Walchand College of Engineering

(Government Aided Autonomous Institute)

Vishrambag, Sangli-416415



Course Content for F. Y. M. Tech. (Control and Instrumentation)

Semester-I and II

2024-25

Semester- I Professional Core Theory Courses

Course Contents for F. Y. M. Tech. Control and Instrumentation Programme, Dept. of Electrical Engineering AY 2024-25

		Wale	chand College	of Engineering, Sa	ngli	
	AY 2024-25					
			Course	Information		
Progr	amme		M. Tech. All Brar	nches		
Class,	Semester		First Year M. Tec	h., Sem I		
Cours	e Code		1IC501			
Cours	e Name		Research Methode	ology		
Desire	ed Requisi	tes:	NIL			
	Teaching	Scheme		Examination Schen	ne (Marks)	
Lectu	re	3 Hrs/week	MSE	ISE	ESE	Total
Tutor	ial	-	30	20	50	100
				Credits: 3	,	
			Course	Objectives		
	To prepa	re students for u	indergoing research	identify and formulate	the research pr	oblems state the
1	hypothes	is, design a rese	arch layout, set a re	search process and meth	odology.	serenis, state the
`	To enabl	e students to int	erpret the results, pr	opose theories, suggest	possible/alterna	ative solutions,
	solve, an	d prove the solu	tion adapted-logica	Illy and analytically, con	clude the resea	rch findings.
3	To impar	t knowledge to	analyze critically th	e literature and publish	research in repu	ited conferences/
5	journals.					
4	4 To expose students to research ethics, IPR and Patents					
A 4 4h a	and of the	Course	Outcomes (CO) w	with Bloom's Taxonomy	/ Level	
At the end of the course, the students will be able to, Rhom's Rhom's Rhom's				Bloom's		
CO Course Outcome S			se Outcome Statem	nent/s	Taxonomy Level	Taxonomy Description
CO1	CO1 Demonstrate a research solution in each engineering domain using appropriate Engineering research process and research methodology.				II	Apply
CO2	Device f	easible solution	n to a research pro	oblem in the respective		
	engineer	ing domain bas	ed on economic, social and legal aspects III			Analyze
	using app	propriate researc	ch procedures and p	ractices.		
$\frac{\text{CO3}}{\text{CO4}}$	Compose	e research public	cations and dissertat	tion reports efficiently.	VI	Create
	for resea	rch work.	uments, as well as c	copyright documentation	VI	Create
Mody			Modulo (ontents		Hours
WIGUU	Engi	neering Resear	ch Process:	ontents		liburs
I	Mean Chara probl inves interp	ing of research acteristics of a em, Definition, tigation of solu- pretation.	h problem, Source good research pro scope and objective utions for research	es of research problem oblem, Errors in selection es of research problem. n problem, data collec	, Criteria and ng a research Approaches of tion, analysis,	6
II	Research Methodology : Problem statement formulation, resources identification for solution, II Experimental and Analytical modeling, Simulations, Numerical and Statistical methods in engineering research. Hypothesis and its testing by different techniques: T-Test, Z-test etc.,				6	
III	Rese: Uni Meth Proce Prese Interp	arch Methods: and Multivarian od, Regression A essing and Anal ntation and Inte- pretation. Analys	te Analysis: ANO Analysis. Software ysis of Data: Proce rpretation of Data l se your results and o	VA, Design of Experitools like spreadsheets. essing Operations, Type Editing, Classification a draw conclusions.	ments/Taguchi s of Analysis- nd Tabulation-	7

Course Contents for F. Y. M. Tech. Control and Instrumentation Programme, Dept. of Electrical Engineering AY 2024-25

	Research Practices:				
	Effective literature studies approaches, critical analysis, Plagiarism, Research				
	ethics. Mendeley - Reference Management Software.				
	Research communication- Effective Technical Writing, Writing a research				
IV	article for Journal/conference paper Technical report Dissertation/ Thesis	7			
1 V	raport writing	1			
	Software used for report writing such as word I stay at a Dresentation techniques				
	Software used for report writing such as word, Latex etc. Presentation techniques				
	for paper/report/seminar. Publishing article in Scopus/SCI/web of science				
	indexed journal or conference.				
	Intellectual Property Rights (IPR):				
	Nature of Intellectual Property: Patents, Designs, Trade and Copyright,				
V	Ownership of copyright, Term of copyright, Technological research, innovation,	7			
V V	patenting, development. International Scenario: International cooperation on	1			
	Intellectual Property, New developments in IPR, Traditional knowledge,				
	Various Case Studies.				
	Patents				
	Patent Rights: Scope of Patent Rights, Various Patent databases, Geographical				
	Indications. Procedure for grants of patents, Patenting under Patent Cooperation				
VI	Treaty (PCT). Licensing and transfer of technology. Administration of Patent	6			
	System. Introduction to International Scenario: World Intellectual Property				
	(TPIPe) Detention of PCT				
	(TRIPS), Patenting under PCT.				
	Textbooks				
1	Kothari C. R. "Research Methodology". 5 th Edition New Age International 202	23			
	Melville Stuart and Goddard Wayne. "Research Methodology: An Introductio	n for Science &			
2	Engineering Students" Juta and Company Ltd, 4 th edition 2023.				
2	Kumar Ranjit, "Research Methodology: A Step-by-Step Guide for beginners". SAGE				
3	Publications, , 4 th edition 2023.				
	References				
1	References				
2	Merges Robert, Menell Peter, Lemley Mark, "Intellectual Property in New Tecl ASPEN Publishers, 2018.	mological Age",			
3	Ramappa T., "Intellectual Property Rights Under WTO", S. Chand, 2008				
4	Mayall, "Industrial Design", McGraw Hill, Oct 2021.				
5	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2020				
1	Useful Links				
	Useful Links				
<i>L</i>	https://onlinecourses.nptel.ac.in/noc21_ge05/preview- introduction to research	- Doport			
3	Writing	e Report			
4	https://onlinecourses.nptel.ac.in/noc21_ge12/preview - Qualitative Research Met	thods And			
	Research Writing				
5	nttps://onlinecourses.nptei.ac.in/noc21_hs44/preview - Effective Writing				
	<u>nttps://www.scopus.com/searcn/torm.uri?display=basic#basic</u>				
/ 0	https://weboiscienceacademy.clarivale.com/learn				
	https://www.wipo.ini/adout-wipo/en/				
7					

	CO-PO Mapping						
		Programme Outcomes (PO)					
	1	2	3	4	5	6	
CO1	2	2	1				
CO2	3	2	2	3	2	2	
CO3		3		3	1		
CO4				3	1		
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High							

Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

Syllabus Prepared By	Mrs. A. A. Dhamangaonkar
Syllabus Checked By	

		Walo	chand College	of Engineering	, Sangli	i		
	(Government Aided Autonomous Institute)							
			Course	Information				
Progr	amme		M Tech Control	and Instrumentation				
Class.	Semester		First Year M. Tec	ch., Sem, I				
Cours	e Code		1CI501					
Cours	e Name		Linear Control Sy	/stems				
Desire	d Requisi	tes:	Control System E	Ingineering				
			· · · · ·	0 0				
	Teaching SchemeExamination Scheme (Marks)							
Lectu	re	3 Hrs/week	MSE	ISE	ESF	C	Total	
Tutor	ial	-	30	20	50		100	
				Cred	its: 3			
			~	014				
			Course	Objectives				
	To impar	t knowledge for	modelling physica	l systems.	- 4	.1.		
2	To enable	e students to ana	uyse physical syste	ms using State Spac	e Approac	cn.		
3	To enable	e students to det	ermine the stability	of linear systems up	sing differ	ent metho	Das.	
4		Course	Outcomes (CO) v	state feedback desig		പ		
At the	end of the	course the stud	ents will be able to		iomy Lev			
At the		course, the stud	ents will be able to	,	B	Rloom's	Bloom's	
СО		Cours	se Outcome Staten	nent/s		xonomv	Taxonomy	
						Level	Description	
CO1	D1 Construct state models for linear continuous–time systems. III						Applying	
CO2	Analyze	the stability of a	control systems using	ng state space appro	ach.	IV	Analyzing	
CO3	CO3 Assess the stability of linear control system using State Transition V Evaluating					Evaluating		
	Matrix							
CO4	Design p	ole placement	and state observe	r controllers using	state	VI	Creating	
	feedback	design.						
	•						TT	
Modu	lle Tratus	Justian to Stat	Module (Contents			Hours	
	Intro State	Space Deprese	e Space	Earm (Controllable	Cononia	al Earm)		
T	- State Exter	ded Controllabl	e Canonical Form	Observable Canoni	cal Form	al Forni), Diagonal	6	
1	Cano	nical Form Jorg	an Canonical Form, Numerical Examples of			ate Space	0	
	Mode	elling.		in, i taineitear Enam		are space		
	Mode	elling of Linear	Control Systems					
п	Mode	elling of Mecha	inical Systems in	State Space, Model	lling of D	OC Servo	7	
	Moto	r, Determination	n of Transfer Functi	of Transfer Function from State Space Model, Numerical				
	Exam	ples on Modelli	ng of Mechanical a	and Electromechanic	cal System	S.		
	Stabi	lity Analysis in	State Space	-	~			
	Conc	Concept of Eigenvalues and Eigenvectors, Lyapunov Stability Analysis:						
	Diago	Sylvester's Criterion, Stability Criterion, Direct Method, Concept					0	
	Syste	m	ition of State Equa	tion, steady state El	for for Su	ate space		
	Syste	Transition Me	atrix					
State Transition Mat		Transition Matr	ix using Caley Han	nilton Theorem. Cor	ntrollabilit	v in State	_	
IV Space, Observability		y in State Space	ce, Observable D	ecomposit	ion and	7		
	Detec	tability.			<u>.</u>			
	State	Feedback Desi	gn					
	Kalm	an Decompositi	on and Minimal R	ealisation, Canonica	al Forms a	and State		
	Feedb	back Control, Co	ontrol Design using	g Pole Placement, St	tate Estim	ation and	6	
	Outpu	it Feedback, T	racking Problem i	n State Feedback	Design, D	Design of		
	Obsei	ver and Observ	er based Controller	•				

VI	Optimal Control Optimal Control and Linear Quadratic Regulator (LQR), Feedback Invariant and Algebraic Ricatti Equation, Linear Matrix Inequalities, Properties of LMIs and Delay LMIs.	7
	Textbooks	
1	K. Ogata, "Modern Control Engineering", 4th Edition, Prentice Hall, 2002.	
2	N. S. Nise, "Control Systems Engineering", 6/e, Wiley Eastern, 2010.	
3	D. Roy Choudhuary, "Modern Control Engineering, PHI, 2005.	
4	Ashish Tewari, Modern Control Design: with MATLAB and SIMULINK, Wiley	, 2002.
	References	
1	M. Gopal, "Control Systems: Principles and Design",4th Edition, McGraw Hill	Education, 2012.
2	B. C. Kuo, "Automatic Control System", 9th Edition, Prentice Hall, 2010.	
3	R. C. Dorf and R. H. Bishop, "Modern Control Systems", Pearson Education, 20	11.
	Useful Links	
1	https://nptel.ac.in/courses/108107115	
2	https://nptel.ac.in/courses/108106150	

	CO-PO Mapping					
			Programme	Outcomes (PO)	
	1	2	3	4	5	6
CO1			3			
CO2			3			
CO3				3		
CO4				3		
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High						

Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

Syllabus Prepared By	Dr. Mrs. A. S. Karvekar
Syllabus Checked By	

	Walchand College of Engineering, Sangli							
	(Government Aided Autonomous Institute)							
			Course	2024-25				
Progr	amme		M Tech Control	and Instrumentation				
Class	Semester		First Year M Tec	h Sem I				
Cours	e Code		1CI502					
Cours	e Name		PLC and Embedd	led Control				
Desire	ed Requis	ites:	Electrical Measur	ement and Instrume	entatio	n		
				<u></u>				
	Teaching	Scheme		Examination S	cheme	(Marks)		
Lectu	re	3 Hrs/week	MSE	ISE		ESE	Total	
Tutor	ial	-	30	20		50	100	
				Cred	lits: 3	ii		
		•						
			Course	e Objectives				
1	The cou	rse intends to ex	plore the PLC and I	Embedded Control f	for ind	ustrial autom	ation	
2	The cou	rse aims at devel	oping programs usi	ng ladder logic for	industr	rial automation	on	
3	It intend	s to analyze the	performance of auto	omation systems em	nployin	ng PLC and E	Embedded Control	
4	The cou	rse aims to integ	rate sensors with PI	LCs for application	develo	pment		
		Course	e Outcomes (CO) v	vith Bloom's Taxo	nomy	Level		
At the	end of the	e course, the stud	lents will be able to	,				
						Bloom's	Bloom's	
CO		Cour	e Outcome Statement/s			Taxonomy	Taxonomy	
	Level						Description	
COL	COI Use key concepts related to PLC and SCADA systems, including					Applying		
	hardwar	e components,	communication p	protocols for indu	Istrial			
<u> </u>	automation.					A		
	of PLC	imers, counters	for industrial autom	nique to demonstrat	e use	111	Applying	
CO3	Constru	ict PLC progra	ms using ladder	logic to control si	mple	III	Applying	
CO4	Evaluat	e the performa	nce of PLC netwo	ork configurations	PLC	V	Evaluating	
	function	s used for differ	ent application		TLC	•	Evaluating	
	-			-				
Modu			Module (Contents			Hours	
	Intr	duction to PLC		. 1 1 4 .	T			
т	Intro	duction, Basics	of Industrial Co	ntrol and Automa	tion, I	PLC Wiring	,	
1	Mod	ule PI C Archi	ecture PLC Operation PLC as a computer PLC output					
	and	nterfacing Pow	er Supply for PLC					
	Basi	c PLC program	ming:					
	Lado	ler Logic Symbo	ols, Latching and U	ls. Latching and Unlatching of PLC. Programming on/ off				
II inputs to produce on/			off outputs, relation	on of digital gate lo	gic to	contact / coi	1	
logic, creating ladder			diagrams from pro	cess control descrip	tion.			
	PLC	Timer and Co	unter Functions:					
	PLC	timer functions	s, Types of PLC t	imers, Programmin	g of l	Non-retentive	e	
III	time	rs for various ap	plications, Program	nming of ON timers	s, OFF	timers, PLC	C 7	
counter functions, Pr			ogramming of UP,	DOWN counters, (Case st	tudies related	1	
	to In	dustrial Automa	tions, Counter Appl	lication examples			_	
		Arithmetic and	d Comparison Fun	ictions:		.		
тт 7		Arithmetic fund	cuons, PLC compa	rison functions, Co	nversi	on functions	,	
IV	Mas	No metror for	functions, PLC jum	p runctions, Jump w	ith ret	urn and Jump		
	With Drom	ch functions	cuons, programs re	cialed to Arithmeti	u, Con	iiparison and	1	
	Didi							

v	PLC Functions Data move system, data handling functions, Digital bit functions and applications, sequencer functions, Analog input and outputs in PLC, Analog PLC operations, Application Examples, PID control using PLC, Updates in Industrial Internet of Things	6		
VI	PLC Networking Networking of PLCs, Levels of Industrial Control, Types of Networking, Network Communications, Cell control by PLC Networks, Factors to consider in selecting a PLC, PLC troubleshooting and maintenance	б		
	Textbooks			
1	John W. Webb, Ronald A. Reis, Programmable logic controllers, principles & a publication, Eastern Economic Edition, 1994.	pplications, PHI		
2	Gary dunning, Introduction to PLC, Thomson learning, Edition III, 2006.			
3	Frank D. Petruzella ,Programmable Logic Controllers, 3rd Edition, Tata McGraw 2010	Hill, New York,		
4	Madhuchhanda Mitra, Samarjit Sengupta, Programmable logic controllers Automation: An Introduction, Penram International, Edition II, 2017.	and Industrial		
	References			
1	John R. Hackworth and Peterson, PLC controllers programming methods and ap 2004.	pplications, PHI,		
2	Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition Systems, Press, 2010.	4th Edition, ISA		
3	William H. Bolton, Programmable logic controllers, Newnes, Edition VI, 2006.			
	Useful Links			
1	Industrial Automation and Control, IIT Kharagpur Prof S. Mukhopadhyay, Prof S. Sen https://nptel.ac.in/courses/108105063			
2	NOC:Industrial Automation and Control, IIT Kharagpur: https://nptel.ac.in/courses/	ses/108105088		

CO-PO Mapping						
]	Programm	e Outcom	es (PO)	
	1	2	3	4	5	6
CO1			3			
CO2				3		3
CO3				3		
CO4			3			

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

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Syllabus Prepared By	Dr. S. S. Karvekar
Syllabus Checked By	

