

SCHOOL OF MECHANICAL ENGINEERING

M.Tech – Mechanical specialization in Cyber Physical System

M.Tech (CPS)

Curriculum

(2020-2021 admitted students)



VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF MECHANICAL ENGINEERING

• To be a leader in imparting world-class education in Mechanical Engineering, leading to nurturing of scientists and technologists of the highest caliber who would engage in the sustainable development of the globe.

MISSION STATEMENT OF THE SCHOOL OF MECHANICAL ENGINEERING

• The mission of the school is to create and maintain an environment for Excellence in Instruction, Learning, and Applied Research in the area of Mechanical and allied disciplines so as to equip our students with necessary knowledge and skills for higher education/employment and to meet the social demands.



PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- 1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems.
- 2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry.
- 3. Graduates will function in their profession with social awareness and responsibility.
- 4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country.
- 5. Graduates will be successful in pursuing higher studies in engineering or management.
- 6. Graduates will pursue career paths in teaching or research.



PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering applications

PO_02: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints

PO_03: Having an ability to design and conduct experiments, as well as to analyze and interpret data

PO_04: Having an ability to use techniques, skills and modern engineering tools necessary for engineering practice

PO_05: Having problem solving ability- solving social issues and engineering problems

PO_06: Having adaptive thinking and adaptability

PO_07: Having a clear understanding of professional and ethical responsibility

PO_08: Having a good cognitive load management [discriminate and filter the available data] skills



PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M.Tech. –Mechanical specialization in Cyber Physical system, graduates will be able to

PSO_01: Design and analyze overall specifications of Cyber Physical System and translate it to the different sub-systems design requirements.

PSO_02: Adopt a multidisciplinary approach to design overall Cyber Physical System using Hybrid system and other approaches and validate the model.

PSO_03: Independently carry out research / investigation to solve practical problems and write / present a substantial technical report/document.



CREDIT STRUCTURE

Category-wise Credit distribution

Category		Credits
University core	(UC)	27
Programme core	(PC)	19
Programme elective	(PE)	18
University elective	(UE)	06
Total credits		70



DETAILED CURRICULUM

UNIVERSITY CORE

SI. No.	COURSE CODE	COURSE TITLE	L	Т	Р	J	С
1.	MAT5005	Advanced Mathematical Methods	3	0	0	0	3
	ENG5001	Fundamentals of Communication skills	0	0	2	0	1
	&	&					
	ENG5002	Professional and Communication Skills	0	0	2	0	1
2.	(or)						
	FRE5001	Francais Fonctionnel	2	0	0	0	2
	(or)						
	GER5001	Deutsch fuer Anfänger	2	0	0	0	2
	STS5001	Essentials of Business Etiquette and Problem	3	0	0	0	1
3	&	Solving					
0.	STS5002	× .	3	0	0	0	1
		Preparing for Industry				Ū	_
4.	SET5001 & SET5002	SET Projects	-	-	-	-	4
5.	MEE6099	Master's Thesis	-	-	-	-	16

PROGRAMME CORE

S.No	COURSE	COURSE TITLE		Т	Р	J	С
	CODE						
1.	MEE5028	Mechatronics and Cyber-Physical Systems	3	0	2	0	4
2.	MEE5029	System Modeling and Simulation	2	0	2	0	3
3.	MEE5030	Smart Mobility and Intelligent Vehicles	3	0	0	4	4
4.	MEE5031	Digital Manufacturing and Factory Automation		0	2	0	4
5.	MEE5032	Artificial Intelligence and Machine learning	3	0	0	4	4



PROGRAMME ELECTIVES

COURSE	COURSE	COURSE TITLE		Т	Р	J	С
	CODE						
1.	MEE6061	IIoT and Cloud Computing	2	0	2	0	3
2.	MEE6062	Virtual Reality & Augmented Reality	2	0	2	0	3
3.	MEE6063	MEMS in Cyber Physical Systems	2	0	0	4	3
4.	MEE6064	Applied Robotics and Programming	2	0	2	0	3
5.	MEE6065	Hybrid and Electric Automotive Vehicle systems	3	0	0	4	4
6.	MEE6066	Cyber-Security in Design and Manufacturing	3	0	0	0	3
7.	MEE6067	Transportation Cyber Physical Systems	3	0	0	0	3
8.	MEE6068	Smart Health Technology	2	0	0	4	3
9.	MEE6069	Digital Systems Design and Architecture	3	0	0	0	3
10.	MEE6070	Data Science and Analytics	2	0	0	4	3
11.	MEE6071	Wireless Networking of Embedded Systems	2	0	0	4	3
12.	MEE6072	Multi-Agent System	3	0	0	4	4
13.	MEE6073	Control System Analysis and Design	3	0	2	0	4



University Core



Course code	Course T	itle	L	Т	Р	J	C
MAT5005	Advanced Mathema	tical Methods	3	0	0	0	3
Pre-requisite			Syllab	us ver	sion		
					2.0		
Course Objectives	s(CoB):						
1. To provide the students with sufficient exposure to advanced mathematical							
methods and tools that are relevant to engineering research.							
2. Improving the computational skills of students by giving sufficient knowledge							
of analy	rtical and numerical tecl	nniques useful fo	or solv	ing pro	oblem	s arisi	ng in
Mechan	ical Engineering.						
3. Impartii	ig the knowledge of re	al time applicati	ions of	Auto	nomou	is sys	tems,
Non-lin	ear systems of ordinary	differential equ	lations	and p	artial	differ	ential
equation	15.						
Course Outcome		. 1 (1)	. 1.			1 (*	1.
1. Distinguish an	d analyse a variety of	tools for solvin	ig linea	ar syst	ems a	ind fii	nding
eigenvalues of	tnese systems.		f th	1	· ·	C .	
2. Derive and	use the numerical tech	iniques needed	for th	e solu	tion (DIA	given
engineering pro	JUIEIIIS d. correlato the applytical	and numerical n	acthoda				
3. Understand and	at mathematical proof	and numerical in		monte		noodo	d to
4. White Colleter	he results obtained from	differential equa	c algu	adole)	neede	u io
5 Demonstrate th	ne understanding of how	v physical phone	mena	are mo	مالمام	lhvn	artial
differential equ	le understanding of now	physical pheno			Juenec	гоур	aitiai
unrerentiar eqe							
Module:1 Eige	envalue Problems					5 ł	ours
Standard Eigen val	ue problems–Eigenvalue	s and Eigenvect	ors–Ge	rschgo	rin Ci	rcles	
theorem–Rutishaus	er method. Power metho	od. Inverse Powe	r metho	8- od.			
				Jui			
Module:2 Iter	ation Methods					6 l	iours
Sturm sequence, Ja	cobi method, Given's m	ethod, Househol	der me	thod, I	Deflati	on,	
Lanczo's method.	,	,		,		,	
Module:3 Cale	culus of Variations					9 I	nours
Euler-Lagrange's	equation –Isoperimetric	problems, Rayl	leigh–F	Ritz m	ethod	- Gal	lerkin
method.							
						~ ~ ~	
vioaule:4 Syst	em of First Urder					6 I	iours
Ord	inary Differential						
Equ	ations	1		<u></u>			
Linear Systems - H	10mogeneous linear sys	tems with consta	ant coe	Ificien	ts - A	utono	mous



systems - Phase Plane Phenomena - for linear systems.

Critical Points - Stability

ical Follits - Stability

6 hours

6 hours

Module:5 Nonlinear systems

Simple critical points of nonlinear systems-Stability by Liapunov's method –

Non- Linear Mechanics: Conservative systems.

Module:6	Partial Differential	5 hours
	Equations	

Classification of Second-Order Partial Differential Equations, Significance of characteristic curves, Canonical Form, Sturm–Liouville problems and Eigen function expansions.

Module:7	Wave equ	lation			

Displacements in a long string – a long string under its weight – a bar with prescribed force on one end – free vibrations of a string. Method of Separation of variables, Solution by method of Laplace transforms

Module:8	Contemporary Issues	2 hours
Industry Expert Lecture		

		Total Lecture hours:	45 hours
Text	Book(s)		
1	Differe	ntial Equations: Theory, Te	echnique and Practice, G.F. Simmons, S. G.
	Krantz,	Tata McGrawHill Publishing	g, 2007. (Topics from Chapters 10, 11)
2	Elemen	ts of Partial differential eq	uations, Ian N. Sneddon, Dover Publications,
	New Y	ork, 2006. (Topics from Chap	oters 3, 5)
3	Numeri	cal Methods for Scientific and	nd Engineering Computation, M. K. Jain, S. R.
	K. Iyer	ngar, R. K. Jain, New Age	International publishers, 7 th edition,New Delhi,
	2019. (Topics from Chapter 3, 7)	
4	Introdu	ctory Methods of Numerica	l Analysis, S. S. Sastry, PHI Pvt. Ltd., 5th
	Edition	, New Delhi, 2015. (Topics f	rom Chapter 11)
5	The Ca	alculus of Variations, Bruc	e van Brunt, Springer, 2004. (Topics from
	Chapter	rs 2, 4, 5)	
Refe	rence Bo	ooks	
1	Differe	ential Equations and Dynamic	cal Systems, Lawrence Perko, 3rd ed., Springer-
	Verlag,	2001.	
2	An intr	oduction to Ordinary Different	ntial Equations, James C. Robinson, Cambridge
	Univers	sity Press, New York, 2008 (4	4th print).
3	Elemen	tary Applied Partial Differe	ential Equations, Richard Haberman, Prentice
	Hall Int	ternational, 1998.	



4	Numerical Analysis, R. L.	Burden and J. D. Faires,			
	10 th Edition, Cengage Learnin	ıg, India e	dition, 20)15.	
Mode	e of Evaluation: Continuous Ass	sessment '	Tests, Fin	al Assessment Test, Digital	
Assig	nments, Quizzes.				
Mode	e of evaluation:				
Reco	Recommended by Board of Studies 03-06-2019				
Approved by Academic Council No. 55 Date 13-06-2019				13-06-2019	

Course code	Course title	L	Т	P	J	С
ENG5001	Fundamentals of Communication Skills	0	0	2	0	1



Pre-requisite	As per the	academic	Syllabus version
	regulations		x 10
Course Objective	s (CoB):		v. 1.0
1. To enable learne	ers learn basic communication skills - Listen	uing, Speaking, Re	ading and Writing
2. To help learners	apply effective communication in social an	d academic conte	xt
3. To make studen	ts comprehend complex English language th	nrough listening ar	nd reading
Course Outcome	(CO):		
1. Ability to comm	unicate effectively in social and academic c	ontexts	
2.Develop effectiv	e writing skills		
3.Demonstrate the	ir understanding the communication Skills		0.1
Module:1	Jistening		8 hours
Listoning to Speed	nversation		
Listening for Speed	nes ific Information		
Module:2	Speaking		4 hours
Exchanging Inform	nation		
Describing Activit	ies, Events and Quantity		
Module:3 F	Reading		6 hours
Identifying Inform	ation		
Inferring Meaning			
Interpreting text			
Module:4	Writing: Sentence		8hours
Basic Sentence Str	ructure		
Transformation of	Sontoncos		
Synthesis of Sente			
Module:5	Writing: Discourse		4hours
Instructions			mours
Paragraph			
Transcoding			
	Т	otal Lecture hou	rs: 30 hours
Toxt Dool:(c)			
1 Podston	Chris Thoroca Clomontson and Cillio	Cuppingham Ea	colface Upper
Intermedi	ate Student's Book. 2013, Cambridge Unive	rsity Press.	τε μιτε Ορρει
Reference Books			
1 Chris Juzy	wiak .Stepping Stones: A guided approach to	o writing sentence	s and Paragraphs
(Second E	Edition), 2012, Library of Congress.		
2. Clifford A	Whitcomb & Leslie E Whitcomb, Effective	e Interpersonal an	d Team
Communi	cation Skills for Engineers, 2013, John Wile	ey & Sons, Inc., H	oboken: New
3. Jersey. ArunPatil	, Henk Eijkman &Ena Bhattacharya, <i>Nev</i>	v Media Commu	nication Skills for

	VIT VIIT		
4.	Engineers and IT Profe	ssionals,2012	, IGI Global,
5.	Hershey PA.	,	, , ,
	Judi Brownell, <i>Listening: Attitudes, Principles and</i> Routledge:USA	Skills, 2016	5, 5 th Edition,
	John Langan, Ten Steps to Improving College Reading	g Skills, 201	14, 6 th Edition,
	Townsend Press:USA	ingham Eg	andfaca Unnar
	Intermediate Teacher's Book. 2013, Cambridge University P	ress.	ceziace Opper
	Authors, book title, year of publication, edition number, pres	s, place	
Mod	de of Evaluation: CAT / Assignment / Quiz / FAT / Project / Semi	inar	
	List of Challenging Experiments (Indicat	ive)	
1.	Familiarizing students to adjectives through brainstorming adject all letters of the English alphabet and asking them to add an adject starts with the first letter of their name as a prefix.	ctives with ective that	2 hours
2.	Making students identify their peer who lack Pace, Clarity and V during presentation and respond using Symbols.	Volume	4 hours
3.	Using Picture as a tool to enhance learners speaking and writing	skills	2 hours
4.	Using Music and Songs as tools to enhance pronunciation in the language / Activities through VIT Community Radio	e target	2 hours
5.	Making students upload their Self- introduction videos in Vime	o.com	4 hours
6.	Brainstorming idiomatic expressions and making them use those writings and day to day conversation	e in to their	4 hours
7.	Making students Narrate events by adding more descriptive adje add flavor to their language / Activities through VIT Communit	ectives and v Radio	4 hours
8	Identifying the root cause of stage fear in learners and providing	g remedies	4 hours
	to make their presentation better		
9	Identifying common Spelling & Sentence errors in Letter Writin day to day conversations	ng and other	2 hours
10.	Discussing FAQ's in interviews with answers so that the learner	gets a	2 hours
	better insight in to interviews / Activities through VIT Commun	ity Radio	
	Total Labora	atory Hours	30 hours
Mod	de of evaluation: Online Quizzes, Presentation, Role play, Group	Discussions,	Assignments,
Min	ni Project		
Rec	commended by Board of Studies 22-07-2017		
Арр	proved by Academic Council No. 46 Date 2	24-8-2017	



Course code	Course title		L T P J C
ENG5002	Professional and Communication	n Skills	0 0 2 0 1
Pre-requisite	ENG5001		Svllabus version
			v. 1.1
Course Objective	s(CoB):	1	
1. To enable stude	nts to develop effective Language and Comm	unication Skills	
2. To enhance stu	dents' Personal and Professional skills		
3. To equip the stu	dents to create an active digital footprint		
Course Outcome	(CO):		
Students will be al	ble to apply the acquired skills and excel in a	professional env	vironment
Module:1	Personal Interaction		2hours
Introducing Oneself	- one's career goals		
Activity: SWOT A	allysis) hours
Interpersonal Comm	unication with the team leader and colleagues at	the workplace	2 nours
	iunication with the team leader and confedgues at	uie workplace	
Activity: Role Plays	/Mime/Skit		
Module:3	Social Interaction		2 hours
Use of Social Media	ı, Social Networking, gender challenges		
Activity: Creating L	inkedIn profile, blogs		
Module:4	Résumé Writing		4 hours
Identifying job requ	irement and key skills		
A ativity Dranava an	Electronic Décumé		
Modulo:5	Interview Skills		1 hours
Discoment/Job Inter	view Group Discussions		4 110415
Activity: Mock Inte	rview, Group Discussions		
Module:6	Report Writing		4 hours
Wibduic.0	insport trining		- nours
Language and Mech	anics of Writing		
Activity: Writing a]	Renort		
Module:7	Study Skills: Note making		2hours
Summarizing the rej	port		
Activity: Abstract, I	Executive Summary, Synopsis		
Module:8	Interpreting skills		2 hours
Interpret data in tabl	es and graphs		
Activity Transco di	a d		
	15 Dresentation Skills		1 hours
Oral Presentation us	ing Digital Tools		4 110u15
Activity: Oral prese	ntation on the given topic using appropriate non-	verbal cues	
Module:10	Problem Solving Skills		4 hours

			VIT VIT VIT VIT VIT VIT VIT VIT VIT VIT	hnology UGC Act, 1950		
Prot	olem Solving &	Conflict Resolution				
Acti	vity: Case Ana	ysis of a Challenging S	Scenario			
			Total Lecture h	ours:		30hours
Tor	t Dools(c)					
1 1	BhatnagarN	itin and MamtaBhatn	agar Communicat	ivo Engli	ch Eor	
L	Engineers A	and Professionals 20	agai, Communicat 10 Dorling Kindor	clov (Indi	in) Dut Itd	
Ref	erence Books	<u>ilu i rojessionuis, 20.</u>	io, Dornig Kinder	siey (ind		
1	Jon Kirkma	n and Christopher Tu	rk. Effective Writin	na: Impro	vina Scientific.	Technical and
-	Business Co	mmunication, 2015.	Routledge	.gp. o	, ing concinence,	
2	Diana Baira	ktarova and Michele	Eodice, <i>Creative</i>	Wavs of	Knowing in En	aineerina, 2017,
	Springer Int	ernational Publishing		51	5	
3	Clifford A	Whitcomb & Le	slie E Whitcom	b, Effect	tive Interperson	nal and Team
	Communica	tion Skills for Engine	<i>ers</i> , 2013, John W	iley & So	ons, Inc., Hobok	en: New Jersey.
4	ArunPatil,	Henk Eijkman &En	a Bhattacharya,	New Me	dia Communice	ation Skills for
14	Engineers a	nd IT Professionals,2	<u>1012, IGI Global, I</u>	Hershey P	·A.	
Mo	de of Evaluation	on: CAI / Assignmen	nt / Quiz / FAT / Pi	roject / Se	eminar	
List	t of Challengi	ng Experiments (Ind	licative)			
1.	SWOT Ana	lysis – Focus special	ly on describing tv	vo strengt	hs and two	2 hours
	weaknesses					
2.	Role Plays/I		ace Situations			4 hours
2			·]]] D (·)	1 1	•	
3.	Use of Socia	il Media – Create a L	inkedIn Profile an	d also wr	ite a page or	2 hours
	two on areas	s of interest				
4.	Prepare an I	Electronic Résumé an	d upload the same	in vimeo		2 hours
	Croup discu					1 hours
5. 6	Boport Writ	ing Pool time repor	***			4 Hours
7	Writing an	Abstract Executive S	ummary on short s	cientific	or research	4 hours
/	articles	Ibstruct, Executive 5	diffinition y off short s		or research	4 110013
8	Transcoding	– Interpret the given	graph, chart or di	agram		2 hours
9	Oral present	ation on the given for	Dic using appropria	ate non-ve	erbal cues	4 hours
10	Problem So	lving Case Analysi	s of a Challenging	Scenario		4 hours
			т	otal Lab	anatary Haura	30 hours
			1			SUNUUS
Mo	de of evaluation	on: : Online Quizzes,	Presentation, Role	play, Gro	oup Discussions	, Assignments,
Min	ni Project					
Rec	ommended by	Board of Studies	22-07-2017	D		
App	proved by Aca	demic Council	No. 4/	Date	05-10-2017	

