course	MOLECULAR GAS DYNAMICS	Course	0	OPEN ELECTIVE	L	Т	Р	С
Code	21A3O3071	Name	MOLECULAR GAS DYNAMICS	Category	0	OPEN ELECTIVE	3	0	0	3

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

Course L	earning Rationale (CLR): The purpose of learning this course is to:	J.	4			Progr	<mark>am O</mark> u	tcome	s (PO)					rogram	1
CLR-1:	discuss need for molecular description of fluid flow, binary collision and the Boltzmann equation	1	1 2 3 4 5 6 7 8 9 10 11 12						12	_	pecific utcomes					
CLR-2:	explain the significance of elastic and inelastic collision	dge		o	SL					Work		9				
CLR-3:	interpret the chemical reactions and thermal radiation with respect to engineering problem		S	velopment	stigations	Usage		. '		am W		Finan	bu			
CLR-4:	describe importance of collisionles <mark>s flow</mark>	ering Knowle	Analysis	lobi	estig		r and	∞ × >	N	Teal	ion	∞ŏ	arnii			
CLR-5:			Ang	deve	t in y	Tool	engineer sty	nment	. 1	<u>a</u>	nical	Mgt.	g Le			
					onduct	Modern	The eng society	viron s <mark>tain</mark>	Ethics	ndividual	Sommunication	Project	Long	PS0-1	PSO-2 PSO-3	
Course O	utcomes (CO): At the end of this course, learners will be able to:	Engi	Problem		35	₽	S I	Su	击	<u>2</u>	පි	Pro	Life	PS	PSO.	
CO-1:	define the importance of molecular perspective fluid flow, binary collision and need for Boltzmann equation	1	15	Tay		-	7	-		-	-	-	ı	-		
CO-2:	explain the difference betwe <mark>en inela</mark> stic and elastic collision and its significance	2	1	4	3	-		-	1	-	-	1	1	-		
CO-3:	examine the role of bimolecular reactions and termolecular reactions in chemical reaction			Z.,	-	-	-	-		-	-	-	2	-		
CO-4:	0-4: describe the significance of collisionless flow				-1	-	-	-	-	-	-	-	-	-		1
CO-5:	demonstrate the need for mesoscopic and microscopic numerical technique for fluid flow					-		-	-	-	-	-	2	-		1

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.

- 1. Gombosi, Tamas I., and Atmo Gombosi. Gaskinetic theory. No. 9. Cambridge University Press, 1994.
- 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).
- 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.

ning Assessme	Bloom's Level of Thinking	CLA-1 Avera	Continuous Learning mative age of unit test 0%)	CL	g Learning _A-2 0%)	Final Ex	mative amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	*	20%	2 - 1	20%	-
Level 2	Understand	20%	A COLUMN	20%	- A	20%	-
Level 3	Apply	60%	20 E 10 D 10	60%	A 1-3	60%	-
Level 4	Analyze	~ ·	1 Sept. 272			-	-
Level 5	Evaluate			70.00	- 2	-	-
Level 6	Create		Commence of the Commence of th	3, 3,42%		-	-
•	Tot <mark>al</mark>	10	0%	- 10	00 %	10	0 %

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

Course	21AIO251T Course	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	Course	OPEN ELECTIVE	L	Т	Р	C	
Code	Name	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	Category	OPEN ELECTIVE	2	1	0	3	

Pre-requisite Courses	Ni	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offeri	ng Department	Computational Intelligence	Data Book / Codes / Standards		Nil

Course L	earning Rationale (CLR):	The purpose of learning this course is to:	111	4			Prog	am O	utcome	s (PO)				Progi	
CLR-1:	analyze the various chara	cteristics of Intelli <mark>gent agents</mark>	1	2	3	4	5	6	7	8	9	10	11	12	Spec Outco	
CLR-2:	organize different search	strategies in Al	dge		of	ડા					Work		90			
CLR-3:	incorporate knowledge in	solving AI p <mark>roblems</mark>	Knowledge	S	velopment of	stigations	Usage	ъ					Finance	ng		
CLR-4:	construct in different ways	s of desig <mark>ning soft</mark> ware agents		alysis	udoli	vestig probl		r and	∞ ×		Team	ţį	∞ర	arni		
CLR-5:	plan various applications	of AI	ering	٩	deve	.⊆ ∺	Tool	engineer	ronment tainability		<u>8</u>	Sommunication	Mgt.	ng Le		
			9	Problem	ign/dev tions	omple	dern	enç etv	tai io	S	ndividual	l li	roject	Long	20-1 20-2	- 23
Course C	outcomes (CO):	At the end of this course, learners will be able to:	Engi	Pro	Des	Se	₩ W	The	Envi Sust	Ethics	<u> </u>	Š	Proj	Life	PSO-1	PSO-3
CO-1:	use appropriate search al	gori <mark>thms for</mark> any Al problem	3	- 1	1	-	-		-		-	-	-	-		-
CO-2:	represent a problem using	g fi <mark>rst order</mark> and predicate logic	3	3	3	- 19	2	3	-		-	-	-	-		-
CO-3:	provide the apt agent stra	te <mark>gy to sol</mark> ve a given problem	3	3	_2	13	2	-	-	-	-	-	-	-		-
CO-4:	design software agents to	s <mark>olve a pr</mark> oblem	3	1	3	-	2	3	-		-	-	-	-		-
CO-5:	develop application that u	se <mark>s Artifici</mark> al Intelligence	3	- 1	3		_		-		-	-	-	-		-

Unit-1 - Introduction

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 Al Problems

Unit-3 - Intelligent Agents

9 Hour

Architecture for intelligent agents, Agent communication, Negotiation, Bargaining, Argumentation, Agents, Trust, Reputation, Multi agent systems, Al 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	

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

earning Assessme	ent			4 ((2)4)		T				
	Bloom's Level of Thinking	CLA-1 Avera	native age of unit test 0%)		Learning A-2 %)	Summative Final Examination (40% weightage)				
	/ 37	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%	- R. July 977	20%		20%	-			
Level 2	Understand	20%		20%	1 G 2	20%	-			
Level 3	Apply	30%	CONTRACTOR OF	30%		30%	-			
Level 4	Analyze	30%	Charles To the Contract	30%		30%	-			
Level 5	Evaluate		1 CAMP - 24 CA	- 10 May 1		-	-			
Level 6	Create	A	William Comment to 1	Box 1 32. 78		-	-			
	Total -	10	0%	100) %	10	0 %			