Walchand College of Engineering, Sangli								
			AY	2023-24	<i>c)</i>			
	Course Information							
Progr	amme		M. Tech. Control	and Instrumentation	on			
Class,	Semester		First Year M. Teo	ch., Sem. I				
Cours	se Code		1CI503					
Cours	se Name		Process Instrume	ntation				
Desired Requisites: Control System Engineering								
			·					
	Teaching	Scheme		Examination S	cheme	(Marks)		
Lectu	re	3 Hrs/week	MSE	ISE		ESE	Total	
Tutor	ial	-	30	20		50	100	
				Cred	its: 3			
	· _ ·		Course	Objectives				
	To provid	the basics of	process control.	(ha mar 1 - 1	1 -	a a m 4 m - 1		
2	To provid	les the methodo	logy of modelling	the process and close	se loop	control.		
3	To provid	he overview of	advanced controlle	ontrollers for single	control	and multiver	ishle predictive	
4	control	lie overview of		is used in process	contro		able predictive	
	control.	Course	Outcomes (CO) w	ith Bloom's Taxor	10mv I	Level		
At the	end of the	course, the stud	ents will be able to	,				
						Bloom's	Bloom's	
CO		Cours	se Outcome Staten	nent/s	t/s Taxonom		Taxonomy	
						Level	Description	
<u>CO1</u>	Calculate	the various mo	dels of industrial p	rocesses.		III	Appling	
CO2	Analyze process c	the problems as ontrol system.	sociated with open	loop and close loop)	IV	Analyzing	
CO3	Evaluate	the performance	e of processes with	various convention	nal	V	Evaluating	
CO4	Design va	arious conventio	onal and advanced o	controllers for the		VI	Creating	
	processes	S						
	•			~				
Modu	ile Inte	aduation to Du	Module (Contents			Hours	
I	Intro Intro proc deve purp	oduction, Desig ess control sys clopment of a n oses, the input-	n aspects of a pro- tem. Mathematical nathematical mode putput model, degree	bcess control syste modeling and an l, Modeling consid ee of freedom.	em, Ha alysis leratior	rdware for a of processes, as for control	7	
II	II Modeling of Process Computer Simulation and linearization of nonlinear systems, Transfer functions and the Input-output models. Dynamic behavior of first-order systems second-order system and higher order systems					6		
ш	IIIFeedback Control of Process Elements of feedback control system, types of feedback controllers, sensors, Transmission lines, final control elements. Dynamic behavior of feedback- controlled process, Effect of proportional (p) control, Integral (I) control and derivative (D) control on the response of controlled process, effect of composite control actions					6		
IV	Mul Feec with inve rang forw F/F	ti Loop Contro lback control of large Dead tim rse response. Co e control, feed vard controllers, – F/B control.	I system with large c ne, Dead time compontrol systems with forward control, Ra practical aspects of	lead time or inverse pensation, and com n multiple loops, ca atio-control, proble n the design of feed	e respon trol of uscade m in d forwa	nse, processes systems with control, split- esigning feed rd controllers,	7	

	MIMO Process					
V	Multi-input, multi-output processes, degree of freedom and number of controlled and Manipulated variables, interaction and decoupling of control loops, relative gain array and selection of loops, design of non-interacting control loops. Overview of modern control methodologies: PLC, SCADA, DCS, Adaptive control, variable structure control.	6				
	Centralized Multivariable Control					
	Multivariable model predictive control, single-variable dynamic matrix control					
VI	(DMC) algorithm, multivariable dynamic matrix control, internal model control, smith predictive, model predictive control, process model based control, implementation guidelines. Process control design: sequence of design steps, statistical process control.	7				
	Textbooks					
1	"Chemical Process Control - An introduction to Theory and Practice"	", by George				
1	Stephanopoulos, Prentice-Hall of India, 1 st Edition 1984.					
	References					
1	"Process Control - Design Processes and Control System for Dynamic Performance	e", by Thomas				
I	E. Marlin, 2 nd Edition, McGraw Hill publication.					
2	"Process Control System – Application, Design and Tuning", by F.G. Shinskey, McGraw-Hill					
	Publication, 3 rd Edition, 1988.					
3	3 "Process Control Instrumentation Technology", by Curtis D. Johnson, 7 th Edition, Pearson					
	Useful Links					
1	https://nptel.ac.in/courses/103105064					
2	https://archive.nptel.ac.in/courses/103/101/103101142/					
L						

CO-PO Mapping							
		P	rogramme Ou	itcomes (POs)			
	PO1	PO2	PO3	PO4	PO5	PO6	
CO1	CO1 1 1						
CO2			1				
CO3				2			
CO4				2		1	
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High							
Each CO of the course must map to at least one PO.							

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

Professional Core Laboratory Courses

Walchand College of Engineering, Sangli							
			(Government Ala	7 2024-25	iuie)		
Course Information							
Progra	amme		M. Tech Control	and Instrumentatio	n		
Class,	Semester		First Year M. Tec	ch., Sem. I			
Course	e Code		1CI551				
Course	e Name		Linear Control Sy	vstems Lab			
Desire	d Requisi	tes:	Control System E	ngineering			
r	Feaching	Scheme		Examination	Scheme (Marks)	
Practi	cal	2 Hrs/ Week	LA1	LA2	Lab I	ESE	Total
Intera	ction	-	30	30	40)	100
				Cre	edits: 1		
1		1 (* 11		se Objectives	. 1 .	1	
1	To provid	de practical kno	wledge regarding r	nodelling of differe	ent physic	al systems.	
2	To impar	t skills to evalu	ate the performance	e of systems using	transient	analysis.	
3	To provid	de hands on ski	lis to estimate the s	tability of linear sy	stems.		
4	To provid	de skills to desi	gn state feedback a	nd optimal control	for linear	systems.	
<u> </u>	and of the		e Outcomes (CO)	with Bloom's Tax	conomy L	evei	
At the	end of the	course, the stud	ients will be able to),		Dloom?g	Dloom ² a
CO		Com	rsa Autooma Stata	mont/s		DIUUIII S Toyonomy	DIOOIII S Tevonomy
CO		Cou	ise Outcome State	ment/s		Lovol	Description
CO1	Constru	et and Analyze	nhysical systems u	using simulation to	ole		Applying
CO1	<u>Analyze</u>	the stability of	f systems using sta	ote space technique	e using		Apprying
02	simulatio	on tools.	systems using sta	tte space teeninque	cs using	IV	Analyzing
CO3	CO3 Assess the stability of linear control system based on State Transition Matrix using MATLAB code					V	Evaluating
CO4	Design p	ole placement	and state observer	controllers based	on state	VI	Creating
	feedback	design in MAT	TLAB code.			V1	Creating
			List of Experimen	ts / Lab Activities	/Topics		
List of	Lab Acti	vities:			, I opies		
1. Con	struct trans	sfer function us	ing software tools.				
2. Ana	lyze the ef	fect of feedbacl	k using software an	d simulation tools.			
3. Con	version of	transfer function	ons to state space ar	nd vice versa using	software	tools	
4. Calc	ulate the t	ransfer functior	of Electrical, Mec	hanical and Rotation	onal syste	ms using MA'	ГLAB
5. Calc	ulate the s	tate transition r	natrix, state and eig	gen values for Elect	trical Syst	tems.	
6. Eval	uate the tr	ansient respons	e of first and secon	d order systems.			
7. Com	pute the C	Controllability a	nd Observability of	f physical systems			
8. Stab	ility analy	sis of control sy	stem using softwar	re tools.			
9. Sket	ch root loo	cus and design of	compensator using	G.U.I. and softwar	e tools.		
10. De	sign pole p	placement contr	oller for physical s	ystem.			
11. De	sign LQR	using MATLA	В.				
				extbooks		2002	
1	<u>K. Og</u>	gata, "Modern (ontrol Engineering	g", 4th Edition, Pre	ntice Hall	i, 2002.	
2	<u>N. S.</u>	Nise, "Control	Systems Engineeri	ng", 6/e, Wiley Eas	stern, 201	0.	
3	<u> </u>	by Choudhuary,	"Modern Control	Engineering, PHI, 2	2005.		2002
4	Ashis	h Tewari, Mod	ern Control Design	: with MATLAB a	nd SIMU	LINK, Wiley,	2002.
				0			
	10.0	1.40	R	eterences	D 11.1	10	
1	<u> </u>	iopal, "Control	Systems: Principle	es and Design",4th	Edition, N	VICGraw Hill H	Education, 2012.
2	<u> </u>	Kuo, "Automa	tic Control System'	", 9th Edition, Pren	ntice Hall,	2010.	
3	R. C.	Dorf and R. H.	Bishop, "Modern	Control Systems",	Pearson E	ducation, 201	1.

Course Contents for F. Y. M. Tech. Control and Instrumentation Programme, Dept. of Electrical Engineering AY 2024-25

Useful Links					
1	https://nptel.ac.in/courses/108107115				
2	https://nptel.ac.in/courses/108106150				

CO-PO Mapping								
		Р	rogramme C	Outcomes (PO))			
	1	1 2 3 4 5 6						
C01			3	2				
CO2			3	2				
CO3			3	2		2		
CO4			3	2		2		
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High								

Each CO of the course must map to at least one PO.

	Assessment							
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%								
Assessment	Based on	Conducted by	Typical Schedule	Marks				
	Lab activities,		During Week 1 to Week 8					
LA1	attendance,	Lab Course Faculty	Marks Submission at the end of	30				
	journal		Week 8					
	Lab activities,		During Week 9 to Week 16					
LA2	attendance,	Lab Course Faculty	Marks Submission at the end of	30				
	journal		Week 16					
	Lab activities,	Lab Course Faculty and	During Week 18 to Week 19					
Lab ESE	journal/	External Examiner as	Marks Submission at the end of	40				
	performance	applicable	Week 19					
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing								
experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the								
nature and requ	irement of the lab	course. The experimental l	lab shall have typically 8-10 experim	ents and				
related activitie	es if any.							

Syllabus Prepared By	Dr. Mrs. A. S. Karvekar
Syllabus Checked By	

Walchand College of Engineering, Sangli								
	AY 2024-25							
			Cours	e Information				
Progra	amme		M. Tech. Control	and Instrumentation	on			
Class,	Semester		First Year M. Teo	ch., Sem. I				
Cours	e Code		1CI552					
Cours	e Name		PLC and Embedo	led Control Lab				
Desire	d Requisi	tes:	Electrical Measur	rement and Instrum	entation			
			I					
	Teaching	Scheme	.	Examination	Scheme (Marks)		
Practi	<u>cal</u>	2 Hrs/ Week				<u>ESE</u>	Total	
Intera	ction	-	30	30	40)	100	
				Cre	eaits: 1			
			Cour	sa Objectives				
1	The lab (course is aimed	to develop program	nming skills using	PLC for I	ndustrial A	utomation	
2	The cour	se intends to in	troduce the use of]	PLC for solving rea	al world m	roblems	atomation	
3	It will en	able students to	use PLC for contr	ol applications in e	lectrical e	engineering		
	The lab c	course will enab	ble students to integ	grate PLC. SCADA	and HMI	for various	s projects in	
4	industria	l automation	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2				~ F- J	
		Cours	e Outcomes (CO)	with Bloom's Tax	konomy L	evel		
At the	end of the	course, the stu	dents will be able t	0,				
						Bloom's	s Bloom's	
CO		Cou	rse Outcome State	ement/s		Taxonom	ny Taxonomy	
						Level	Description	
CO1	Demons	trate skills to c	lesign, write, and t	roubleshoot PLC p	rograms	III	Applying	
	using var	rious programm	ing languages such	n as ladder logic		TTT	A	
C02	Execute	experiments ba	ised on PLC and So	ADA systems.	lity and		Applying	
	operation	al efficiency ir	industries	to improve renadi	inty and	1 V	Anaryzing	
CO4	Design 1	adder logic pro	grams for various F	PI C applications		VI	Creating	
	Design	udder logie proj		Le applications.		11	Creating	
			List of Experimen	ts / Lab Activities	/Topics			
List of	f Lab Acti	vities:						
1.	To under	rstand and impl	ement the function	ality logic gates usi	ng PLC			
2.	Impleme	ent ladder diagra	am for ON/OFF an	d latching function	s.			
3.	Design o	of PLC program	for motor reversal	control.				
4.	Illustrate	stair case light	ing using PLC prog	gramming.				
5.	Dosign of	of PLC program	for various arithm	mation.				
0.	Design C Devise fl	he PLC program	n for traffic control	system				
8.	Devise a Design o	of ON/ OFF con	trol mechanism us	ing PLC timer func	tions.			
9.	Design c	of basic applicat	ions employing PL	C counter function	S.			
10.	Design o	of basic applicat	ions employing PL	C analog inputs.				
11.	11. Demonstrate analog input operations using PLC							
			T	extbooks				
1	John	W. Webb, Ron	ald A. Reis, Prog	rammable logic con	ntrollers, p	principles &	& applications, PHI	
	publi	cation, Eastern	Economic Edition,	<u>1994.</u>	1:4: a - TTT /	2006		
2	Gary	uunning, Introc	Drogrammable I	oinson learning, Ec	Edition III, 2	2000. Foto Marcus	au Uill Naw Varl-	
3	2010	D. Feiruzella,	FIOGRAMMADIE LOS	gie Controllers, 3rd	cultion,	i ata MCGfa	aw mill, inew York,	
		uchhanda Mit	ra Samariit Sen	ounta Programme	able logi	c controlle	ers and Industrial	
4	Auto	mation: An Intr	oduction. Penram	International. Editional	on II. 2017	7.	and mousular	
	1 1000			Latti				

	References					
1	John R. Hackworth and Peterson, PLC controllers programming methods and applications, PHI,					
	2004.					
2	Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition Systems, 4th Edition, ISA					
2	Press, 2010.					
3	William H. Bolton, Programmable logic controllers, Newnes, Edition VI, 2006.					
	Useful Links					
1	Industrial Automation and Control, IIT Kharagpur					
1	Prof. S. Mukhopadhyay, Prof. S. Sen https://nptel.ac.in/courses/108105063					
2	NOC:Industrial Automation and Control, IIT Kharagpur: https://nptel.ac.in/courses/108105088					

CO-PO Mapping						
		l	Programm	e Outcom	es (PO)	
	1	2	3	4	5	6
CO1			3		3	
CO2				3	3	
CO3					3	3
CO4				3	3	

	Assessment							
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%								
Assessment Based on Conducted by Typical Schedule Mar								
	Lab activities,		During Week 1 to Week 8					
LA1	attendance,	Lab Course Faculty	Marks Submission at the end of	30				
	journal		Week 8					
	Lab activities,		During Week 9 to Week 16					
LA2	attendance,	Lab Course Faculty	Marks Submission at the end of	30				
LA1 attenda journ Lab activ LA2 attenda journ Lab activ Lab activ	journal		Week 16					
	Lab activities,	Lab Course Faculty and	During Week 18 to Week 19					
Lab ESE	journal/	External Examiner as	Marks Submission at the end of	40				
	performance	applicable	Week 19					
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing								
experiments, m	ini-project, preser	ntations, drawings, program	ming, and other suitable activities, a	s per the				
nature and requ	irement of the lab	o course. The experimental	lab shall have typically 8-10 experim	ents and				

Syllabus Prepared By	Dr. S. S. Karvekar
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related activities if any.

Walchand College of Engineering, Sangli								
(Government Aided Autonomous Institute)								
	Course Information							
Progre	amma		M Tech Contr	ol and Instrument	ation			
Class	Somostor	•	First Vear M T	ech Sem I				
Class,	Semester	- -						
Cours			Due soon Lu struur	autotion Lab				
Cours		• 4	Process Instrum					
Desire	a Requis	ites:	Control System	Engineering				
Teaching Scheme Examination Scheme (Marks)								
Practi	cal	2 Hrs/ Week	LA1	LA2	Lab	ESE	Total	
Intera	ction	-	30	30	4	0	100	
				<u> </u>	redits: 1	•	100	
		1	1					
			Сош	rse Obiectives				
1	To prov	ide the foundati	on level knowledg	e of Process Cont	rol.			
2	To prov	ide the basics fo	or mathematical mo	odel of the proces	s.			
3	To provi	ide the knowled	ge of various types	s of controller for	single loo	p and multi	-loop control sy	stem.
4	To prov	ide the knowled	ge of advanced co	ntrollers used in p	process co	ntrol.		
5	Provide	the knowledge	of multivariable p	redictive control.				
	1	Cours	se Outcomes (CO) with Bloom's T	axonomy	v Level		
		At	the end of the cour	rse, the students w	ill be abl	e to,		
СО		Cour	rse Outcome State	ement/s		Bloom's Taxonom Level	s Bloom' ny Taxonor Descripti	's ny ion
CO1	Apply e	experimental n	nethods to determ	nine the model o	f	TIT	Applyin	ıg
	process	es in Process (Control Systems.			111		
CO2	Apply th	ne tuning techni	ques for various co	ontrollers.		III	Applyin	ıg
CO3	Demons	trate the use of	advanced controlle	ers.		III	Applyin	ıg
CO4	Evaluate	e the performan	ce of given Process	s Control system.		V	Evaluati	ng
			List of Experime	nts / Lab Activiti	es/Topics	5		
 List of Lab Activities: Step response of first order system (single capacity system). Step response of multi capacity process (coupled tank system). Closed loop computer controlled pressure control system. Tuning of P PI and PID controllers based on process reaction curve and Ziegler Nichols method. Closed loop computer controlled level control system. Closed loop computer controlled flow control system. Closed loop computer soft for level control system. Tuning of controllers for level control system. Tuning of controllers for flow control system. Study of cascade controller for a flow control system. Study of PLC and its process controlled applications. 								
	Textbooks							
1	Pren	tice-Hall of Indi	ia, 1 st Edition 1984	tocess Control	An introd	iuction to 1	neory and Prac	uce",
1	Thor Perfo	nas E. Marlin, ormance, 2 nd Ed	"Process Contro ition", McGraw H	xeterences 1 - Design Proce ill publication.	esses and	Control S	System for Dyn	namic

2	F.G. Shinskey, "Process Control System – Application, Design and Tuning", McGraw-Hill Publication, 3 rd Edition, 1988.				
3	Curtis D. Johnson, "Process Control Instrumentation Technology", 7 th Edition, Pearson Education, 7 th Edition. 2003.				
Useful Links					
1					

CO-PO Mapping							
		Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6	
CO1	2		1				
CO2				1		1	
CO3				2		2	
CO4			2				
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High							
Each CO of the course must map to at least one PO.							