Course code	Deutsch für Anfänger	L T P J C
GER5001		2 0 0 2
Pre-requisite		Syllabus version



	v.1
Course Objectives (CoB):	
The course gives students the necessary background to:	
1. Enable students to read and communicate in German in their day to day life	2
2. Become industry-ready	
3. Make them understand the usage of grammar in the German Language.	
Course Outcome(CO):	
The students will be able to	
1. To greet people, introduce oneself and understand basic expressions in Germa	an
2. To acquire basic grammar and skills to use these in a meaning way	
3. To attain beginner's level vocabulary	
4. To write on a variety of topics with significant precision and in detail	
5. To demonstrate good comprehension of written discourse in areas of sp	pecial interests
Module:1	3 hours
Einleitung, Begrüssungsformen, Landeskunde, Alphabet, Personalpronomen	, Verb Konjugation,
Zahlen (1-100), W-fragen, Aussagesätze, Nomen – Singular und Plural	
Lernziel:	
ElementaresVerständnisvon Deutsch, Genus- Artikelwörter	
Module:2	3 hours
Konjugation der Verben (regelmässig /unregelmässig) die Monate, die Woche	ntage, Hobbys,
Berufe, Jahreszeiten, Artikel, Zahlen (Hundert bis eine Million), Ja-/Nein- Fra	
	ge, Imperativ mit
Sie	ge, Imperativ mit
Sie Lernziel :	ge, Imperativ mit
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw.	ge, Imperativ mit
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw.	ge, Imperativ mit
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3	ge, Imperativ mit 4 hours
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un	ge, Imperativ mit 4 hours nbestimmterArtikel),
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz	ge, Imperativ mit <hr/> <hr/> 4 hours <hr/> abestimmterArtikel), aeiten, Lebensmittel,
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke	ge, Imperativ mit 4 hours hbestimmterArtikel), seiten, Lebensmittel,
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke Lernziel :	ge, Imperativ mit 4 hours nbestimmterArtikel), zeiten, Lebensmittel,
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke Lernziel : Sätze mit Modalverben, VerwendungvonArtikel, über Länder	ge, Imperativ mit 4 hours abestimmterArtikel), teiten, Lebensmittel, undSprachensprechen,
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke Lernziel : Sätze mit Modalverben, VerwendungvonArtikel, über Länder übereineWohnungbeschreiben.	ge, Imperativ mit 4 hours hbestimmterArtikel), weiten, Lebensmittel, undSprachensprechen,
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke Lernziel : Sätze mit Modalverben, VerwendungvonArtikel, über Länder übereineWohnungbeschreiben.	ge, Imperativ mit 4 hours bestimmterArtikel), teiten, Lebensmittel, undSprachensprechen,
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke Lernziel : Sätze mit Modalverben, VerwendungvonArtikel, über Länder übereineWohnungbeschreiben.	ge, Imperativ mit 4 hours bestimmterArtikel), eiten, Lebensmittel, undSprachensprechen, 6 hours
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke Lernziel : Sätze mit Modalverben, VerwendungvonArtikel, über Länder übereineWohnungbeschreiben. Module:4 Übersetzungen : (Deutsch – Englisch / Englisch – Deutsch) Lornziel :	ge, Imperativ mit 4 hours bestimmterArtikel), eiten, Lebensmittel, undSprachensprechen, 6 hours
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke Lernziel : Sätze mit Modalverben, VerwendungvonArtikel, über Länder übereineWohnungbeschreiben. Module:4 Übersetzungen : (Deutsch – Englisch / Englisch – Deutsch) Lernziel : Grummetäle Wertenhete, Üburg	ge, Imperativ mit 4 hours bestimmterArtikel), eiten, Lebensmittel, undSprachensprechen, 6 hours
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke Lernziel : Sätze mit Modalverben, VerwendungvonArtikel, über Länder übereineWohnungbeschreiben. Module:4 Übersetzungen : (Deutsch – Englisch / Englisch – Deutsch) Lernziel : Grammatik – Wortschatz - Übung	ge, Imperativ mit 4 hours bestimmterArtikel), eiten, Lebensmittel, undSprachensprechen, 6 hours
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke Lernziel : Sätze mit Modalverben, VerwendungvonArtikel, über Länder übereineWohnungbeschreiben. Module:4 Übersetzungen : (Deutsch – Englisch / Englisch – Deutsch) Lernziel : Grammatik – Wortschatz - Übung	ge, Imperativ mit 4 hours bestimmterArtikel), eiten, Lebensmittel, undSprachensprechen, 6 hours 5 hours
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke Lernziel : Sätze mit Modalverben, VerwendungvonArtikel, über Länder übereineWohnungbeschreiben. Module:4 Übersetzungen : (Deutsch – Englisch / Englisch – Deutsch) Lernziel : Grammatik – Wortschatz - Übung Module:5 Leseverständnis Mindmanmachen Korrespondenz- Briefe Postkarten E-Mail	ge, Imperativ mit 4 hours hbestimmterArtikel), teiten, Lebensmittel, undSprachensprechen, 6 hours 5 hours
Sie Lernziel : Sätzeschreiben, über Hobbys erzählen, überBerufesprechenusw. Module:3 Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, un trennnbareverben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlz Getränke Lernziel : Sätze mit Modalverben, VerwendungvonArtikel, über Länder übereineWohnungbeschreiben. Module:4 Übersetzungen : (Deutsch – Englisch / Englisch – Deutsch) Lernziel : Grammatik – Wortschatz - Übung Module:5 Leseverständnis,Mindmapmachen,Korrespondenz- Briefe, Postkarten, E-Mail Lernziel :	ge, Imperativ mit 4 hours bestimmterArtikel), eiten, Lebensmittel, undSprachensprechen, 6 hours 5 hours



3 hours

4 hours

WortschatzbildungundaktiverSprachgebrauch

Module:6

Aufsätze :

MeineUniversität, Das Essen, mein Freund odermeineFreundin, meineFamilie, einFest in Deutschlandusw

Module:7

Dialoge:

- a) Gespräche mit Familienmitgliedern, Am Bahnhof,
- **b)** GesprächebeimEinkaufen ; in einemSupermarkt ; in einerBuchhandlung ;
- **c)** in einemHotel an der Rezeption ;einTerminbeimArzt.

TreffenimCafe

Mo	dule:8						2 ho	urs
Gue	est Lectures	/Native Speakers / Fei	nheiten der deutso	chen Spr	ache, Basis	information	über	die
deu	tschsprachige	en Länder						
			Total Lecture he	ours: 3	30 hours			
Tex	t Book(s)					•		
1.	Studio d A	1 Deutsch alsFremdspra	che, Hermann Fun	k, Christ	ina Kuhn, Si	ilkeDemme	: 2012	
Ref	erence Boo	ks						
1	Netzwerk	Deutsch alsFremdsprach	ne A1, Stefanie De	ngler, Pa	aul Rusch, H	lelen Schmt	iz, Ta	nja
	Sieber, 20	13						
2		artmut Aufdorstrasso Ju	tta Müller Thoma	s Storz (0010			
2	Doutscho	Sprachlohrofür A Helände	ua Muner, Inoma	b Dora	2012. Schulz 2011			
3	Deutsche	SprachienierurAOsianue		li, Dula s	5CHUIZ, 2011	-		
4	ThemenAl	ktuell 1, HartmurtAufde	rstrasse, Heiko Bo	ck, Mecl	nthildGerdes	s, Jutta Müll	er und	1
	Helmut M	üller, 2010						
	www.goet	he.de						
	wirtschafts	deutsch.de						
	hueber.de							
	klett-sprac	hen.de						
	www.deutschtraning.org							
Mo	de of Evalua	ation: CAT / Assignmer	nt / Ouiz / FAT					
Rec	commended	by Board of Studies	22-07-2017					
App	proved by A	cademic Council	No: 47	Date	05-10-20	17		

Course code	FRANCAIS FONCTIONNEL	L T P J C			
FRE5001		2 0 0 2			
Pre-requisite		Syllabus version			
		v.1			
Course Objectives(CoB):					



The course gives students the

necessary background to:

9 hours

- **1.** Demonstrate competence in reading, writing, and speaking basic French, including knowledge of vocabulary (related to profession, emotions, food, workplace, sports/hobbies, classroom and family).
- **2.** Achieve proficiency in French culture oriented view point.

Course Outcome(CO):

The students will be able to

- 1 To Identify in French language the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations, interrogations etc
- 2 To communicate effectively in French language via regular / irregular verbs
- 3 To demonstrate comprehension of the spoken / written language in translating simple sentences
- 4 To understand and demonstrate the comprehension of some particular new range of unseen written materials
- 5 To demonstrate a clear understanding of the French culture through the language studied

Module:1Saluer, Se présenter, Etablir des contacts

Les Salutations, Les nombres (1-100), Les jours de la semaine, Les mois de l'année, Les Pronoms Sujets, Les Pronoms Toniques, La conjugaison des verbes réguliers, La conjugaison des verbes irréguliers- avoir / être / aller / venir / faire etc.

Module	:2	Présenter correspond d'une perso	quelqu'u ant(e), De onne.	in, Chercher emander des r	r un(e) nouvelles			9 hours
La	conj	ugaison	des	verbes	Pronom	iinaux,	La	Négation,

L'interrogation avec 'Est-ce que ou sans Est-ce que'.

Module:3	Situer un objet ou un lieu, Poser des	9 hours				
	questions					
L'article (défin	ni/ indéfini), Les prépositions (à/en/au/aux/sur/d	ans/avec etc.), L'article contracté,				
Les heures en	français, La Nationalité du Pays, L'adjectif	(La Couleur, l'adjectif possessif,				
l'adjectif déme	onstratif/ l'adjectif interrogatif (quel/que	elles/quelle/quelles), L'accord des				
adjectifs avec l	e nom, L'interrogation avec Comment/ Combien	/ Où etc.,				
Module:4	Faire des achats, Comprendre un texte	8 hours				
	court, Demander et indiquer le chemin.					
La traduction simple :(français-anglais / anglais –français)						
Module:5	Trouver les questions, Répondre aux	7 hours				

questions générales en français.

L'article Partitif, Mettez les phrases aux pluriels, Faites une phrase avec les mots donnés,



		(Deemed to be University under section 3 of UGC Act, 1956)	
Exprin	nez les	phrases données au	Masculin ou Féminin, Associez les
phrases	s.	-	
1			
Modul	le:6	Comment ecrire un passage	9 hours
Décriv	vez :		
La Fan	nille /La	Maison, /L'université /Les Loisirs/ La Vie quo	tidienne etc.
Modul	le:7	Comment ecrire un dialogue	7 hours
Dialog	gue:		
d)	Réserve	er un billet de train	
e)	Entre de	eux amis qui se rencontrent au café	
f)	Parmi le	es membres de la famille	
g)	Entre le	e client et le médecin	
Modul	le:8	Invited Talk: Native speakers	2 hours
Modul	le:8	Invited Talk: Native speakers	2 hours
Modul	le:8	Invited Talk: Native speakers Total Lecture hours:	2 hours 30 hours
Modul Text B	le:8 Book(s)	Invited Talk: Native speakers Total Lecture hours:	2 hours 30 hours
Modul Text B 1. Ec	le:8 Book(s) cho-1, M	Invited Talk: Native speakers Total Lecture hours: éthode de français, J. Girardet, J. Pécheur, Publ	30 hours isher CLE International, Paris 2010.
Modul Text B 1. Ecc 2 Ecc	le:8 Book(s) cho-1, M cho-1, Ca	Invited Talk: Native speakers Total Lecture hours: éthode de français, J. Girardet, J. Pécheur, Publ ahier d'exercices, J. Girardet, J. Pécheur, Publis	2 hours 30 hours isher CLE International, Paris 2010. her CLE International, Paris 2010.
Modul Text B 1. Ec 2 Ec Refere	le:8 Book(s) cho-1, M cho-1, Ca ence Boo	Invited Talk: Native speakers Total Lecture hours: éthode de français, J. Girardet, J. Pécheur, Publi ahier d'exercices, J. Girardet, J. Pécheur, Publis ks	2 hours 30 hours isher CLE International, Paris 2010. her CLE International, Paris 2010.
Module Text 1. 2. Ecc Reference 1.	le:8 Book(s) cho-1, M cho-1, Ca ence Boo ONNEX	Invited Talk: Native speakers Total Lecture hours: éthode de français, J. Girardet, J. Pécheur, Publ ahier d'exercices, J. Girardet, J. Pécheur, Publis ks IONS 1, Méthode de français, Régine Mérieux,	2 hours 30 hours isher CLE International, Paris 2010. her CLE International, Paris 2010. Yves Loiseau,Les Éditions Didier,
Module Text 1. 2. Ecc Reference 1. CC 2.	le:8 Book(s) cho-1, M cho-1, Ca ence Boo ONNEX 004.	Invited Talk: Native speakers Total Lecture hours: éthode de français, J. Girardet, J. Pécheur, Publi ahier d'exercices, J. Girardet, J. Pécheur, Publis aks IONS 1, Méthode de français, Régine Mérieux,	2 hours 30 hours isher CLE International, Paris 2010. her CLE International, Paris 2010. Yves Loiseau,Les Éditions Didier,
Moduli Text 1. 2. 2. 1. C. Text 1. C. 2. 2. 2. 2. 2. 2. 2.	le:8 Book(s) cho-1, M cho-1, Ca ence Boo ONNEX OONEX CONNEX	Invited Talk: Native speakers Total Lecture hours: éthode de français, J. Girardet, J. Pécheur, Publis ahier d'exercices, J. Girardet, J. Pécheur, Publis ks IONS 1, Méthode de français, Régine Mérieux, IONS 1, Le cahier d'exercices, Régine Mérieux	2 hours 30 hours isher CLE International, Paris 2010. her CLE International, Paris 2010. Yves Loiseau, Les Éditions Didier, x, Yves Loiseau, Les Éditions
Motion Text 1. 2. 2. 7.	le:8 Book(s) cho-1, M cho-1, Ca ence Boo ONNEX 004. CONNEX idier, 200	Invited Talk: Native speakers Total Lecture hours: éthode de français, J. Girardet, J. Pécheur, Publis ahier d'exercices, J. Girardet, J. Pécheur, Publis bks IONS 1, Méthode de français, Régine Mérieux, IIONS 1, Le cahier d'exercices, Régine Mérieux 04.	2 hours 30 hours isher CLE International, Paris 2010. her CLE International, Paris 2010. Yves Loiseau, Les Éditions Didier, x, Yves Loiseau, Les Éditions
Module Text 1. 2. 2. 6. 7. 1. 1. 2. 2. 2. 2. 2. 2. 2. 3.	le:8 Book(s) cho-1, M cho-1, Ca ence Boo ONNEX ONNEX OO4. CONNEX Didier, 200 ALTER E	Invited Talk: Native speakers Total Lecture hours: éthode de français, J. Girardet, J. Pécheur, Publis ahier d'exercices, J. Girardet, J. Pécheur, Publis iks IONS 1, Méthode de français, Régine Mérieux, CIONS 1, Le cahier d'exercices, Régine Mérieur 04. GO 1, Méthode de français, Annie Berthet, Cat	2 hours 30 hours isher CLE International, Paris 2010. her CLE International, Paris 2010. Yves Loiseau, Les Éditions Didier, x, Yves Loiseau, Les Éditions herine Hugo, Véronique M.
Motule Text 1. 2. 2. 6. 7.	le:8 Book(s) cho-1, M cho-1, Ca ence Boo ONNEX OO4. CONNEX Didier, 200 ALTER E izirian, E	Invited Talk: Native speakers Total Lecture hours: éthode de français, J. Girardet, J. Pécheur, Publis ahier d'exercices, J. Girardet, J. Pécheur, Publis bks IONS 1, Méthode de français, Régine Mérieux, CIONS 1, Le cahier d'exercices, Régine Mérieux 04. GO 1, Méthode de français, Annie Berthet, Cat Béatrix Sampsonis, Monique Waendendries , Ha	30 hours isher CLE International, Paris 2010. her CLE International, Paris 2010. Yves Loiseau, Les Éditions Didier, x, Yves Loiseau, Les Éditions herine Hugo, Véronique M. achette livre 2006.
MoUI Text B 1. EC 2 EC Reference 1. CC 20 20 20 20 20 20 20 20 20 20	le:8 Book(s) cho-1, M cho-1, Ca ence Boo ONNEX OOVNEX OO4. CONNEX DO4. CONNEX CONNEX CONNEX DO4. CONNEX DO4. CONNEX CONNEX DO4	Invited Talk: Native speakers Total Lecture hours: éthode de français, J. Girardet, J. Pécheur, Publis ahier d'exercices, J. Girardet, J. Pécheur, Publis ahier d'exercices, J. Girardet, J. Pécheur, Publis ks IONS 1, Méthode de français, Régine Mérieux, CIONS 1, Le cahier d'exercices, Régine Mérieux, CIONS 1, Méthode de français, Annie Berthet, Cat Séatrix Sampsonis, Monique Waendendries , Ha ation: CAT / Assignment / Quiz / FAT	30 hours isher CLE International, Paris 2010. her CLE International, Paris 2010. Yves Loiseau, Les Éditions Didier, x, Yves Loiseau, Les Éditions herine Hugo, Véronique M. achette livre 2006.

Course code	Course title		L	Т	Р	J	С
STS5001	Essentials of Business Etiquette and problem solving		3	0	0	0	1
Pre-requisite		Sy	lla	bu	s v	ers	sion

No. 47

05-10-2017

Date

Approved by Academic Council



Course Objectives(CoB):

- 1 To develop the students' logical thinking skills
- 2 To learn the strategies of solving quantitative ability problems
- **3** To enrich the verbal ability of the students
- 4 To enhance critical thinking and innovative skills

Course Outcome(CO):

- 1 To enable students to use relevant aptitude and appropriate language to express themselves
- 2 To communicate the message to the target audience clearly

Module:1Business Etiquette: Social and Cultural Etiquette and
Writing Company Blogs and Internal Communications and
Planning and Writing press release and meeting notes

Value, Manners, Customs, Language, Tradition, Building a blog, Developing brand message, FAQs', Assessing Competition, Open and objective Communication, Two way dialogue, Understanding the audience, Identifying, Gathering Information, Analysis, Determining, selecting plan, Progress check, Types of planning, Write a short, catchy headline, Get to the Point – summarize your subject in the first paragraph., Body – Make it relevant to your audience,

Module:2	Study skills – Time	e management skills			3 hours
Prioritization, Pr	ocrastination, Sched	uling, Multitasking, N	/Ionitoring,	working under	pressure and
adhering to dead	lines				

Module:3	Presentation skills – Preparing	7 hours
	presentation and Organizing materials	
	and Maintaining and preparing visual	
	aids and Dealing with questions	

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

Module:4	Quantitative Ability -L1 – Number					11 hours
	properties and Averages and					
	Progressions a	and Percentages and F	latios			
Number of fact	ors Factorials	Remainder Theorem	Unit d	ligit nosition	Tens digit	position

Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position, Averages, Weighted Average, Arithmetic Progression, Geometric Progression, Harmonic Progression, Increase & Decrease or successive increase, Types of ratios and proportions



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Module:5		Reasoning Ability-L1 – Analytical Reasoning	8 hours			
Data	Arrangeme	ent (Linear and circular & Cross Variable Relati	onship), Blood Relations,			
Order	ring/rankin	g/grouping, Puzzle test, Selection Decision tabl	e			
			r			
Modı	ıle:6	Verbal Ability-L1 – Vocabulary Building	7 hours			
Sync	onyms & A	ntonyms, One-word substitutes, Word Pairs, Sp	cellings, Idioms, Sentence			
com	pletion, Ar	nalogies				
		Total Lasteria harris	45 hours			
		1 otal Lecture nours:	45 nours			
Refer	rence Bool	KS				
1.	Kerry Patterson, Joseph Grenny, Ron McMillan, AlSwitzler (2001) Crucial					
	McGraw	Conversations: Tools for Talking when Stakes are High. Bangalore. McGraw-Hill Contemporary				
2.	Dale Ca Books	rnegie, (1936) How to Win Friends and Influe	nce People. New York. Gallery			
3.	Scott Peo	ck. M (1978) Road Less Travelled. New York C	City. M. Scott Peck.			
4.	FACE (2	2016) Aptipedia Aptitude Encyclopedia. Delhi.	Wiley publications			
5.	ETHNU	S (2013) Aptimithra. Bangalore. McGraw-Hill 1	Education Pvt. Ltd.			
Webs	sites:					
1.	www.cha	alkstreet.com				
2.	www.skillsyouneed.com					
3.	www.mi	ndtools.com				
4.	www.the	ebalance.com				
5.	www.eg	<u>uru.000</u>				
Mode	of Evalua	ation: FAT, Assignments, Projects, Case studie	s, Role plays,			