Course Designers	Marie N		
Experts from Industry	147,1-	Experts from Higher Technical Institutions	In <mark>ternal E</mark> xperts
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	21AIO352T	Course	MACHINE I FARNING	Course	0	OPEN ELECTIVE	L	Т	Р	С
Code	21A103321	Name	MACHINE LEARNING	Category)	OPEN ELECTIVE	2	1	0	3

Pre-requisite Courses	Ni	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offerin	ng Department	Computational Intelligence	Data Book / Codes / Standards		Nil

Course L	earning Rationale (CLR):	The purpose of learning this course is to:	11	- 4			Progr	am Oı	ıtcome	s (PO)					rogram	
CLR-1:	explore the fundamentals	s of Machine Lear <mark>ning along wi</mark> th its Mathematical concepts	1	2	3	4	5	6	7	8	9	10	11	12	_	pecific Itcomes	
CLR-2:	provide deeper understa outputs	nding of various tools and techniques for Machine Learning Algorithms a	and §		of	IS of	L.	society			Work		eo O				
CLR-3:	apply linear learning mod	lels to perf <mark>orm classi</mark> fication in Machine Learning	Knowlec		nent	stigations	age			l.	≽ ≥		Finance	gu			
CLR-4:	understand the various C	Clustering Methods		alysi	lob	vestigati oblems	Tool Usage	er and	۲ م ک ک		Team	tion	⊗ F	arning			
CLR-5:	learn and understand the	Tree based Machine Learning Algorithms	eering	roblem Analysis	n/development of	્રી.⊑ હ	ern Too	engineer	vironment stainability		dual &	ommunication	roject Mgt.	Long Le	_	2 0	^
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	Engine	Proble	Design	Conduct	Mode	The el	Enviro Sustair	Ethics	Individual	Comn	Projec	Life Lo	PSO-1	PSO-2	
CO-1:	understand the concepts	of machine learning	3	1.10	18.5	Ver-	-	1	-		-	-	-	-	-		-
CO-2:	learn and understand too	Is <mark>and libra</mark> ries of machine leaming	3	3	3		3		i, -		-	-	-	-	-		-
CO-3:	implement machine learr	ing models using supervised learning algorithms	3	3	-75	-	3	-	-		-	-	-	-	-		-
CO-4:	implement machine leari	ing models using unsupervised learning algorithms	3	3		2.5	3	_	-	-:	-	-	-	-	-		-
CO-5:	implement the tree-base	d m <mark>achine l</mark> earning 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

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).

	1.	Kevin P. Murphy, - Machine learning: A Probabilistic Perspectivell, MIT Press, 2012.	5.	Carol Quadros, Il Machine Learning with python, scikit-learn and Tensorflowll, Packet Publishing,
Learning	2.	Ethem Alpaydin, — Introduction to Machine Learningll, Prentice Hall of India, 2005		2018.
Resources	3.	Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.	6.	Sebastian Raschka, Vahid Mirjilili, Python Machine Learning and deep learning 1, 2nd edition,
	4.	Gavin Hackeling, Il Machine Learning with scikit-learnII, Packet publishing, O'Reily, 2018.	7 7	kindle book, 2018

arning Assessme			Continuous Learnin	g Assessment (CLA)		0					
	Bloom's Level of Thinking	Form CLA-1 Averaç (50	ative ge of unit test	Life-Long CL	Learning A-2 %)	Summative Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	20%		20%	A	20%	-				
Level 2	Understand	20%	A CONTRACTOR	20%	*	20%	-				
Level 3	Apply	30%	20 7 7 7 10	30%		30%	-				
Level 4	Analyze	30%	A 18 18 18 18 18 18 18 18 18 18 18 18 18	30%		30%	-				
Level 5	Evaluate					-	-				
Level 6	Create		ALL HOME PROPERTY OF THE	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		-	-				
	Tot <mark>al</mark>	100) %	100) %	10	0 %				

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



Course	21∆I∩353T	Course	DVTHON FOD DATA ANALYTICS	Course)	OPEN ELECTIVE	L	Т	Р	С
Code	21AIO3531	Name	PYTHON FOR DATA ANALYTICS	Category	0	OFEN ELECTIVE	2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil	
Course Offering Dep	artment	Computational Intelligence	Data Book / Codes / Standa	rds	Nil	

THE PROPERTY OF THE PARTY OF TH

Course L	earning Rationale (CLR): The purpose of learning this course is to:	11	4			Progr	<mark>am O</mark> u	ıtcome	s (PO)				_	rogram	1
CLR-1:	introduce a range of topics and concepts related to data and data analysis process	1	2	3	4	5	6	7	8	9	10	11	12	_	Specific utcomes	
CLR-2:	understand the basic data structures involved in python to perform exploratory data analysis			of	SI	4	. "			Work		9				
CLR-3:	apply EDA for different file formats	owledge	w	Jent	estigations problems	Usage	ъ			₩		Finan	βĹ			
CLR-4:	understands data visualization using python	조	Analysis	udoli	estig	ol Us	r and	م × ح ×	h.	Team	tion	∞ర	arning			
CLR-5:	LR-5: provides an exposure to basic machine learning techniques to solve real world problems			n/development of	> -	2	engineer a	ment ability		<u>∞</u>	ommunication	Mgt.	g Le			
		ineering	roblem	ign/	nduct in complex	dern		iron		ndividual	nur	Project	Long	7	75	
Course C	outcomes (CO): At the end of this course, learners will be able to:	Eng	Prof	Des	g G	Moc	The	Sus	Ethics	Indi	Con	Proj	Life	PS0-1	PSO-2 PSO-3	
CO-1:	understand different types of <mark>data and</mark> starts working in python environment	3	- 3	2	-	-		-		-	-	-	-	-	- -	
CO-2:	understand various data stru <mark>ctures in</mark> volved in python and perform exploratory data analysis	3	3	2	- 19	-	2	-		-	-	-	-	-	- -	1
CO-3:	apply the concepts of EDA i <mark>n variou</mark> s datasets	- X	3	12	154	_	-	<i>)</i> -	-	-	-	-	-	-		
CO-4:	formulate and use appropria <mark>te visua</mark> lization 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		-4	1-54	3	2		-	-	-	-	-	-	-		