	Assessment						
There are three components of lab assessment, LA1, LA2 and Lab ESE.							
IMP: Lab ESE	is a separate head	of passing.(min 40 %), LA	1+LA2 should be min 40%				
Assessment Based on Conducted by Typical Schedule Marks							
	Lab activities,		During Week 1 to Week 8				
LA1	attendance,	Lab Course Faculty	Marks Submission at the end of	30			
	journal		Week 8				
	Lab activities,		During Week 9 to Week 16				
LA2	attendance,	Lab Course Faculty	Marks Submission at the end of	30			
	journal		Week 16				
	Lab activities,	Lab Course Faculty and	During Week 18 to Week 19				
Lab ESE	journal/	External Examiner as	Marks Submission at the end of	40			
	performance	applicable	Week 19				
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing							
experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the							
nature and requ	irement of the lab	course. The experimental l	ab shall have typically 8-10 experim	ents and			
related activitie	es if any.						

Professional Elective Theory Courses

Walchand College of Engineering, Sangli								
(Government Aided Autonomous Institute)								
Course Information								
Progra	Programme M. Tech Control and Instrumentation							
Class,	Semester		First Year M. Tec	h., Sem. I				
Cours	e Code		1CI511	,				
Cours	e Name		Professional Elect	ive 1: Advanced Digital	Signal Processi	ng		
Desire	Desired Requisites: Digital Signal Processing							
			1					
	Teaching	Scheme		Examination Schem	e (Marks)			
Lectur	re	3 Hrs/week	MSE	ISE	ESE	Total		
Tutori	ial	-	30	20	50	100		
				Credits: 3	•			
			Course	Objectives				
1	To impar	t skills for analy	vzing discrete time s	vignals using transforms				
2	To make	students familia	r with methods of c	ligital filters design				
3	To impar	t basic knowled	ge of random signal	processing				
4	To introd	luce the concept	of signal modelling	. <u> </u>				
	10 11100	Course	Outcomes (CO) w	,. vith Bloom's Taxonomy	Level			
At the	end of the	course, the stud	ents will be able to,	,				
					Bloom's	Bloom's		
CO	CO Course Outcome Statement/s Tax					Taxonomy		
	Level							
CO1	CO1Apply transforms to discrete time signals for analysis.III					Applying		
CO2 Analyze the properties of discrete time systems and random signals					Analyzing			
	processin	lg.						
CO3	Evaluate	e digital filters, s	tructures, and discr	ete time random signals.		Evaluating		
<u>CO4</u>	Design d	igital filters for	desired specification	ns.	VI	Creating		
Modu	ام		Modula	ontants		Hours		
WIUUU	Discr	ete time signal	and system			110015		
T	Class	ification of sig	and system mals operation of	n sequences propertie	s of systems	6		
-	convo	olution sum, san	pling process.	n sequences, properties	, or systems,	0		
	Discr	ete Time Fouri	er Transform			7		
	DFT,	FFT, DIT FFT,	DIF FFT algorithm	, circular convolution.		/		
	Digita	al filter structu	re					
	review	w of z - transfe	orm, transfer func	tion classification, IIR	and FIR filter			
Ш	chara	characteristics, complementary transfer function, inverse system, digital two-						
	pairs,	algebraic sta	bility test, block	diagram representatio	n, equivalent			
	struct	ures, FIR and II	R digital filter struc	tures, all pass filters, lat	tice structures,			
	all pa	ss realization of	TIR transfer functio	on.				
		al Filler Design	l hyshav filtars IIP f	ilter design impulse inv	ariant method	7		
1 V	biline	ar transformatic	on FIR filter design	inter design, impulse mv	arrant methou,	/		
	Discr	ete Time Rand	om Processes	•				
v	Revie	w of linear alg	ebra, quadratic and	d Hermitian form, rand	lom variables.	6		
	rando	m processes, fil	tering random proce	esses, special type of rand	lom processes.	0		
	Signa	l Modelling	<u> </u>	, 1	I			
VI	Least	square method	, Pade approximati	on, Prony's method, FI	R least square	6		
	inverse filters.							
			Tex	atbooks				
1	Sanji	t Mitra , "Digita	l Signal Processing	", Tata McGraw Hill Pu	ublication, 3rd E	dition, 2008.		
2	Mons	on Hayes , "Sta	tistical Signal Mode	elling", John Wiley 200	2.			
3	Rao &	& Gejji, "Digital	Signal processing'	', Pearson Education, 2 nd	¹ Edition, 2008.			

References						
1	Oppenheim Schafer, Ronald, "Discrete Time Signal Processing", Pearson Education, 2 nd Edition, 1999.					
2	Ifeachor, Jerris, "Discrete Signal Processing", Pearson Education, 2 nd Edition, 2002.					
3	Ashok Ambardar, "Digital Signal Processing: A Modern Introduction", Thomson, 2007.					
Useful Links						
1	https://nptel.ac.in/courses/117102060					

CO-PO Mapping							
	Programme Outcomes (PO)						
	1	2	3	4	5	6	
CO1			3				
CO2			3				
CO3				3			
CO4				3			

Assessment

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

Syllabus Prepared By	Dr. Mrs. A. S. Karvekar
Syllabus Checked By	

	Walchand College of Engineering, Sangli							
		(•	AY	2024-25				
Course Information								
Progr								
Class.	Semest	er	First Year M. Te	ech., Sem. I				
Cours	se Code	-	1CI512	1CI512				
Cours	se Name		Professional Elec	tive 1: Optimization	Fechniques			
Desire	ed Requ	isites:	-	-	-			
Teaching Scheme Examination Scheme (Marks)								
Lectu	Lecture 3 Hrs./week		MSE	ISE	ESE	Total		
Tutor	ial	-	30	20	50	100		
				Credits	:3			
			Course	Objectives				
1	To dev	elon basic know	vledge of Optimiz	ation Techniques				
2	To prov	vide skills for cl	assical optimizati	on techniques for an	nlications in en	gineering		
3	To jmr	art skills for Sir	gle-variable and	multivariable optimi	zation algorith	ns		
	It will	nake students to	study and imple	ment the application	s related Non-tu	raditional		
4	4 Optimization Algorithms							
Course Outcomes (CO) with Bloom's Taxonomy Level								
At the	At the end of the course, the students will be able to,							
					Bloom's	Bloom's		
CO		Course	Outcome Statement/s		Taxonomy	Taxonomy		
					Level	Description		
CO1	Apply	the concepts of	Optimization Tec	hniques	III	Applying		
CO2	Apply	Optimization Te	echniques to deve	lop solutions to	III	Applying		
CO3	Implen	the applicat	ions related to Si	nole-variable and		Applying		
	multiva	ariable optimiza	tion algorithms	ingre variable and	III	rippijing		
CO4	Implen	nent the applicat	ions related Non-	traditional	TTT	Applying		
	Optimi	zation Algorith	ns					
Modu	le		Module C	ontents		Hours		
		roduction to Op	ptimization		,.			
т	H1S Stat	corical Develop	timization Drobler	g Applications of Opt	Imization,	0		
1	Drol	blems. Optimize	ution Techniques	Solution of Optimize	option			
	Pro	blems Using M	ATI AR	Solution of Optimiza	ation			
		ssical Optimiza	tion Techniques					
	Intr	oduction, Single	-Variable Optimi	zation, Multivariable	2			
	Opt	imization with I	No Constraints an	d with Equality Con	straints,			
	II Direct Substitution, Lagrange Multipliers, Multivariable Optimization							
	with Inequality Constraints, Kuhn–Tucker Conditions, Constraint							
	Qua	lification, Con	vex Programming	Problem.				
	Lin	ear Programm	ing I: Simplex M	lethod				
Ш	Intr	oduction, Appli	cations of Linear	Programming, Stand	ard Form of a	6		
		ear Programmin	g Problem, Simpl	lex Algorithm, Two l	Phases of the	, v		
	S1m	Simplex Method, MATLAB Solution of LP Problems.						

IV	Single-variable Optimization Algorithms Optimality Criteria ,Bracketing Methods , Exhaustive search method , Region-Elimination Methods ,Interval halving method, Golden section search method, Point-Estimation Method, Successive quadratic estimation method ,Gradient-based Methods, Newton-Raphson method, Bisection method. MATLAB Solution of One-Dimensional Minimization Problem.	7
V	Multivariable Optimization AlgorithmsOptimality Criteria, Unidirectional Search, Direct Search MethodsSimplex search method, Powell's conjugate direction method ,Gradient-based Methods ,Cauchy's (steepest descent) method,Newton's method , MATLAB Solution of Optimization Problems.	7
VI	Non-traditional Optimization AlgorithmsEvolutionary algorithms, Genetic Algorithms ,Working principles,Differences between GAs and traditional methods, GAs forconstrained optimization, Simulated Annealing, particle swarm andartificial bee algorithms, Modern nature inspired algorithms.	7
	Textbooks	XXZ'1 0
1	Singiresu S. Rao, "Engineering Optimization Theory and Practice", Jon Sons,4 th Edition,2009.	n wiley &
2	Kalyanmoy Deb, ' <i>Optimization For Engineering Design: Algorithms An</i> Prentice-Hall of India Private Limited, 1995.	nd Examples',
	References	
1	Chankong, V., Haimes, Y. Y, 'Multiobjective Decision Making Theory of Methodology.' New York: North-Holland Pub., 1983.	ınd
2	David E. Goldberg, 'Genetic Algorithms in Search, Optimization, and Learning', Addison Wesley, 1995.	Machine
	Useful Links	

CO-PO Mapping							
	Programme Outcomes (PO)						
	1	2	3	4	5	6	
C01			3				
CO2			3				
CO3				3			
CO4				3		2	

Assessment

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Mr. A.B. Patil
Syllabus Checked By	

Course Contents for F. Y. M. Tech. Control and Instrumentation Programme, Dept. of Electrical Engineering AY 2024-25

Walchand College of Engineering, Sangli								
	AY 2024-25							
	Course Information							
Progr	amme		M. Tech. Control	and Instrumentation	1			
Class.	Semester		First Year M Tec	ch Sem I	•			
Course Code 10			1CI513	1CI513				
Cours	e Name		Professional Ele	ective 1. Modern Co	ontrol Systems			
Desire	d Requisi	tes:	Linear Control S	Systems	Juitor Bystems			
Teaching Scheme Examination Scheme (Marks)								
Lectur	re	3 Hrs/week	MSE	ISE	ESE	Total		
Tutor	ial	-	30	20	50	100		
Tuton				Cred	its: 3	100		
		1	1	0104				
			Course	e Obiectives				
1	To provi	de the basics of	modeling of the phy	vsical system. analy	sis.			
2	To provi	des the methodo	logy of designing t	he controller with re	alization.			
3	To give a	n overview of a	dvanced controller	s like LOR.				
	Incorpora	ate practical imp	elementation consid	lerations into contro	ller design method	ologies, including		
4	issues su	ch as hardware	imitations, sensor i	noise, and actuator c	onstraints.	0, 0		
	1	Course	Outcomes (CO) v	vith Bloom's Taxor	omy Level			
At the	end of the	course, the stud	ents will be able to	,	V			
					Bloom's	Bloom's		
СО		Cours	e Outcome Statement/s		Taxonom	Taxonomy		
					Level	Description		
CO1	Demonst	rate the ability t	o apply controller d	lesign techniques.	III	Applying		
CO2	Analyze	various controll	er structures.		IV	Analyzing		
CO3	Evaluate	controller perfo	rmance using vario	ous control algorithm	is. V	Evaluating		
CO4	Design a	controller to me	et given nerformar	nce specification	VI	Creating		
	Design u					Crouting		
Madu	la		Madula	Nomtonta		II.		
Nioau	le Cont	nollon Structur	Niodule (ontents		Hours		
	Ead	forward control	lors one degree of	fraadom Two daar	o of frondom. I ac			
I	Lead	controller PIC	Controller Well	behaved signal So	lving Arvabhatta?	- 7		
	Ident	ity	Controller, wen	benaved signal, 50	Iving Aryaonana	5		
	Cont	ny. roller Realizati	on					
	Direct structure Canonical and non-canonical structure Cascade and parallel			1 _				
II	realiz	ation. PID cont	roller Implementati	on. Microcontroller	implementation of	f 7		
	$1^{st}, 2^{r}$	^d and higher ord	ler modules, Choice	e of Sampling interv	al.			
	PID	Controller	· · · · · ·	1 0				
	Intro	luction, samplin	ng, discretization to	echniques, PID con	troller, methods of	f		
	tunin	g, 2-DOF contr	oller with integral	action, bumpless F	ID controller, PII) 0		
	with	filtering, 2-DOF	PID, systems with	delay.				
	Pole	Placement Con	trollers					
	Dead	-Beat and Dahl	in Control, Pole P	lacement Controller	with performance	e		
IV	speci	fications, Impl	ementation of U	nstable Controllers	, Internal Mode	1 7		
1,	Princ	iple for Robustr	ess, Redefining Go	ood & Bad Polynom	ials, Comparing 1	- , ,		
	DOF	& 2-DOF Contr	ollers, Anti Windu	p Controller, PID Tu	ining Through Pol	e		
	Place	ment Control.	· · · · · · · · · · · · · · · · · · ·					
	Pole	Placement Con	troller with IMC					
v	Smith	Predictor, Inte	rnal Model Control	(IMC), IMC Desig	n tor Stable Plants	6		
	IMC	in Conventiona	I Form for Stable I	Plants, PID Tuning	Through IMC, an	d Ŭ		
	IMC design fo unsta		ole plant, LQR throu	ugh pole placement.				

VI	State Space Technique to Control Design Pole placement, Ackerman formula, controllability, estimators, prediction estimators, observability, current estimators, regulator design, combined control law and estimator, LQR, kalman filter design.	6
	Textbooks	
1	"Digital Control", by Kannan M. Moudgalya, John Wiley and Sons Ltd., 2007.	
2	<i>"Microcontroller Based Applied Digital Control"</i> , by Dogan Ibrahim, John Wile Edition 2006.	ey and sons Ltd.,
	References	
1	<i>"Digital Control Engineering Analysis and Design"</i> , by M. Sami Fadali and An vier publication 2 nd Edition 2013.	toni Visioli Else
2	"Discrete Time Control System" By Katsuhiko Ogata, Pearson Education 2 nd Ed	ition 2005.
	Useful Links	
1	http://moudgalya.org/	

CO-PO Mapping						
		Pro	gramme Out	comes (POs)		
	PO1	PO2	PO3	PO4	PO5	PO6
C01				3	2	
CO2				3		
CO3			2			
CO4				3		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High						
	Each CO of t	he course mus	t map to at lea	st one PO.		