Course code Course title L T P				
STS5002	Preparing for Industry	y	3 0 0 1	
Pre-requisite			Syllabus version	
			1	
Course	1 To challenge students to explore th	eir problem-so	olving skills	
Objectives:	2 To enhance the essential skills to ta	ickle advanced	l quantitative and	
	verbal ability questions	·	a in Taaliah	
		communicati	ng in English	
Course	Enabling students to simplify, evaluate	. analyze and	use functions and	
Outcome:	expressions to simulate real situations	to be industry	ready.	
		<u></u>		
Module:1	Interview skills – Types of interview		3 hours	
	and Techniques to face remote			
	interviews and Mock Interview			
Structured and unst	ructured interview orientation, Closed quest	ions and hypo	thetical questions,	
Interviewers' persp	ective, Questions to ask/not ask during an ir	nterview, Vide	o interview,	
Recorded feedback	, Phone interview preparation, Tips to custor	mize preparati	on for personal	
interview, Practice	rounds			
Module:2	Resume skills – Resume Template and		2 hours	
	Use of power verbs and Types of			
	resume and Customizing resume			
Structure of a stand	dard resume, Content, color, font, Introduc	tion to Power	verbs and Write up,	
Quiz on types of	resume, Frequent mistakes in customizing	g resume, Lay	out - Understanding	
different company's	s requirement, Digitizing career portfolio			
Madula 2	Emotional Intelligence I 1		10 h a	
Module:5	Emotional Intemgence - L1 – Transactional Analysis and Brain		12 Hours	
	storming and Psychometric Analysis			
	and Rebus Puzzles/Problem Solving			
Introduction. Con	tracting, ego states, Life positions, I	ndividual Br	ainstorming. Group	
Brainstorming, Ste	pladder Technique, Brain writing, Crawfor	d's Slip writir	ng approach, Reverse	
brainstorming, Sta	r bursting, Charlette procedure, Round	robin brains	torming, Skill Test,	
Personality Test, M	ore than one answer, Unique ways			
Module:4	Quantitative Ability-L3 –		14 hours	
	Permutation-Combinations and			
	Probability and Geometry and			
	mensuration and Trigonometry and			
	Logarithms and Functions and			
Counting Crossie	Quadratic Equations and Set Theory	amonto Com	ditional Drahahilit	
Counting, Groupir	ig, Linear Arrangement, Circular Arran	gements, Cor	iuiuonai Probability,	



Independent and Dependent Events, Properties of Polygon, 2D & 3D Figures, Area & Volumes, Heights and distances, Simple trigonometric functions, Introduction to logarithms, Basic rules of logarithms, Introduction to functions, Basic rules of functions, Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations, Basic concepts of Venn Diagram Module:5 **Reasoning ability-L3 – Logical** 7 hours reasoning and Data Analysis and Interpretation Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic, Data Sufficiency, Data interpretation-Advanced, Interpretation tables, pie charts & bar chats Module:6 Verbal Ability-L3 – Comprehension 7 hours and Logic Reading comprehension, Para Jumbles, Critical Reasoning (a) Premise and Conclusion, (b) Assumption & Inference, (c) Strengthening & Weakening an Argument 45 hours **Total Lecture hours:** References Michael Farra and JIST Editors(2011) Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Saint Paul, Minnesota.Jist Works Daniel FlagePh.D(2003) The Art of Questioning: An Introduction to Critical Thinking. London. Pearson FACE(2016) Aptipedia Aptitude Encyclopedia. Delhi. Wiley publications **Mode of Evaluation**: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)



Course code	SCIENCE, EN	GINEERING AN	D TECH	NOLOGY	I	,	Т	Р	J	C
	· · · · · · · · · · · · · · · · · · ·	PROJECT-	I						-	-
SET 5001										2
Pre-requisite					Sylla	bu	s \	/er	sio	n
Anti-requisite						1	.10			
Course Objectives	(CoB):									
To provide of	opportunity to involv	e research related	to science	/ engineerin	g / teo	hn	olc	ogy		
 To inculcate 	research culture and	l applied learning								
 To enhance 	the rational and inno	vative thinking cap	pabilities							
Course Outcome(C	C O):									
On completion of th	nis course, the studen	t should be able to	:							
1 Correct out in	dopondont rocoarch i	n the grade of inter	oct							
2 Interpret the	sciontific results and	tost hypothesis	est							
2. Interpret the	a peer reviewed jour	nals / International	l Conferen	CAS						
4 Understand	the ethical aspects of	research and plag	iarism							
4. Onderstand	the ethical aspects of	research and plug	Iurisiii							
Modalities / Requi	rements									
1. Individual o	r group projects can	be taken up								
2. Involve in li	terature survey in the	e chosen field								
3. Use Science	/Engineering princip	les to solve identif	ied issues							
4. Adopt releva	ant and well-defined	/ innovative metho	odologies t	o fulfill the	specif	ied	oł	ojec	tiv	/e
5. Submission	of scientific report ir	n a specified forma	t (after pla	giarism che	ck)			5		
	1	1	、 1	0	,					
		1/								
Student Assessmer	it : Periodical review	vs, oral/poster pres	entation							
Recommended by H	Board of Studies	17-08-2017	D /	05 10 501	-					
Approved by Acade	emic Council	INO. 47	Date	05-10-201	./					

SCIENCE, ENGINEERING AND TECHNOLOGY PROJECT– II





		(Deemed to be University under	r section 3 of UGC Act, 1956)					
SET 5002								2
Pre-requisite				S	yllabu	ıs V	⁷ ersi	on
Anti-requisite								1.10
Course Objectives	(CoB):							
To provide of	opportunity to involv	e in research relate	ed to scienc	e / engineerin	ng /tecl	hno	logy	
 To inculcate 	 To inculcate research culture and applied learning 							
 To enhance 	 To enhance the rational and innovative thinking capabilities 							
Course Outcome((<u></u>							
Course Outcome(C	JUJ:	t should be shis to						
On completion of th	lis course, the studen	it should be able to	•					
1. Carry out in	dependent research in	n the areas of inter	est					
2. Interpret the	e scientific results and	l test hypothesis						
3. Publish in th	ne peer reviewed jour	nals / International	l Conferen	ces				
4. Understand	the ethical aspects of	research and plag	iarism					
	-	1 0						
Modalities / Requi	rements							
1. Individual o	r group projects can	be taken up						
2. Involve in li	iterature survey in the	e chosen field						
3. Use Science	/Engineering princip	les to solve identif	ied issues					
4. Adopt releva	ant and well-defined	/ innovative metho	dologies to	o fulfill the sp	ecified	l ob	oiecti	ve
5. Submission	of scientific report ir	a specified forma	t (after pla	giarism check)		5	
	or occontinue report in	a specifica forma	e (arter pra)			
Student Assessment : Periodical reviews, oral/poster presentation								
Recommended by E	3oard of Studies	17-08-2017		1				
Approved by Acade	emic Council	No. 47	Date	05-10-2017				

Course code	Master Thesis	L	Τ	P	J	C
MEE6099		0	0	0	0	16
Pre-requisite	As per the academic regulations	S	yllat	ous v	vers	sion
						1.0



Course Objectives(CoB):

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field and also to give research orientation.

Course Outcome(CO):

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

- 1. Acquire in-depth knowledge of the major subject/field of study, including deeper insight into current research and development work
- 2. Use holistic view to critically, independently and creatively identify, formulate and deal with complex issues
- 3. Understand the ethical aspects of research and development work
- 4. Apply modern scientific software tools and underlying concepts for solving industrial and societal problems

Modalities / Requirements

- **1.** Master thesis should be individual work, it may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research.
- **2.** Project can be for two semesters based on the completion of required number of credits as per the academic regulations.
- **3.** Master thesis can be carried out inside or outside the university, in any relevant industry or research institution.
- **4.** Publications in the peer reviewed journals / International Conferences will be an added advantage

Mode of Evaluation: Periodic reviews, Presentation, Final oral viva, Poster submission							
Recommended by Board of 10.06.2016							
Studies							
Approved by Academic Council	41 st AC	Date	17.06.2016				



Programme Core



Course code	Mechatronics And Cyber-Physica	Svstems	L T P J C
MEE5028			3 0 2 0 4
Pre-requisite			Svllabus version
			1.0
Course Objective	es(CoB):		
The main objectiv	res of the course are to:		
 Acquire kan Physical S Develop a computation 	nowledge and skills on various hardware and ystems (CPS) - modeling, analysis, and desig n exposition of the challenges in implemention onal perspective, but based equally on the prin	software desig n ng a cyber-phys nciples of autor	n aspects of Cyber sical system from a nated control
Expected Course	Outcome(CO):		
At the end of the	course, a student will be able to:		
 Desigr archite Catego Selecta Unders Elabor Develo 	CPS for meeting the requirements based of cture constraints. prize the essential modeling formalisms of Cy actuators and its associated drivers for several stand architecture and working principles of a ate processors, Networking, Communication op CPS, security, safety aspects and its imple	n operating system ber-Physical System working condi- ctuators and dr protocols and pr nentation	stem and hardware ystems (CPS). tions ives programming
Module:1 Intro svste	oduction to Mechatronic systems and cyber m	physical	5 hours
Architecture of m Drives and Actua SW controllers fo	echatronics and Cyber physical systems- K ators, Controller, Electronics devices-Comn r ABS, ACC, Lane Departure Warning,	ey elements- P nunication Prot	rocessors, Sensors, ocols. Case study:
Module 2 Basi	rs of Drives and Actuators:		6 hours
Construction, Prin AC motors, step control, cylinder,	ciple of Operation, Basic Equations and App per motor, servo motor. Pneumatic and FilterApplications in Automation.	olications of ele hydraulic actu	ectrical motors-DC, ators-Valves-Flow,
Madula 2 Dasi			C h anna
binary number sy	stem – logic gates – Boolean algebra – ha	If and a full a	dder – flip-flops –
register and count	ers –Rectifiers – Voltage Regulation- A/D an	d D/A conversi	on.
Module:4 Sens	ors and signal conditioning circuits:		6 hours
Transduction prin	ciples of peizo, resistive, capacitive, ultraso	nic, IR sensors	-Examples-Thermo
couples, strain ga	auge, pressure sensor-Analog to Digital co	onversion, Data	a acquisition-Filter
Module:5 Proc	essors and programming:		9 hours
Basics in Microco	ontroller - 8051 Architecture: Memory map	- Addressing 1	nodes, I/O Ports –



	unters an	d Timers – Serial data - I/ O – Interrupts	–Instruction set.				
PLO	C- Princi	ples of operation – PLC Architecture– PLC hardware components	Analog & digital				
I/O	modules	s, CPU & memory module –PLC ladder diagram. PLC programming	-Interfacing with				
sen							
Ма	dular	Notworking and Communication protocols	E houwa				
IVIO Dr	inciploc	of Modulation and Domodulation: Drinciples of Amplitude	ond Frequency				
	nicipies odulation	of Modulation and Demodulation. Finiciples of Amplitude of as CDS Network - WirelessHart CAN Ethernet CDS Sw s	and Frequency				
	heduling	Real Time control tasks CPS	$\operatorname{Rec} = \operatorname{R100},$				
	incutinit						
Mo	dule:7	Systems Engineering for design of mechatronic system and CPS:	6 hours				
V	Model a	nd its variants - System boundary definition- Multi-view and multi-	level modeling-				
Tc	pologica	al modeling- Semantic interoperability modeling- Multi-ag	ent modeling-				
Co	ollaborati	on modeling- internal block diagrams- multi-agent developme	ent platform –				
So	oftware	cools-Java, Modelica. Case Study: Suspension Control, Healthc	are : Artificial				
Pa	ncreas/I	nfusion Pump/Pacemaker, Green Buildings : automated lighting	g, AC control,				
Di	gital Tw	in system					
MO	dule:8	Contemporary Issues	2 hours				
	dustrial I	Expert Guest Lecture and Seminars					
Tot	al Loctu	ira haurs	15 hours				
	lai Lecu Iode: Fli	ned Class Room [Lecture to be videotaned] Use of physical and	45 110015				
con	nniiter m	adals to locture. Visit to Industry Min of 2 loctures by industry					
		$\cup \cup \neg \neg$					
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5.	Study and Programming of		Inc	lustrial	1.5 hours	
	Robot.					
6.	Speed control of motor using PI	D.			1.5 hours	
7.	Study on Wired and wireless co	mmunication.			1.5 hours	
8.	Data acquisition using thermoco	ouple, strain gauge.			1.5 hours	
9.	Modeling and simulation of me	echatronics system	s using co	ding software	1.5 hours	
	tools.			-		
10.	Modeling and simulation of cy	ber physical system	ms using o	open software	1.5 hours	
	tools.					
			Total Lab	oratory Hours	15hours	
Mode of evaluation:						
Reco	Recommended by Board of Studies 07-03-2019					
App	roved by Academic Council	No. 55	Date	13-06-2019		



Course code	SYSTEM MODELLING AND SIMULATION		L	Т	P	J	С
MEE5029			2	0	2	0	3
Pre-requisite		Sy	lla	bu	s v	ers	ion
						v.	1.0

Course Objectives(CoB):

The main objectives of the course are to:

- 1. Characterize Cyber-Physical Systems (CPS) in terms of their essential elements, purpose, parameters, constraints, performance requirements, sub-systems, interconnections and environmental context.
- 2. Develop a model real world situation related to CPS development, prediction and evaluation of outcomes against design criteria and analyze the simulation results.

Expected Course Outcome (CO):

At the endofthe course, astudent will be able to:

- 1. Model deterministic systems and differentiate between nonlinear and linear models in discrete and continuous time
- 2. Acquire knowledge on numerical simulation of linear and non-linear ordinary differential equations and deterministic systems.
- 3. Analyze the results and validate a multi-domain model based upon input and output data.
- 4. Develop model based upon new input, interface and validates the output data.
- 5. Comprehend and apply advanced theory-based understanding of engineering fundamentals
- 6. Design a simple CPS system and determine the stability of system

Module:1 Modeling Discrete-time Systems –

Modeling of Physical Systems -Discrete-Time Systems Concepts - A Discrete-Time Modeling, Simulation of a Discrete-Time Model, Discrete-time Case studies – Modeling & Simulation -Temperature control in a Room, Cruise control of ground vehicle, Spring-mass-damper system

Module:2 Modeling Continuous-Time Systems -

Continuous-Time Concepts - A Continuous-Time Modeling, Simulation of a Continuous-Time Model, A Continuous-Time Model of a Linear Time-Invariant System, Continuous-time Systems Case studies – Modeling & Simulation -Temperature control in a Room, Cruise control of ground vehicle, Spring-mass-damper system, Design Optimization - Fmincon, Genetic Algorithm, Simulated Annealing, and Evolutionary Algorithm.

Module:3 Modeling Cyber Components:

Finite State Machines, Computations, Algorithms, and a First CPS Model, Simulation of a Finite State Machine, A Finite-State Machine – Control simulation. Case studies - Temperature control in a Room, A Finite State Machine Modeling a Chess Game, A CPS Model of a Thermostat, Simulation of a CPS Model of a Thermostat, Models of Computations, A General Discrete-Time Model of a Linear Time-Invariant Algorithm