Unit-1 - Introduction to Python

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 Ioading 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

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

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

	Bloom's Level of Thinking	g Learning LA-2 10%)	Summative Final Examination (40% weightage)				
	/	Theory	0%) Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	2.50	20%		20%	-
Level 2	Understand	20%	18 2 W S (4)	20%	A 1-3	20%	-
Level 3	Apply	30%	R. J. S. 3777	30%		30%	-
Level 4	Analyze	30%		30%	1 - 4	30%	-
Level 5	Evaluate		A THE WATER A TO	1414		-	-
Level 6	Create	-	Carlotte State Comment				-
	To <mark>tal</mark>	10	0 %	10	00 %	10	00 %

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
	AND THE REAL PROPERTY OF THE P	2. Mr. Joseph Jam <mark>es, SRM</mark> IST

Course	21AIO354T	Course	SOFT COMPUTING	Course	^	OPEN ELECTIVE	L	Т	Р	С
Code	21A1O3341	Name	SOFT COMPUTING	Category	U	OPEN ELECTIVE	2	1	0	3

Pre-requisite Courses	Ni	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offerin	ng Department	Computational Intelligence	Data Book / Codes / Standards		Nil

Course L	earning Rationale (CLR): The purpose of learning this course is to:	11	4			Prog	am Ou	tcome	es (PO))					rogram
CLR-1:	understand the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience	1	2	3	4	5	6	7	8	9	10	11	12	_	pecific utcomes
CLR-2:	gain knowledge on neural networks with examples			14	/)		. "	,							
CLR-3:	gain knowledge on the mathematical <mark>backgroun</mark> d for carrying out the optimization associated with neural network learning	mathematical background for carrying out the optimization associated with neural													
CLR-4:	gain knowledge on genetic algorithms and other random search procedures useful while seeking alphal				vestigation oblems	ool Usage	and so	& Susta		eam W	=	Finance	aming		
CLR-5:	introduce case studies utilizing the above and illustrate the intelligent behavior of programs based or		blem Analysis	gn/development	onduct inves	em Tool L	engineer a	Environment 8	6	∞ ~	Communication	ct Mgt. &	Long Lear	-	3 8
Course C	Outcomes (CO): At the end of this course, learners will be able to:	Engine	Probl	Desig	Cond	Mode	The e	Envir	Ethics	Individual	Comr	Project	Life L	PSO-	PSO-2 PSO-3
CO-1:	analyze a given computational task to recognize the appropriateness through fuzzy sets	3	17.	-		-				-	-	-	-	-	
CO-2:	design a fuzzy based soft computing system to address the computational task	3	124	3		-	-	-		-	-	-	-	-	
CO-3:	analyze a given computatio <mark>nal task t</mark> o solve it through neural network	3	3	2	3.5	-		-	-:	-	-	-	-	-	
CO-4:	apply Genetic Algorithm ope <mark>rations f</mark> or solving a computational task	-3	2	2	· ·	-	2	-		-	-	-	-	-	
CO-5:						-	-	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,

	1. Sandnya Bansai & Rajiv Goel "Fundamentals of Soft Computing", 18
	Publication, 2020
	2. Saroj koushik & Sunita Tiwari "Soft Computing, Fundamentals, Techn
Learning	1st Edition, McGraw Hill Publication, 2018
Resources	3. Samir Roy and Udit Chakraborthy, "Introduction to Soft Computer 1981)
	Genetic Algorithms" Pearson Education, 2013

- niques and Applications"
- Genetic Algorithms" Pearson Education, 2013.
- Approach to Learning and Machine Intelligence, Pearson Education, 2004.
- 1st Edition, Notion Press 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,
- uting: Neuro-Fuzzy and 7. G.J.Klir and B.Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Second Reprint, PHI, 2000.
- 4. J.S.R. Jang, C.T.sun and E. Mizutani, "Neuro-fuzzy and Soft Computing: A computational 8. J.A.Freeman and D.M.Skapura, "Neural Networks: Algorithms, Applications and Programming Techniques", Pearson Education, 2011

rning Assessme			Continuous Learnin	g Assessment (CLA)		0				
	Bloom's Level of Thinking	CLA-1 Avera	mative age of unit test 50%)	Life-Long CL	Learning A-2 %)	Summative Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%		20%	(-4	20%	-			
Level 2	Understand	20%	化二氯甲基甲基甲基	20%		20%	-			
Level 3	Apply	30%	A TOTAL TOTAL CONTRACT	30%		30%	-			
Level 4	Analyze	30%	A 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	30%		30%	-			
Level 5	Evaluate		1021 1 1 - Land 197	Sec. 1 30 . 1175	- 4	-	-			
Level 6	Create	3	All the second	7 10 10 10 10		-	-			
	Total	10	00 %	100) %	10	0 %			

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	21EIO131 I	Course	VIRTUAL INSTRUMENTATION	Course	0	OPEN EL ECTIVE	L	Т	Р	С
Code	216101313	Name	VIRTUAL INSTRUMENTATION	Category	J	OPEN ELECTIVE	2	0	2	3

Pre-requisite Courses	N	Co- requisite Courses	Nil	Progressive Courses		Nil	
Course Offer	ing Department	Electronics and Instrumentation Engineering	Data Book / Codes / Standards		٠. ٦	Nil	