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

Syllabus Prepared By	
Syllabus Checked By	

Walchand College of Engineering, Sangli						
AY 2024-25						
Course Information						
Programme M. Tech. Control and Instrumentation						
Class,	Semester	•	First Year M. Tec	h., Sem. I		
Cours	e Code		1CI514			
Cours	e Name		Professional Elect	tive 2: Advanced Transe	lucers and Me	asurement
			Technique			
Desired Requisites: Basic Electronics, Instrumentation, Linear Control Systems, Digital Signal Processing Signal Processing				ems, Digital		
	Teaching	Scheme		Examination Sche	ne (Marks)	
Lectur	re	3 Hrs/week	MSE	ISE	ESE	Total
Tutori	ial	-	30	20	50	100
				Credits:	3	
			Course	Objectives		
1	To unde	rstand about mea	asurement systems a	and their classification		
2	To unde	rstand about erro	ors in measurement	systems and calibration	of measureme	ent systems
2	To enab	le the students to	select and design s	uitable instruments to n	neet the requir	ements of
3	industria	applications an	id various transduce	ers used for the measure	ment of variou	us physical
1	Toundo	rstand about Var	ious types of Sansa	re & Transducare and th	oir working n	rinciplo
4	10 unde		Outcomes (CO) v	with Bloom's Taxonom	v Lovol	incipie.
At the	end of the	course the stud	ents will be able to		y Level	
		course, the stud		,	Bloom's	Bloom's
CO	CO		se Outcome Statement/s Taxonom		Diooni s	
CO Course Outco			se Outcome Staten	nent/s	Taxonom	y Taxonomy
		Cours	se Outcome Statem	nent/s	Taxonom Level	y Taxonomy Description
C01	Apply th	ne concepts and plications.	brinciples of differe	nent/s	Taxonom Level III	y Taxonomy Description Applying
CO1 CO2	Apply th in practi Apply	cours the concepts and p cal applications. the principles	principles of differe and operation of	nent/s nt types of transducers various pressure and	Taxonom Level III	y Taxonomy Description Applying Applying
CO1 CO2	Apply th in practi Apply tempera	the principles	be Outcome Statem principles of differe and operation of at devices in real wo	nent/s nt types of transducers various pressure and ord scenarios.	Taxonom Level III	y Taxonomy Description Applying Applying
C01 C02 C03	Apply th in practi Apply tempera Apply th	the principles ture measuremer the basic principle	erinciples of differe and operation of at devices in real wo es of different flow	nent/s nt types of transducers various pressure and ord scenarios.	Taxonom Level III III III	y Taxonomy Description Applying Applying Applying
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IV	Pressure and Temperature Measurement Techniques Temperature measurement: Filled-in thermal systems- Bimetallic thermometers - RTD, Thermistor, Thermocouple - Radiation and Optical pyrometers - Digital IC thermometers - Accuracy, errors, and compensation.	7
V	Flow Measurement Methods Flow measurement: Head flow meters- types, Area flow meters- Rotameter bypass rotameter-Turbine meter. Electromagnetic flowmeter – Principle – DC AC and pulsed type. Ultrasonic flow meters – Principles – transit time – Doppler shift – beam deflection– Cross correlation flowmeters. Vortex flowmeters - Coriolis flowmeters- Solid flow measurement- conveyor belt type. Installation and Calibration procedures of various flowmeters	б
VI	Level Measurement and Other Techniques Level Measurement: Conductive and Capacitive methods –Ultrasonic, Microwave and RADAR level sensors - Solid level measurement by Paddlers method. Capacitance method for powder level measurement. Density, Viscosity and PH measurement.	6
	Textbooks	
1	Patranabis.D., "Principles of Industrial Instrumentation," McGraw-Hill Publ 1984.	ishingCompany,
2	D. V.S.Murthy, Transducers in instrumentation, Prentice Hall, 1995.	
3	Ernest. O. E. Doebelin, "Measurement Systems", McGraw-Hill publishing co	ompany, 1990.
	References	
1	Bela G. Liptak, Process measurement and Analysis-Instrument Engineers' Ha Third edition- Butterworth Heinemann publishing company	andbook- Vol. I
2	James.W.Dally, "Instrumentation for Engineering Measurement", John Will 1993.	ey &Sons, Inc.,
	Useful Links	

1 https://www.coursera.org/learn/sensors-circuit-interface

CO-PO Mapping						
		Pr	ogramme Out	comes (POs)		
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2	2		2			
CO3	2		3	3		
	3			3		
The strength	h of mapping is to	be written as	1,2,3; Where,	1:Low, 2:Medi	um, 3:High	

Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

	Walchand College of Engineering, Sangli (Covernment Aided Autonomous Institute)					
	(Government Atded Autonomous Institute)					
				2024-25 Information		
Drogr	ommo		M Tash Contro	and Instrumentation		
Close	Somosto		M. Tech. Contro Einst Voor M. T.	and instrumentation		
Class, Semester			TIISU I CAI MI. IC			
Cours	Course Name Professional Elective 2: Smart Sensors and Actuators					
Cours	se Name		Professional Ele	Digital Signal Procession	and Actuators	b tion and
Desire	ea kequi	sites:	Measurement	, Digital Signal Processin	g, instrumenta	non, and
]	Feaching	Scheme		Examination Schem	e (Marks)	
Lectu	re	3 Hrs./week	MSE	ISE	ESE	Total
Tutor	ial	-	30	20	50	100
				Credits: 3		
			Course	Objectives		
1	To deve	lop basic know	ledge of Sensor S	ystems In Engineering		
2	To prov	ide skills for In	tegrated Smart Sen	sors		
3	To impa	rt skills for Im	plementation of 1	Micro machined Actuator	s	
4	It will n	ake students to	study Communi	cation And Standards F	or Smart Sens	sors
	Course Outcomes (CO) with Bloom's Taxonomy Level					
At the end of the course, the students will be able to,						
					Bloom's	Bloom's
CO			e Outcome Statement/s Taxonom		Toyonom	Toyonomy
v Level			e Outcome State	menu/s	Галонони	Гахоношу
				ment/s	y Level	Description
C01	Apply th	ne basic Sensor	Systems In Engi	neering	y Level	Description Applying
CO1 CO2	Apply the Apply In	ne basic Sensor	Systems In Engi	neering	y Level III III	Description Applying
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CO1 CO2 CO3 CO4 Modu	Apply the Apply the Apply the Apply the Implement Sensors and the Apple	ne basic Sensor Integrated Smart ent Micro machinent the Communication or Systems In E of sensors and section scenarios ication examples	Systems In Engi Sensors ined Actuators nication And Star Module (Ingineering ensor systems – Inr - Instrumentation Smart sensor, bas	neering ndards For Smart Contents novative sensor Technolo Process – Instrumentation sics - General sensing syst	gies, Steps, tem. Classical	Taxonomy Description Applying Applying Applying Applying Hours 7
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CO1 CO2 CO3 CO4 Modu	Apply the sensors of the sensors of the sensor of the sens	ne basic Sensor itegrated Smart ent Micro machi- ent the Commu- or Systems In E of sensors and se- ication scenarios ication examples r Model – Smar id integrated sm- al Conditionin umentation Am-	Systems In Engi Sensors ined Actuators nication And Star Module (Ingineering ensor systems – Ini - Instrumentation S. Smart sensor, bas t sensor model – M art sensor. Ing For Smart Ser polifier , Step model Capacitor Ampli	neering ndards For Smart Contents novative sensor Technolo Process – Instrumentation Sics - General sensing syst fonolithic integrated smar Isors le operational amplifier ifier , 4 to 20 mA Signa	y Level III III III III gies, a Steps, tem, Classical t sensor -	Taxonomy Description Applying Applying Applying Hours 7 7
CO1 CO2 CO3 CO4 I I II	Apply the Apply the Apply the Implement of Sensors of Apple Apple Apple Apple Apple Sensor of Hybre Sign Instruction (Op-A), Inhered (Sensor Apple App	ne basic Sensor ntegrated Smart ent Micro machi- ent the Commu- or Systems In E of sensors and si- cation scenarios ication scenarios ication examples r Model – Smar id integrated smi al Conditionin umentation Am Amp , Switched erent power suj	Systems In Engi Sensors ined Actuators nication And Stat Module (ingineering ensor systems – Inf - Instrumentation s. Smart sensor, bas t sensor model – M art sensor. ing For Smart Ser pilifier , Step mod l Capacitor Ampli oply rejection, Se	neering neering Contents Contents Novative sensor Technolo Process – Instrumentation Sics - General sensing syst Conolithic integrated smar Sors le operational amplifier ifier , 4 to 20 mA Signa parate Versus Integrate	y Level III III III III III III III sensor -	Taxonomy Description Applying Applying Applying Hours 7 7
CO1 CO2 CO3 CO4 Modu	Apply the Apply the Implement of Sensors of Apple Apple Apple Apple Apple Sensor of Apple Sens	ne basic Sensor ntegrated Smart ent Micro machine ent the Communi- or Systems In E of sensors and section scenarios ication examples r Model – Smarting id integrated smarting al Conditioning umentation Among Switched erent power sup- litioning ,Digit	Systems In Engi Sensors ined Actuators nication And Star Module (Ingineering ensor systems – Init s - Instrumentation s Smart sensor, bas t sensor model – M art sensor. Ing For Smart Sen pilifier , Step mod l Capacitor Ampli oply rejection, Sen al Conversion.	neering ndards For Smart Contents Novative sensor Technolo Process – Instrumentation Sics - General sensing syst Jonolithic integrated smar Isors de operational amplifier ifier , 4 to 20 mA Signa parate Versus Integrated	y Level III III III III III III III III ransmitter d Signal	Taxonomy Description Applying Applying Applying Hours 7 7
CO1 CO2 CO3 CO4 Modu	Apply the sensors of the sensors of the sensor of the sens	ne basic Sensor ntegrated Smart ent Micro machi ent the Commu or Systems In E of sensors and se ication scenarios ication examples r Model – Smar id integrated smart al Conditionin umentation Am Amp , Switched erent power sup litioning ,Digit rated Smart Se	Systems In Engi Sensors ined Actuators nication And Stat Module (Ingineering ensor systems – Inf - Instrumentation s. Smart sensor, bas t sensor model – M art sensor. Ing For Smart Ser pilifier , Step mod I Capacitor Ampli poply rejection, Sej al Conversion.	neering ndards For Smart Contents novative sensor Technolo Process – Instrumentation Sics - General sensing syst fonolithic integrated smar Isors de operational amplifier ifier , 4 to 20 mA Signa parate Versus Integrated	y Level III III III III III III III sigies, a Steps, tem, Classical t sensor -	Taxonomy Description Applying Applying Applying Hours 7 7
CO1 CO2 CO3 CO4 I I II	Apply the Apply the Implement of Sensors of Sensors of Apple Apple Apple Apple Sensor of Apple	ne basic Sensor ntegrated Smart ent Micro machi- ent the Commu- or Systems In E of sensors and s- ication scenarios ication scenarios ication examples r Model – Smar id integrated smart al Conditionin umentation Am Amp , Switched erent power sup litioning ,Digit rated Smart Second	Systems In Engi Sensors ined Actuators nication And Stat Module (ingineering ensor systems – Inr - Instrumentation s. Smart sensor, bas t sensor model – M art sensor. g For Smart Ser polifier , Step mod l Capacitor Ampli poly rejection, Ser al Conversion. nsors erface, MCU's for	neering ndards For Smart Contents novative sensor Technolo Process – Instrumentation sics - General sensing syst conolithic integrated smar Isors le operational amplifier ifier , 4 to 20 mA Signa parate Versus Integrated sensor interface, DSP for	y Level III III III III III III III III III I	Taxonomy Description Applying Applying Applying Hours 7 7
CO1 CO2 CO3 CO4 Modu I II	Apply the sensors of the sensors of the sensor of the sens	ne basic Sensor ntegrated Smart ent Micro machi ent the Commu- or Systems In E of sensors and se ication scenarios ication examples r Model – Smar id integrated smart al Conditionin umentation Am Amp , Switched erent power sup litioning ,Digit rated Smart Se polithic sensor int ace, Techniques	Systems In Engi Sensors ined Actuators nication And Stat Module (ingineering ensor systems – Init - Instrumentation s. Smart sensor, bas t sensor model – M art sensor. g For Smart Ser polifier , Step mod l Capacitor Ampli oply rejection, Se al Conversion. nsors erface, MCU's for and system consid ange Diagnostics	neering ndards For Smart Contents novative sensor Technolo Process – Instrumentation Sics - General sensing syst Ionolithic integrated smar Isors le operational amplifier ifier , 4 to 20 mA Signa parate Versus Integrated sensor interface, DSP for erations: Linearization, P Software tools and suppo	y Level III III III III III III III III sensor - r,Rail to rail I transmitter d Signal sensor WM Control, rt Sensor	Taxonomy Description Applying Applying Applying Hours 7 7 6

IV	Micro machined Actuators Micro valves, Micro motors, Micro Pumps, Micro dynamometer, Micro steam engines, Actuators in other semiconductor materials, Various Micro machined structures: Cooling channels, Micro optical actuator, Micro grippers.	7
V	Communication And Standards For Smart Sensors Automotive Protocols, CAN protocol, Industrial networks. Industrial usage of CAN, Protocols in Silicon: MI-Bus. IEEE 1451 family of standards, Extending the system to network.	7
VI	Introduction To Internet Of Things Overview of Internet of Things, The Edge, Cloud and the Application, Development, Anatomy of the Thing, Industrial Internet of Things (IIoT - Industry 5.0), Real Time Diagnostics, Design and Development for IoT.	5
	Textbooks	
1	Randy Frank, "Understanding Smart Sensors", 3rd Edition, Artech House, 2013.	
2	Ananthasuresh G K, Vinoy K J, Gopalakrishnan S, Bhat K N, Aatre V K, <i>Smart Systems</i> ", Wiley Publishers, 2011.	"Micro and
	References	
1	Subhas Chandra Mukhopadhyay, "Smart Sensors, measurement and Instr Springer Heidelberg, New York, 2013.	umentation",
2	Gerord C M Meijer, "Smart Sensor Systems", John Wiley and Sons, 2008	
	Useful Links	

CO-PO Mapping						
		Р	rogramme (Outcomes (PO))	
	1	2	3	4	5	6
CO1			3			
CO2			3			
CO3				3		
CO4				3		2

Assessment

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

Syllabus Prepared By	Mr. A.B. Patil
Syllabus Checked By	

	Walchand College of Engineering, Sangli				
	(Government Aided Autonomous Institute)				
	AY 2024-25				
	Course Information				
Programme	M. Tech. Control and Instrumentation				
Class, Semester	First Year M. Tech., Sem. I				
Course Code	1CI516				
Course Name	Professional Elective 2: Biomedical Instrumentation				
Desired Description	Basic Electronics, Digital Signal Processing, Instrumentation, and				
Desired Requisites: Measurement					
	mousurement				

Teaching	Scheme	Examination Scheme (Marks)					
Lecture	3 Hrs/week	MSE ISE ESE					
Tutorial	-	30	20	50	100		
		Credits: 3					

	Course Objectives					
1	To explain the basics body cell structure and different types of transd	ucers				
2	To explain the different types of patient monitoring system					
3	3 Understand the design concept of different medical instruments					
4	4 To demonstrate different medical instruments					
	Course Outcomes (CO) with Bloom's Taxonomy	Level				
At the	end of the course, the students will be able to,					
		Bloom's	Bloom's			
CO	CO Course Outcome Statement/s Taxonomy Taxonomy					
		Level	Description			

		Level	Description
CO1	Apply knowledge of the CNS-PNS and Cardiopulmonary systems in clinical practice.	III	Applying
CO2	Apply the understanding of block diagrams to explain the operation of patient monitoring systems, X-ray machines, CT scans, and ultrasonography machines.	III	Applying
CO3	Select proper sensors for sensing biomedical signals to be applied to biomedical instrumentation setup	III	Applying
CO4	Design ECG, EEG and EMG amplifier	VI	Creating

Module	Module Contents	Hours
I	Fundamentals of Medical Instrumentation Physiological Systems of the body, Sources of Biomedical signals, Basic Medical Instrumentation system, Micro-Electro-Mechanical System (Mems), Wireless Connectivity in Medical Instruments, General Constraints in design of Medical Instrumentation Systems	7
II	The Origin of Bio potentials, Bio potential Electrodes & Biosensors Electrical activity of Excitable Cells, Functional Organization of the Peripheral Nervous System, Electrocardiogram (ECG), Electromyogram (EMG), Electroencephalogram (EEG), Electroretinogram (ERG) and their recording system, Biomedical signal Analysis and Processing Techniques.	7
III	Patient Monitoring Systems System Concepts, Cardiac Monitor, Bedside patient Monitoring Systems, Central Monitors, Measurement of Heart rate, Measurement of Temperature, Measurement of respiration Rate, Biomedical Telemetry Systems	6
IV	Modern Imaging Systems X-ray machines And Digital Radiography, X-ray Computed Tomography, Nuclear Medical Imaging Systems, Magnetic Resonance Imaging Systems, Ultrasonic Imaging Systems and Thermal Imaging Systems.	7

v	Assisting and Therapeutic Equipment's Cardiac Pacemakers, Defibrillators, Diathermy, Haemodialysis Machines, Ventilators	6			
VI	Laser Application in Biomedical Field The Laser, Types of Lasers, Laser Application, Laser Safety	6			
	Textbooks				
1	"Medical Instrumentation", John. G. Webster, John Wiley				
2	"Principles of Applied Biomedical Instrumentation", Goddes& Baker, John Wiley				
3	"Biomedical Instrumentation & Measurement", Carr & Brown, Pearson				
	References				
1	Hand book of Medical instruments by R.S. Khandpur – TMH, New Delhi, 1987.				
2	Medical Electronics and Instrumentation by Sanjay Guha – University Publication	on, 200.			
3	Introduction to Biomedical electronics by Edward J. Bukstein –sane and Co. Inc, 1973				
	Useful Links				
1	https://www.coursera.org/specializations/biomedical-engineering				
2	https://nptel.ac.in/courses/102106457				

CO-PO Mapping									
		Programme Outcomes (POs)							
	PO1	PO1 PO2 PO3 PO4 PO5 PO6							
CO1	3								
CO2				3					
CO3	3								
CO4 3									
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High									
Each CO of the course must men to at least one PO									

Each CO of the course must map to at least one PO.