5 hours

5 hours



Power Bond Graph modeling -Different systems analogy: mechanical, electrical, hydraulic. Power Variables, Standard elements (R, L, C, gyrator, transformer), Causality- Causality strokes and modelling and simulation of spring-mass-damper system and electrical system Module:5 Modeling Interfaces for Cyber-Physical Systems: 3 hours Conversion, Networks, and Complete CPS Models, Analog to Digital Conversion, A Model of an Analog to Digital Converter, Digital to Analog Conversion, A Model of an Implemented Finite-State Machine, Simulation of an Implemented Finite-State Machine, Simulation of an Implemented Finite State Machine, Simulation of a Digital Communication Network, A CPS Model for Estimation Over a Network, Simulation of a Digital Communication Network, A CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, Simulation for Sample and Hold Control, Simulation of an Executions (or Solutions) Module:7 Trajectories in CPS and Simulations: 3 hours Time Domains, Executions, and Complete CPS Models - Introduction to Executions (or Solutions) 5 hours Module:8 Contemporary issues: 2 hours Total Lecture hours: # 4 Mode: Fipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry , Min of 2 lectures by industry experts 30 hours Text Book(S) 1 Gr. M. Siddesh, G. C. Deka, K. G. Srinivasa, L. M. Patnaik, Cyber-Physical Systems: A Computational Perspective, CRC p	Mo	dule:4	Multi-domain Physical System modeling -	4 hours		
Variables, Standard elements (R, L, C, gyrator, transformer), Causality- Causality strokes and examples, Integrative and Derivative Causality, Generation of system equations, Case study - modelling and simulation of spring-mass-damper system and electrical system Module:5 Modeling Interfaces for Cyber-Physical Systems: 3 hours Conversion, Networks, and Complete CPS Models, Analog to Digital Conversion, A Model of an Analog to Digital Converter, Digital Converter, Digital Converter, 3 hours Module:6 Finite-State Machine and Digital Communication Network - A Model of an Implemented Finite-State Machine, Simulation of a Digital Communication Network, A CPS Model for Estimation Over a Network, Simulation of a Digital Communication Network, A CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, Simulations: 3 hours Module:7 Trajectories in CPS and Simulations: 3 hours Time Domains, Executions, and Complete CPS Models - Introduction to Executions (or Solutions) to Cyber-Physical Systems, Hybrid Time Domains, Hybrid Arcs, Definition of an Execution (with Inputs), Definition of an Execution (with Inputs), Types of Executions, Executions for the Digital Converter, Simulations of Cyber-Physical Systems, Introduction to Hybrid Equations Module:8 Contemporary issues: 2 hours Industrial Expert Guest Lecture and Seminars 30 hours Module:8 Contemporary issues: 2 hours Industrial Expert Guest Lecture and Seminars 30 hours # Mo	Pov	ver Bond	Graph modeling -Different systems analogy: mechanical, electrical, hy	draulic. Power		
examples, Integrative and Derivative Causality, Generation of system equations, Case study - modelling and simulation of spring-mass-damper system and electrical system Module:5 Modeling Interfaces for Cyber-Physical Systems: 3 hours Conversion, Networks, and Complete CPS Models, Analog to Digital Conversion, A Model of an Analog to Digital Converter, Digital to Analog Conversion, A Model of an Implemented Finite-State Machine and Digital Communication Network - 3 hours A Model of an Implemented Finite-State Machine, Simulation of a Digital Communication Over a Network, Simulation of a Digital Communication Over a Network, A CPS Model for Estimation Over a Network, Simulation of a Digital Communication Over a Network, A CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, Simulation of a CPS Model for Sample and Hold Control. 3 hours Module:7 Trajectories in CPS and Simulations: 3 hours Time Domains, Executions, and Complete CPS Models - Introduction to Executions (or Solutions) to Cyber-Physical Systems, Hybrid Time Domains, Hybrid Arcs, Definition of an Execution (without Inputs), Definition of an Execution (with Inputs), Types of Executions, Executions for the Digital to Analog Converter, Simulations of Cyber-Physical Systems, Introduction to Hybrid Equations: 30 hours Module:8 Contemporary issues: 2 hours Industrial Expert Guest Lecture and Seminars 30 hours # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min of 2 lectures by industry experts	Variables, Standard elements (R, L, C, gyrator, transformer), Causality- Causality strokes and					
modelling and simulation of spring-mass-damper system and electrical system Module:5 Modeling Interfaces for Cyber-Physical Systems: 3 hours Conversion, Networks, and Complete CPS Models, Analog to Digital Conversion, A Model of an Analog to Digital Converter, Digital to Analog Conversion, A Modeling and simulation of an Analog to Digital Converter, 3 hours Module:6 Finite-State Machine and Digital Communication Network - 3 hours A Model of an Implemented Finite-State Machine, Simulation of a Digital Communication Network, A CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, A CPS Model for Sample and Hold Control. 3 hours Module:7 Trajectories in CPS and Simulations: 3 hours Time Domains, Executions, and Complete CPS Models - Introduction to Executions (or Solutions) to Cyber-Physical Systems, Hybrid Time Domains, Hybrid Arcs, Definition of an Execution (without Inputs), Definition of an Execution (with Inputs), Definition of an Execution (with puts), Definition of an Execution (Without Inputs), Definition of an Execution Structure to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min of 2 lectures by industry experts 30 hours Text Book(s) 1. G. M. Siddesh, G. C. Deka, K. G. Srinivasa, L. M. Patnaik, Cyber-Physical Systems: A Computational Prepsective, CRC press, 2016, 2. 33. hours P. Fritzson, Principles of Object-Oriented Modeling and Simulation with Modelica 3.3: A Cyber-Physical Approach. Wiley-IEEE Press, 2014. 33. hours <td>exa</td> <td>mples, I</td> <td>ntegrative and Derivative Causality, Generation of system equations</td> <td>, Case study -</td>	exa	mples, I	ntegrative and Derivative Causality, Generation of system equations	, Case study -		
Module:5 Modeling Interfaces for Cyber-Physical Systems: 3 hours Conversion, Networks, and Complete CPS Models, Analog to Digital Conversion, A Model of an Analog to Digital Converter, Digital to Analog Conversion, A Modeling and simulation of an Analog to Digital Converter, Module:6 Finite-State Machine and Digital Communication Network - 3 hours A Model of an Implemented Finite-State Machine, Simulation of a Digital Communication Network, Simulation of a Digital Communication Network, A CPS Model for Estimation Over a Network, Simulation of a Digital Communication Network, A CPS Model for Sample and Hold Control, Simulation for Sample and Hold Control. Control Trajectories in CPS and Simulations: 3 hours Module:7 Trajectories in CPS and Simulations: 3 hours Time Domains, Executions, and Complete CPS Models - Introduction to Executions (or Solutions) to Cyber-Physical Systems, Hybrid Time Domains, Hybrid Arcs, Definition of an Execution (with Inputs), Definition of an Execution (with Inputs), Types of Executions, Executions for the Digital to Analog Converter, Simulations of Cyber-Physical Systems, Introduction to Hybrid Equations 30 hours Module:8 Contemporary issues: 2 hours Industrial Expert Guest Lecture and Seminars 30 hours # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min of 2 lectures by industry experts 30 hours Text Book(s) 1. G. M. Siddesh, G. C. Deka, K. G	mo	delling a	nd simulation of spring-mass-damper system and electrical system			
Module:5 Modeling Interfaces for Cyper-Physical Systems: 3 hours Conversion, Networks, and Complete CPS Models, Analog to Digital Conversion, A Model of an Analog to Digital Converter, Digital Converter, Digital Converter, 3 hours Module:6 Finite-State Machine and Digital Communication Network - 3 hours A Model of an Implemented Finite-State Machine, Simulation of an Implemented Finite State Machine, A Digital Communication Network, Simulation of a Digital Communication Network, A CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, A CPS Model for Sample and Hold Control, Simulation for Sample and Hold Control Module:7 Trajectories in CPS and Simulations: 3 hours Time Domains, Executions, and Complete CPS Models - Introduction to Executions (or Solutions) to Cyber-Physical Systems, Hybrid Time Domains, Hybrid Arcs, Definition of an Execution (with Inputs), Definition of an Execution (with Inputs), Definition of an Execution to Hybrid Equations 2 hours Module:8 Contemporary issues: 2 hours Industrial Expert Guest Lecture and Seminars 30 hours # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical Agnotoch, Wiley-TeEP res, 2016, 3 C G. M. Siddesh, G. C. Deka, K. G. Srinivasa, L. M. Patnaik, Cyber-Physical Systems: A Computational Perspective, CRC press, 2016, 3 P. Fritzson, Principles of Object-Oriented Modeling and Simulati						
Conversion, Networks, and complete Conversion, A Modeling and Conversion, A Modeling and Converter, 3 hours Module:6 Finite-State Machine and Digital Communication Network - 3 hours A Model of an Implemented Finite-State Machine, Simulation of an Implemented Finite State Machine, A Digital Communication Network, Simulation of a CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, A CPS Model for Sample and Hold Control, Simulation for Sample and Hold Control Module:7 Trajectories in CPS and Simulations: 3 hours Time Domains, Executions, and Complete CPS Models - Introduction to Executions (or Solutions) to Cyber-Physical Systems, Hybrid Time Domains, Hybrid Arcs, Definition of an Execution (with Inputs), Definition of an Execution (with Inputs), Types of Executions, Executions for the Digital to Analog Converter, Simulations of Cyber-Physical Systems, Introduction to Hybrid Equations Module:8 Contemporary issues: 2 hours Industrial Expert Guest Lecture and Seminars 30 hours # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min of 2 lectures by industry experts 30 hours Text Book(S) I G. M. Siddesh, G. C. Deka, K. G. Srinivasa, L. M. Patnaik, Cyber-Physical Systems: A Computational Perspective, CRC press, 2016, P. Fritzson, Principles of Object-Oriented Modeling and Simulation with Modelica 3.3: A Cyber-Physical Approach. Wi		dule:5	Modeling Interfaces for Cyber-Physical Systems:	<u>3 hours</u>		
Analog to Digital Converter, 3 hours Analog to Digital Converter, 3 hours A Model of an Implemented Finite-State Machine, Simulation of an Implemented Finite State Machine, A Digital Communication Network, Simulation of a Digital Communication Network, A CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, A CPS Model for Estimation Over a Network, Simulation of a CPS Model for Estimation Over a Network, A CPS Model for Sample and Hold Control, Simulation for Sample and Hold Control Module:7 Trajectories in CPS and Simulations: 3 hours Time Domains, Executions, and Complete CPS Models - Introduction to Executions (or Solutions) to Cyber-Physical Systems, Hybrid Time Domains, Hybrid Arcs, Definition of an Execution (with Inputs), Definition of an Execution for the Digital to Analog Converter, Simulations of Cyber-Physical Systems, Introduction to Hybrid Equations Module:8 Contemporary issues: 2 hours Industrial Expert Guest Lecture and Seminars 30 hours # Module:8 Contemporary issues: 2 hours Industrial Expert Guest Lecture and Seminars 30 hours Total Lecture hours: # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry , Min of 2 lectures by industry experts 30 hours Text Book(s) I G. M. Siddesh, G. C. Deka, K. G. Srinivasa, L. M. Patnaik, Cyber-Physical Systems: A Computational Perspective, CRC press, 2016, 2.	an	Analog	to Digital Converter. Digital to Analog Conversion. A Modeling and sir	nulation of an		
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a Network, A CPS Model for Sample and Hold Control, Simulation for Sample and Hold Control Module:7 Trajectories in CPS and Simulations: 3 hours Time Domains, Executions, and Complete CPS Models - Introduction to Executions (or Solutions) to Cyber-Physical Systems, Hybrid Time Domains, Hybrid Arcs, Definition of an Execution (without Inputs), Definition of an Execution (with Inputs), Types of Executions, Executions for the Digital to Analog Converter, Simulations of Cyber-Physical Systems, Introduction to Hybrid Equations 2 hours Module:8 Contemporary issues: 2 hours Industrial Expert Guest Lecture and Seminars 30 hours # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry , Min of 2 lectures by industry experts 30 hours Text Book(s) . . . 1. G. M. Siddesh, G. C. Deka, K. G. Srinivasa, L. M. Patnaik, Cyber-Physical Systems: A Computational Perspective, CRC press, 2016, 2. . . 2. Pert Fritzson, Principles of Object-Oriented Modeling and Simulation with Modelica 3.3: A Cyber-Physical Approach. Wiley-IEEE Press, 2014. . . Reference Books 2. Francois E. Cellier and Ernesto Kofman, "Continuous System Simulation," Springer-Verlag New York, Inc. Secaucus, NJ, USA, 2013. . . <t< td=""><td>A</td><td>CPS Mo</td><td>del for Estimation Over a Network, Simulation of a CPS Model for Esti</td><td>mation Over</td></t<>	A	CPS Mo	del for Estimation Over a Network, Simulation of a CPS Model for Esti	mation Over		
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	1.	Develo	opment of State space models for automotive steering system	1.5 hours		



2.	Development of transfer	tion model of	1.5 hours				
	spring mass damper system						
3.	3. Simulation of quarter car model using coding tools.						
4.	Finite state machine model for a v	vending machine.			1.5 hours		
5.	A CPS Model of a Thermostat.				1.5 hours		
6.	6. Virtual instrumentation model for data acquisition.						
7.	Power Bond Graph modeling for	1.5 hours					
8.	8. Agent model for CPS in JADE environment.						
9.	Modeling and simulation of an A	1.5 hours					
10.	Application of modeling and simu	ulation methodolo	gies to a co	mplex	1.5 hours		
	engineering system						
	Total Laboratory Hours 15 hours						
Mod	Mode of evaluation: Digital Assignments /Seminars/Surprise Tests / CATs /FAT						
Reco	ommended by Board of Studies	07-03-2019					
Арр	Approved by Academic Council No. 55 Date 13-06-2019						

		VIT Vellore Institute of Technology
Course code	SMART	MOBILITY AND L T P J (INTELLIGENT VEHICLES
		INTELLIGENT VEHICLES



			(Deemo	med to be University under sec	tion 3 of UGC Act, 1956)						
MEE5030								3	0	0 4	4
Pre-requisite								Syll	abu	s ver	sion
											1.0
Course Object	ives(CoB):									
The main object	tives of th	e course are	to:								
 Introductiver a Highlig systems 	ce student ssistance s ht impact to source	to the vari systems in ve of automations of informat	ous techn hicles n in vario ion that as	nologies ous drivi ssist wit	and sy ng func th a tasł	vstems etions an «.	used to in	mplem	ent a ne au	advan Itomo	iced itive
Expected Cou	rse Outco	me(CO):									
At the endofthe	course,as	student will b	e able to:								
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Madular) C	magetad	and Autono	moue Vek	hiele Te	chnolo	<i>a</i>				- F ha	
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Module:3 Se	nsor Tec	hnology for S	Smart Mo	obility						6 ha	ours
Basics of Rad and Systems, Fusion	ar Techno Camera Te	ology and Sy echnology, N	stems, Uli ight Visic	ltrasonic on Tech	Sonar nology,	Systen , Other	ns, Lidar Sensors,	Sensor Use of	a Teo Sen	chnol Isor E	ogy Data
Module:4 O	verview n	f Wireless T	echnolog	v & Ne	tworki	ng				6 hr	ours
Wireless Syste Modulation/En of Things, Wire	m Block coding, R eless Netw	Diagram a eceiver Syste vorking Fund	amentals	view o pts–Bas	f Com	ponent Comput	s, Transı ter Netwo	nissior orking	1 Sy – the	/stem e Inte	s –



Module:5	Connected Car &		Aut	tonomous	7 hours
	Vehicle Technology				
Connectiv	ity Fundamentals, Navigatio	on and Other Appl	ications, V	/ehicle-to-Vehicl	e Technology
and Applic	Cations, Venicle-to-Roadsid	e and Venicle-to-li	nfrastructu	ire Applications,	Autonomous
venicies -	Driveriess Car Technology	, Molal, Legal, Ro	audiock is	ssues.	
Module:6	Advanced Driver Assista	nce System & Dr	ognostics	Technology	6 hours
Basics of	Theory of Operation Applic	rations Integration	of ADAS	S Technology into	Vehicle
Electronic	s. System Examples. Role of	of Sensor Data Fus	ion. Vehic	le Prognostics Te	chnology.
Advanced	Driver Assistance System S	Sensor Alignment	and Calibr	ation	, contrology
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Module:7	Connected Car Display	& Impaired Drive	er Techno	logy	8 hours
Center Cor	sole Technology, Gauge	Cluster Technolog	gy, Heads	-Up Display Te	chnology, and
Warning T	echnology – Driver Notifi	ication. Impaired	Driver Te	echnology -Driv	er Impairment
Sensor Tecl	nnology, Sensor Technolog	y for Driver Impai	rment Det	ection	_
Module:8	Contemporary Discussi	ons			2 hours
Industrial E	xpert Guest Lecture and Se	minars			
	Total Lecture hours:				45 hours
	# Mode: Flipped Class Ro	oom, [Lecture to b	e videotap	ed], Use of	
	physical and computer mo	odels to lecture, V	isit to Indu	ustry, Min of 2	
	lectures by industry exper	ts			
Text Book	<u>s)</u>	1 - 11			
1. Radova	an Miucic, Connected Vehic	cles: Intelligent Tr	ansportatio	on Systems, Sprin	nger, 2015
2. Intellig	ent Transportation Systems	and Connected an	id Automa	ited Vehicles, Ira	ansportation
Resear	Ch Board 2016				
1 Occoir	DUUKS yn Afif Ioco E Moncor	rat and Datrick	Marcob	ode 50 mobile	and wireless
L. USSElla	in, AIII, JUSE F. WUIISEI	iai, allu Pauliek bridge University	$\frac{1}{2} \frac{1}{2} \frac{1}$	eus. Je moome 6	and wheress
	nications technology. Calli No Clara Renata Paola Da	meri and Reatrice	D'Auria	"Smart mobility	in smart city "
In Empowering Organizations on 13-28 Springer Cham 2016					
Mode of Ex	valuation: CAT / Assignmer	nt / Ouiz / FAT / P	roject / Set	minar	
	analisi, crit, rissigniner				
Mode of ev	aluation:				
Recommen	ded by Board of Studies	07-03-2019			
Approved b	y Academic Council	No. 55	Date	13-06-2019	



Course cod	e	Digital Manufacturing and factory automation	L T P J C				
MEE5031			3 0 2 0 4				
Pre-requisi	te		Syllabus version				
			v. 1.0				
Course Obj	jectives	(CoB):					
The main ot	The main objectives of the course are to:						
1. Expl 2. Dem appro	 Explore the facets of manufacturing "Fourth Revolution", Industry 4.0 standard. Demonstrate proficiency in the use of digital manufacturing tools and to evaluate of appropriate technologies for a digital enterprise. 						
Expected C	ourse	Outcome(CO):					
At the endo	fthe cou	urse,astudent will be able to:					
 Unde Dem Anal Anal Illust and j Impl Elab manu 	 Understand the concept of product development and digital manufacturing system Demonstrate the CAD data transformation and automated process planning. Analyze and design automated material handling systems and supervisory control. Illustrate aspects of industrial internet of things- functional layers of Industry 4.0 standards and protocols. Implement digital and IT techniques for manufacturing planning and quality control Elaborate virtual reality and augmented reality applications, safety aspects in automated 						
Module 1	Intro	Ing Inction to Digital Manufacturing	5 hours				
Product dev	elonme	nt cycle-stages- Product Lifecycle Management- Role of con	nuters in design				
and manufac system.	cturing-	Digital thread- Connected enterprise- architecture of digital	manufacturing				
Madular		CAM Tools for Digital Manufacturing	E hours				
Solid Boun	dary ar	d Function representations. Voxel representations. File for	nats Standards of				
data exchang architecture, process plan	data exchange Parametric, Topology optimization. Numerical control technology- CNC machines- architecture, G codes and M codes, programming for milling and lathe operations. Computer aided process planning.						
Module 3	Digita	l Additive Manufacturing Processes	6 hours				
Digital add	litive r	nanufacturing in product development process chain	- Modeling, data				
transmission	n, Build	ling and post processing. Hardware basics - Contact and nor	n-contact scanners,				
point processing, Additive manufacturing data formats -Applications.							
		~ ~ ~ ~ ~					
Module:4	Conce	pts of Industry 4.0 and Connected Machines:	8 hours				
Smart facto	Smart factory- Industrial internet of things-Reference Architecture Model for Industry 4.0-						
functional layers Connected machines - Standards and protocols- M2M Services Architecture-							
REST Arch	nitectur	al Style - UART (Universal Asynchronous Receiver/	Transmitter)- MT				
standard.							
Module:5	Facto	ry Automation:	6 hours				
		<u> </u>	0				