Course L	Learning Rationale (CLR): The purpose of learning this course is to:		- 4			Progr	am Oı	ıtcome	s (PO)					rogram
CLR-1:	understand various building elements of virtual instrumentation	1	2	3	4	5	6	7	8	9	10	11	12		pecific itcomes
CLR-2:	know the basics of creating VI programs	dge		of	SI					Work		9			
CLR-3:	impart knowledge on usage of arrays and clusters	Knowledge	ဟ	nent	ation	Usage	ъ			N W		Finance	рu		,
CLR-4:	introduce various graphs and structures used in developing VI program		alysis	udoli	vestigations problems	l Us	r and	× ×		Team	ţį	∞ర	arning		,
CLR-5:	understand the concepts of data acquisition by interfacing modules	ering	۱A	sign/development of utions	i⊆ X	Tool	engineer ety	nment nability		al &	ınica	Mgt.	ng Le		ı
Course C	Outcomes (CO): At the end of this course, learners will be able to:	Engine	Problem	Design solution	Conduct in of complex	Modern	The en society	Enviror Sustair	Ethics	ndividual	Communication	Project I	life Long	PS0-1	PSO-2 PSO-3
CO-1:	explain the procedure for creating virtual instrumentation program	2	- 7	-	-	Ē		-	1	-	-	-	-	-	
CO-2:	select the appropriate condition loops for the given application	2	14-	40.00	-19	-	1	-		-	-	-	-	-	
CO-3:	examine the usage of array <mark>s and clu</mark> sters	2	والمالية	4.0	15	-	-	-		-	-	-	-	-	
CO-4:	compare the data from grap <mark>hs and c</mark> harts	2	1 1	Tage 1	-	_	-	-		-	-	-	-	-	- -
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:

- 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
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.
- 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.
- Lisa K. Wells and Jeffrey Travis, "LABVIEW for Everyone", PHI, 1997.
 6. S. Gupta, J.P. Gupta," PC Interfacing for Data Acquisition and Process Control", ISA, 2nd ed., 1994.

	Bloom's Level of <mark>Thinkin</mark> g	CLA-1 Avera	Continuous Learning native ge of unit test 5%)	CL	Learning A-2 5%)	Summative Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	20%		A Park Contract Contr	20%	20%	-				
Level 2	Understand	20%	. N N. I.		20%	20%	-				
Level 3	Apply	30%	- 1	-	30%	30%	-				
Level 4	Analyze	30%	- 1111	-	30%	30%	-				
Level 5	Evaluate	() - \	- 7/3/6	-	7 - 71 - 1	-	-				
Level 6	Create				- / - <u>-</u>	-	-				
	Total	10	0 %	100	0%	10	0 %				

Course Designers	CALDER TO TOTAL - LEVIL	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Manoj Gupta, Mitsubishi Electric India,	1. Dr.K.Srinivasan, NIT, Trichy,	1. Dr. C. Likith Kumar, SRMIST
Manoj.Gupta@asia.meap.com	srinikkn@nitt.edu	3.
Mr. Gautham, Schneider Electric, gautham.r@se.com	2. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	

Course	Ourse Course	ANALYTICAL INSTRUMENTATION	Course	OPEN ELECTIVE	L	T	Р	(;
Code	Name	ANALYTICAL INSTRUMENTATION	Category	OPEN ELECTIVE	3	0	0	3	j

Pre-requisite Courses	Ni	Co- requisite Courses	Nil	Progressive Courses	Nil	
Course Offerin	ng Department	Electronics and Instrumentation Engineering	Data Book / Codes / Standards		Nil	

Course L	earning Rationale (CLR):	The purpose of learning this course is to:	111	4			Prog	ram Oı	ıtcome	s (PO)					rogram
CLR-1:	understand the principle	e and theory of anal <mark>ytical instrum</mark> ents	1	2	3	4	5	6	7	8	9	10	11	12	_	pecific Itcomes
CLR-2:	know the quantitative a	nalysis of dissol <mark>ved compo</mark> nents	dge		of	ટા					Work		99			
CLR-3:	provide the concept of s	separation sc <mark>ience and</mark> its applications	Knowledge	S	velopment of	restigations problems	Usage	ъ					inance	guir		
CLR-4:	impart the knowledge o	n various s <mark>pectrosco</mark> pic techniques and its instrumentation		alysis	udoli	estig		r and	∞ × >		Team	ion	∞ ⊥	a		
CLR-5:	identify the engineering	problems associated with Radiation Techniques	Sering	٩	n/deve	iduct inve	n Tool	engineer ety	nment		lual &	mmunication	t Mgt.	ong Le		3
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	Engine	Problem	Design	Condi	Modern	The el	Enviro S <mark>ustai</mark>	Ethics	Individual	Comn	Project	Life Lo	PS0-1	PSO-2 PSO-3
CO-1:	summarize the principle	es and <mark>theory o</mark> f instrumental analysis	3		3 72	-	-	/	-		-	-	-	-	-	
CO-2:	apply the principles of v	rariou <mark>s chemi</mark> cal analysis instruments in industries	3	2	100	77-19	-	4	-		-	-	-	-	-	
CO-3:	analyze and understand	d the operation of various radio chemical methods of analysis	3	di ris		13	-	-	-		-	-	-	-	-	
CO-4:	illustrate the operation of	of ins <mark>trument</mark> s based on optical properties	3	1			-	-	-		-	-	-	-	-	
CO-5:	outline the engineering	prob <mark>lems as</mark> sociated with Radiation Techniques	3	4	1		_		-		-	-	-	-	-	

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 elec<mark>trodes - 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</mark>

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

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

		.0	Continuous Learning	Assessment (CLA)	V '. V	Summative				
	Bloom's Level of Thinking	Formative Life-Long Learning CLA-1 Average of unit test CLA-2 (50%) (10%)		CLA-2	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice Practice	Theory	Practice			
Level 1	Remember	20%	- 4 - 4	20%	7 2	20%	-			
Level 2	Understand	20%	1000	20%	- A- 1	20%	-			
Level 3	Apply	30%	20 E 10 E 10	30%	(42.7) P	30%	-			
Level 4	Analyze	30%	A. J. M. 1997	30%		30%	-			
Level 5	Evaluate			A. S. C.	4-5	4 -	-			
Level 6	Create		S. J. S. MAN S. A. A.	34114		-	-			
•	Tot <mark>al</mark>	10	0%	1	00 %	10	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Expe <mark>rts</mark>
1. Mr. Manoj Gupta, Mitsubishi Electri <mark>c India, M</mark> anoj.Gup	ta@asia.meap.com 1. Dr.K.Srinivasan, NIT, Trichy, srinikkn@nitt.edu	1. Dr. Vibha. <mark>K, SRMI</mark> ST
2. Mr. Gautham, Schneider Electric,gautham.r@se.com	2. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.	com