Assessment

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ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

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Semester- II Professional Core Theory Courses

	Walchand College of Engineering, Sangli						
AY 2024-25							
			Course	Information			
Progra	amme		M. Tech. Control	and Instrumentation	1		
Class, Semester First Year M. Tech., Sem. II							
Course Code 1CI521							
Cours	e Name		Instrumentation S	ystem Design			
Desire	d Requisi	tes:	Process Instrumer	ntation			
	T 	C - L		F	- 1		
Leatur	Teaching	Scheme	MCE	Examination Solution	cheme	(Marks)	Tatal
Lectur	re iol	3 Hrs/week		15E	E	50	100
Tutor	lai	-	30	20 Cred	ite. 3	30	100
					115. 5		
			Course	Objectives			
	To make	students under	stand the overall	view of instrumenta	ation sv	stem and	various processing
	blocks as	sociated with in	strumentation syste	em.	J		r8
2	Student s	hould able to ur	nderstand the use of	various types of ser	nsor.		
3	Student s	hould able to ur	derstand the signal	processing required	l for ins	struments.	
4	Student s	hould able to de	esign the instrument	tation system to mea	asure th	e process p	arameters.
		Course	Outcomes (CO) v	vith Bloom's Taxor	10my L	Level	
At the	end of the	course, the stud	lents will be able to	,			
СО	Course Outcome Statement/s Bloom's Taxonomy Level				Bloom's Taxonomy Description		
CO1	Applying requirem	design specific ents in systems.	ations to meet accur	racy and sampling sp	peed	III	Applying
CO2	Applying strain gat electrode	g principles of uges (including s.	operation for sense Wheatstone bridge	ors like thermocoup circuits), and chem	ples, nical	III	Applying
CO3	Evaluate	of Instrumentat	ion system for typic	cal process industry.		V	Evaluating
CO4	Explain processir technique	the principles ag, including es.	of analog and d amplifiers, filters	igital signal and and A-D conver	data sion	VI	Creating
	-						
Modu		.	Module C	Contents			Hours
I	Intro Introc indus for te	duction to Inst luction to instru try. General transt sting of transduct	rumentation system mentation system c nsducer design, sele cer.	m: lesign (ISD). Scope ection of transducer	e of ISE genera) in process 1 procedure	6
П	Design of transducers: Design of RTD, T/C, thermistor based temperature instrumentation, Design of LVDT strain gauges and piezo electric crystal based displacement instrumentation. Design of sensing elements such as resistive sensing elements, (Potentiometers), capacitive sensing element (Variable separation, area and dielectric), Induction sensing element (e.g. Variable reluctance), electromagnetic sensing element (e.g. velocity sensors), level instrumentation design.7					7	
III	Defle Defle Oscil Quan comp	n of signal con ction bridges, a lations and R tization, encod ensation, dynan	ditioning elements amplifiers and AC assonation, analog ding, signal pro- nic digital compens	carrier systems cu to digital conv cessing calculation ation and filtering.	urrent tu ersion, ns, ste	ransmitters, sampling, eady state	6

IV	 Intrinsically safe measurement systems: i) Pneumatic measurement system: Fapper Nozzle, relay, torque balance transmitters, transmission and data presentation. ii) Intrinsically safe Electronic systems: Zener barrier, Energy storage calculations. 	б
V	Instrumentation and Control system component Design: Classification of instruments, indications, recorders, monitors, analysers, data loggers and controller selection of instruments, general design considerations. Control valve and their selections, pumps motors and transmission systems, design of control panels.	7
VI	Process Industry Instrumentation: Comparison of Pneumatic, hydraulic and Electrical electronic instrumentation systems and their selection for present process industry requirement. Project documentation, Specification sheet, Index sheet, flow diagrams, schedule used in typical process industry, testing, erection and commission of typical process industry.	7
	Textbooks	
1	B. G. Liptak, Instrument Engineers Handbook, Vol. I and II, Third Edition, C Company, 1990.	Chilton and Book
2	D. M. Considine, Process/Industrial Instruments and Control Handbook, Fourth H Hill Inc., 1993	Edition, McGraw-
3	C. D. Johnson, Process Control Instrumentation Technology, Fourth Edition, PH	HI, 1996.
4	Andrew and Williams, Applied Instrumentation in Process Industries, Vol. I Publishing Company, 1979.	, II, III, IV Gulf
	References	
1	John P. Bentley, Principles of Measurement Systems, Addison-Wesley Publicat	ion, 1999.
2	T. R. Padmanabhan, Industrial Instrumentation: Principles and Design, Publication, 1999.	Springer-Verlag
3	B. C. Nakra and K. K. Choudhari, Instrumentation: Measurement and Analysis, 7 Pub, 1985.	Fata McGraw Hill
	Useful Links	
1		

CO-PO Mapping								
	Programme Outcomes (PO)							
	1 2 3 4 5 6							
CO1	2			2				
CO2	1		3			1		
CO3	1			3		2		
CO4	1			2		2		
The stars of a stars	·	4	M. J 2. II.	-1-				

Assessment

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

Syllabus Prepared By	Dr. D. S. More
Syllabus Checked By	

	Walchand College of Engineering, Sangli								
	AY 2024-25								
Course Information									
Progr	amme		M. Tech. Control	and Instrumentation	n				
Class.	Semester		First Year M. Tec	ch., Sem, II					
Cours	Course Code 1CI522								
Cours	e Name		Non-Linear Syste	m Analysis					
Desire	Desired Requisites: Linear Control Systems								
	A		<u> </u>						
	Teaching	Scheme		Examination S	cheme	(Marks)			
Lectu	re	3 Hrs/week	MSE	ISE	J	ESE	Total		
Tutor	ial	-	30	20		50	100		
				Cred	lits: 3	I			
			1						
			Course	e Objectives					
1	To make	students unders	tand difference betw	ween Linear and No	on-Line	ar Systems.			
2	To make	students familia	ar with features of N	Non-Linear Systems	5.				
3	To devel	op skills in stud	ents for analyzing t	he behavior of Non	-Linear	Systems.			
4	To devel	op skills in stud	ents for evaluating	Non-Linear System	s.	_			
		Course	Outcomes (CO) v	vith Bloom's Taxo	nomy I	Level			
At the	end of the	course, the stud	ents will be able to	,					
						Bloom's	Bloom's		
CO		Cours	se Outcome Staten	nent/s		Taxonomy	Taxonomy		
	Level						Description		
CO1	Examine	features of Non	-Linear Systems.			III	Applying		
CO2	Analyze	the stability of N	Non-Linear Systems	8.		IV	Analyzing		
CO3	Explain t	he behavior of I	Non-Linear System	s through various		IV	Analyzing		
CO4	Assess in	terconnection b	etween Linear Syst	em and nonlineariti	es	V	Evaluating		
	_			-					
Modu	ile		Module (Contents			Hours		
	Nonli	near dynamical	systems:-						
I	Introc	luction, Some fe	eatures of nonlinear	atures of nonlinear dynamical systems, First order			6		
	syster	ns, Second orde	er system, Equilibrit	um points, Classific	cation o	I			
		contini points.	colution						
	Linco	bitz functions. I	solution:-	nachitz					
	Epse	tence/Uniquene	ss of solutions. Cau	pseintz, ichy sequence - Ban	ach sna	2005			
II	Bellm	an Gronwall in	ce/Uniqueness of solutions, Cauchy sequence, Banach spaces,						
	of Ly	of Lyapunov Asymptotic stability Lyapunov's theorem on stability Global							
	asym	ototic stability.	Linear systems.		i stuoini	ty, Global			
	Adva	nced Stability th	eory:-						
	Exten	sion of Lyapun	ov's theorem in diff	ferent context, Conv	verse L	yapunov			
III	theore	em, Instability th	neorem, Equilibriur	n sets, LaSalle's In	varianc	e principle,	5		
	Barbashin and Krasovskii's theorems.								
	Perio	dic Orbits:-							
IV	Bend	xson criterion a	nd Poincare-Bendiz	xson criterion, Lotk	a preda	ator prey	6		
	mode	l, Van-der-Pol o	scillator, Lineariza	tion.	_				
	Inter	connection betw	veen linear system a	and nonlinearities:-					
	Signa	ls, operators, No	orm of signals, Fini	te gain L2 stable, P	assive	filters,			
	Dissi	pation equality,	Positive real lemma	a, Kalman Yakubov	vich-Poj	pov	8		
	theore	em, Memoryless	s nonlinearities, Loo	op transformation, C	Circle c	riterion,			
1	Limit	cycle. Popov ci	riterion.						

VI	Describing function:- Describing function method, jump hysteresis, sufficient condition for existence and nonexistence of periodic orbits, Describing function for nonlinearities, Ideal relay with hysteresis and dead zone.							
	Textbooks							
1	H.K.Khalil. Nonlinear systems Prentice Hall, 3rd Edition 2002.							
2	Jean-Jacques E.Slotine & Weiping Li. Applied Nonlinear Control by Prentice Ha	ıll, 1991.						
	References							
1	1 Shankar Sastry, Nonlinear Systems: Analysis, Stability and Control, Springer, New-York, 1999.							
2	M. Vidyasagar, Nonlinear Systems Analysis, Prentice-Hall, 1993.							
	Useful Links							
1	https://archive.nptel.ac.in/courses/108/101/108101002/							

CO-PO Mapping									
Programme Outcomes (PO)									
	1 2 3 4 5 6								
CO1	2								
CO2	1		2						
CO3	1			2					
CO4									
The strength of man	ning is to be writt	on as 1. Low 2.	Modium 3. Hic	rh					

Assessment

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

Syllabus Prepared By	Mr. N. V. Patel
Syllabus Checked By	

	Walchand College of Engineering, Sangli (Government Aided Autonomous Institute)							
		, , , , , , , , , , , , , , , , , , ,	AY	2024-25	,			
			Course	Information				
Progr	amme		M. Tech. Contro	ol and Instrumenta	tion			
Class,	Class, Semester First Year M. Tech. Control and Instrumentation, Se							
Cours	se Code		1CI523					
Cours	se Name	;	Adaptive Contro	ol				
Desire	ed Requ	isites:	Linear Control					
			I					
]	Feachin	g Scheme		Examination S	cheme (Marks)			
Lectu	re	3 Hrs./week	MSE	ISE	ESE	Total		
Tutor	ial	-	30	20	50	100		
				Cred	its: 3			
			~	<u> </u>				
	m 1		Course	Objectives				
	To dev	elop basic know	ledge of Adaptiv	e Control				
	To pro	vide skills for P	arameter Estimati	on and Observer c	lesign.			
3	To imp	art skills for Se	If-Tuning Regulat	ors and Adaptive	Pole Placement C	ontrol		
4	It will	make students to	study the Adapt	ive Control Of De	terministic System	IS		
	1.0	Course (Dutcomes (CO) w	with Bloom's Tax	onomy Level			
At the	end of	he course, the s	tudents will be ab	le to,				
		G	O ()		Bloom's	Bloom's		
CO		Course	Outcome Staten	nent/s	Taxonomy	Taxonomy		
		Level	Description					
COI	Apply	the concepts of	Adaptive Control			Applying		
<u>CO2</u>	Apply	Parameter Estin	hation and Observ	er design.		Applying		
CO3	Implen	ient the Self-Tu	ning Regulators a	nd Adaptive Pole		Applying		
	Placen	ent Control						
<u> </u>	T1				- TT	A		
04	Implen	ient the Adaptiv	e Control Of Det	erministic System	8 111	Applying		
Modu			Madula	Vontonta		Hanna		
Nioau		ntivo Control	Module	ontents		Hours		
	Au	apuve Control	ol System Design	Stope Dobust Co	ntrol goin	7		
	Sch	eduling Direct	and Indirect Adar	steps, Robust Co	lel Reference	1		
I		untive Control (Conventional tech	niques of identific	ation systems			
	wit	dead time AF	MA process Le	ast squares technic	mes Recursive			
	Lea	st Squares algor	ithms.	ust squares teening				
	On	Line Paramete	er Estimation					
	Intr	oduction. Adapt	ive Laws with No	ormalization. Grad	ient Method.			
II	Lea	st-Squares, Eff	ect of Initial Cond	litions, Parameter	Identifier,	7		
	Ada	ptive Observers	. The Luenberger	· Observer, Adapt	ive Luenberger			
	Obs	erver, Hybrid A	Adaptive Luenber	ger Observer	U			
	Sel	-Tuning Regul	ators	-				
	Intr	oduction, Pole p	blacement design,	7				
111	con	tinuous time and	l direct Self-Tuni	ng Regulators, dis	turbances with	/		
	kno	wn characteristi	cs, Adaptive Pole	Placement Control	ol			
	Sto	chastic and Pre	dictive Self-Tun	ing Regulators				
TTT	Intr	oduction, minin	num variance, mo	ving average cont	collers, linear	_		
	qua	dratic STR, Ada	ptive predictive c	controller. Model	Reference			
	Ada	ptive Control						

	Adaptive Control Of Deterministic Systems							
	Introduction, The MIT rule, Determination of adaptation gain,							
V	Minimum prediction error adaptive controls, Adaptive control of time	7						
	varying systems, MRAC using Lyapunov method, BIBO Stability,							
	Model free adaptive control, Applications of adaptive control.							
	Modern Adaptive Control Methods							
VI	Introduction, modern methods, neural network and fuzzy systems based	4						
	adaptive control schemes.							
	Textbooks							
1	Karl J Astrom, Bjorn Wittenmark, "Adaptive Control", Pearson Education	on Inc, 2003.						
2	Arun K. Tangirala, "Principles of System Identification: Theory and Pra	ctice", CRC						
Z	Press, 2014.							
	References							
	Anthony Zaknich," Principles of adaptive filters and self-learning system	s", Springer						
1	London, Year: 2005							
2	2 Simon Haykin, 'Adaptive Filter Theory', Prentice Hall, 2010							
	Useful Links							

CO-PO Mapping								
Programme Outcomes (PO)								
CO1	2							
CO2	1	1				1		
CO3	1			2		2		
CO4	1			2				

Assessment

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Syllabus Prepared By	Mr. A.B. Patil
Syllabus Checked By	