manufacturing cell- Automation pyramid in modern production systems- Supervisory Control and Data Acquisition (SCADA) control system, Robotics, Human Machine interface. Module:6 Computer Aided Shop Floor Control: 7 hours Computer aided production planning and control, computer aided material requirement planning, factory data collection system, computer aided quality control. 7 hours Module:7 Smart Maintenance: 6 hours Virtual reality and Augmented reality applications in manufacturing- Smart maintenance-Artificial intelligence in manufacturing -Decision support system-Prognosis and control-Data analytics. 2 hours Module:8 Contemporary issues: 2 hours Industrial Expert Guest Lecture and Seminars 45 hours # Mode: Plipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min. of 2 lectures by industry experts. modular automation systems and additive manufacturing. 45 hours I Andrew Kusiak, Smart Manufacturing, Publisher, Taylor & Francis, 2018 1 Reference Books 1 1 1 1 Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016. 1 3 Frank Lamb, Industrig Automation, Hands On, McGraw Hill Professional, 2013. Tien-Chein Chang, Richard A. Wysk, Hsu-Pin (Ben) Wang, Computer Aide Manufacturing (2016), Pearson Education. 1.5 hours <td< th=""><th>Au</th><th colspan="5">Automated material handling systems- AS/RS- Flexible</th></td<>	Au	Automated material handling systems- AS/RS- Flexible				
and Data Acquisition (SCADA) control system, Robotics, Human Machine interface. Module:6 Computer Aided Shop Floor Control: 7 hours Computer aided production planning and control, computer aided material requirement planning, factory data collection system, computer process monitoring, IT support-Software tools-MES-SAP- Fundamental of Networking- computer aided quality control. Wolule:7 Smart Maintenance: 6 hours Virtual reality and Augmented reality applications in manufacturing- Smart maintenance-Artificial intelligence in manufacturing -Decision support system-Prognosis and control-Data analytics. 2 hours Industrial Expert Guest Lecture and Seminars 7 total reality and Logenter models to lecture, Visit to Industry, Min. of 2 lectures by industry experts. modular automation systems and additive manufacturing. 45 hours Text Book(s) 1. Nulliam MacDougal, Industrie 4.0: Smart Manufacturing for the Future, Germany Trade & Invest, 2014. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016. 1. Frank Lamb, Industrial Automation: Hands On, McGraw Hill Profeesional, 2013. Teien-Chein Chang, Richard A. Wysk, Hsu-Pin (Ben) Wang, Computer Aided Manufacturing (2016), Pearson Education. 1.5 hours 2. Development of an automated production system with simulation package. 1.5 hours 3. Development of a 3D model and production system with simulation package. 1.5 hours 3. PLC Data capt	ma	anufactu	ring cell- Automation pyramid in modern production systems- Supervi	isory Control		
Image: Normal and the state of the sta	an	d Data A	Acquisition (SCADA) control system, Robotics, Human Machine inter	face.		
Module:6 Computer Aided Shop Floor Control: 7 hours Computer aided production planning and control, computer aided material requirement planning, factory data collection system, computer process monitoring, IT support-Software to Us-MES-SAP- Fundamental of Networking- computer aided quality control. 7 hours Module:7 Smart Maintenance: 6 hours Virtual reality and Augmented reality applications in manufacturing- Smart maintenance-Artificial intelligence in manufacturing -Decision support system-Prognosis and control-Data analytics. 2 hours Industrial Expert Guest Lecture and Seminars 7 total Lecture hours: 45 hours # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min. of 2 lectures by industry experts. 45 hours Industrial Expert Book(S) modular automation systems and additive manufacturing. 7 addee Kusiak, Smart Manufacturing, Publisher, Taylor & Francis, 2018 Reference Books Invest, 2014. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016. 5 Frank Lamb, Industrial Automation: Hands On, McGraw Hill Professional, 2013. Tien-Chein Chang, Richard A. Wysk, Hsu-Pin (Ben) Wang, Computer Aidee Manufacturing (2016), Pearson Education. 1.5 hours 2. Develpernet of a 3D model and production system with simulation package. 1.5 hours 3. Develpernet of a 3D model and production system with simu						
Computer aided production planning and control, computer aided material requirement planning, factory data collection system, computer aided quality control. Module7 Smart Maintenance:	Mo	dule:6	Computer Aided Shop Floor Control:	7 hours		
planning, factory data collection system, computer process monitoring, IT support-Software tools-MES-SAP- Fundamental of Networking- computer aided quality control. Module:7 Smart Maintenance: 6 hours Virtual reality and Augmented reality applications in manufacturing- Smart maintenance-Artificial intelligence in manufacturing -Decision support system-Prognosis and control-Data analytics. 6 hours Module:8 Contemporary issues: 2 hours Industrial Expert Guest Lecture and Seminars 45 hours # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min. of 2 lectures by industry experts. modular automation systems and additive manufacturing. 45 hours Text Book(s) . . Andrew Kusiak, Smart Manufacturing, Publisher, Taylor & Francis, 2018 . Reference Books . . Andrew Kusiak, Smart Manufacturing for the Future, Germany Trade & Invest, 2014. . . Madadari Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016. . . . Frank Lamb, Industrial Automation: Hands On, McGraw Hill Professional, 2013. Tien-Chein Chang, Richard A. Wysk, Hsu-Pin (Ben) Wang, Computer Aideut Manufacturing (2016), Pearson Education. . . . Design of 3D model and automated process plan generation. 1.5 hours . . . <t< td=""><td>Co</td><td>mputer</td><td>aided production planning and control, computer aided material requir</td><td>ement</td></t<>	Co	mputer	aided production planning and control, computer aided material requir	ement		
Module:7Smart Maintenance:6 hoursVirtual reality and Augmented reality applications in manufacturing- Smart maintenance-Artificial intelligence in manufacturing -Decision support system-Prognosis and control-Data analytics.Module:8Contemporary issues:2 hoursIndustrial ExpertenceTotal Lecture and Seminars45 hoursModule:8Total Lecture hours: # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min. of 2 lectures by industry experts. modular automation systems and additive manufacturing.45 hoursText BookgImage: Smart Manufacturing, Publisher, Taylor & Francis, 2018Image: Smart Manufacturing, Publisher, Taylor & Francis, 2018Reference BooksImage: Smart Manufacturing, Publisher, Taylor & Francis, 2018.Image: Smart Manufacturing, Publisher, Taylor & Francis, 2018.Invest, 2014.Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.Image: Smart Manufacturing (2016). Pearson Education.Note: First Lamb, Industrial Automation: Hands On, McGraw Hill Professional, 2013. Tene-Chein Chang, Richard A. Wysk, Hsu-Pin (Ben) Wang, Computer Aidetturing (2016). Pearson Education.1.5 hoursI.Development of a 3D model and automated process plan generation.1.5 hoursI.Development of a 3D model and production system with simulation package.1.5 hoursI.Out a capture with Bar code/ QR code systems.1.5 hoursI.Out a capture with RFID systems.1.5 hoursI.Deta capture with	pla	anning, f	actory data collection system, computer process monitoring, IT support	rt-Software		
Image: Normal interaction of the probability of the p	too	ols-MES	-SAP- Fundamental of Networking- computer aided quality control.			
Module: 7 Smart Maintenance: Image: Composition of the probability						
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Intelligence in manufacturing -Decision support system-Prognosis and control-Data analytics.Module:8Contemporary issues:2 hoursIndustrial Expert Guest Lecture and Seminars45 hoursIndustrial Expert Guest Lecture nours: # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min. of 2 lectures by industry experts. modular automation systems and additive manufacturing.45 hoursText Book(s*********************************	Virt	tual real	ity and Augmented reality applications in manufacturing- Smart maint	enance-Artificial		
Image: Note: Interpretent of the second s	inte	lligence	in manufacturing -Decision support system-Prognosis and control-Da	ta analytics.		
Module:8Contemporary issues:Contemporary issues:Contemporar			Contraction	2.1		
Industrial Expert Guest Lecture and Seminars 45 hours Total Lecture hours: # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min. of 2 lectures by industry experts. modular automation systems and additive manufacturing. 45 hours Text Book(s)	Mo	dule:8	Contemporary issues:	2 hours		
Total Lecture hours: # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min. of 2 lectures by industry experts. modular automation systems and additive manufacturing.45 hoursText Book(s)Text For BooksText For Colspan="2">Text For Colspan="2">Text For Colspan="2">Text For Colspan="2">Text For Colspan="2">Text For Chain Chains (A. Wysk, Hsu-Pin (Ben) Wang, Computer Aide Wanufacturing (2016), Pearson Education.Text For Experiments (Indicative)1.5 hoursDevelopment of an automated production system with simulation package. <t< td=""><td>Indu</td><td>ustrial E</td><td>xpert Guest Lecture and Seminars</td><td></td></t<>	Indu	ustrial E	xpert Guest Lecture and Seminars			
# Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min. of 2 lectures by industry experts. modular automation systems and additive manufacturing.Text Book(s)Text Colspan="2">Text Colsp			Total Lecture hours:	45 hours		
Image: Physical and computer models to lecture, Visit to Industry, Min. of 2 lectures by industry experts. modular automation systems and additive manufacturing.Text Book(s)1.Andrew Kusiak, Smart Manufacturing, Publisher, Taylor & Francis, 2018Reference Books1.William MacDougall, Industrie 4.0: Smart Manufacturing for the Future, Germany Trade & Invest, 2014.2.Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.3.Frank Lamb, Industrial Automation: Hands On, McGraw Hill Professional, 2013. Tien-Chein Chang, Richard A. Wysk, Hsu-Pin (Ben) Wang, Computer Aided Manufacturing (2016), Pearson Education.Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / SeminarList of Experiments (Indicative)1.Design of 3D model and automated process plan generation.2.Development of an automated production system with simulation package.3.Development of a 3D model and production with additive manufacturing (3D printing).4.Simulate and analyse production system using material flow simulation.5.PLC Data capture with and Open Platform Communication and analysis.6.Data capture with Bar code/QR code systems.7.Data capture with RFID systems.8.CAD model development and visualization in VR environment.9.Working with AR for engineering components assembly.9.Working with AR for engineering components assembly.			# Mode: Flipped Class Room, [Lecture to be videotaped], Use of			
Image: Provide the set of th			physical and computer models to lecture, Visit to Industry, Min.			
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Text Book(s) 1. Andrew Kusiak, Smart Manufacturing, Publisher, Taylor & Francis, 2018 Reference Books 1. William MacDougall, Industrie 4.0: Smart Manufacturing for the Future, Germany Trade & Invest, 2014. 2. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016. 3. Frank Lamb, Industrial Automation: Hands On, McGraw Hill Professional, 2013. Tien-Chein Chang, Richard A. Wysk, Hsu-Pin (Ben) Wang, Computer Aided Manufacturing (2016), Pearson Education. Model of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar Manufacturing (2016), Pearson Education. Its Design of 3D model and automated process plan generation. 1.5 hours 2. Development of an automated production system with simulation package. 1.5 hours 3. Development of a 3D model and production with additive manufacturing (3D printing). 1.5 hours 4. Simulate and analyse production system using material flow simulation. 1.5 hours 5. PLC Data capture with Bar code/QR code systems. 1.5 hours 7. Data capture with RFID systems. 1.5 hours 8. CAD model development and visualization in VR environment. 1.5 hours 9. Working with AR for engineering components assembly. 1.5 hours <td>_</td> <td></td> <td>modular automation systems and additive manufacturing.</td> <td></td>	_		modular automation systems and additive manufacturing.			
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 Invest, 2014. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016. Frank Lamb, Industrial Automation: Hands On, McGraw Hill Professional, 2013. Tien-Chein Chang, Richard A. Wysk, Hsu-Pin (Ben) Wang, Computer Aided Manufacturing (2016), Pearson Education. Mototic Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar List of Experiments (Indicative) Development of an automated process plan generation. Development of a 3D model and production system with simulation package. Development of a 3D model and production with additive manufacturing (3D printing). Simulate and analyse production system using material flow simulation. I.5 hours PLC Data capture with and Open Platform Communication and analysis. Data capture with RFID systems. CAD model development and visualization in VR environment. Working with AR for engineering components assembly. 	1.	Willian	n MacDougall, Industrie 4.0: Smart Manufacturing for the Future, Ger	many Trade &		
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Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / SeminarList of Experiments (Indicative)1.Design of 3D model and automated process plan generation.1.5 hours2.Development of an automated production system with simulation package.1.5 hours3.Development of a 3D model and production with additive manufacturing (3D printing).1.5 hours4.Simulate and analyse production system using material flow simulation.1.5 hours5.PLC Data capture with and Open Platform Communication and analysis.1.5 hours6.Data capture with Bar code/ QR code systems.1.5 hours7.Data capture with RFID systems.1.5 hours8.CAD model development and visualization in VR environment.1.5 hours9.Working with AR for engineering components assembly.1.5 hours		(2016)	Dearson Education			
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List of Experiments (Indicative)1.Design of 3D model and automated process plan generation.1.5 hours2.Development of an automated production system with simulation package.1.5 hours3.Development of a 3D model and production with additive manufacturing (3D printing).1.5 hours4.Simulate and analyse production system using material flow simulation.1.5 hours5.PLC Data capture with and Open Platform Communication and analysis.1.5 hours6.Data capture with Bar code/ QR code systems.1.5 hours7.Data capture with RFID systems.1.5 hours8.CAD model development and visualization in VR environment.1.5 hours9.Working with AR for engineering components assembly.1.5 hours	1010					
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 Development of an automated production system with simulation package. Development of a 3D model and production with additive manufacturing (3D printing). Simulate and analyse production system using material flow simulation. PLC Data capture with and Open Platform Communication and analysis. Data capture with Bar code/ QR code systems. Data capture with RFID systems. CAD model development and visualization in VR environment. Working with AR for engineering components assembly. 	1.	Desig	n of 3D model and automated process plan generation.	1.5 hours		
 Development of a 3D model and production with additive manufacturing (3D printing). Simulate and analyse production system using material flow simulation. PLC Data capture with and Open Platform Communication and analysis. Data capture with Bar code/ QR code systems. Data capture with RFID systems. CAD model development and visualization in VR environment. Working with AR for engineering components assembly. 	2.	Devel	opment of an automated production system with simulation package.	1.5 hours		
(3D printing).4.Simulate and analyse production system using material flow simulation.1.5 hours5.PLC Data capture with and Open Platform Communication and analysis.1.5 hours6.Data capture with Bar code/ QR code systems.1.5 hours7.Data capture with RFID systems.1.5 hours8.CAD model development and visualization in VR environment.1.5 hours9.Working with AR for engineering components assembly.1.5 hours	3.	Devel	opment of a 3D model and production with additive manufacturing	1.5 hours		
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 Data capture with RFID systems. CAD model development and visualization in VR environment. Working with AR for engineering components assembly. 1.5 hours 	6.	Data o	apture with Bar code/ QR code systems.	1.5 hours		
8.CAD model development and visualization in VR environment.1.5 hours9.Working with AR for engineering components assembly.1.5 hours	7.	Data o	apture with RFID systems.	1.5 hours		
9.Working with AR for engineering components assembly.1.5 hours	8.	CAD	model development and visualization in VR environment.	1.5 hours		
	9.	Worki	ng with AR for engineering components assembly.	1.5 hours		



10.	10. Basic IIoT system			elopment	1.5 hours		
	15 hours						
Digital Assignments /Seminars/Surprise Tests / CATs /FAT							
Reco	Recommended by Board of Studies 07-03-2019						
App	roved by Academic Council	No. 55	Date	13-06-2019			



Course code	Artificial Intelligence and Machine learning	L T P J C			
MEE5032		3 0 0 4 4			
Pre-requisite		Syllabus version			
		1.0			
Course Objectives	s(CoB):				
The main objective	es of the course are to:				
1. Provide a stron	ng foundation of fundamental concepts in Artificial Intelliger	ice			
2. Elobarate diffe	erent AI and machine learning techniques for design of AI sy	stems.			
Expected Course	Outcome(CO):				
On completion of t	he course students will be able to				
 Understand the basics of probability and statistical learning for artificial intelligence Apply AI and ML techniques which involve perception, reasoning and learning. Comprehend heuristic approach such as fuzzy logic and Shallow Artificial Neural Network Acquire the knowledge of Adaptive Neuro-Fuzzy Systems Analyze a real world problems and solve it using computer vision, Machine learning and Deep learning techniques 					
	hachine feating techniques to design AT based systems.				
Module:1 Found	dations of data science- Statistical learning:	5 hours			
Distributions - Typ Testing	es of distribution – Binomial, Poisson & Normal distribution	n, Hypothesis			
Module:2 Fuzzy	/ Set Theory and Fuzzy Logic Control	5 hours			
Basic concepts of control – Fuzzific Membership functi	fuzzy sets – Operations on fuzzy sets –Fuzzy relation equation – Defuzzification – Knowledge base – Decision ons – Rule base.	tions – Fuzzy logic n making logic –			
Module:3 Artifi	cial Neural Networks:	6 hours			
Introduction – history of neural networks – multilayer perceptrons –Back propagation algorithm and its variants – Different types of learning, examples					
Module:4 Adan	tive Neuro Fuzzy Systems.	6 hours			
Performance index	x - Modification of rule base - Modification of member	r ship functions –			
simultaneous modification of rule base and membership functions – Genetic algorithms – Adaptive fuzzy system- Neuro fuzzy systems					
Module:5 Com	outer vision and Deep learning:	7 hours			
Introduction to Convolutional Neural Networks, Forward propagation & Back propagation for CNNs, Convolution, Pooling, Padding & its mechanisms, CNN architecture -AlexNet, VGGNet, Inception Net&ResNet, Transfer Learning, Semantic segmentation, YOLO, Siamese Networks-					



coding tool programming

Module:6 Machine learning algorithms-1:

Multiple Variable Linear regression, Multiple regression, Logistic regression, K-NN classification, Naive Bayes classifiers, and Support vector machines.

Module:7Machine learning algorithms-2:8 hoursK-means clustering, Hierarchical clustering, High-dimensional clustering, Dimension Reduction-
PCA, Ensemble techniques Decision Trees, Random Forests, Bagging, Boosting-Value based
methods Q-learning.8 hours

Module:8 Contemporary issues:

2 hours

6 hours

Industrial Expert Guest Lecture and Seminars

Total Lecture hours:	45 hours

Text Book(s)

- 1. Chandra S.S.V Artificial Intelligence and Machine Learning, Prentice Hall India Learning Private Limited; 4 edition (2018)
- 2. Janet Finlay and Alan Dix, An Introduction To Artificial Intelligence, CRC Press; 1 edition ,2017

Reference Books

- 1. Yager, Ronald R., and Lotfi A. Zadeh, eds. An introduction to fuzzy logic applications in intelligent systems. Vol. 165. Springer Science & Business Media, 2012.
- Abe, Shigeo. Neural networks and fuzzy systems: theory and applications. Springer Science & Business Media, 2012.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Mode of evaluation:

Recommended by Board of Studies	07-03-2019		
Approved by Academic Council	No. 55	Date	13-06-2019



Programme Electives



Course code	IIOT AND CLOUD COMPUTING	L	T P J C
MEE6061		2	0 2 0 3
Pre-requisite		Sylla	bus version
			v. 1.0
Course Objective	s(CoB):		
The main objective	es of course are to:		
1 Design &	evelon IIOT Devices		
2 Understand	the cloud concepts canabilities across the various cloud set	rvice mo	dels
Expected Course	Outcome(CO):		
At the endof the co	burse.astudent will be able to:		
1. Understand	the drivers and enablers of Industry 4.0		
2. Appreciate	the Smart Factories, Smart cities, smart products and smart	services	
3. Understand	the opportunities, challenges brought about by Industry 4.0)	
4. Articulate t	he concepts, key technologies, strengths and limitations of c	cloud con	nputing.
5. Learn the k	ey and enabling technologies that help in the development of	of cloud.	1 0
6. Understand	the architecture of computing and storage cloud, service an	ıd deliver	y models.
Module:1 Intro	duction to the Industrial Internet		3 hours
Industrial Internet	Use Cases-The Technical and Business Innovators of the In	dustrial I	nternet-IIoT
Reference Archite	cture		
Module:2 Desig	ning Industrial Internet Systems		4 hours
Examining the Ac	cess Network Technology and protocols-Examining the M	liddlewar	e Transport
protocols -middlev	vare Software Patterns		
Module:3 Softw	are design concepts		4 hours
Middleware Indus	trial Internet of things platforms-IIoT WAN Technolog	ies and	Protocols -
Securing the Indus	trial Internet-Introducing Industry 4.0-Smart Factories		
	1		41
Module:4 Cloud	I computing		4 hours
General Benefits	and Architecture, Business Drivers, Main players in the	Field, C	Overview of
Security Issues, Xa	as Cloud Based Service Offerings.		
Madula: Claur	Anchitastura Samisas And Starage		E hours
Invored Cloud Ar	Architecture, Services And Storage	rebitectu	<u> </u>
Drivate and Hybri	d Clouds loos Doos Soos Architectural Design	Challong	ie – Public,
Storage Storage	u Ciulus – Idas – Faas – Saas – Alciniectulai Design	Chanteng o Drovid	cs = Cloud
Storage - Storage-	as-a-Service – Auvaniages of Ciouu Storage – Ciouu Storag	, e FIUVIU	eis – 33.
Module:6 Decou	urce Management And Security In Cloud		1 hours
Inter Cloud Decour	n ce management Anu Security III Cloud	wisioning	4 IIUUIS
Global Evenando	of Cloud Resources - Security Overview - Cloud Sec	Curity C	hallongos
Software-ac-a-Sor	vice Security – Security Covernance – Virtual Machine	Security	$T = I\Delta M$
Jon ware-as-a-Jerv	see becanty – becanty Governance – vintual Machine	Security	y <u>1711</u> 11 —



Security Standards.

Mo	dule:7	Cloud technologies and advancements	4 hours
Ha Go Feo	doop – 1 ogle Ap lerated S	MapReduce – Virtual Box — Google App Engine – Programming E p Engine — Open Stack – Federation in the Cloud – Four Levels o ervices and Applications – Future of Federation.	nvironment for of Federation –
Mo	odule:8	Contemporary Issues	2 hours
In	dustrial	Expert Guest Lecture and Seminars	
To # N cor exp	tal Lect u Aode: Fl nputer n perts	are hours: ipped Class Room, [Lecture to be videotaped], Use of physical and nodels to lecture, Visit to Industry, Min of 2 lectures by industry	30 hours
Te	xt Book	(s)	
1.	Gilchri	st, Alasdair: Industry 4.0: The Industrial Internet of Things. Apress, No	ew York, 2016.
2.	Kai Hy Paralle	wang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Co l Processing to the Internet of Things", Morgan Kaufmann Publishers, 20	omputing, From 012.
3.	Ritting Manag	house, John W., and James F. Ransome, —Cloud Computing: I ement and Security, CRC Press, 2017.	mplementation,
Re	ference	Books	
1.	Rajkun Mcgrav	narBuyya, Christian Vecchiola, S. ThamaraiSelvi, —Mastering Cloud C w Hill, 2013	computing, Tata
2.	Toby V Tata M	/elte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Prac cgraw Hill, 2009.	tical Approach,
3.	George the Clo	e Reese, "Cloud Application Architectures: Building Applications and I oud: Transactional Systems for EC2 and Beyond (Theory in Practice), O'	nfrastructure in Reilly, 2009.
Mo	de of Ev	valuation: CAT / Assignment / Quiz / FAT / Project / Seminar	
Lis	t of Eyn	eriments (Indicative)	
1010	1. Sett	ing up of Raspberry Pi and connect to a network	1.5 Hr
	2. Fam	iliarization with GPIO pins and control hardware through GPIO pins.	1.5 Hr
	3. Spe	ed Control of motors using PWM with coding programming.	1.5 Hr
	4. Use	sensors to measure temperature, humidity, light and distance.	1.5 Hr
	5. Web	based hardware control	1.5 Hr
	6. Con	nect IOT devices through cloud using IoT protocol such as MQTT.	1.5 Hr
	7. Con	trolling IoT devices using Arduino.	1.5 Hr
	8. Crea	ate Wireless network of sensors using Zigbee.	1.5 Hr
	9. Dev	elopment of ERP level of Automation	1.5 Hr
	10. Dev	elopment of MES system	1.5 Hr
		Total Hours	15 Hr
Ree	commen	ded by Board of Studies 06-09-2019	