Course	21EIO123T	Course	INDUSTRIAL ALITOMATION SYSTEMS	Course	0	OPEN ELECTIVE	L	Т	Р	С
Code	215101331	Name	INDUSTRIAL AUTOMATION SYSTEMS	Category	U	OPEN ELECTIVE	3	0	0	3

Pre-requisite Courses	Ni	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offeri	ng Department	Electronics and Instrumentation Engineering	Data Book / Codes / Standards		Nil

Course L	earning Rationale (CLR): The purpose of learning this course is to:	111	4			Progr	am Ou	itcome	s (PO)					rogram
CLR-1:	introduce the hardware components of programmable logic controller	1	2	3	4	5	6	7	8	9	10	11	12		pecific Itcomes
CLR-2:	provide knowledge on PLC programming using various function blocks	dge		of	SI	,	. "			Work		8			
CLR-3:	understand distributed control system in process automation	Knowledge	S	evelopment of	stigations roblems	Usage	ъ			N N		Finance	ning		
CLR-4:	impart basic information on operator interface in distributed control system		alysis	lopi	estig/ probl	l Us	r and	× ×		Team	fion	∞ర	ਕ		
CLR-5:	understand the hardware compo <mark>nents an</mark> d communication in SCADA	ering	٩	in/deve	iduct inve	n Tool	engineer ety	nment nability		ual &	Sommunication	t Mgt.	Long Le		
Course C	Outcomes (CO): At the end of this course, learners will be able to:	Engine	Problem	Design solutio	Condu of com	Moder	The en society	Enviro S <mark>ustai</mark>	Ethics	Individual	Comm	Project	Life Lo	PS0-1	PSO-2 PSO-3
CO-1:	summarize the working of programmable logic controller	2		-	-	-	/	-	-	-	-	-	-	-	
CO-2:	write basic ladder logic progr <mark>am for c</mark> ontrol application	2		2	7-19	-	1	-	-1	-	-	-	-	-	
CO-3:	outline the various local control unit architecture in distributed control system	2	er. 173		13	-	-	-		-	-	-	-	-	
CO-4:	analyze the various operato <mark>r display</mark> s used in distributed control system	2		The f	2	-	-	-	- :	-	-	-	-	- 1	
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 SCAD<mark>A - Key features - Remote terminal unit - Analog and discrete control - Monitoring signals - Master terminal unit - RTU/MTU communication - System components - Communication protocols.</mark>

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

earning Assessme	ent				•,		
	Bloom's Level of Thinking	CLA-1 Avera	Continuous Learning native ge of unit test 0%)	CL	g Learning .A-2 0%)	Final Exa	native amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%		20%	7 2 - 1	20%	-
Level 2	Understand	20%	No.	20%	- A- 10	20%	-
Level 3	Apply	30%	20 E 10 E 10	30%	(P)	30%	-
Level 4	Analyze	30%	Sec. 277	30%		30%	-
Level 5	Evaluate			- Att 11 11 11 11 11 11 11 11 11 11 11 11 1	1-2	<u> </u>	-
Level 6	Create		2, 194 W275 A S	3919		-	-
	Tot <mark>al</mark>	10	0%	- 10	0 %	100	0 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Manoj Gupta, Mitsubishi Electri <mark>c India, M</mark> anoj.Gupta@asia.meap.com	1. Dr.K.Srinivasan, NIT, Trichy, srinikkn@nitt.edu	1. Dr. J. Sam Jeb <mark>a Kumar</mark> , SRMIST
2. Mr. Gautham, Schneider Electric,gautham.r@se.com	2. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	

Course	24EIO124T Course	INTRODUCTION TO SENSORS	Course	OPEN ELECTIVE	L	Т	Р	(,
Code	Name	INTRODUCTION TO SENSORS	Category	OF EN ELECTIVE	3	0	0	3	i

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil	
Course Offering	ng Department Elec	tronics and Instrumentatio <mark>n Engineerir</mark>	g Data Book / Codes / Standa	rds	Nil	

Course Le	characteristics gain knowledge on the construction and principle of motion, proximity and ranging sensors impart the knowledge of basic principles of force, magnetic and heading sensors understand the concepts of optical, pressure and temperature sensors					Progr	am Ou	itcome	s (PO)					gram
CLR-1:	introduce different types of Sensing physical quantity and their basic principle and sensing characteristics	g 1	2	3	4	5	6	7	8	9	10	11	12		cific comes
CLR-2:	gain knowledge on the construction and principle of motion, proximity and ranging sensors	dge		of	าร					Work		ce			
CLR-3:	impart the knowledge of basic principles of force, magnetic and heading sensors	Knowlec	S	nent	stigations	Usage	ъ		L.			inance	В		
CLR-4:	understand the concepts of optical, pressure and temperature sensors		alysis	n/development of	estig orobl	I Us	er and	t &		Team	tion	∞ π	ami		
CLR-5:	provide the different types of se <mark>nsors em</mark> ployed in various applications	ering	₽	deve	ex l	Modern Tool	engineer ety	nment nability	<u>.</u> 1	<u>8</u>	ommunication	Mgt.	ig Le		
		9	roblem	1.00.∺	onduct i	ern	et G	5 <u>'e</u>	SS	ndividual	l E	roject	Long	7 6	7 5
Course O	utcomes (CO): At the end of this course, learners will be able to:	Engi	Pro	Design	Con	Mod	The eng society	Envi Sust	Ethics	Indi	Com	Proj	Life	PSO-1	PSO-2 PSO-3
CO-1:	familiarize the transduction principles and label their characteristics of the measurement system	2	2	F 39		-	1	-	1	-	-	-	-	-	- -
CO-2:	describe the principle of mot <mark>ion, pro</mark> ximity and ranging sensors	2	2	1	4	-	7	-	-	-	-	-	-	-	
CO-3:	recall the performance of fo <mark>rce, mag</mark> netic and heading sensors	2	2	2	7	-	_	-		-	-	-	-	-	- -
CO-4:	outline the working principle <mark>s optical</mark> , pressure and temperature sensors	2		2	2.2	-	-	-	-:	-	-	-	-	-	- -
CO-5:	select the type of sensors used in various real time applications	_2		1-54	-	-		-		-	-	-	-	-	- -