Professional Core Laboratory Courses

Walchand College of Engineering, Sangli							
(Government Aided Autonomous Institute)							
			Course	e Information			
Progra	amme		M. Tech. Control	and Instrumentation	on		
Class,	Class, Semester First Year M. Tech., Sem. II						
Cours	e Code		1CI571				
Cours	e Name		Non-Linear Syste	em Analysis Lab			
Desire	d Requisi	tes:	Linear Control Sy	ystems			
r							
Draati	l'eaching a	Scheme	TA1	Examination	Scheme (Marks)	Tatal
Intore	cal dian	2 Hrs/ week	20	20			1001 100
mera		-		SU Cre	40 edits: 1		100
		<u> </u>	<u> </u>				
			Cours	se Objectives			
1	To make	students simula	ate Non-Linear Sys	tems for analyzing	its proper	ties.	
2	To devel	op skills in prog	gramming for deter	mining stability of	Non-Line	ar Systems.	1 1'
3	To make	students unders	stand behaviour of	the Non-Linear Sy	stems by j	plotting phase	plane diagram
4	To make	students under	stand the behavior	of Periodic orbit th	rough pro	gramming and	1 simulation
-	10 11111	Cours	e Outcomes (CO)	with Bloom's Tax	conomy L	evel	
At the	end of the	course, the stud	dents will be able to	0,	•		
CO		C				Bloom's	Bloom's
CO		Cou	rse Outcome State	ement/s		Level	1 axonomy Description
CO1	Demonst	rate the propert	ies of Non-Linear	Systems using simu	ilation.	III	Applying
CO2	Examine	the behaviour of	of Non-Linear Syst	ems by plotting ph	ase	Ш	Applying
~~~	plane dia	gram using sim	ulation tools.			111	Apprying
CO3	Analyze simulatio	the stability of lon tools.	Non-Linear System	ns using programm	ing and	IV	Analyzing
CO4	Assess th simulation	e behavior of pon tools.	eriodic orbit using	programming and		V	Evaluating
			ist of Fundation on	ta / Tab A attrition	/Taniaa		
List of	Lah Acti	vities:	List of Experimen	us / Lad Activities	/ I opics		
1. To s	imulate th	e effects of vari	ous non-linearities	on linear system u	sing MA7	TLAB.	
2. To s	imulate lir	near and non-lir	near differential equ	uations using MAT	LAB.		
3 To c	calculate eq	milibrium state	s of Non-Linear Sy	stems using MAT			
4 To c	alculate li	near model of N	Son-Linear System	s using MATLAR			
5 Con	structing n	hase portrait of	Linear System usi	ng MATLAB			
6 Con	structing p	hase portrait of	Non-Linear System	ms using MATI AI	3		
7 Stud	ly of limit	cycle using MA	TI AB Simulink		J.		
8 Sim	ulation of a	predicting limit	cycle using descri	hing function analy	reie		
0. Sim	w of Cart 1	mounted Inverte	ed Pendulum system	m	515.		
9. Stuc	bility on ol	voia voing MAT					
10. Sta	ding for or	ysis using MA	LAD.	inour Systems			
11. Co		fish ucting phas	se portrait of Non-	Linear Systems.			
			Т	extbooks			
1	Jean-	Jacques E.Sloti	ne & Weiping Li. A	Applied Nonlinear	Control by	y Prentice Hal	1, 1991.
				-			
			R	eferences			
1	H.K.I	Khalil Nonlinea	r systems 3rd Editi	on Prentice Hall, 2	002.		
2	Vukio	c, kuljaca, Donl	agic, Nonlinear con	ntrol systems by N	Marcel De	kker publishe	r, 2003
	Useful Links						

	CO-PO Mapping													
		Programme Outcomes (PO)									PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3													
CO2	3	2												
CO3	2		2											
CO4				3										
The stre	noth of	fmanni	na is to	he wri	tten ac	The strength of manning is to be written as 1.2.2; where 1: Low 2: Madium 2: High								

The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.

Assessment							
There are three components of lab assessment, LA1, LA2 and Lab ESE.							
IMP: Lab ESE	is a separate head	of passing.(min 40 %), LA	1+LA2 should be min 40%				
Assessment	Based on	Conducted by	Typical Schedule	Marks			
	Lab activities,		During Week 1 to Week 8				
LA1	attendance,	Lab Course Faculty	Marks Submission at the end of	30			
	journal		Week 8				
	Lab activities,		During Week 9 to Week 16				
LA2	attendance,	Lab Course Faculty	Marks Submission at the end of	30			
	journal		Week 16				
	Lab activities,	Lab Course Faculty and	During Week 18 to Week 19				
Lab ESE	journal/	External Examiner as	Marks Submission at the end of	40			
	performance	applicable	Week 19				
Week 1 indicate	es starting week o	f a semester. Lab activities/	Lab performance shall include performance	rming			
experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the							
nature and requ	irement of the lab	course. The experimental l	lab shall have typically 8-10 experim	ents and			
related activitie	s if any.						

Syllabus Prepared By	Mr. N.V. Patel
Syllabus Checked By	

Walchand College of Engineering, Sangli										
			A	Y 2024-25						
	Course Information									
Progra	Programme         First Year M. Tech. Control and Instrumentation									
Class, Semester First Year M. Tech. Control and Instrumentation, Sem. II										
Cours	e Code		1CI572			,				
Cours	e Name		Adaptive Control	Lab						
Desire	d Requisi	tes:	Adaptive Control	l						
r	<b>Feaching</b>	Scheme		Examination	Scheme (	Marks)				
Practi	cal	2 Hrs/ Week	LA1	LA2	Lab F	ESE	Total			
Intera	ction	-	30	30	40	)	100			
				Cre	edits: 1					
			·							
			Cour	se Objectives						
1	To devel	op basic knowle	edge of Adaptive C	Control						
2	To provi	de skills for Par	ameter Estimation	and Observer desig	gn.					
3	To impa	rt skills for Self	-Tuning Regulator	s and Adaptive Pol	e Placeme	ent Control				
4	It will m	ake students to	study the Adaptive	Control Of Detern	ninistic Sy	stems				
		Cours	e Outcomes (CO)	with Bloom's Tax	onomy L	evel				
At the	end of the	course, the stud	dents will be able t	0,						
						Bloom's	Bloom's			
CO		Cou	rse Outcome State	ement/s		Taxonomy	Taxonomy			
						Level	Description			
CO1	Apply th	e salient feature	es of Adaptive Con	trol		III	Applying			
CO2	Apply Pa	arameter Estima	tion and Observer	design.		III	Applying			
CO3	Impleme	nt Adaptive alg	orithm for Control			III	Applying			
CO4	Impleme	ent the Adaptive	Control using mo	dern algorithms.		III	Applying			
			6	6	I					
		]	List of Experimen	nts / Lab Activities	/Topics					
List of	Lab Acti	vities:	•							
Lab ex	xperiment	s based on sim	ulation study as p	er following conte	ents (mini	mum 8 )-				
1.	Control	system design u	sing Matlab and Si	imulink model for a	closed loop	p performanc	e.			
2.	Study of	System identifi	cation using Matla	b and Simulink.						
3.	Paramete	er identification	using System iden	tification toolbox.						
4.	Robust p	performance of s	system study.							
5.	Estimation	on and optimal	performance algori	ithm study using M	atlab and	Simulink.				
6.	Steepest	descent and LM	IS based adaptive	algorithm Matlab a	nd Simuli	nk.				
7.	Study of	Neuro-adaptive	e algorithm for con	trol system design.						
δ.	Case stu	dy for adaptive	algorithm application	ions.						
			Т	ovthools						
1	<b>V</b> orl	I Astrom Diam	Wittenmerk "Ad	CALUUUKS	arcon Ed.	Leation Inc. ?	003			
<u>1</u> 2		K Tangirala !	Principles of System	aprive Control, Pt	heory and	Practica" C	$\frac{1}{1000}$			
4		ix. rangilala,	1 merples of Syste		neory and	r racuet, C	1000, 2014.			
			P	eferences						
1	Anth	ony Zaknich,"	Principles of adap	ptive filters and sel	f-learning	; systems", S	pringer London,			
2	Sime	n Haykin, 'Ada	aptive Filter Theor	y', Prentice Hall, 20	010					
			Us	eful Links						

	CO-PO Mapping													
	Programme Outcomes (PO)					PS	50							
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1			3											
CO2					3									
CO3					3									
CO4			3											2
The stre	The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High													

Each CO of the course must map to at least one PO, and preferably to only one PO.

	Assessment						
There are three IMP: Lab ESE	There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%						
Assessment	Based on	Conducted by	Typical Schedule	Marks			
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30			
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30			
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40			
Week 1 indicate	Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing						
experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.							

Syllabus Prepared By	Mr. A.B. Patil
Syllabus Checked By	

	Walchand College of Engineering, Sangli (Government Aided Autonomous Institute)							
	AY 2023-24							
			Course	e Information				
Progra	amme		M. Tech. Control	and Instrumentation	n			
Class,	Semester		First Year M. Tec	ch., Sem. II				
Cours	e Code		1CI545					
Cours	e Name		Seminar					
Desire	d Requisi	tes:	Control System E	Ingineering				
			•	<u> </u>				
r	<b>Teaching</b>	Scheme		Examination S	Scheme (	Marks)		
Practi	cal	2 Hrs/ Week	LA1	LA2	Lab H	ESE	Total	
Intera	ction		30	30	40	)	100	
				Cree	dits: 1	I		
			Cours	se Obiectives				
1	To unde	rstand industri	al problems					
2		est engineerin	a solutions to the	defined problem				
	10 sugg	Cours	e Outcomes (CO)	with Bloom's Tax	nomy L	evel		
At the	end of the	course the stur	lents will be able to		Juoniy L			
		course, the stud		,		Bloom's	Bloo	m's
СО		Сош	rse Outcome State	ement/s		Taxonom	v Taxon	omv
		000				Level	Descri	otion
C01	<b>CO1</b> Chose. Formulate a clear problem.					III	Apply	/ing
CO2 Select and apply appropriate engineering methods and toolsfor solving				solving	VI	Creat	ing	
	the probl	em.	1	•	•			
CO3	Develop methodo	the project and logy.	d its results follow	ving an established	project	V	Evalua	iting
<b>CO4</b>	Present t	he project result	s.			IV	Analy	zing
	1	1 J						
		]	List of Experimen	ts / Lab Activities/	Topics			
List of	Lab Acti	vities:	the selection of a	oproprieto real timo	industry	problem by	understandi	ng tho
uorkir	uusuy pro	yeet will involve	plication Formula	optopriate real time	nicusu y	problem by	odology to fi	nd the
colutio	n Constru	uta muusuy aj	system by using a	and the problem, set	cet uesigi	ra toola E	och student	should
solutio	ua dagian	and develop the	system by using a	appropriate natuwa	le soltwa	at should a	ubmit a soft	hound
roport	ot the ord	of the semaster	The final product	t as a result of Indu	stry proj	act should	ho domonstr	otod in
report	at the time	of the semiester	n nie mai produc	t as a result of filtu	suy proje	eet should	be demonstra	neu m
This	at the time	tudent to unde	II.	monogoment in ind	history a	utainabla	davalanmant	with
consid	oration to l	both scientific a	nd athical aspects	and its presentation	with took	ustallable	development	, with
consid			ind cuncar aspects a	and its presentation	with teel	inical tepoi		
			Т	ovthooks				
1	Tobe	used based on	selected project	CALUUUN3				
1	10.00	used based off	servered project					
			P	eferences				
1	Indue	$try 40 \cdot fourth$	Industrial Revolution	on guide to Industry	40			
1	Indus	uy +.0.100101		on guide to madelly	<b>-</b>			
			Ua	oful I inke				
1			08					

	CO-PO Mapping					
		P	Programme Ou	utcomes (POs)		
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2				
CO2				2		2
CO3			2			
CO4				3		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High						
Each CO of the course must map to at least one PO.						

Assessment						
There are three IMP: Lab ESE	There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%					
Assessment	Based on	Conducted by	Typical Schedule	Marks		
	Lab activities,		During Week 1 to Week 8			
LA1	attendance,	Lab Course Faculty	Marks Submission at the end of	30		
	journal		Week 8			
	Lab activities,		During Week 9 to Week 16			
LA2	attendance,	Lab Course Faculty	Marks Submission at the end of	30		
	journal		Week 16			
	Lab activities,	Lab Course Faculty and	During Week 18 to Week 19			
Lab ESE	journal/	External Examiner as	Marks Submission at the end of	40		
	performance	applicable	Week 19			
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing						
experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the						
nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and						
related activitie	related activities if any.					

# **Professional Elective Theory Courses**

Course Contents for F. Y. M. Tech. Control and Instrumentation Programme, Dept. of Electrical Engineering AY 2024-25

Walchand College of Engineering, Sangli						
	(Government Aided Autonomous Institute)					
AY 2023-24						
Course Information						
Programme M. Tech. Control and Instrumentation						
Class, Semester	First Year M. Tech., Sem. I					
Course Code	1CI531					
Course Name	Professional Elective 3: Modern Power Electronics					
Desired Requisites:	Power Electronics					

Teaching	Scheme	Examination Scheme (Marks)				
Lecture	3 Hrs/week	MSE	ISE	ESE	Total	
Tutorial	-	30	20	50	100	
		Credits: 3				

	Course Objectives					
1	It is aimed to impart skills of analysis for different types of advanced converters and shunt active power filters.					
2	Make the students acquainted with control strategies of different type shunt active power filters.	s of advanced	converters and			
3	To make the students aware of research avenues in the field of power	electronics.				
4	To make the students aware of the recent advances in power electron applications	ics and their u	se in industrial			
	Course Outcomes (CO) with Bloom's Taxonomy I	Level				
At the	end of the course, the students will be able to,	1				
СО	Course Outcome Statement/s Bloom's Taxonomy Level					
CO1	Interpret configuration and working of various Power Electronic III					
CO2	Analyse different advanced power electronic converters and systems. IV					
CO3	3Evaluate various power electronic systems using power electronic converters.V					
CO4	CO4Design active power filters using advanced power electronic systems for power quality improvement.VI					
			·			
Modu	le Module Contents		Hours			
I	PWM rectifiersAdvantages & disadvantages of three phase thyristor converter, Single phase andIthree phase VSI PWM converters working, types, Control of PWM rectifiers,analysis and application. Three phase CSI PWM converter, control andapplications					
Ш	II Multilevel inverters Three phase two level Voltage source inverter, various PWM methods, Multilevel Voltage source inverter, Types: Diode clamp multilevel inverter, flying capacitor multilevel inverter, cascaded multilevel inverter, applications of multilevel inverters, comparison of multilevel inverter. Control method: Multiple carrier PWM for MLI					

	Resonant pulse inverters					
	Series resonant inverter with unidirectional and bi-directional switches, parallel					
III	resonant inverters, voltage control of resonant inverters, zero current and zero					
	voltage switching resonant converters, two-quadrant ZVS resonant converters,					
	resonant DC link inverters and control technique.					
	Photovoltaic Inverters					
	Photovoltaic Inverters structures derived from H bridge topology such as H5					
IV	inverter, Heric inverter, REFU inverter, full bridge inverter with DC bypass,	7				
	inverter structures derived from NPC topology such as neutral point clamped					
	half bridge inverter, co-energy NPC inverter, three phase PV inverter.					
	Matrix Converters and Z source inverters					
V	Topology, working and control methods of Matrix converters, Various circuit	7				
v	topologies and control of Z source inverter, Application of Z source in induction					
	motor control.					
	Active power filters					
	Power Quality Issues due to power Electronics, Introduction to active power					
VI	filter, types of active power filters overall control of shunt active power filter,	6				
VI	control of shunt active filter based on SRF theory. Control of shunt active filter	0				
	based on instantaneous power theory. Harmonic compensation & reactive power					
	compensation.					
	Textbooks					
1	M. H. Rashid, "Power Electronics: circuits devices and applications", Pearson Ededition.	lucation, Third				
	References					
1	B. K. Bose, "Modern Power Electronics and AC drives", PHIPL, New Delhi.					
2	M. B. Patil, V. Ramayanan and V. T. Ranganathan, "Simulation of Power Electron	onics circuits",				
	Narosa publication.	atopoltais and				
3	Wind Power Converters", A john Wiley and sons Ltd., first edition 2011.					
4	IEEE Transaction papers.					
1	Useful Links					
1	<u>nups://oninecourses.nptei.ac.in/noc20_ee28/</u>					

CO-PO Mapping						
Programme Outcomes (PO)						
	1	2	3	4	5	6
CO1	1		1			
CO2	1	2		1		2
CO3	1	2	2	2		2
CO4 2 1						
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High						

Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

Syllabus Prepared By	Dr. D. S. More
Syllabus Checked By	

		Wale	chand College	of Engineering	, San	ngli	
AY 2024-25 Course Information							
			Course	Information			
Progr	amme		M. Tech. Control	and Instrumentation	1		
Class,	Semester		First Year M. Tech., Sem. II				
Cours	e Code		1CI532				
Cours	e Name		Professional Elec	tive 3: Electric Vehi	cle Te	chnology	
Desire	ed Requisi	tes:	Linear Control Sy	stems, Power Election	ronics		
	Teaching	Scheme		Examination Sector	cheme	(Marks)	
Lectu	re	3 Hrs/week	MSE	ISE	I	ESE	Total
Tutor	ial	-	30	20	-	50	100
				Cred	its: 3		
	1		Course	e Objectives			
	To devel	op basic knowle	dge related to archi	tecture of Electric V	/ehicle	S.	
2	To provid	de knowledge re	lated to design asp	ects and dynamics o	t Elect	ric Vehicles.	anoin a star d d-
3	for Electr	se anns at enabl	ing students to und	erstand the motor sp	ecifica	mons and ch	arging standards
4	To course	e aims at enabling and in Electric y	ng students to interj	pret the design aspec	ets of p	ower conver	ters, electric
	motors a	Course	Outcomes (CO) v	vith Bloom's Taxor	10mv I	Level	
At the	end of the	course, the stud	ents will be able to	,			
со		Cours	se Outcome Staten	nent/s		Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	Examine	the architecture	and features of Ele	ectric Vehicles		III	Applying
CO2	Illustrate considera	various topolog	ties of Electric vehi	cles for different de	esign	III	Applying
CO3	Compute	the vehicle dyn	amics for Electric	vehicle systems		III	Applying
CO4	Evaluate used in e	the performant lectric vehicle a	ce of control techn pplications	iques for drive sys	tems	V	Evaluating
Modu	ıle		Module (	Contents			Hours