Course code	Virtual Reality and Augmented Reality	L	T P J	С		
MEE6062		2 0 2 0 3				
Pre-requisite		Syllab	ous versio	n		
		1.0.0				
Course Objecti	ves(CoB):					
The main object	tives of course are to:					
1. Provide an overview of VR/AR systems architectures and requirements for the development of VR/AR applications.						
2. Acquire kno	wledge on hardware and software aspects of virtual reality and	nd augn	nented rea	ality		
for modeling	g, analysis and design of engineering systems.	1.				
3. Impart exerc	cises aiming to design and develop simple prototype AR/VR	applicat	tions usin	g		
state-of-the-	art tools.					
Expected Cour	se Outcome(CO):					
At the endofthe 1. Understa concepts	course, astudent will be able to: and the overview of AR/VR systems and realize the differenc 5.	es in A	R/VR			
2. Comprel 3. Cognize	hend the functions and select the appropriate hardware for VI Geometric modeling and dynamics of 3D models for VR sin	R/AR ap nulation	pplication 1	IS.		
4. Develop	and prototype effective AR/VR applications	1	C ,			
5. Interpret	and match VR/AR technology to human needs and use with	human	factors.			
6. Demons	trate the trends and trajectories in current and future AR/VR	system	S			
Module: 1 II	ntroduction to Virtual Reality and Augmented Reality	3 hou	rs			
Virtual reality,	Augmented reality and Mixed Reality concepts – Virtual	world	space an	d real		
world – Interfac VR/AR systems	te to virtual world (inputs and outputs) – Types of interactio – Benefits and Applications of VR and AR.	ns – Re	equireme	nts for		
Module: 2 V	R/AR Hardware Technologies	5 hour	rs			
Input devices - filtering & tracking, Output devices-Visual Displays, Auditory Displays, Haptic Displays and Augmenting displays. Augmented Reality (AR) hardware, spatial audio, computing architectures for VR - Haptic assembly architecture - Haptic Interface.						
Module: 3 G	eometric modeling and dynamics	5 hou	rs			
Geometric mod	leling transforming rigid hodies vaw nitch roll axis	-angle	renresen	tation		
quaternions. 31) rotation inverses and conversions, homogeneous trans	sforms.	transfor	ms to		
displays look-at and eve transforms canonical view and viewnort transforms. Motion in Virtual						
world - simulati	on, collision detection, avatar motion and vection.			in caur		
	,					
Module: 4 V	isual perception and rendering	5 hour	rs			
Implications of	nercention on VR -Depth perception motion perception and	color pr	ercention			
Graphical rendering, ray tracing, shading, BRDFs, rasterization, barvcentric coordinates, VR						



rendering problems, anti-aliasing, distortion shading, image warping				
(time warp),	panoramic rendering.			
Module: 5	Tracking and Interaction	4 hours		
Tracking sys	tems – sensors for tracking position, orientation and motion, est	timating rotation, IMU		
integration,	drift errors, tilt and yaw correction. Devices for navigation a	nd interaction -sensor		
fusion, eye	tracking and map building.Remapping, locomotion, man	ipulation, specialized		
interaction m	echanisms.Sound propagation and auditory perception.			
Module: 6	Evaluating VR/AR Systems and Experiences	3 hours		
Human Facto	ors in Virtual Reality, Perceptual training, best practices, VR sic	kness, experimental		
methods invo	olving human subjects.			
Module: 7	Case Studies in VR/AR:	3 hours		
Traditional a	nd emerging VR/AR applications in Engineering, Architecture,	, Education, Medicine,		
Entertainmer	nt, Science, and Training Implementation. Touch, haptics a	nd robotic interfaces,		
telepresence	and Brain-machine interfaces.			
Module: 8	Contemporary Discussions	2 hours		
Industrial Ex	pert Guest Lecture and Seminars			
Total Lectur	re hours:	30 hours		
# Mode: Flip	ped Class Room, [Lecture to be videotaped], Use of physical			
and compute	r models to lecture, Visit to Industry, Minimum of 2 lectures			
by industry e	xperts			
Text Book(s				
1. GrigoreBu	urdea, Philippe Coiffet, Virtual Reality Technology (2006), 2 nd e	dition. Wiley India.		
2. Steve Auk	stakalnis, Practical Augmented Reality: A Guide to the Technol	ogies, Applications,		
and Human I	Factors for AR and VR (Usability)(2017), ISBN-13: 978-013409	94236.		
Reference B	ooks			
1. John vind	ce, Virtual Reality Systems (2007), Pearson Education.			
2. MatjazM	ihelj, Jonezpodobnik, Haptics for virtual reality and tele operation	on (2012), Springer.		
3. Sean Mo	rey and John Tinnell, Augmented Reality: Innovative Perspectiv	res across Art,		
Industry,	and Academia (2016), ISBN-13: 978-1602355569.			
Mode of Eva	aluation: CAT / Assignment / Quiz / Seminar / FAT			
List of Expe	riments (challenging Experiments)			
1. Introdu	ction to virtual reality hardware and software.	2 hours		
2. Conver	sion of CAD models into VR models.	2 hours		
3. Creatio	n of assemblies of products and digital mockup IN VR environn	nent. 3 hours		
4. Creatio	n of AR environment for product / systems	3 hours		
5. Compu	ter graphics of 3D scene by OpenGL / VRML /UNITY3D	3 hours		
6. VR/AR	for ergonomic and aesthetic studies	2 hours		
Total Labora	tory Hours	15 hours		
Mode of eva	luation: Lab Experiments / FAT			
Recommend	ed by Board of Studies 06-09-2019			



	Chemist to be University under section 3 of UGC Act, 1956)						
Approved by Acad	lemic Council No. 56 Date	24	-09	-20	19		
Course code	MEMS in Cyber Physical Systems		L	Т	P J	C	
MEE6063			2	0	0 4	3	
Pre-requisite		Sv	llal	2116	Ver	sion	
11t-requisite		<u> </u>	mai	Jus	V	1 0	
Course Objective	s(CoB):				•	. 1.0	
The main objective	es of course are to:						
J							
1. Unders	tanding the concept of MEMS						
2. Unders	tand the diverse technological/functional approaches and app	plica	atio	ns			
3. Provide	es an insight of micro sensors, actuators and micro fluidics.						
Expected Course	Outcome(CO):						
On completion of	the course the students will be able to						
1 Understand	about the basics of MEMS						
2 Become fa	miliar with micro fabrication techniques						
3 Provide M	FMS based solution for industrial applications						
5. 110 viac ivi	most suitable manufacturing process and strategies for micro	fab	rica		•		
4 Soloct the r	4. Select the most suitable manufacturing process and strategies for micro fabrication						
4. Select the 1	Alices Suitable manufacturing process and strategies for micro			1110	1		
 Select the r Design a M 	ficro System withPackaging at device and system level.			1110	.1		
 4. Select the n 5. Design a M Module:1 Over Definition – hist microelectronics, disciplinary nature 	view - MEMS torical development – properties, design and fabricati working principle, applications and advantages of micro s e of MEMS- Survey of materials central to micro engineerin	on yste ig- A	mi em. App	cro. Th	3 h -syst e m ition	ours tem, ulti- is of	
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Modu	ule:6	MEMS components				4 hours
Micro sensors - Basic principles and working of micro sensors - Bio-medical micro sensors- Bio-						
sensors- Chemical micro sensors – Optical Sensors – Pressure micro sensorsacceleration micro						
sensors; Micro actuators - Basic principles and working of micro actuators- Electrostatic micro						
actuat	tors- P	iezoelectric micro actuator	s- SMA micro act	uators- El	ectromagne	tic micro actuators,
micro	o valve	s, micro pumps.				
Modu	ule:7	CPS applications of ME	MS			4 hours
CPS	Applic	cations –Biomedical, Lab	-on-a-chip, Distr	ibuted int	elligent me	ems, RF-MEMS-
base	ed circu	iits, PZT-based piezoelectr	ic MEMS, MEMS	5 energy ha	arvester	
Modu	ule:8	Contemporary Issues				2 hours
Indu	istrial I	Expert Guest Lecture and S	eminars			
		-				
Total	l Lectu	re hours:				45 hours
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and c	comput	er models to lecture, Vis	it to Industry , N	Min of 2 l	ectures by	
indus	try exp	perts			U	
Text	Book(s)				
1. T	Гаі-Ran	Hsu, MEMS and Microsyste	ms design and man	ufacture, T	ata McGraw	Hill 2011
2. N	Moham	ed Gad – el – Hak , " MEMS	Handbook" Edited	CRC Press	2002.	
3. V	Vijay '	Varadan, Xiaoning Jiang	and VasundaraVa	radan, Mi	crostereolith	ography and other
F	Fabricat	ion techniques for 3D MEMS	5, Wiley 2001.			0 1 9
Reference Books						
1. T	Frimme	r William S "Micromachanic	s and MEMS", IEE	E Press Ne	w York 1997	7
2. F	Francis	E.H Tay and W. O. Choor	ng "Micro fluidics	and bio M	1EMS appli	cation" IEEE Press
New York 1997						
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar						
Mode	e of eva	aluation:				
Reco	mmen	led by Board of Studies	06-09-2019			
Annre	oved h	v Academic Council	No 56	Date	24-09-201	9
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MEE6064 2 0 2 0 2 0 3 Pre-requisite Syllabus version v. 1.0 Course Objectives (CoB): v. 1.0 The main objectives of course are to: v. 1.0 Develop application with the acquired knowledge to solve industrial and service robot issues. Expected Course Outcome(CO): At the endofthe course, astudent will be able to: 1. Ability to categorize the various types of industrial robots with its applications. 2. Analyze the kinematics and dynamics for various types of manipulator configurations. Solve the trajectory planning problem for robotic application. 4. Realize the role of mobile robot in industries and service sectors. 5. Develop knowledge on SLAM, path planning and navigation. 6. Realize the importance of bio-inspired robotic system Module:1 Introduction to Industrial robotic system 3 hours Components of Industrial robotic system, workspace, work-cell, types of industrial robots, end-effector, applications. 4 hours Representation of frame and transformations, Forward and inverse kinematics, DH matrix, Dynamics of two link planer. 4 hours Module:3 Trajectory planning 4 hours Basics of Path and trajectory, joint space trajectory, Third order polynomial, Fifth order polynomial, Cartesian space	Course code	Applied Robotics and programming	L T P J C
Pre-requisite Syllabus version Course Objectives (CoB): v. 1.0 Course of course are to: . 1. Acquire knowledge about the various types of robotic system and its mathematical formulation. 2. Develop application with the acquired knowledge to solve industrial and service robot issues. Expected Course Outcome(CO):	MEE6064		2 0 2 0 3
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Module:3Trajectory planning4 hoursBasics of Path and trajectory, joint space trajectory, Third order polynomial, Fifth order polynomial, Cartesian space trajectory.Fifth order polynomial, Fifth orderModule:4Mobile robots4 hoursIntroduction to autonomous robotic system, wheeled mobile robots and its types, kinematics of differential and car link mobile robot, legged mobile robot, Industries and service applications.Module:5Module:5SLAM5 hoursMap based localization, Simultaneous Localization and mapping, Challenges, Local GPS localization, vision based localization, Map representation and building4 hoursModule:6Path planning and Navigation4 hoursPath planning and reacting, Path Planning: Road map, cell decomposition, potential field, Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram.4	Dynamics of two	link planer.	
Basics of Path and trajectory, joint space trajectory, Third order polynomial, Fifth order polynomial, Cartesian space trajectory. Module:4 Mobile robots 4 hours Introduction to autonomous robotic system, wheeled mobile robots and its types, kinematics of differential and car link mobile robot, legged mobile robot, Industries and service applications. 5 hours Module:5 SLAM 5 hours Map based localization, Simultaneous Localization and mapping, Challenges, Local GPS localization, vision based localization, Map representation and building 4 hours Module:6 Path planning and Navigation 4 hours Path planning and reacting, Path Planning: Road map, cell decomposition, potential field, Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram. 9	Module:3 Trai	ectory planning	4 hours
Module:4 Mobile robots 4 hours Introduction to autonomous robotic system, wheeled mobile robots and its types, kinematics of differential and car link mobile robot, legged mobile robot, Industries and service applications. 4 hours Module:5 SLAM 5 hours Map based localization, Simultaneous Localization and mapping, Challenges, Local GPS localization, vision based localization, Map representation and building 4 hours Module:6 Path planning and Navigation 4 hours Path planning and reacting, Path Planning: Road map, cell decomposition, potential field, Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram. 4	Basics of Path a	and trajectory, joint space trajectory. Third order polyno	omial. Fifth order
Module:4Mobile robots4 hoursIntroductionto autonomous robotic system, wheeled mobile robots and its types, kinematics of differential and car link mobile robot, legged mobile robot, Industries and service applications.Module:5SLAM5 hoursMap basedlocalization, Simultaneous Localization and mapping, Challenges, Local GPS localization, vision based localization, Map representation and buildingModule:6Path planning and Navigation4 hoursPath planning and reacting, Path Planning: Road map, cell decomposition, potential field, Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram.	polynomial, Carte	sian space trajectory.	
Introduction to autonomous robotic system, wheeled mobile robots and its types, kinematics of differential and car link mobile robot, legged mobile robot, Industries and service applications. Module:5 SLAM Map based localization, Simultaneous Localization and mapping, Challenges, Local GPS localization, vision based localization, Map representation and building Module:6 Path planning and Navigation 4 hours Path planning and reacting, Path Planning: Road map, cell decomposition, potential field, Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram.	Module:4 Mob	ile robots	4 hours
differential and car link mobile robot, legged mobile robot, Industries and service applications. Module:5 SLAM Map based localization, Simultaneous Localization and mapping, Challenges, Local GPS localization, vision based localization, Map representation and building Module:6 Path planning and Navigation Path planning and reacting, Path Planning: Road map, cell decomposition, potential field, Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram.	Introduction to au	tonomous robotic system, wheeled mobile robots and its ty	pes, kinematics of
Module:5SLAM5 hoursMap based localization, Simultaneous Localization and mapping, Challenges, Local GPS localization, vision based localization, Map representation and building6Module:6Path planning and Navigation4 hoursPath planning and reacting, Path Planning: Road map, cell decomposition, potential field, Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram.	differential and ca	r link mobile robot, legged mobile robot, Industries and serv	vice applications.
Map based localization, Simultaneous Localization and mapping, Challenges, Local GPS localization, vision based localization, Map representation and building Module:6 Path planning and Navigation 4 hours Path planning and reacting, Path Planning: Road map, cell decomposition, potential field, Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram.	Module:5 SLA	Μ	5 hours
Module:6Path planning and Navigation4 hoursPath planning and reacting, Path Planning: Road map, cell decomposition, potential field, Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram.	Map based local localization, vision	ization, Simultaneous Localization and mapping, Challen based localization, Map representation and building	enges, Local GPS
Module:6Path planning and Navigation4 hoursPath planning and reacting, Path Planning: Road map, cell decomposition, potential field, Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram.4 hours			
Path planning and reacting, Path Planning: Road map, cell decomposition, potential field, Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram.	Module:6 Path	planning and Navigation	4 hours
Obstacle avoidance: Bug algorithm, A* algorithm, Vector field histogram.	Path planning an	d reacting, Path Planning: Road map, cell decomposition	n, potential field,
	Obstacle avoidance	e: Bug algorithm, A* algorithm, Vector field histogram.	. ,



Mo	dule:7	Special Purpose robots				4 hours
Mu	lti robot	ic system, collaborative ro	bots, Redundant	manipulato	ors, soft robot	s, Nano robots,
me	dical rob	ots, origami robots.				
Mo	dule:8	Contemporary Issues				2 hours
In	dustrial	Expert Guest Lecture and S	Seminars			
Tot	tal Lectu	ire hours:				30 hours
# N	/lode: Fl	ipped Class Room, [Lectu	re to be videotap	oed], Use o	of physical	
and	l compu	ter models to lecture, Vis	sit to Industry,	Min of 2	lectures by	
ind	ustry ex	perts				
Te	xt Book	<u>s)</u>				
1.	Craig, Hall.	John J., Introduction to Ro	obotics: Mechani	cs and Co	ntrol (2005),	Pearson/Prentice
2.	Roland Mobile	Siegwart, Illah Reza Noui Robots, (2011), MIT press	rbakhsh, DavideS s.	caramuzza	, Introductior	n to Autonomous
Re	ference	Books				
1.	Niku, S	Saeed B (2005), Introducti	on to Robotics: I	Mechanics	and Control,	Second Edition,
	Pearso	n Education, New Delhi.				
2.	Farbod	Fahimi, Autonomous Robo	ots Modelling, Pat	th Planning	g and Control	(2008), Springer
	Science	e and Business Media.	_		-	
Lis	t of Exp	eriments (challenging Ex	periments)			
	1. For	ward and inverse kinematic	s of two link plan	ar		
						2 hours
	2. Traj	ectory planning using poly	nomial equation			
						2 hours
	3. Fan	uc robot Program 1 (Basic)				
						3 hours
	4. Fan	uc robot Program 2 (Specia	al functions)			
						3 hours
	5. Wo	k-cell development using I	Robo-guide softw	are		
			_			3 hours
	6. Prog	gramming differential whee	el mobile robot			
						2 hours
Tot	tal Labo	ratory Hours				15 hours
Mo	de of Ev	aluation: CAT / Assignme	nt / Quiz / FAT /	Project / S	eminar	
Mo	de of ev	aluation:				
Rec	commen	ded by Board of Studies	06-09-2019			
Ap	proved b	y Academic Council	No. 56	Date	24-09-2019	



Course code	Hybrid and Electric Automative Vehicle Systems					
MEE6065	Hybrid and Electric Automotive Venicle Systems					
Pre-requisite		Syllabus version				
		v. 1.0				
Course Objective	s(CoB):					
The main objective	es of course are to:					
1. Introduce t vehicles.	he fundamental concepts, principles, analysis and design of	f hybrid and electric				
2. Understand	the mechatronic system and component design of hybrid a	and electric vehicles				
based on t vehicle dyr	he requirements to power flow management, power conv namics and energy/fuel efficiency.	version and thus to				
Expected Course	Outcome(CO):					
The students will b	be able to					
1. Choose a s	uitable drive scheme for developing an electric hybrid ve	hicle depending on				
2 Design and	develop basic schemes of electric vehicles and hybrid elec	tric vohiclos				
2. Design and	por operate storage systems for vehicle applications	uic venicies.				
J. Identify ya	rious communication protocols and technologies used in ve	hicle networks				
5 Interpret w	orking of different configurations of electric vehicles and it					
6 Analyze h	vbrid vehicle configuration performance analysis and E	nergy Management				
strategies	fond venicle configuration, performance analysis and E	nergy manugement				
Strategies						
Module:1 Intro	duction	5 hours				
Conventional Veh transmission chara of hybrid and ele vehicles, impact of	icles - Basics of vehicle performance, vehicle power sour icteristics, and mathematical models to describe vehicle pe ctric vehicles, social and environmental importance of modern drive-trains on energy supplies (include IC engine	re characterization, erformance. History hybrid and electric eCPS related.)				
Module:2 Hybr	id and Electric Drive-trains	6 hours				
Basic concept of h	ybrid and electric vehicle traction, introduction to various	hybrid and electric				
drive-train topologies, power flow control in hybrid and electric drive-train topologies, hybrid						
venicie -iuei eifici						
Module:3 Elect	ric Propulsion unit	5 hours				



Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.						
Mo	dule:4	Energy Storage				7 hours
Intr	oduction	to Energy Storage Requi	rements in Hvbr	id and El	ectric Veh	icles. Battery based
ene	rgy stora	age and its analysis, Fuel C	ell based energy	storage an	d its analy	sis, Super Capacitor
base	ed ener	gy storage and its analy	sis, Flywheel b	ased ener	gy storag	e and its analysis,
Hyt	oridizati	on of different energy stora	ge devices.			
Mo	dule:5	Sizing the drive system				5 hours
Mat	tching th	e electric machine and the	internal combus	tion engin	e (ICE), S	izing the propulsion
mot	or, sizir	ig the power electronics, so	electing the energe	gy storage	technolog	y, Communications,
sup	porung	subsystems				
Мо	dulo:6	Enorgy Management Str	atorios			0 hours
Intr	oduction	to energy management sti	ategies used in h	vbrid and	electric ve	bicles classification
of	differen	t energy management st	rategies compar	ison of <i>c</i>	lifforont c	morgy management
stra	togios i	molementation issues of end	ardy manadement	stratogios		inengy management
Situ	icgics, i	inprementation issues of en	ergy munugement	. suucsies		
Mo	dule:7	Case studies				7 hours
De	sign of	an Electric and Hybrid Ele	ctric Vehicle (H	EV) –Para	llel and Se	eries configuration.
_	0	5	(,		0 ,
De	sign of	a Battery Electric Vehicle (BEV).			
De	esign of	a Battery Electric Vehicle (BEV).			
De Mo	esign of dule:8	a Battery Electric Vehicle (Contemporary Issues	BEV).			2 hours
De Mo Inc	esign of dule:8	a Battery Electric Vehicle (Contemporary Issues Expert Guest Lecture and S	BEV).			2 hours
De Mo Inc	esign of dule:8 dustrial 1	a Battery Electric Vehicle (Contemporary Issues Expert Guest Lecture and S	BEV). eminars			2 hours
De Mo Inc Tot	esign of a dule:8 dustrial dustriad dustriad dustriad dustriad dustriad dustriad dustriad dus	a Battery Electric Vehicle (Contemporary Issues Expert Guest Lecture and S Ire hours:	BEV). eminars			2 hours 45 hours
De Mo Inc Tot # M	dule:8 dustrial 1 al Lectu Iode: F1	a Battery Electric Vehicle (Contemporary Issues Expert Guest Lecture and S Ire hours: ipped Class Room, [Lecture	BEV). eminars e to be videotape	d], Use of	physical	2 hours 45 hours
Mo Inc Tot # M and	dule:8 dustrial al Lectu Iode: Fl comput	a Battery Electric Vehicle (Contemporary Issues Expert Guest Lecture and S ure hours: ipped Class Room, [Lectur er models to lecture, Visit	BEV). eminars e to be videotape t to Industry , M	d], Use of lin of 2 le	^c physical ctures by	2 hours 45 hours
De Mo Inc Tot # M and indu	dule:8 dustrial al Lectu lode: Fl: comput ustry exj	a Battery Electric Vehicle (Contemporary Issues Expert Guest Lecture and S ire hours: ipped Class Room, [Lecture ter models to lecture, Visit perts	BEV). eminars e to be videotape t to Industry , M	d], Use of lin of 2 le	² physical ctures by	2 hours 45 hours
De Mo Inc Tot # M and indu Tex	dule:8 dustrial 1 al Lectu lode: Fl comput 1stry exj ct Book(a Battery Electric Vehicle (Contemporary Issues Expert Guest Lecture and S ire hours: ipped Class Room, [Lecture er models to lecture, Visit perts (s)	BEV). eminars e to be videotape t to Industry , M	d], Use of lin of 2 le	physical ctures by	2 hours 45 hours
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Mo Ind Tot # M and indu Tex 1. 2.	dule:8 dustrial 1 al Lectu lode: Fl comput istry exj ct Book(Iqbal H James I	a Battery Electric Vehicle (Contemporary Issues Expert Guest Lecture and S ire hours: ipped Class Room, [Lecture er models to lecture, Visit perts s) ussein, Electric and Hybrid Vol- arminie, " Electric Vehicle To	BEV). eminars e to be videotape t to Industry , M ehicles: CRC Press echnology Explain	d], Use of lin of 2 le ; 2 nd editior ed", John V	physical ctures by n, 2010. Viley & Sor	2 hours 45 hours as, 2 nd edition, 2015
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Mo Ind Tot # M and indu Tex 1. 2. Ref 1. 2. Mo Rec App	dule:8 dustrial 1 al Lectu lode: Fl comput istry exj t Book(Iqbal H James I Gerence 1 Mehrda Vehicle Emadi, CRC P de of Ev de of ev commene proved b	a Battery Electric Vehicle (Contemporary Issues Expert Guest Lecture and S ire hours: ipped Class Room, [Lecture ter models to lecture, Visit perts s) ussein, Electric and Hybrid Vo arminie, " Electric Vehicle To Books adEhsani, YiminGao, Ali I es: Fundamentals", CRC Pr A. (Ed.), Miller, J., Ehsar ress, 2003. raluation: CAT / Assignmer aluation: ded by Board of Studies by Academic Council	BEV). eminars e to be videotape t to Industry , M ehicles: CRC Press echnology Explaine Emadi, "Modern ess, 2010. ni, M., "Vehicula nt / Quiz / FAT / I 06-09-2019 No. 56	d], Use of lin of 2 le ; 2 nd edition ed", John V Electric, I r Electric Project / So	F physical ctures by n, 2010. Viley & Son Hybrid Ele Power Sy eminar	2 hours 45 hours as, 2 nd edition, 2015 ectric, and Fuel Cell stems" Boca Raton, 19



Course code	Cyber Security in Design and Manufacturing	Ι	T	Р	J	С		
MEE6066		3	0	0	0	3		
Pre-requisite		Sylla	bus	s ve	rs	ion		
					v.	1.0		
Course Objective	s(CoB):							
The main objective	es of course are to:							
 Provide fun risks associate necessary t Provide wo threats to a Enable stud attacks and systems and 	ndamental knowledge on cloud based manufacturing, secur ciated with different cloud deployment models along o protect manufacturing systems. orking knowledge of using different data mining techniques manufacturing system. dents to detect and prevent system intrusion, improve defen l incident response, master modern technologies for securit d cyber-physical systems.	ity cha with s to id se aga ty of r	alle ech enti inst nacl	nge inol ify tar hine	s a og cy ge	and gies ber ted ool		
Expected Course	Outcome(CO):							
On completion of	the course, the students will be able to							
1. Develop te	chnical expertise in security of cyber-physical systems.							
2. Categories	intrusion and security breaches to cyber-physical systems.							
3. Propose see	curity solutions for cyber-physical systems.							
4. Assess the	cost of security solutions for cyber-physical systems.	_						
5. Analyze an	d solve cyber security and system safety issues in cyber-phy	sical s	yste	ems	•			
6. Create sect	urity metrics from the vulnerabilities, threats, risks and so	olution	s fo	or c	yb	er-		
physical sy	stems.							
Module:1 Indus	strial control systems:			61	10	urs		
An overview of an	industrial control system-the industrial control system archi	itectur	e-th	e p	uro	lue		
model for industrial control systems- industrial control system communication media and								
protocols								
Madular? Trace	ure by inheritance			F 1	• • •			
INIOQUIE:2 INSEC	ure by inneritance		IT	51	10	urs		
found in the ICS	System instory-moddus and moddus ICP / IP - Profinet-Con		II [orot	00	OIS		
Iouna in the ICS	o- Anatomy ICS attack scenario –Attacks-consequences	-KISK	dSS	essi	.116	:III-		



Backend protocols-advanced grid-Industrial protocol simulators

metering infrastructure and smart

6 hours

45 hours

Module:3 The Purdue model and a converged plant-wide Ethernet:	6 hours
The converged plant wide Enterprise-The safety zone-the manufacturing zon	ne-the enterprise
zone-the CPwE industrial network security framework- Physical ICS security	ity-ICS network
security-ICS computer security-ICS Application security-ICS Device security -	- The ICS cyber
security program development process.	

Module:4 Industrial Network design and architecture

Introduction to industrial networking- common topologies- network segmentation-network services- Wireless networks-Remote access -performance considerations-safety instrumented systems-special considerations

Module:5 | Hacking Industrial control systems |

6 hours Consequences of successful cyber incident-cyber security and safety-common industrial targetscommon attack methods- Attack trends-industrial application layer attacks

Module:6 Risk and vulnerability assessments

9 hours Cyber security and risk management-methodologies for accessing risk within industrial control system-system characterization-threat identification-vulnerability identification-risk classification and ranking-risk reduction and mitigation

Module:7 | Security of Machine Tool Systems- Standards and regulations: 5 hours Cyber physical systems - Safety and security of cyber physical systems- Cyber-attacks and measures in cyber-physical systems - Cyber risks in industrial control systems - Costing security solutions -NERC CIP-CFATS-ISA/ IEC62443-mapping Industrial network security to compliance –common criteria and FIPS standards-standards organizations-NIST security guidelines

Module:8	Contemporary Issues	2 hours
Industrial	Expert Guest Lecture and Seminars	

Total Lecture hours:

Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min of 2 lectures by industry experts

Text Book(s)

- Pascal Ackerman, "Industrial Cyber security-Efficiently secure critical infrastructure 1. systems", Packt Publishing Ltd., Bringham, 2017.
- 2. Eric D.Knapp and Joel Thomas Langill, "Industrial Network Security- Securing Critical



	Infrastructure Networks for		sm	art Grid, SCADA, and other		
	Industrial Control Systems" Syng	gress is an Imprint	of Elsevie	er, 2015.		
Ref	erence Books					
1.	Lihui Wang, Xi Vincent Wang, "	Cloud-Based Cyb	er –Physic	cal systems in Manufacturing",		
	Springer Nature, 2018					
2.	2. Edward J.M. Colbert and Alexander Kott, "Cyber-Security and SCADA and other Industrial					
	control Systems" Springer International Publishing AG Switzerland, 2016					
Mo	de of Evaluation: CAT / Assignme	nt / Quiz / FAT / I	Project / Se	eminar		
Mo	Mode of evaluation:					
Rec	commended by Board of Studies	06-09-2019				
Ар	proved by Academic Council	No. 56	Date	24-09-2019		
			•			



MEE6067	Transportation Cyber Physical Systems	L	T	P J	J
		3	0	0 (D 3
Pre-requisite		Sylla	ibus '	vers	ion
-		v. 1.0	0		
Course Obie	ctives(CoB):				
The main obi	ectives of course are to:				
 Description Undering Undering The endormality Assess transition Select apping Analyze data Infer hum Plan and in Realize endormality Module: 1 Introduction System 	be the concepts of transportation cyber physical system architected stand the capability of transportation technologies and important of an and implementation. The provide the course of the course of the course, astudent will be able to: asportation system user services in real world. The course of transportation cyber physical system more of transportation cyber physical system more of transportation cyber physical system more of transportation cyber physical systems of transportation services and networked oper of transportation cyber physical systems of tran	cture a nce of le mot specific /ber pl odels. l syste ration 5 ho transp	and e huma oility. c cond hysic ms. s. urs ortati	volu an fa dition al sy ion r-Ph	ns. cybovsic
			ay bei		
Systems. Env Module: 2	ironmental and societal benefits. Infrastructure for Transportation Cyber Physical	5 ho	urs		
Systems. Env Module: 2	ironmental and societal benefits. Infrastructure for Transportation Cyber Physical Systems Canagement Importance of networking among data structure	5 hor	urs	tror	
Systems. Env Module: 2 Information systems. Da Transponders	ironmental and societal benefits. Infrastructure for Transportation Cyber Physical Systems Management. Importance of networking among data structu a processing engines and serving layer, Traffic flow s and Communication systems. Real time control in autonomous	5 ho res in ensor vehic	urs the tech	trar	nspo
Systems. Env Module: 2 Information systems. Da Transponders Module: 3	ironmental and societal benefits. Infrastructure for Transportation Cyber Physical Systems Management. Importance of networking among data structu a processing engines and serving layer, Traffic flow s and Communication systems. Real time control in autonomous Data management in Transportation Cyber Physical Systems	5 ho res in ensor vehic 6 ho	urs the tech cles. urs	trar	nspo
Systems. Env Module: 2 Information systems. Da Transponders Module: 3 Data Manage Transport sy Identification at traffic man	Infrastructure for Transportation Cyber Physical Systems Management. Importance of networking among data structu a processing engines and serving layer, Traffic flow s and Communication systems. Real time control in autonomous Data management in Transportation Cyber Physical Systems ment Issues; Data Base Systems and Data Analytics for Cyber stem data collection techniques – Detectors, Automatic Ve GIS, video data collection. Route Navigation and Guidance co agement centers.	5 ho res in ensor vehic 6 ho er Phy ehicle oncep	urs the tech cles. urs vsical Loca ts; D	tran nnolo Sys atior ata f	nspo ogie tem n an
Systems. Env Module: 2 Information systems. Da Transponders Module: 3 Data Manage Transport sy Identification at traffic man Module: 4	Infrastructure for Transportation Cyber Physical Systems Management. Importance of networking among data structu a processing engines and serving layer, Traffic flow s and Communication systems. Real time control in autonomous Data management in Transportation Cyber Physical Systems ment Issues; Data Base Systems and Data Analytics for Cybe stem data collection techniques – Detectors, Automatic Ve GIS, video data collection. Route Navigation and Guidance co agement centers. Human factors in Transportation Cyber Physical Systems	5 ho res in ensor vehic 6 ho er Phy ehicle oncep 6 ho	urs the tech tech urs zsical Loca ts; Da urs	trar nnolo Sys atior ata f	nspo ogie stem n an fusic

VIT NIT	VIT [®]
	Vellore Institute of Technology (Deemed to be University under section 3 of UGC Act, 1956)

Module: 5	Intelligent		al Causton	7 hours
Intelligent T	I ransportation C	yder Physic om Modole	al System	opt of transportation
interrigent 1	ansportation Systematic Systematic Collabore	etivo modol	ing and co simulation	ept of transportation
Services III SI	liant City, Collabola			
Modulo: 6	Transportation	Cybor Dhy	sical Systems security and	6 hours
	control	Cyber Fily	sical Systems security and	0 nours
Case studies	on deployment pla	nning and s	system design and operation; Safet	ty and Security
models in Tra	ansportation Cyber	Physical S	ystem. Applied security control in	connected vehicles,
emerging tec	hnologies.	5		
Module: 7	Transportation	System Ap	plications	8 hours
Emerging Au	itonomous Transpo	ortation serv	vices in smart city construction, ra	ilways and aviation -
Traffic and	incident manage	ment syste	ems; sustainable mobility, Tra	nsportation network
operations; st	rategic transportat	ion plannin	g, Integration of Automated Trans	portation Systems.
Module: 8	Contemporary I	Discussions	i	2 hours
Industrial Ex	pert Guest Lecture	and Semin	ars	
Total Lectur	re hours:			45 hours
# Mode: Flip	ped Class Room, [Lecture to l	be videotaped], Use of physical	
and compute	r models to lecture	, Visit to In	dustry, Minimum of 2 lectures	
by industry e	xperts			
Text Book(s)				
1. Lipik	aDeka, MashrurC Elsevier, 2018, I	howdhury, SBN:01281	Transportation Cyber-Physical .42960	Systems, Publisher
2. Asier	Perallos, Unai	Hernan	dez-Jayo, Enrique Onieva,	Ignacio Julio
Garcí Wiley	aZuazola, Intellige v & Sons. 2015. IS	nt Transpo BN:111889	ort Systems: Technologies and 4782	l Applications, John
3. Janić.	Milan. Advanced	l Transpor	t Systems Analysis, Modeling,	and Evaluation of
Perfo	rmances, Springer-	Verlag Pub	lishers, London. 2014. ISBN: 978	8-1-4471-6287-2
Reference B	ooks	0		
1. J. de J	D. Ortuzar and L.C	6. Willumse	en, Modelling Transport, 4th Editio	on, John Wiley and
	2011.	Dag Dring	inles of Transportation Engineer	ing (2017) Drantica
2. P. Cl. Hall c	of India Pvt. Ltd.	Das, Princ	iples of Transportation Engineer	ing (2017), Prenuce
3. C.Joh	nKhisty and	B.KentLal	l, Transportation Engineerin	ng, 3rd Edition,
	Teodorovic Mil	an Ianic	Transportation Engineering: Th	peory Practice and
Mode	ling, Butterworth-	Heinemann	, 2016. ISBN:0128038896	
Mode of Eva	luation: CAT / As	signment /	Quiz / Seminar / FAT	
Recommende Studies	ed by Board of	06-09-201	.9	
Approved by	Academic	No. 56	Date	24-09-2019
Council	-			
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Course code	Smart Health Technology]	LΤ	P	JC
MEE6068				2 0	0	4 3
Pre-requisit	<u> </u>		Svll	abu		rsin
TTC TCquisit	-		Oyn	uvu	<u>3 vc</u>	v. 1.
Course Obje	ctives(CoB):					
The main obj	ectives of course are to:					
1 Introduc	loading technology tronds in the field of smart healthcare					
 Introduct Provide 	application of acquired theoretical and technological knowled	lao in	tho	fiold	lof	e ma
2. Trovide a		ige in	i uie i	lieit	1013	Silla
ileaitiica	ς.					
Expected Co	urse Outcome(CO):					
At the endot	the course, astudent will be able to:					
1 Familiar	ze with health system organization and hasic concepts of sma	art he	althc	are		
2. Apply th	eir knowledge successfully, design, and develop mobile appli	icatio	ons fo	or he	alth	
3. Develop	skills in major architectures and technologies of IoT in health	icare	110 10			
4. Improve	knowledge on cloud computing technologies and infrastructu	ire				
5. Develop	technologies and infrastructure needed for development of w	earat	ole sc	luti	ons	
6. Impleme	ntation of smart health services in smart cities					
Module 1	Introduction to eHealth				31	10111
Introduction	to health system concepts. Basic concepts of Smart health	care.	Mul	tidis	scipl	inar
design of Sm	art healthcare				- r	
Module:2	nHealth - Mobile technologies				4 h	our
Mobile techn	ologies and health services. Mobile networking fundamentals	s. Bo	dy A	rea	Netv	vorl
Mobile devic	es and applications in eHealth. Examples of mobile healthcar	e imj	olemo	enta	tions	5.
			1			
Module:3	Implementation of IoT in eHealth				4 h	lour
Emerging teo	nnological trends in nealthcare and their implementation if	1 the	sma s in b	rt n	ealth	icare
Technologies		ution	5 111 1	lean	IICal	e
Module:4	Wearable computing				4 h	our
A notion of	wearable computing. Examples of applications of wearable	arabl	es ir	ı h	ealth	care
Technologies	and infrastructure needed for development of wearable so	lutio	ns. E	xan	ples	s an
case studies i	n smart healthcare					
N/- J-1					- 1	
Trends in sm	Smart nealthcare services in smart cities		 1 COPT	vico	5 h	iour
cities. Inclusi	ve healthcare in smart cities. Examples of health services in s	mart	citie	S.) III S	SIIId



Module:6 Gamification in Healthcare and applications	4 hours
Introduction to gamification. Application of gamification in healthcare. Learning	ng through games
in healthcare. Technologies for healthcare games development. Examples.	Areas of smart
healthcare applications. Healthcare services suitable for smart healthcare implen	nentation.
Module:7 Cloud computing and big data	4 hours
Basic concepts of cloud computing. Basic concepts of cloud services and cloud	ud IoT services.
Technologies and infrastructure necessary for cloud computing in sr	nart healthcare
implementation. Big data infrastructure, services and analytics in smart heal	thcare. (content
robotics application in medical – surgical applications)	
Module:8 Contemporary Issues	2 hours
Industrial Expert Guest Lecture and Seminars	
Total Lecture hours:	30 hours
# Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and	
computer models to lecture, Visit to Industry, Min of 2 lectures by industry	
experts	
Text Book(s)	
1. AdwitiyaSinha, MeghaRathi, "Smart Healthcare Systems", CRC Press, 201	9.
2. Bruno Bouchard, "Smart Technologies in Healthcare", CRC Press, 2017.	
Reference Books	
1. Andreas Holzinger, CarstenRöcker, "Smart Health: Open Problems and Fu	ture Challenges",
CRC Press, 2015.	0 .
2. Thomas F. Heston "eHealth: Making Health Care Smarter" Boca Raton, Int	tech Open, 2013.
	I Ý
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	
Mode of evaluation:	
Recommended by Board of Studies 06-09-2019	
Approved by Academic CouncilNo. 56Date24-09-2019	



Course codeDigital Systems Design and ArchitectureLTPJCMEE606930003Pre-requisiteSyllabus versionv. 1.0

Course Objectives(CoB):

The main objectives of course are to:

- 1. Acquire basic knowledge in digital systems design and architecture
- 2. Understand the steps in designing of digital circuits and systems.
- 3. Develop an digital electronic control system for general engineering applications

Expected Course Outcome(CO):

At the endof the course, astudent will be able to:

- 1. Understand basics of digital devices and architecture.
- 2. Provide specifications of digital circuit using hardware description language.
- 3. Analyze the building blocks and designing of digital system.
- 4. Distinguish architecture of various processors and memory device.
- 5. Develop program using interfacing peripherals and communications in a digital circuit.
- 6. Design the digital circuits for various types of processors.