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

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

	Bloom's Level of Thinking		Continuous Learning native ge of unit test 9%)	Life-Lono CL	g Learning LA-2 0%)	Summative Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	20%	* A - A	20%	7 2 - 1	20%	-				
Level 2	Understand	20%	A.F	20%	- A-	20%	-				
Level 3	Apply	30%		30%	A 100 TO	30%	-				
Level 4	Analyze	30%	Sept. 272	30%		30%	-				
Level 5	Evaluate				1 - 2	4 -	-				
Level 6	Create		8, 5 to 1827 5 to 5	3444		-	-				
	Tot <mark>al</mark>	100)%	- 10	00 %	10	00 %				

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.Vim <mark>ala Julie</mark> t, SRMIST
2. Mr. Gautham, Schneider Electric, gautham.r@se.com	2. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	

Course	21EI∩135T	Course	INTRODUCTION TO MEMS	Course	0	OPEN ELECTIVE	L	Τ	Р	С
Code	216101331	Name	INTRODUCTION TO MEMS	Category	U	OPEN ELECTIVE	3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil	
Course Offering	ng Department Elec	tronics and Instrumentatio <mark>n Engineerir</mark>	g Data Book / Codes / Standa	rds	Nil	

Course Le	earning Rationale (CLR): The purpose of learning this course is to:		4			Progr	am Oı	itcome	s (PO)					gran	
CLR-1:	know the importance of microsystem technology and the operating principle of various micro sens	ors 1	2	3	4	5	6	7	8	9	10	11	12		ecific come	
CLR-2:	impart knowledge of MEMS materials and their properties	ge		of	าร	4		, '		Work		ce				
CLR-3:	introduce different MEMS fabrications steps and procedures	Knowledge	ဟ	ign/development tions	stigations	Usage	ъ			am W		inance	В			
CLR-4:	explore packaging process and so <mark>lutions</mark>		alysis	lopr	estig orobl	I Us	er and	t ⊗		Теа	tion	∞	ami			
CLR-5:	gain knowledge on the impleme <mark>ntation of</mark> MEMS and microsystems in various industries	ering	Æ	deve	i ×	Modern Tool	engineer ety	nment nability		<u>8</u>	ommunication	Mgt.	ng Le			
		ě	roblem	ign/	onduct i	lern	et e	ironn taina	S	ndividual	<u>ا</u> الآ	roject	2	7	-5	-3
Course O	utcomes (CO): At the end of this course, learners will be able to:	Engi	Pro	Des	Conduct of comple	Мос	The eng	Envi	Ethics	Indi	Con	Proj	Life	PS0-1	PS0-2	PS0-3
CO-1:	summarize the fundamental concepts in MEMS technology	3	3	\mathbb{F}_{2N}		-	1	-	-	-	-	-	-	-	-	-
CO-2:	familiarize the various MEM <mark>S materi</mark> al and their properties	2	3	1.4	4	-				-	-	-	-	-	-	-
CO-3:	understand the fabrication and machining tools needed for MEMS structure development	3	3	Z	7	-	_	<u> </u>		-	-	-	-	-	-	-
CO-4:	explain the various process <mark>involved</mark> in packaging	3	- 3		2.2	-	_	-		-	-	-	-	-	-	-
CO-5:	apply MEMS and microsystem concepts to real-time challenges	_3	3	-54	-	-		-		-	-	-	-	-	-	-

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	 H. Tai-ran," Designs, Manufacture and Nanoscale engineering" John Wiely Publications, 2008 Williams. K, Maluf.N "An Introduction to Microelectromechanical Systems Engineering", second edition Artech House Publishers; 2nd ed., 2004. 	,
L	3000ml 30ml 1100ml 1000 1 autono 10	The state of the s

Learning Assessme	nt	0.01									
		7 .0" -	Continuous Learning	g Assessment (CLA)	*. `	Cum	mative				
	Bloom's Level of Thinking	Form CLA-1 Averaç (50	ge of unit test	CL	g Le <mark>arning</mark> .A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice Practice	Theory	Practice				
Level 1	Remember	20%	-	20%		20%	-				
Level 2	Understand	20%	- 6 - 6	20%	2	20%	-				
Level 3	Apply	30%	PAGE 1	30%	1/2-	30%	-				
Level 4	Analyze	30%	27 TO 10	30%	(P)	30%	-				
Level 5	Evaluate		A 5 A 3 A 5 A 5 A 5 A 5 A 5 A 5 A 5 A 5			-	-				
Level 6	Create					4	-				
	Tota <mark>l</mark>	100)%	10	0 %	10	0 %				

Course Designers	PER STATE OF A STATE OF THE STA
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	215101361	Course	PLC FOR INDUSTRIAL AUTOMATION	Course	0	OPEN ELECTIVE	L	Т	Р	С
Code	21EIO136J	Name	PLC FOR INDUSTRIAL AUTOMATION	Category)	OPEN ELECTIVE	2	0	2	3

Pre-requisite Courses	Ni	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offeri	ng Department	Electronics and Instrumentation Engineering	Data Book / Codes / Standards		Nil