I	Intro Backy Electri Comp	duction to Elect ground of Elect ric Vehicles, A parison with con	tric Vehicles tric Vehicles, Elec Advantages of Elec ventional vehicles,	etric Vehicle System ectric Vehicles, Eff Fundamentals of El	m, Con ficienc	mponents of y, Pollution Vehicles	6
II	Type Conc of Hy Parall Cell I	s of Electric Ve ept of Electric, F /brid Electric V lel Configuratio Electric Vehicles	hicles and Archite Hybrid and Plug-in I ehicle, Topologies n, Topologies of H s, Solar Powered El	ecture of EVs Electric Vehicles, Ty of HEVs: Series, F Plug-in Hybrid Elec lectric Vehicles	vpical c Parallel etric Ve	configuration l and Series- ehicles, Fuel	7
ш	Design Considerations for Electric Vehicles         Introduction to EV design fundamentals, Aerodynamic Consideration, Rolling         resistance, Transmission efficiency, Consideration of vehicle mass, Basics of         Electric vehicle chassis and body design, general issues in Electric vehicle         design						7
IV	Vehic Road Propu and A Requ	cle Dynamics way fundamen Ilsion power: Fo Acceleration: Ve ired, Propulsion	tals, Vehicle Kind orce velocity charad locity Profile, Dist System Design for	etics, Dynamics of cteristics, Vehicle gr ance traversed, tract EV systems	f Vehi radabil tive po	cle Motion ity, Velocity ower, Energy	7

	Electric Valida Deirar and Control Tasketings	
V	Characteristics of ac electrical machines used in hybrid and pure electric vehicles, Induction motors and their optimization for EV applications, Permanent motor drives and their optimization for EV applications, Voltage control of DC- AC Converters using PWM for EV systems	6
	Electric Vehicle Chargers and Charging Standards	
VI	EV charging: requirements and Classification, Charging standards for Electric vehicles, Introduction to AC and DC chargers for EV systems, Working of Electric Vehicle Supply Equipment (EVSE), Fast Chargers for EV systems	6
	Textbooks	
1	Iqbal Husain ,' Electric and Hybrid Vehicles: Design Fundamentals ', CRC Press	s, 2003.
2	James Larminie, John Lowry, "Electric Vehicle Technology Explained", Wiley 2012	, 2nd edition,
	References	
1	Sheldon Williamson, 'Energy Management Strategies for Electric and Plug-in Vehicles', Springer-Verlag, 2012	Hybrid Electric
2	M. Ehsani, Y. Gao, S. Gay and A. Emadi , Modern Electric, Hybrid Electric Vehicles, CRC Press, 2005.	c, and Fuel Cell
3	William H. Bolton, Programmable logic controllers, Newnes, Edition VI, 2006.	
	Useful Links	
1	https://nptel.ac.in/courses/108/103/108103009/	
2	https://nptel.ac.in/courses/108/102/108102121/	
3	https://nptel.ac.in/courses/108/106/108106170/	

	С	O-PO Ma	pping			
		]	Programm	e Outcom	es (PO)	
	1	2	3	4	5	6
CO1			3			
CO2				3		3
CO3				3		
CO4			3			

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

Syllabus Prepared By	Dr. S. S. Karvekar
Syllabus Checked By	

		Walc	hand College	of Engineering, Sa	ngli	
			AY	2023-24		
			Course l	Information		
Progr	amme		M. Tech. Control	and Instrumentation		
Class,	Semester		First Year M. Teo	ch., Sem. II		
Cours	se Code		1CI533			
Cours	se Name		Professional Elec	tive 3: Optimal Control		
Desire	ed Requisi	tes:	Control System E	Engineering		
<b>.</b>	Teaching	Scheme		Examination Schem	e (Marks)	<b>T</b> ( )
Lectu	re	3 Hrs/week	MSE	ISE	ESE	Total
Tutor	ial	-	30	20	50	100
				Credits: 3		
			<b>C</b>	Objectivez		
1	To provi	do the basis as a	Course	objectives		
2	To provid	le the methodol	cepts of optimal co	IIII 01. OR and I OT optimal or	ntrol	
3	To give f	he overview of	optimization in con	ustrained and non-constr	ained controls	
5		Course	Outcomes (CO) w	ith Bloom's Taxonomy		
At the	end of the	course, the stud	lents will be able to		Lever	
		,		,	Bloom's	Bloom's
CO		Cours	se Outcome Staten	nent/s	Taxonomy	Taxonomy
					Level	Description
CO1	Apply va	rious concepts of	of optimal control.		III	Applying
CO2	Analyze	the systems usir	ng LQR and LQT o	ptimal control.	IV	Analyzing
CO3	Design of	f optimal contro	ol in constrained and	d non-constrained	VI	Creating
	systems.	nt ontimal contr	ol algorithms in sir	mulation and real world		Creating
<b>CO4</b>	applicatio	ni optiniai conti ons	of algorithms in sit	inulation and real-world	VI	Creating
	upplication	<u> </u>				
Modu	ıle		Module (	Contents		Hours
	Intro	duction to Opt	imal Control			
T		-				
	Class	ical and Mod	lern Control, Op	timization, Optimal (	Control, Plant,	7
	Perfo Color	rmance Index, (	Constraints, Calcult	is of Variations.		
	Calci	nus or variatio	ons and Optimal C			
	Optin	num of a Funct	ion and a Function	al, Basic Variational P	roblem, Fixed-	
II	End	Fime and Fixed	I-End State System	n, Euler-Lagrange Equa	ation ,Different	
	Cases	for Euler-La	grange Equation	,The Second Variation	n, Extrema of	6
	Funct	and the contraction	altions , Direct N	Lagrange Mul	m	
	Line	ar Ouadratic O	ptimal Control Sv	stems		
		- <b>L</b>	F C			
111	Finite	e-Time Linear	Quadratic Regulat	tor, Riccati Coefficient	, Finite-Time	6
	Linea	r Quadratic Reg	gulator: Time-Vary	ing Case, Infinite-Time	LQR System.	0
	Linea	ar Quadratic T	racking System			
	Linoo	r Quadratia Tre	alting System, Fin	ita Tima Casa I OT Su	stom. Infinito	
1 V	Time	Case Fixed-l	Exing System: Fin End-Point Regulat	or System And Frequence	stem: minite-	7
	Interr	pretation.		or system rule rieqt	ency Domain	
	Cons	trained Optima	al Control Systems	S		
		·····	,			
V	Time	-Optimal Contro	ol of LTI System, S	Solution of the TOC Sys	stem, TOC of a	
	Doub	le Integral Sy	stem, Fuel-Optima	al Control Systems, H	Energy-Optimal	6
	Contr	ol Systems. Opt	timal Control Syste	ms with State Constrain	ts.	

	Pontryagin Minimum Principle	
VI	Constrained System, Pontryagin Minimum Principle, The Hamilton-Jacobi-Bellman Equation, LQR System Using H-J-B Equation.	7
	Textbooks	
1	"Optimal Control Systems", by D.S.Naidu, CRC Press, 2002.	
	References	
1	"Optimal Control", by Frank L Lewis, John Wiley, New York, 1986.	
2	"Optimal Control Theory", by Kirk D.E, Dover Publications, 2004.	
	Useful Links	
1	https://onlinecourses.nptel.ac.in/noc21_ee48/preview	

		СО-РО М	apping			
		Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		3			
CO2	2	2				
CO3	2		2			1
CO4	2		2	2		2
The strength	The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High					
Each CO of the course must map to at least one PO.						

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

			alchand College Government Aided	of Engineering, Sangl d Autonomous Institute)	i		
			AY	2024-25			
			Course	Information			
Progr	amme		M. Tech. Contro	ol and Instrumentation			
Class,	, Semeste	er	First Year M. Tech., Sem. II				
Cours	se Code		1CI534				
Cours	se Name		Professional Ele	Professional Elective 4: Power Plant Instrumentation			
Desire	ed Requi	sites:	-				
	<b>Feaching</b>	Scheme	Examination Scheme (Marks)				
Lectu	re	3 Hrs /week	MSE	ISE	ESE	Total	
Tutor	ial		30	20	50	100	
1 4001	141		50	Credits: 3	50	100	
				Creation 5			
			Course	Objectives			
1	To deve	lop basic know	ledge of power p	lant and power generati	on.		
2	To prov	ide skills for n	neasurements in p	ower plants:			
3	To mak	e students to stu	udy analyzers in p	ower plants.			
4	It will n	nake students to	study control lo	ops in power plant instru	umentation		
		Course C	Outcomes (CO) w	vith Bloom's Taxonom	y Level		
At the	end of th	ne course, the st	tudents will be ab	le to,	•		
со		Course	e Outcome State	ment/s	Bloom's Taxonom	Bloom's Taxonomy	
			<u> </u>	, 1	y Level	Description	
COI	Apply t	ne salient featu	res of power plan	t and power	III	Applying	
CO2	Apply r	neasurements i	n power plants		Ш	Applying	
CO3	Implem	ent the analyze	rs in power plants	5.		Applying	
	T 1		· · · · ·	·····			
<u>CO4</u>	Implem	ent the control	loops in power pl	ant instrumentation		Applying	
Modu	الم		Module (	Contents		Hours	
Mouu	Pow	er Generation				nours	
	Metl	nods of power s	eneration: Hydro	. Thermal. Nuclear. Sol	ar and	7	
	Win	d power. Ocean	Energy System.	Geothermal Energy, and	d Energy		
I	from	Bio mass. Bui	lding Blocks of T	hermal power plant - C	ombined		
	Cycl	e System – Cor	mbined Heat and	Power System: Sub Cri	tical and		
	Supe	ercritical boilers	s – Operating Pres	ssure and Temperature 1	anges –		
	Over	rview of Instru	nentation System	in Thermal power plan	t.		
	Mea	surements In ]	Power Plants				
п	Mea	surement of fee	ed water flow, Fue	el flow, Airflow and Ste	am flow	7	
	with	correction fact	or - Steam pressu	re and temperature mea	surement-		
	Turb	oine speed and	vibration measure	ment.			
	Ana	lyzers In Powe	er Plants	. <u>.</u>			
	Ana	lysis of impurit	ies in feed water a	and steam: Dissolved ox	xygen		
	anal	yzer, Chromato	graphy pH meter,	, Fuel analyser, Flue gas	oxygen	6	
	meas	surements.	monitoring instru	ments, SOX and NOX			

IV	<b>Control Loops In Boiler</b> Combustion control , Air/fuel ratio control , Furnace draft control ,Main steam and reheat steam temperature control , Super heater control, Distributed control system in power plants , Interlocks in boiler operation	7			
V	Nuclear Power Plant Instrumentation Different types of Nuclear power plant, Nuclear reactor control loops, Reactor dynamics, Control and Safety instrumentation, Reliability aspects	7			
VI	<b>Computer Based Process Control</b> Data loggers - Data Acquisition Systems (DAS) ,Supervisory Control and Data Acquisition Systems (SCADA),Hardware and software, Remote terminal units, Master station, communication architectures.	5			
	Textbooks				
1	1 David Lindsley, " <i>Power Plant Control and Instrumentation</i> ", Institution of Electrical Engineers, London, 2000.				
2	Sam G Dukelow, " <i>The Control of Boilers</i> ", 2nd Edition, Instrument Societ 1991.	ty of America,			
	References				
1	Elonka S M, Kohal A L , " <i>Standard Boiler Operations</i> ", McGraw Hill, New Delhi, 1994.				
2	Bela G Liptak, "Process Measurement and Analysis", Vol. 1, CRC press,	, 2003.			
	Useful Links				

		CO-PO Ma	pping			
		Pro	gramme Outc	omes (POs)		
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3					
CO2		3				
CO3			2			
CO4				2		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High						
Each CO of the course must map to at least one PO.						

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

Syllabus Prepared By	Mr. A.B. Patil
Syllabus Checked By	

		Wale	chand College o	f Engineering, Sa	ngli	
			(Government Aided	Autonomous Institute)		
				024-25		
D			Course In	iformation		
Progra	amme		M. Tech. Control and Instrumentation			
Class,	Semester	•	First Year M. Tech., Sem. II			
Cours	se Code		1CI535	A A	136.11	<b>.</b> .
Cours	se Name		Professional Electiv	ve 4: Artificial Intelliger	nce and Machin	he Learning
Desire	ed Requis	ites:	Strong mathematica	al background, knowled	ge of data struc	ctures and
	-		algorithms, and fam	hillarity with probability	, statistics, and	linear algebra.
	Taashina	Cah ang a		Energinetian Cohem	(Manlag)	
Lootu	Teaching		MSE	Examination Scheme	e (Marks)	Total
Tuton	re ial	3 Hrs/week			<u>ESE</u>	100
TULOF	lal	-	30		50	100
				Creans: 5		
			Course	Thiactives		
1	Underst	and Artificial Int	elligence and its appr	ongecuves		
-	Solving	some problems	ising supervised une	upervised and semi sur	ervised machin	ne learning
2	algorith	n.	some supervised, uns	aper rised, and serin sup	er vised maeim	ie ieurining
3	Study of	probabilistic an	alysis, parametric and	d non-parametric algorit	hms.	
4	Estimati	on of Maximum	Likelihood, losses, a	nd risks for classification	ons problems.	
	1	Course	Outcomes (CO) wit	th Bloom's Taxonomy	Level	
At the	end of the	e course, the stud	lents will be able to,	<i>v</i>		
			· · · ·		Bloom's	Bloom's
CO		Cours	e Outcome Statement/s		Taxonomy	Taxonomy
					Level	Description
	Apply A	I principles, app	roaches, and method	ologies, including		
CO1	supervis	ed, unsupervised	l, and semi-supervise	d learning algorithms,	III	Applying
	to solve	real-world probl	ems.			
CO2	Apply	supervised, uns	upervised, and sem	i-supervised machine	III	
	learning	Apply supervised, unsupervised, and semi-supervised machine				Annlying
	A nalwa and compare probabilistic analysis techniques, peremetric			sets effectively.	111	Applying
CO3	Analyze	algorithms to so and compare pr	olve diverse problem s obabilistic analysis to	sets effectively. echniques, parametric,	IV	Applying
CO3	Analyze and non	algorithms to so and compare pr -parametric algor	volve diverse problem s robabilistic analysis to rithms in the context	sets effectively. echniques, parametric, of machine learning.	IV	Applying Analyzing
CO3	Analyze and non Evaluate	algorithms to so and compare pr -parametric algor e the estimation	lve diverse problem s obabilistic analysis to rithms in the context of Maximum Likelih	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks	IV	Applying Analyzing
CO3	Analyze and non Evaluate for clas	algorithms to so and compare pr -parametric algore the estimation sification proble	lve diverse problem s obabilistic analysis to rithms in the context of Maximum Likelih ms, and propose ap	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to	IV IV V	Applying Analyzing Evaluating
CO3 CO4	Analyze and non Evaluate for clas mitigate	algorithms to so and compare pr -parametric algore the estimation sification proble them.	volve diverse problem s obabilistic analysis to rithms in the context of Maximum Likelih ms, and propose ap	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to	IV IV V	Applying Analyzing Evaluating
CO3 CO4	Analyze and non Evaluate for clas mitigate	algorithms to so and compare pr -parametric algore the estimation sification proble them.	volve diverse problem s obabilistic analysis to rithms in the context of Maximum Likelih ms, and propose ap	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to	IV IV V	Applying Analyzing Evaluating
CO3 CO4 Modu	Analyze and non Evaluate for clas mitigate	algorithms to so and compare pr -parametric algore the estimation sification proble them.	vive diverse problem s obabilistic analysis to rithms in the context of Maximum Likelih ms, and propose ap Module Co	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to ontents	IV IV V	Applying Analyzing Evaluating Hours
CO3 CO4 Modu	Analyze and non Evaluate for clas mitigate	algorithms to so and compare pr -parametric algorithms the estimation sification proble them.	volve diverse problem s robabilistic analysis to rithms in the context of of Maximum Likelih ms, and propose ap <u>Module Co</u> ficial Intelligence	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to mtents	III IV V	Applying Analyzing Evaluating Hours
CO3 CO4 Modu	Analyze and non Evaluate for clas mitigate	algorithms to so and compare pr -parametric algore the estimation sification proble them.	volve diverse problem s obabilistic analysis to rithms in the context of Maximum Likelih ms, and propose ap <u>Module Co</u> ficial Intelligence te – Introduction, In Searching Informed	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>ontents</b> ntelligent Agents, Pro	III IV V blem-solving,	Applying Analyzing Evaluating Hours 7
CO3 CO4 Modu	Analyze and non Evaluate for clas mitigate Ile Intr Artif Solv	algorithms to so and compare pr -parametric algorithms the estimation sification proble them.	volve diverse problem s obabilistic analysis to rithms in the context of Maximum Likelih ms, and propose ap <u>Module Co</u> ficial Intelligence re – Introduction, In Searching, Informed s Adversarial Search	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>ontents</b> ntelligent Agents, Pro d Search and Exploratio	II IV V blem-solving, on, Constraint	Applying Analyzing Evaluating Hours 7
CO3 CO4 Modu	Analyze and non Evaluate for clas mitigate Ile Intr Artif Solv Satis	algorithms to so and compare pr -parametric algorithms the estimation sification problection them.	Nodule Co Module Co Module Co Module Co Module Co ficial Intelligence be – Introduction, In Searching, Informed s, Adversarial Search Intation and Reason	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>ontents</b> ntelligent Agents, Pro d Search and Exploratio.	II IV V blem-solving, on, Constraint	Applying Analyzing Evaluating Hours 7
CO3 CO4 Modu I	Analyze and non Evaluate for clas mitigate Ile Intr Artif Solv Satis	algorithms to so and compare pr -parametric algored the estimation sification problection them.	volve diverse problem s obabilistic analysis to rithms in the context of Maximum Likelih ms, and propose ap Module Co ficial Intelligence the – Introduction, In Searching, Informed s, Adversarial Search ntation and Reasonian oning Logical Agents	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>ontents</b> ntelligent Agents, Pro d Search and Exploratio.	II IV V blem-solving, on, Constraint	Applying Analyzing Evaluating Hours 7 7
CO3 CO4 Modu I II	Analyze and non Evaluate for clas mitigate Ile Intr Artif Solv Satis Kno Kno	algorithms to so and compare pr -parametric algore the estimation sification proble them. oduction to Arti- ficial Intelligence ing Problems by faction Problems wledge Represe wledge and reaso er Logic, Knowle	Note diverse problem s obabilistic analysis to rithms in the context of Maximum Likelih ms, and propose ap Module Co ficial Intelligence be – Introduction, It Searching, Informed s, Adversarial Search ntation and Reasoni oning, Logical Agents, adge Representation	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>ontents</b> ntelligent Agents, Pro d Search and Exploratio ing , First-Order Logic, Infe	II IV V blem-solving, on, Constraint rence in First-	Applying Analyzing Evaluating Hours 7 7 7
CO3 CO4 Modu I II	Analyze and non Evaluate for clas mitigate Ile Intr Artif Solv Satis Kno Orde Plar	algorithms to so and compare pr -parametric algorithms the estimation sification problection them. oduction to Arti- ficial Intelligence ing Problems by faction Problems wledge Represe wledge and reaso er Logic, Knowlec- ning and Decisi	Nodule Co Module Co Module Co Module Co Module Co ficial Intelligence e – Introduction, In Searching, Informed s, Adversarial Search ntation and Reasoni oning, Logical Agents edge Representation.	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>intents</b> ntelligent Agents, Pro d Search and Exploration. ing , First-Order Logic, Infe	II IV V blem-solving, on, Constraint rence in First-	Applying Analyzing Evaluating Hours 7 7 7