Module:1 Digital Devices

4 hours

7 hours

Digital circuit-Device technologies- IC, classification of ASIC-FPGA-Development cycle-Electronic Design Automation

Module:2 Hardware Description Languages

Introduction to reconfigurable computing, circuit specification using hardware description languages, use of HDL packages

Module:3 RTL based System Design

Introduction to RTL based design, data paths and controllers

Module:4 RISC architecture

Features of RISC architecture, pipelining, register windows, register renaming Vector processing, Multithreading, Multiprocessing.

Module:5 Processor design

Instruction set architecture, hardwired and micro programming approaches to processor design

Module:6 Memory design

RAM, ROM, EPROM, SRAM, DRAM, memory cells and memory organization, cache memory design, memory interfacing **-Virtual memories**.

7 hours

9 hours

5 hours



Mo	dule:7	Asyn	chronous sequei	ntial			syst	ems		5	hours
Int	roduction	to	asynchronous	sequential	systems,	race	conditi	ions,	stability	issues,	state
red	luction tee	chnique	es-finite state n	nachine							
Mo	dule:8	Cont	emporary Iss	ues						2	hours
Ac	lvanced	techni	ques in digital	system de	sign-Digita	ıl elect	ronic co	ontrol	system-a	applicatic	ons
an	d case st	udies									
Tot	al Lectu	ıre ho	urs:							45	hours
# N	lode: Fli	pped (Class Room, [I	Lecture to	be videota _l	oed], U	Jse of p	hysica	al and		
con	nputer m	odels	to lecture, Vis	sit to Indus	stry, Min	of 2 le	ectures	by inc	lustry		
exp	erts										
Tex	t Book(s)									
1.	David I	Harris,	, Sarah Harris,	Digital De	esign and C	Comput	ter Arch	nitectu	ire, MK	Publisher	s,
	Second	Edisc	on, 2012								
2.	ArrozG	uiherr	ne, Monteiro J	ose, Olive	ira Arlindo	, Com	puter A	rchite	cture: D	igital Ciro	cuits
	to Micr	oproc	essors, World S	Scientific I	Publishing,	2018					
3.	Morris	Mano	, Computer Sy	stem Arch	itecture , Tl	nrid ed	ition, P	earso	n, 2007		
Ref	erence l	Books									
1.	Morris	Mano	, Digital Logic	and Comp	uter Desig	n. Mor	gan Ka	ufmai	ın, 2016		
2.	Ata Ela	hi . Co	omputer Systen	ns: Digital	Design, Fu	ındam	entals o	of Con	nputer A	rchitectur	re and
	Assemt	oly La	nguage. Spring	ger, 2018.							
Mo	de of Ev	aluatio	on: CAT / Assi	ignment / (Quiz / FAT	/ Proj	ect / Se	minar			
Mo	de of eva	aluatic	on:								
Rec	commend	ded by	Board of Stud	lies 06-	-09-2019	i					
Ар	proved b	y Aca	demic Council	No	. 56	Da	ate	24-09	9-2019		



Course code	Data Science & Analytics	L T P J C
MEE6070		2 0 0 4 3
Pre-requisite		Syllabus version
		v. 1.0
Course Objective	5(CoB):	
The main objective	es of course are to:	
1. Introduc	e data analytics software tools for processing, extracting and	analysing data for
engineer	ing applications.	
2. Apply d	ata mining techniques to realistic data sets in which they can rec	cognize the demands
Within the average of the within the second	ierr area of specialization.	nming language and
apply a	structured and systematic approach to data processing	iiiiiiig language anu
Expected Course	Outcome(CO):	
On completion of the	e course, the students will be able to	
1. Use	basic statistical concepts and techniques (like the mean, media	n, mode, percentile,
rang	e, variance, confidence intervals, p-value, correlation, and t-test).	-
2. Ana	lyze and model data (linear regression, clustering, decision tree	mining, association
rule	s learning).	J-4- h
3. Alla 4. Ider	tify and apply data transformations (normalization, aggregation)	data pase.
data	discretion.	, uata reduction, and
5. App	ly suitable visualization techniques (like line graphs, bar chart	ts, scatter plots, pie
char	ts, box plots, violin plots, and heat maps).	
6. Des	ign data analytics problems in a programming language and app	ply a structured and
syst	ematic approach to data processing	
Module:1 Basic	s of Data science	3 hours
Data understandi	ng-Data preparation- Data transformation- Mathemat	ical foundations-
Algebraic view - V	vectors, matrices- Geometric View - vectors, distance, proje	ections, eigenvalue
decomposition -5	austics for decision making- Descriptive statistics, note	on or probability,
Module:2 Basic	s in Data analytics	4hours
Data analytics fra	me work- General software Tools for Data Analysis-B	asic programming
environmentDat	a extraction- Data visualization- Big Data.	100
	<u> </u>	
Module:3 Softw	are tools for data analytics	4 hours
Querying Languag	e, scripting Language (coding tools), Statistical Language	e (R, SAS, SPSS),
and Open source s	oftware tools	
 		1
Module:4 Types	of Data analytics	4 hours
Decision making	process-Descriptive-Diagnostic-Predictive-Prescriptive	types- Advanced



techniques in data analytics

Module:5 Data analytics techniques - 1

Regression-Prediction- Simple linear regression Multivariate linear regression, model assessment, assessing importance of different variables, subset selection

Module:6Data analytics techniques - 24 hoursClassification using kNN and k-means clustering- Naive Bayes -Ensemble technique-Bagging &
Boosting, Random Forest, AdaBoost& Gradient boosting- Decision tree4 hours

Module:7Data analytics techniques - Applications4 hoursDeep learning and natural language processing- Engineering applications of Data analytics- Case
studies- Autonomous driving- Manufacturing-Supply chain-E commerce, Banking, Super market

Module:8 Contemporary Issues

Industrial Expert Guest Lecture and Seminars

Total Lecture hours: # Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry, Min of 2 lectures by industry experts

Text Book(s)

- 1. João Moreira, Andre Carvalho, TomásHorvathm, A General Introduction to Data Analytics, Wily, 2019
- 2. Edward L. Robinson Data Analysis for Scientists and Engineers, Princeton University Press, 2016.
- 3. Thomas A. Runkler Data Analytics: Models and Algorithms for Intelligent Data Analysis, Springer Verlog, 2016

Reference Books

1. **Runkler**, Thomas A. Models and Algorithms for Intelligent Data Analysis, Springer, 2012

2. **Edward L. Robinson,** Data Analysis for Scientists and Engineers, press Princeton, 2017

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Mode of evaluation:

in oue of evaluation.			
Recommended by Board of Studies	06-09-2019		
Approved by Academic Council	No. 56	Date	24-09-2019

30 hours

2 hours



Course code	Wireless Networking of Embedded Systems	L T P J C
MEE6071		3 0 0 4 4
Pre-requisite		Syllabus version
		v. 1.0

Course Objectives(CoB):

The main objectives of course are to:

- 1. Develop an embedded system that requires the understanding of the physical world with the system that has to interact via wireless network.
- 2. Understand the suitable principles and standards (e.g. IEEE 802.15.1 and ZigBee) in design and evaluation of sensor networks and wireless communication protocols for small digital transmitters.
- 3. Teach the basic and advanced concepts in wireless networking architectures and protocols.
- 4. Study the application of WSN Environment Monitoring and Health Care applications.

Expected Course Outcome(CO):

At the endof the course, astudent will be able to:

- 1. Acquire knowledge about the architecture of various embedded devices.
- 2. Ability to get knowledge about real time system and communications.
- 3. Understand the embedded system in the application of CPS.
- 4. Design wireless sensor network based on applications
- 5. Develop and compute the routing protocol
- 6. Demonstrate the protocols for maximizing lifetime of wireless sensor networks

Module:1Embedded Systems:4 hoursIntroduction: Definition, history and applications of Embedded System - Concept of Real timeSystems - Embedded System Design - Components of Embedded Systems

Module:2	Embedded Processor and Memory:	7 hours
Embedded	system design flow - Embedded processors - Microcontroller	s (PIC and ARM
architecture	s) – DSP, ASICs and SoC – Memory interface – Memory	y Technologies –
Heterogene	bus memory system	
Module:3	Embedded Communication Protocols:	9 hours
Emboddod	Notworking Introduction Social/Devalled Communication Soci	
Linbeauea	Networking: Introduction-Senal/Paranet Communication –Sen	ial communication
protocols –	RS232 standard – RS485 Synchronous Serial Protocols – Serial F	al communication Peripheral Interface
protocols – (SPI) – Inte	RS232 standard – RS485 Synchronous Serial Protocols – Serial F r Integrated Circuits (I2C) – PC Parallel port programming – ISA/	eripheral Interface /PCI Bus protocols
protocols – (SPI) – Inte – Firewire.	RS232 standard – RS485 Synchronous Serial Protocols – Serial F r Integrated Circuits (I2C) – PC Parallel port programming – ISA	eripheral Interface PCI Bus protocols

Module:4 Wireless Communication:



Low	-power	RF	modules – Wi-F		(II	EEE 802.1	1) –	Bluetooth
(IEE	LE 802.1	15.1) -	– Zigbee (IEEE 802	2.15.4) – 6LOWI	PAN			
Mo	dule 5	Wir	eless Embedded N	etworking.				9 hours
M/ir		nsor 1	networks – Introdu	ction – Applica	tions – Netw	ork Topolog	$V = I \alpha c$	alization _
Tim	o Synch	noniz	ation - Energy officiation	ciont MAC prot	1000 = 1000	C = Epergy	gy – LUC officient	and robust
rout	$in \sigma = D^{\prime}$	nonz ata Ce	ation – Energy entric	cient MAC prot	00015 - 5101A	C – Ellergy	emclem	
Tout	iiig – Do							
Mo	dule:6	Rou	ting protocols:					5 hours
Go	ssiping	and a	agent-based unicast	t forwarding –	Energy-effic	ient unicast	– Broa	dcast and
mu	lticast –	- Geog	graphic routing – M	obile nodes				
Mo	dule:7	Syst	em Level discussio	on on Specific A	pplications			5 hours
Me	edical m	nonito	oring systems – Er	nvironment Mo	nitoring – G	reen Buildii	ngs – A	utomated
ver	nding n	nachir	nes – Performance	e analysis of	energy effici	ent clusteri	ng prot	ocols for
ma	ximizin	g lifet	time of wireless sen	sor networks				
							T	
Mo	dule:8	Con	temporary Issues					2 hours
Inc	lustrial I	Exper	t Guest Lecture and	Seminars				
							1	1
Tota	al Lectu	ire ho	ours:		17 77 6 1			45 hours
# M	ode: Fli	pped	Classroom, [Lectur	e to be videotap	ed], Use of p	hysical and		
com	iputer m	lodels	to lecture, Visit to	Industry, Min	of 2 lectures	by industry		
expe	erts	· 、						
lex		<u>s)</u>		1			- IQ	1
1.	E. A. I	Lee ai	id S. A. Seshia, Intr	roduction to Em	bedded Syste	ms - A Cybe	er-Physic	cal
Э	System	ns Ap Sobr	proach, First Eulson	ll, 2012 di Taiah 7 pativ	Winologo S	oncor Note	vorke T	ochnology
۷.	RazemSonrady, Daniel Minoli, TaledZhati: Wireless Sensor Networks Technology,					echnology,		
2	Protocols, and Applications -John whey & Johs, 2007.					the ARM		
Ј.	mbed Wiley 2018							
Ref	erence l	Books	<u>., 2010</u>					
1.	Holge	r Karl	, and Andreas Willi	g. "Protocols an	d Architectur	es for Wirel	ess Sens	or
1.	Networks" John Wiley & Sons I imited 2008					01		
2.	Ian F. Akvildiz, Mehmet Can Vuran, "Wireless Sensor Networks" Wiley 2010							
3	Marilyn Wolf High-Performance Embedded Computing: Applications in Cyber-Dhysical							
0.	Systems and mobile computing Second Edition MK Publishing 2014							
Mod	le of Ev	aluati	on: CAT / Assignm	ent / Quiz / FA	Γ / Proiect / S	eminar		
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		1 1 1		00/00/0010				
Rec	ommeno	ded by	y Board of Studies	06/09/2019				



Course code	Multi Agent System	L T P J C					
MEE6072		3 0 0 4 4					
Pre-requisite		Syllabus version					
		v. 1.0					
Course Objecti	ves(CoB):						
The main object	ives of course are to:						
 Introduce the conceptual framework of multi agent systems and its fundamental concepts of coordination, cooperation, dynamics in multi agent systems Elaborate the different programming approaches for multi agent systems and study the various agent languages and programming platforms Design and develop the multi agent system for different industrial applications Expected Course Outcome(CO): At the endof the course,astudent will be able to: Understand the fundamental concepts and metal models of multi agent systems. Analyze the various programming approaches for multi agent systems. Apply different agent languages and platform for the development of multi agent systems Gain insights of integrating multi agent systems, mobile computing and web platforms 							
	lti agent system	6 hours					
Conceptual fram dynamics.	nework, Agent – Environment- Interaction- Organization-	Coordination and					
Module:2 Pro	ogramming	5 hours					
Agent Oriented	Programming, Environment Oriented Programming, In	teraction Oriented					
Programming ()rganisation Oriented Programming- Multi-Agent Oriented an	nroach					
	right offented i rogianning tratti rigent offented up	prouen					
Module:3 Hy	brid and Embedded Models	7 hours					
Agent meta-mo	del- Agent & Agent Interaction meta-model- Agent's dynai	mics- Environment					
meta-model- Ag	ent & Environment Interaction meta-model Environment's dy	mamics					
Module:4 Org	ganization meta-model	6 hours					
Organisation meta-model - organisational artifacts: Organisation's dynamics- Reorganisation,							
adaptation of the organisation							
Module: 5 A -	ant languages and platforms	0 L					
Computational 1	ent languages and platforms	Y NOUTS					
IADE. Jadex. and JACK							
JILL, JUUCA, UI							



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Mo	odule:6	IS	5 hours			
Mu	ılti agent	architecture for cyber phy	vsical systems-Sm	art agents	- Signal pro	cessing and fusion
for	Cyber	Physical System- Practical	l application-orie	nted syste	em design f	or Cyber Physical
Sys	stem					
Mo	odule:7	CPS with Embedded Ap	plication			5 hours
Int	egration	with technologies- Web	2.0 applications	- mobile	computing	applications- Web
Ser	vices ap	plications- "Web of Things	" Applications- S	emanticall	ly Aware Ag	gents
Ap	plication	s of multi agent system	s-manufacturing,	factory a	automation,	smart factory- E
cor	nmerce-s	supply chain, mobile	computing- hea	alth care	-Automotive	e-Aerospace-Home
aut	omation.		1 0			Ĩ
Mo	odule:8	Contemporary Issues				2 hours
In	dustrial	Expert Guest Lecture and S	eminars			
		•				
To	tal Lectı	ıre hours:				45 hours
# N	Mode: Fl	ipped Class Room, [Lectu	re to be videotap	ed], Use o	of physical	
and	l comput	er models to lecture, Visit	to Industry, Mini	mum of 2	lectures by	
ind	ustry exp	perts				
Te	xt Book(s)				
1.	Paulo 1	Leitão StamatisKarnouskos	, Industrial Age	nts: Emerg	ging Applica	ations of Software
	Agents in Industry, Elsevier, 2015.					
2.	2. Bordini P.H. Dastani M. Div. I. El EallahSoghrouchni A. (Eds.) Multi Agont					
	Programming Languages Platforms and Applications Springer 2009					
Trogramming, Eurgauges, Flattorins and Applications, Opringer 2005.						
Reference Books						
1. YoavShoham , Kevin Leyton-Brown, Multiagent Systems-Algorithmic, Game-Theoretic,						
and Logical Foundations, Cambridge University Press, 2009						
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar						
Μ	de of ev	aluation:				
Re	commen	led by Board of Studies	06-09-2019			
Ap	Approved by Academic Council No. 56 Date 24-09-2019					



Course code	Control System Analysis and Design	L T P J C
MEE6073		3 0 2 0 4
Pre-requisite		Syllabus version
		v. 1.0
Course Obje	ctives (CoB):	
The main obj	ectives of course are to:	
1. In fre 2. Pr 3. U: pr Expected Co At the 1. Form measu 2. Analy and fr 3. Desig Outpu 4. Apply 5. Study	troduce the concept of model based controller and performance measurequency domain. ovide control system design procedures for Single Input Single Output atput system and identification of dynamic models of plants inderstand the basic concepts of control systems for online and offline id occess dynamics urse Outcome(CO): e endof the course, astudent will be able to: alate the mathematical of model based controller and understand to tres in time and frequency domain. ze the effect of measurement noise and load on control system per equency domain. n the model based controllers for Single Input Single Output and it system state space analysis techniques for the identification of dynamic the basic concepts in Nonlinear and optimal control systems	res in time and and Two Input Two dentification of the performance erformance in time Two Input Two models of plants
6 Desig	n of advanced control systems for real time applications	
Module 1	Introduction to Control system	5 hours
		0 110110
Introduction,	Model Based Controller Design-Control structures and performa	ince measures,
Modulov2	Register in Decign of Controller	6 hours
Design of con	Dasies III Design of Controller atrallar for Single Input Single Output system DI DD controllar fo	
Effects of me	asurement noise and load- Identification of dynamic models of p	lants
Module:3	State variable analysis and Design	6 hours
Concepts of s	tate, state variable and state model, state equations. Controllabili	tv and
observability	Observer system. Pole placement by state feed back	
<u></u>		
Module:4	Control System identification:	6 hours
Time domain	and Frequency domain approaches for system identification- Of	f-line identification
of process dy	namics- On-line identification of plant dynamics	
Module:5	Nonlinear control systems	9 hours
Physical non	linearities-Phase plane method – Singular points – Stability of po	nlinear systems-
Liapunov crit	erion- Phase trajectories- Function method- Stability analysis	
	interior indicates i unclion incluod outpinty undigits	
Module 6	Ontimal control systems	5 hours
	- P	5 Hours



	(Deemed to be University under sec	tion 3 of UGC Act, 1956)			
Parameter optimization- Servomechanisms- C				Optimal	
control approach using transfer funct	ions-state variable	S.			
Module:7 Advances in control sy	stems			6 hours	
Adaptive and robust control system of	lesign, LQR, Back	stepping, I	Model predictive	control,	
Sliding mode, Adaptive neuro fuzzy	inference systems∙	Motion co	ntrol applications		
Module:8 Contemporary Issues	<u>C</u>			2 hours	
Industrial Expert Guest Lecture and	Seminars				
Total Lecture hours:				45 hours	
# Mode: Flipped Class Room, [Lec	ture to be videota	ped], Use	of physical		
and computer models to lecture, V	isit to Industry,	Min of 2	lectures by		
industry experts			_		
Text Book(s)					
1. S. Majhi, Advanced Control	Theory-Relay Fe	edback A	pproach, Cenga	ge Asia/India	
Pvt.Ltd, 2009. A. Johnson and I	H.	- ·		a b r	
2. Moradi, New Identifications and	Design Methods,	Springer -	Verlag, 2005. No	orman S. Nise,	
Control Systems Engineering, Jo	ohn Wiley & Sons	, 2008.			
Reference Books 1 A. NagaarKani, Advanced Con	trol Theory DDA	Dublication	2000		
1. A. Nagoor Kalli, Advalleed Coll 2. Varmah, K.B. Control Systems	McGraw Hill Edu	cation 201	0		
		cation, 201	0		
Mode of Evaluation: CAT / Assignm	ent / Quiz / FAT /	Project / S	eminar		
List of Experiments (challenging E	xperiments)				
1. State space models and simulation of physical systems					
2. System design and identification of control system					
3. Time, Frequency response analysis of LEAD -LAG compensating network					
4. Gain selection PID controller for stability and damped response					
5. Bode, Nyquist and Root locus plots for system analysis					
6. Design of Temperature control system using PID controller					
7. Study on Speed-torque control of a servo drive					
8. Study on control system characteristics of inverted pendulum.					
9. Study on control system characteristics of automotive steer by wire system					
10. Study on motion control of an electro hydraulic actuator					
Total Hrs					
Mode of evaluation: CAT / Assignm	ent / Quiz / FAT /	Project / Se	eminar		
Recommended by Board of Studies	06-09-2019		24.00.2010		
Approved by Academic Council No. 56 Date 24-09-2019					