Course L	earning Rationale (CLR):	The purpose of lea <mark>rning this co</mark> urse is to:	EN	11	4			Progr	<mark>am</mark> Ou	itcome	s (PO)					rogram
CLR-1:	introduce the need for proc	ess automation <mark>technologie</mark> s		1	2	3	4	5	6	7	8	9	10	11	12	_	pecific itcomes
CLR-2:	provide the fundamental kn	owledge fo <mark>r ladder logi</mark> c programming		ge		of	SI		. ".			Work		8			
CLR-3:	identify applications of time	s and co <mark>unters in p</mark> rocess automation	and an indicate	Knowledge	W	evelopment of	estigations roblems	Usage	Ъ			Μ		Finance	ning		
CLR-4:	understand the various mat	h and d <mark>ata mani</mark> pulation instructions used in PLC			alysis	ldol	vestig probl	l Us	r and	× ×		Team	fion	∞ర	ਕ		
CLR-5:	provide the knowledge of co	nmmi <mark>ssioning,</mark> maintenance and their importance in indus	tries	ering	An	n/deve	iduct inve	T00	engineer ety	nment nability		al &	ınical	Mgt.	Long Le		
Course C	Outcomes (CO):	At the end of this course, learners will be able to:		Engine	Problem	Design	Condu of com	Moderi	The en society	Enviroi S <mark>ustai</mark> i	Ethics	Individual	Communication	Project	Life Lo	PSO-1	PSO-2 PSO-3
CO-1:	summarize the need for pro	c <mark>ess auto</mark> mation technologies	A 300 - 15.	3	- 3		-	-	/	-		-	-	-	-	-	
CO-2:	apply logical principle in lad	d <mark>er logic</mark> program for control applications	and William	2	3	40	7-19	-	1	-	-1	-	-	-	-	-	
CO-3:	use timer and counter funct	on blocks in PLC programming for process automation		3	3	14	13	-	_	-		-	-	-	-	-	
CO-4:	use data manipulation instr	<mark>ictions in</mark> PLC programming	n 37 s 1	3	3	125	-	-	-	-		-	-	-	-	-	
CO-5:	summarize the troubleshoo	ing techniques of PLC	4 × 10 1	3	- 3		7-	-		-		-	-	-	-	-	

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

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

Learning Assessmen	it		/ 19	A CONTRACTOR		14 TAX 1 TAX 1 TAX 1								
			100	Continuous Lea	rning	Assessment (CLA)		Cumr	notivo					
	Blo <mark>om's</mark> Level of <mark>Thinkin</mark> g	9	Formative CLA-1 Average of unit test (45%)			CL	Learning A-2 %)	Summative Final Examination (40% weightage)						
	-		Theory	Practice		Theory	Practice	Theory	Practice					
Level 1	Remember		20%	The second second	× "	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%	20%	=					
Level 2	Understand		20%				20%	20%	=					
Level 3	Apply		30%	4			30%	30%	=					
Level 4	Analyze		30%		111		30%	30%	-					
Level 5	Evaluate			- /	1	-		-	-					
Level 6	Create		. 1	- 1	11" -		- V /		-					
	Total	1	100	0 %	My	100) %	100	0 %					

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	21EIO120T Course	LOCICAL FOLINDATION OF CYPED DUVCICAL SYSTEMS	Course	0	OPEN ELECTIVE	L	Т	P	С	1
Code	Name	LOGICAL POUNDATION OF CIBER PHISICAL STSTEMS	Category	0	OPEN ELECTIVE	3	0	0	3	

Pre-requisite Courses	N	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offeri	ng Department	Electronics and Instrumentation Engineering	Data Book / Codes / Standards		Nil

ニャコント しょっし

Course L	earning Rationale (CLR):	The purpose of learning	this course is to:	11	4			Progr	<mark>am</mark> Ou	itcome	s (PO)					rogram	
CLR-1:	provide the basic concept	s of cyber-physic <mark>al system</mark> a	and modeling of a continuous system	1	2	3	4	5	6	7	8	9	10	11	12		pecific Itcomes	j
CLR-2:	understand the basic cond	cepts of discr <mark>ete modelin</mark> g o	f a system	lge		Jo	SI	1	. "			Work		g				
CLR-3: impart the adequate information about hybrid system and state machines		Knowledge	W	Jent	atior ems		Ъ			ν		Finance	Б					
CLR-4:				Analysis	ldol	investigations ex problems	Usage r and		∞ × >		Team	ion	∞ర	arning				
CLR-5:	LR-5: explore the knowledge about security issues in CPS		ering		n/development of	t inve	<u>P</u>	engineer ety	nment nability		<u>∞</u>	communication	Mgt.	g Le				
	on plant and manager and manag				Problem	fign/	nduct in complex	Modern	ie eng ciety	ron	SS	ndividual	חת	Project	Long	7	2-5	
Course C	Outcomes (CO):	At the end of this cours	e, learners will be able to:	Engi	Prot	Desi	Con	Mod	The	Envi Sust	Ethics	lpdi	Con	Proj	<u>Lif</u>	PSO-1	PSO-2	3
CO-1:	summarize the basic cond	cept <mark>s of</mark> c <mark>yb</mark> er physical syste	ms and modeling in continuous domain	3		3	-	-	/	-	-	-	-	-	-	-	-	-
CO-2:	illustrate the discrete mod	lel <mark>of contin</mark> uous system		3	- L	3	7-19	-	4	-	-1	-	-	-	-	-	-	-
CO-3: analyze the hybrid system and its interactions		3	172	3	13		_	-		-	-	-	-	-	-	-		
CO-4: select the sensor networks for CPS		3	145	3	-	-	-	-	-:	-	-	-	-	-	-	-		
CO-5:	0-5: examine the CPS design for specific applications		3	4	3	7-	_		-		-	-	-	-	-	-	-	

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

y Houi

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 dyna<mark>mics - Actor</mark> 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 - 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 transportation cyber system - Transportation - Monitoring and tracking

Unit-5 - Security Issues in CPS

9 Houi

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 - 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
- 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
- NPTEL Video Lecture series on "Foundations of cyber-physical systems" by Prof. Soumyajit Dey, IIT Kharagpur

			Summative							
	Bloo <mark>m's</mark> Level of <mark>Thinkin</mark> g	CLA-1 Avera	native age of unit test 0%)	Life-Long CLA (10)	1-2	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%		20%		20%	-			
Level 2	Understand	20%	10 mar 44 N	20%		20%	-			
Level 3	Apply	30%		30%		30%	-			
Level 4	Analyze	30%		30%		30%	-			
Level 5	Evaluate		···	}	-4		-			
Level 6	Create		- 1, 1	-		-	-			
	Total	10	0 %	100	%	10	0 %			