CO3 CO4 Modu I II	Analyze and non Evaluate for clas mitigate Ile Intr Artif Solv Satis Kno Orde Plan Plan	algorithms to so and compare pr -parametric algorithms the estimation sification proble them. oduction to Arti ficial Intelligence ing Problems by faction Problems wledge Represe wledge and reaso or Logic, Knowle ning and Decisi ning, Planning a	Nodule Co Module Co Module Co Module Co ficial Intelligence Searching, Informed s, Adversarial Search ntation and Reasoni oning, Logical Agents edge Representation. on Making and Acting in the Re	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>intents</b> ntelligent Agents, Pro d Search and Exploratio. ing , First-Order Logic, Infe	III IV V blem-solving, on, Constraint rence in First-	Applying Analyzing Evaluating Hours 7 7
CO3 CO4 Modu I II	Analyze and non Evaluate for clas mitigate Ile Intr Artif Solv Satis Kno Orde Plan Plan rease	algorithms to so and compare pr -parametric algored the estimation sification problection them. oduction to Artificial Intelligence ing Problems by faction Problems wledge Represe wledge and reaso er Logic, Knowled ning, Planning a poning, Uncertain	Ive diverse problem s obabilistic analysis to rithms in the context of Maximum Likelih ms, and propose ap Module Co ficial Intelligence me – Introduction, In Searching, Informed s, Adversarial Search ntation and Reasonic oning, Logical Agents, edge Representation. on Making and Acting in the Reasonic ty, Probabilistic Reasonic	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>ontents</b> ntelligent Agents, Pro d Search and Exploratio ing , First-Order Logic, Infe eal World, Uncertain kn soning, Probabilistic Re	II IV V blem-solving, on, Constraint rence in First- nowledge and easoning over	Applying Analyzing Evaluating Hours 7 7 6
CO3 CO4 Modu I II III	Analyze and non Evaluate for clas mitigate Ile Intr Artif Solv Satis Kno Orde Plan rease Time	algorithms to so and compare pr -parametric algorithms to so e the estimation sification proble them. oduction to Artificial Intelligence ing Problems by faction Problems wledge Represe wledge and reaso er Logic, Knowle ning and Decisi ning, Planning a poning, Uncertain e, Making Simple	Note diverse problem s obabilistic analysis to rithms in the context of Maximum Likelih ms, and propose ap Module Co ficial Intelligence re – Introduction, It Searching, Informed s, Adversarial Search ntation and Reasoni oning, Logical Agents edge Representation. on Making and Acting in the Re ty, Probabilistic Reas e Decisions. Making	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>entents</b> ntelligent Agents, Pro d Search and Exploration. ing , First-Order Logic, Infe eal World, Uncertain kn soning, Probabilistic Ro Complex Decisions.	III IV V blem-solving, on, Constraint rence in First- nowledge and easoning over	Applying Analyzing Evaluating Hours 7 7 6
CO3 CO4 Modu I II III	Analyze and non Evaluate for clas mitigate Ile Intr Artif Solv Satis Kno Orde Plan rease Time	algorithms to so and compare pro- parametric algorithms to so and compare pro- parametric algorithms the estimation sification proble them. oduction to Artificial Intelligence ing Problems by faction Problems wledge Represe wledge and reaso er Logic, Knowle ning, Planning a poning, Uncertain e, Making Simple oduction to Mag	Nodule Co Module Co Module Co ficial Intelligence e – Introduction, In Searching, Informed s, Adversarial Search ntation and Reasoni oning, Logical Agents edge Representation. on Making and Acting in the Re ty, Probabilistic Reas e Decisions, Making chine Learning	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>intents</b> ntelligent Agents, Pro d Search and Exploratio ing , First-Order Logic, Infe eal World, Uncertain kn soning, Probabilistic Re Complex Decisions.	III IV V blem-solving, on, Constraint rence in First- nowledge and easoning over	Applying Analyzing Evaluating Hours 7 7 6
CO3 CO4 Modu I II III	Analyze and non Evaluate for clas mitigate Ile Intr Artif Solv Satis Kno Orde Plan rease Time Intr	algorithms to so and compare pr -parametric algorithms to so the estimation sification problection them. oduction to Artificial Intelligence ing Problems by faction Problems wledge Represe wledge and reaso or Logic, Knowle ning and Decisi ning, Planning a poing, Uncertain e, Making Simple oduction to Mach	Nodule Co Module Co Module Co Module Co ficial Intelligence e – Introduction, In Searching, Informed s, Adversarial Search ntation and Reasoni oning, Logical Agents, edge Representation. on Making and Acting in the Re ty, Probabilistic Rease e Decisions, Making ine Learning, Applica	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>ontents</b> ntelligent Agents, Pro d Search and Exploratio. ing , First-Order Logic, Infe eal World, Uncertain kn soning, Probabilistic Re Complex Decisions.	III IV V blem-solving, on, Constraint rence in First- nowledge and easoning over	Applying Analyzing Evaluating Hours 7 7 6
CO3 CO4 Modu I II III	Analyze and non Evaluate for clas mitigate Ile Intr Artif Solv Satis Kno Orde Plan rease Time Intr Intro	algorithms to so and compare pr -parametric algorithms to so the estimation sification proble them. oduction to Artificial Intelligence ing Problems by faction Problems wledge Represe wledge and reaso er Logic, Knowle ming and Decisi ning, Planning a pring, Uncertain e, Making Simple oduction to Mach es in ML, Super	Nodule Co Module Co Module Co ficial Intelligence Adversarial Search ning, Logical Agents adge Representation. on Making and Acting in the Re ty, Probabilistic Reas e Decisions, Making chine Learning, Applica vised Learning, Unsu	sets effectively. echniques, parametric, of machine learning. nood, losses, and risks propriate strategies to <b>ontents</b> ntelligent Agents, Pro d Search and Exploratio ing , First-Order Logic, Infe eal World, Uncertain kn soning, Probabilistic Re Complex Decisions. ations of ML, Design Pe	III IV V blem-solving, on, Constraint rence in First- nowledge and easoning over erspective and mi-supervised	Applying Analyzing Evaluating Hours 7 7 6 7 7 7 7

	Data Pre-processing and Representation				
	Input: Concepts, instances, and attributes, Output: Knowledge Representation				
V	Decision tables, Decision trees, Decision rules, Rules involving relations.	6			
	Instance-based representation, Data Pre-processing: Data cleaning, integration,				
	transformation, reduction, discretization, and concept hierarchy generation.				
	Classification and Evaluation				
	Introduction to Classification, Classification, Diagnostic, Accuracy and Error				
<b>N</b> / <b>T</b>	Measures, Decision Tree, Probabilistic Classifier, Clustering: Unsupervised	6			
VI	Learning Technique, Similarity and Distance Measures, k-means and k-medoids	6			
	Algorithm, Optimization Objective, Random Initialization, Choosing Value of				
	k, EM Algorithm				
	Textbooks				
1	Stuart J. Russell and Peter Norvig, -Artificial Intelligence A Modern Approa	ch, 3rd edition,			
1	Prentice Hall				
2	Tom Mitchell, —Machine Learning, McGraw-Hill, 1997				
3	EthemAlpaydin, —Introduction to Machine Learningl, PHI, 2005				
4	Bishop, C., —Pattern Recognition and Machine Learning:, Berlin: Springer-Ver	lag, 2006			
	References				
1	K.P. Soman, R. Longonathan and V. Vijay, -Machine Learning with SVM and Other Kernel				
1	Methods  , PHI				
2	Christopher M. Bishop, -Pattern Recognition and Machine Learning I, Springer	2006.			
3	Tom M. Mitchell, —Machine Learningll, McGraw-Hill, 1997				
4	The Elements of Statistical Learning - by T. Hastie, R. Tibshirani, and J. Friedman, 2009				
	Useful Links				
1	https://www.coursera.org/learn/machine-learning				
2	https://www.coursera.org/learn/ai-for-everyone				

CO-PO Mapping						
		Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5	PO6
C01		1				
CO2	2		2	2		
CO3	2		3	2		
CO4				3		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High						
Each CO of the course must map to at least one PO.						

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

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		Wal	chand College	of Engineering,	Sangli		
	(Government Aided Autonomous Institute)						
	AY 2024-25						
Drogr			M Tech Control	and Instrumentation			
Class	Programme M. Tech. Control and Instrumentation						
Class,	Semesu	ſ	TIIST TEAT WI. TEC				
Cours	e Coue		Drofossional Elas	tive 1. Magguramont	Data Analytica		
Doging	Course Name         Floressional Elective 4. Measurement Data Analytics           Desired Dequisitest         Measurement principles in engineering						
Desire	u nequi	sites:		icipies in engineering			
	Teachin	g Scheme		Examination Scl	neme (Marks)		
Lectu	re	3 Hrs/week	MSE	ISE	ESE	Total	
Tutor	ial	-	30	20	50	100	
				Credit	s: 3	100	
		1	1				
			Course	Objectives			
1	Provide	a solid foundation	on in measurement	and statistical concept	ts.		
2	Equip s	tudents with tech	niques to evaluate a	and analyze measuren	nent data.		
3	Teach	error propagation	methods and uncer	tainty analysis in mea	surements.		
4	Introdu	ce parameter esti	mation and data vis	ualization techniques			
		Course	e Outcomes (CO) w	vith Bloom's Taxono	omy Level		
At the	end of th	e course, the stud	lents will be able to	,			
					Bloom's	Bloom's	
CO	CO Course Outcome Statement/s			nent/s	Taxonomy	Taxonomy	
					Level	Description	
CO1	CO1 Apply key measurement and statistical terms in the analysis and III				Applying		
<u>CO2</u>	CO2 Evaluate validity compare data sets and conduct variance analysis V				Fyaluating		
CO3Propagate errors, perform error analysis, and calculate uncertainties.IVAn				Analyzing			
CO4	CO4       Conduct regressions, interpret results, and utilize data visualization       VI       Creating				Creating		
	technic	ues.					
Modu	le		Module (	Contents		Hours	
	IN	RODUCTION					
I	Ter star	ms pertaining to dards Distributio	quantity - Measure n function	ement and statistics	- Instruments and	1 7	
	EV	ALUATION OF	MEASUREMEN'	Г ДАТА			
	Eva	luation of validity	y of extreme values	of measurement resu	lts - Evaluation of	2	
п	the	means obtained	otained from two sets of measurement results - Comparison of				
	var	ances of two se	ets of measuremen	t results - Measurer	ments concerning		
	trav	elling standards -	F-test for internal a	nd external consistend	cy - Standard error		
	of t	he overall mean -	Analysis of variand	ce - Tests for uniform	ity of variances		
	ER	<b>KOR PROPAG</b>	ATION	1.1. fronting During			
III	Pro	pagating the erro	or in a single-varia	able function - Prop	agating the error	6	
		lysis Combined	experiments. The	experimental strateg	y based on entor		
		CERTAINTV	IN CALIRI		ELECTRICAT	,	
		TRUMENTS			LLUIMUAL		
	Une	ertainty in calibr	ation of RF power	sensor – Uncertainty	in calibration of a		
IV	Dig	ital Instrument -	Uncertainty calcul	ation for correlated	input quantities	.   7	
	Vec	tor Measurands.	Least- squares fittir	ig with uncertainties	in both variables	.	
	Mo	re complex error	surfaces - Monte Ca	arlo methods - Bootst	rap methods		
	ES	<b>FIMATION OF</b>	PARAMETERS		•		
x7	Sin	ple Linear Regr	ession - Multiple	Linear Regression -	Interpretation of		
	reg	ession coefficier	ts - Visualizations	- Visual Data Anal	ysis techniques	.   0	
	Inte	raction technique	s - Systems and app	olications	-		

	PRACTICAL APPLICATION				
VI	Integration of measurement data analytics concepts in real-world scenarios.	6			
	Case study analysis.				
Textbooks					
1	Semyon G. Rabinovich, "Measurement Errors and Uncertainities - Theory ar	nd Practice", 3rd			
1	Edition, Springer Publication, 2005.				
2	S.V. Gupta, "Measurement Uncertainties: Physical Parameters and Calibration	of Instruments",			
	Springer Publication, 2012.				
2	² Ifan Hughes, Thomas Hase, "Measurements and Their Uncertainties: A Practical Guide to				
3	Modern Error Analysis", Oxford University Press, 2010.				
	References				
1	Michael, Grabe, "Measurement Uncertainties in Science and Technology", 2nd Edition,				
1	Springer Publication, 2014.				
2	Patrick F. Dunn, "Measurement and Data Analysis for Engineering and Science	e", 2nd Edition,			
2	CRC Press, 2010.				
2	Hugh W. Coleman, W. Glenn Steele, "Experimentation, Validation, and Uncerta	inty Analysis for			
3	Engineers", 4th Edition,				
	Useful Links				
1					

CO-PO Mapping							
		Programme Outcomes (POs)					
	PO1	PO1         PO2         PO3         PO4         PO5         PO6					
CO1	2		3				
CO2		2	3	2			
CO3				2			
CO4 3 2 2					3		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High							
Each CO of the course must map to at least one PO.							

The assessment is based on MSE, ISE and ESE.

MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.

ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

### **Open Elective**

	Walchand College of Engineering, Sangli							
			(Government Aidea	l Autonomous Institut 2022-24	e)			
	AY 2023-24 Course Information							
Progr	amme		M Tech Control	and Instrumentatio	n			
Class.	Semester		First Year M. Tec	ch., Sem. II				
Cours	e Code		7OE506	70E506				
Cours	e Name		Open Elective: E	lectrical Drives and	Appli	ications		
Desire	ed Requisit	tes:						
Tester	Teaching Scheme		MCE	Examination So	cheme	e (Marks)	<b>T</b> - 4 - 1	
Lectu	re iol	3 Hrs/week		15E 20		<b>ESE</b> 50	100	
1 0101	141			20 Credi	its: 3	50	100	
			<u> </u>		165.0			
			Course	Objectives				
	To make	students underst	and concept of fun	damental knowledg	e in dy	namics and o	control of Electric	
	Drives.		_	C				
2	To streng	then control pri	nciples of various l	DC and AC motors	using	solid state co	onverters.	
-	To cover	principles of s	election of Electri	c Motors and high	lights	the applicati	ons of Electrical	
3	Drives.	- •		C	~	**		
4	Update th	ne modern contr	ol trends in the fiel	d of electrical drive	s.			
	1	Course	Outcomes (CO) w	ith Bloom's Taxor	nomv	Level		
At the	end of the	course, the stud	ents will be able to	),	v			
			e Outcome Statement/s			Bloom's	Bloom's	
CO		Course				Taxonomy	Taxonomy	
		1 / 1				Level	Description	
COI	Apply fu	ndamental conc	epts in Electric driv	ves.	1		Applying	
CO2	Apply the	e control technic	jues for Electric dr	ives for speed contr	ol.	III	Applying	
CO3	Analyze speed cor	the performance trol of electric	e of various cont drives.	rol techniques use	d in	IV	Analyzing	
CO4	Recomme	end the drives s	ystem for a particul	lar application.		V	Evaluating	
Modu	ıle		Module C	ontents			Hours	
	Fund	amentals of El	ectric Drives					
	Types	s & parts of the I	Electrical drives, Se	election criteria of da	rives,	motor rating,		
	select	ion based on du	ity cycle, selection of converter rating, fundamental to					
I	equati	ion, speed torqu	es characteristics DC motor & Induction motor, n			motor, multi	7	
	quadr	ant operation of	of the drive, classi	fication of mechan	nical 1	oad torques,		
	steady	y state stability of	of the drive, constant	nt torque and consta	int HP	operation of		
	the dr	ive, closed loop	speed control.					
	Powe	r Converters fo	or Electrical Drive	es				
п	Single	e phase and t	hree phase rectifi	ers, Single phase	and	three phase	7	
thyristorised converte		rs, Control and performance of thyristorised converters,						
	Single	e phase and thre	e phase voltage sou	urce inverters and th	neir co	ontrol.		
		lotor Drives				<b>.</b> .		
	Metho	ods of speed co	ontrol, starting and	braking operation.	, sing	le phase and		
	three	phases full cont	rolled and half con	trolled converter fe	d DC	drives, Multi		
III	quadr	ant operation of	t separately excited	d DC shunt motor,	dual c	converter fed	7	
	DC di	rives, circulatin	g and non – circula	ting mode of opera	tion, c	converter fed		
	DC se	eries motor driv	e, chopper control	of DC shunt and se	eries r	notor drives,		
	four q	uadrant operati	on of chopper fed I	DC shunt motor driv	ve.			

	Induction Motor Drives	
IV	Torque equation, Speed control methods for three phase cage induction motor, braking methods, stator voltage control induction motor drive, VSI fed induction motor drive, constant torque (constant E/F and constant V/F), constant HP operation, closed loop speed control block diagram, Various methods of speed control for slip ring induction motors.	6
	Synchronous Motor Drives and Brushless DC Motor Drives	
v	VSI fed synchronous motor drives, true synchronous and self-control mode, open loop and closed loop speed control of Permanent magnet synchronous machine, brushless DC motor drives.	6
	Special Drives	
VI	Construction and operating principle of switched reluctance motors, Current / Voltage control, torque equation, converter circuits, operating modes and applications of switched reluctance motors. Solar panel VI characteristics, solar powered pump, maximum power point tracking and battery-operated	6
	vehicles.	
	Textbooks	
1	G. K. Dubey, "Fundamentals of Electrical Drives", Narosa publication, 2 nd edi	tion, 2002.
	D.C.	
	<b>References</b>	ama Pracad Dac
1	Department of Electrical Engineering, IIT Kanpur.	anna Flasau Das,
2	"Power Electronics – Converter Application", By N. Mohan T.M. Undel and	W. P. Robbins,
2	John Wiely and sons.	
3	"Electrical Drives – Concept and application", Vedam Subramanyam.	
	Useful Links	
1	https://nptel.ac.in/courses/108/104/108104140/	

CO-PO Mapping						
Programme Outcomes (PO)						
	1	2	3	4	5	6
CO1			3			
CO2				3		
CO3	3					
CO4				3		
The strength of mann	The strength of manning is to be written as 1: Low 2: Madium 2: High					

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Syllabus Prepared By	Dr. D. S. More
Syllabus Checked By	