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 <mark>.Y. Rajaa </mark> Vikhram, SRMIST
2. Mr. Vijayarajeswaran, MD, Vi micro Pvt.Ltd, vijay@vimicrosystems.com	2. Dr.S.Latha, TCE, Madurai, sleee@tce.edu	

Course	21ALIO101T Course	HYBRID AND ELECTRIC VEHICLES	Course	OPEN ELECTIVE	L	Т	Р	(;
Code	Name	TITORID AND ELECTRIC VEHICLES	Category	OF EN ELECTIVE	3	0	0	3	j

Pre-requisite Courses	N	Co- requisite Courses	Nil Progress Course		Nil
Course Offeri	ing Department	Automobile Engineering	Data Book / Codes / Standards	74_ 7	Nil

Course L	Learning Rationale (CLR): The purpose of learning this course is to:	U /-	σ,	4			Progr	<mark>am</mark> Ou	itcome	s (PO)				P	rogram	
CLR-1:	provide an insight into how electric vehicle operate	1	4	2	3	4	5	6	7	8	9	10	11	12		pecific itcomes	
CLR-2:	demonstrate the functional requirements of Battery management system in detail	a c c	2		of	SI					Work		e				
CLR-3:	CLR-3: demonstrate how Electric and Hybrid Vehicle vary as per design requirements		≧	S	Jent	stigations	Usage	ъ			μ		Finan	ning			
CLR-4:			Ē -	alysis	lop	estig		r and	∞ >	h.	Team	ion	∞ŏ	a			
CLR-5:	selection of the appropriate drive and driveline system for the different cases	Pripo	2" <	An	n/development of ons	t inve lex pr	<u>6</u>	engineer a	nment nability	. 1	<u>∞</u>	Sommunication	Mgt.	g Le			
		9	3	plem	fign/	nduct ir omplex	dern	eng ety	tain	SS	ndividual	שנו	roject	Long	7	2-0	
Course C	Outcomes (CO): At the end of this course, learners will be able to:	2	3'-	Pro	Des	Con	Moo	The	Sus	Ethi	Indi	Col	Proj	Life	PSO.	PSO-2	3
CO-1:	learn the basic concepts of el <mark>ectric ve</mark> hicle technology and electric vehicles	3	}	- 1	45		-	7	2		-	-	-	-	-		
CO-2:	develop and analyze hybrid and electric drive trains		}	-	3	-19	-	4	-	-1	-	-	-	-	-	- -	
CO-3:	interpret various vehicle power sources in hybrid vehicle technology	.3	3	3	4	13	-	-	-	-	-	-	-	-	-		
CO-4: analyze data to determine appropriate design calculation for hybrid system under study		3	}	10	Ger.	3	-	-	-		-	-	-	-	-		
CO-5:	0-5: apply the concepts in sizing the electric motors		3	4	3	7 -			-		_	_	-	_	-		

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

earning Assessme			Continuous Learning A	0					
	Bloom's Level of Thinking	CLA-1 Avera	mative age of unit test i0%)	C	ng Learning CLA-2 10%)	Summative Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	22 E 10 E 10 E	15%	A 27.7	15%	-		
Level 2	Understand	25%	Sup-19, 27% (1)	25%		25%	-		
Level 3	Apply	30%		30%		30%	-		
Level 4	Analyze	30%		30%		30%	-		
Level 5	Evaluate		A Section of the second	William .			-		
Level 6	Create		7 N 10 - 11 N 11 N	1 - 1 1 1 1	May 3	-	-		
	To <mark>tal</mark>	10	00 %	1	00 %	100	0 %		
				1 82 No. 15 15 15 15 15 15 15 15 15 15 15 15 15					

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	1. Mr S. Madhan K <mark>umar, S</mark> RMIST
	Engineering, PTU, drsj_eee@pec.edu.in	
	2. Mr. Sam Jebakumar, SRM IST, jebakumj@srmist.edu	2. Dr. Carunaiselvane, SRMIST

Course	21AUO102T	Course	DENEWARI E SOUDCES OF ENEDGY	Course)	ODEN ELECTIVE	L	Т	Р	С
Code	21AUU1021	Name	RENEWABLE SOURCES OF ENERGY	Category	0	OPEN ELECTIVE	3	0	0	3

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

Course L	Course Learning Rationale (CLR): The purpose of learning this course is to:			Program Outcomes (PO)											Program Specific	
CLR-1:	explain the concept of wind energy	1	1 2 3 4 5					5 6 7		9	10	11	12	Ou		
CLR-2:	LR-2: create insight on solar energy and its application			of	SL	Usage				Work		99				
CLR-3:	3: evaluate the use of geothermal and hydro power for power generation			velopment	vestigations problems		,	100		_		Finance	bu			
CLR-4:	analyze the biomass energy and ocean energy				estig		r and	∞ >	l.	Team	ion	& F	arni			
CLR-5:	develop knowledge on various e <mark>nergy co</mark> nversion devices		η Analysis	Φ	<u>د</u> ⊒ اي	Tool	engineer stv	Society Environment Sustainability	1	रू ज	Communication	Mgt.	g Le			
		ngineering	roblem	ign/d	ag de	Modern	enç etv	Tou	SS	Individual	שנו	roject	Long	7)-2	<u>ښ</u>
Course C	Course Outcomes (CO): At the end of this course, learners will be able to:		Pog	Des	Conc	Moo	The	Sus	Ethics	lpd	Con	Proj	Life	PSO-1	PSO-2	PSO-3
CO-1:	apply the knowledge of using wind energy for power production	3	- 3	3 (*)	- 1	-		2		-	-	-	-	-	-	-
CO-2:	analyze the economy of using solar power	3	3	40.50	- 1	-	4-	-	-	-	-	-	-	-	-	-
CO-3:	rationalize geo thermal and hydro power plants	.3	3	4	12	-	-	-		-	-	-	-	-	-	-
CO-4:	perceive the concept of biomass and ocean energy for power production	3	100	100	3	-	-	-		-	-	-	-	-	-	-
CO-5:	demonstrate the working of various energy conversion devices	3	4.7	3		_		_		_	_	-	-	-	_	

Unit-1 - Wind Energy 9 Hour

Introduction- Renewable energy sources- statistics and technologies- Wind Energy - Introduction 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

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.