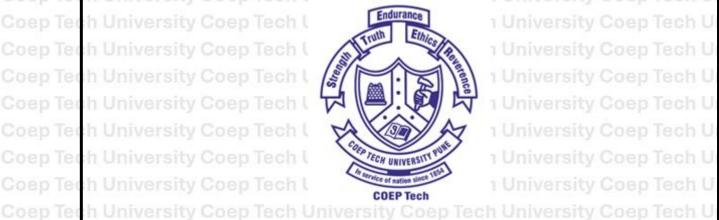
Coep Tech University Coep Tech University Coep Tech University Coep Tech U Coep Tech University Coep Tech University Coep Tech University Coep Tech U Coep Tech University Coep Tech University Coep Tech University Coep Tech U National Education Policy (NEP) Compliant Curriculum Coep Tech University Coep Tech University Coep Tech University Coep Tech Univers Coep Tech University Coep Tech Universit for oep Tech University Coep Tech U Coep Tech University Coep Tech University Coep Tech University Coep Tech U **B. Tech. (Robotics & Artificial Intelligence)** (With effect from Academic Year 2023-24) Coep Tech University Coep ty Coep Tech U Coep Tech University Coep Tech University Coep Tech University Coep Tech U Coep Tech University Coep Tech University Coep Tech University Coep Tech U Coep Tech University Coep Tech University Coep Tech University Coep Tech U

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Computer Network Operation of Mechanical Engineering COEP Technological University (COEP Tech) A Unitary Public University of Government of Maharashtra Comparing Pune) (Formerly College of Engineering Pune) Coop Termination Coop Termination Wellesley Road, Shivajinagar, Coop Termination Pune-411005, Maharashtra, India Coep Tec Phone: +91- 2550 7900 Fax: +91 25507299 Email: hod.mech@coeptech.ac.in Website: www.coep.org.in Coep Tec 1 University Coep Tech University Coep Tech University Coep Tech L Coep Tech University Coep Tech University Coep Tech University Coep Tech L

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COEP Tech1/90BTech (R&AI) Mechanical Engg. Dept.

Vision of the Department: Coep Tec To be a leader amongst engineering institutions in India, offering value based world class **Coep Tereducation and constantly pursuing excellence Mission of the Department:** Coep Tec M1: To offer state-of-the-art undergraduate, postgraduate and doctoral programmes COOP TerM2: To develop employable and skilled undergraduate to accept the global and societal challenges, Vers while imparting quality education at postgraduate and research level. M3: To Foster the passion of life-long learning in all facets of employability. Coep Tec., **Coep** TProgram Educational Objectives (PEOs) PEO1. Core Competence: Fundamental and technical knowledge with skills in Robotics & Artificial Intelligence area to enable and empower to solve problems of the modern industrial world. PEO2. Depth (Research culture): Imbibing a scientific perspective to make a decision of Robotic systems and Artificial Intelligence using Mathematical, Engineering, Computational & Coep Tech U Simulation tools. Tech University Coep Tech University Coep Tech University PEO3. Professionalism: Make acquaint with technical, managerial, and human skills and familiarize COED TECHNO with professional issues like ethics and morality, Intellectual property Rights, Constitution of India and Environmental responsibility. **PEO4.** Learning Environment: Motivation for entrepreneurship and inculcating a spirit of continuous lifelong learning for a successful professional career. **Coep Program Outcomes** Program Outcomes of Engineering program as per norms (common to all UG/ PG Programme) COEPPO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, VErs Coep and an engineering specialization for the solution of complex engineering problems. PO2. Problem analysis: Identify, formulate, research literature, and analyses complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and Wers Coep engineering sciences. PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public COMP health and safety, and cultural, societal, and environmental considerations. PO4. Conduct investigations of complex problems: The problems: • that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline. • that may not have a unique solution. For example, a design problem can be solved in many Coep ways and lead to multiple possible solutions. • that require consideration of appropriate vers constraints/requirements not explicitly given in the problem statement. (like: cost, power requirement,

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 BTech (R&AI) Mechanical Engg. Dept.

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durability, product life, etc.). • which need to be defined (modeled) within appropriate mathematical frame work. • that often require use of modern computational concepts and tools.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess were societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of **Vers** engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering **PO12** and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Coep PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in **Vers** independent and life-long learning in the broadest context of technological change technological change.

Program Specific Objectives (PSOs)

PSO1 Design and Development: The ability to design and develop the products as per the need of the customers in the field of Mechanical and Allied Engineering Industries.

PSO2 Engineering Analysis and optimization: The ability to analyze and optimize the Mechanical systems/processes using various computational tools.

PSO3 Society: To strengthen Mechanical Engineering graduates who would value professional and ethical responsibilities while solving societal problems
COEP Tech 3/90 BTech (R&AI) Mechanical Eng. Dept.

Abbreviation	Title
BS	Basic Science Course
ESC	Engineering Science Course
PCC	Programme Core Course (PCC)
PEC PEC	Programme Elective Course (PEC)
OE/SE	Open/School Elective (OE/SE) other than particular program
ep Tech Un MDM y Co	Multidisciplinary Minor (MD M)
ep Tech UNSEC	Vocational and Skill Enhancement Course (VSEC)
HSMC	Humanities Social Science and
ep Tech University Co	Management
ep Tech UnivIKS	Indian Knowledge System (IKS)
ep Tech UnivVECity Co	Value Education Course (VEC)
ep Tech Univ RM ity Co	Research Methodology (RM)
ep Tech Uni ELC ity Co	Internship University Coep Tech University Coep Tech Univer
ep Tech Univ _{ELC} ity Co	Project Driversity Coep Tech University Coep Tech University
ep Te Ch Un CEA	Community Engagement Activity (CEA)/Field Project
CCA	Co-curricular & Extracurricular Activities (CCA)

Coep Tech University Coep Tech

oe		the second second	versity Co	ep Tech University	Co	ep.	fect	U	nive	L COLLAR			n Scheme ges in %)		
oe	Sr. No.	Course Type	Course Code	Course Name	Go	्म	ep:	S	Cr	rsity	heory	p Teo	Labo	rator /	
oe		ch Uni	versity Co	ep Tech University	CO		ecr	1.0		MSE	TA	ESE	ISE	ESE	
e	01	BSC	MRAIBSC101	Matrix Algebra, Calculus and Probability	2	P]	0	1	3	30	20	50	:h <u>U</u> I	<u>live</u>	
e	02	BSC	MRAIBSC102	Engineering Physics	2	0	2	1	3	30	20	50	CIE:	100	
e	03	ESC	MRAIESC103	Basic Electrical & Electronics Engineering	60	0	2	P	ni ₃ re	30	20	50	CIE:	100	
e	04	ESC	MRAIESC104	Engineering Drawing and Graphics	Col	0	ec 4	1	3	rsit c	IE: 100	p Teo	CIE:	100	
e	05	ESC	MRAIESC105	Engineering Mechanics	3	0	2	1	4	30	20	50	CIE:	100	
ė	06	AEC-I	MRAIAEC106	Communication Skill	do	0	2	0	2	rsit C	IE: 100	h Ter	CIE:	100	
-	07	CCA		Liberal Learning Course-I	0	0	2	2	1				CIE:	100	
e	08	VESC-I	versity Co	Manufacturing Practices/ Fab Lab - I	0	0	2	1	nive	rsity	Coe	p <u>lec</u>	CIE:	100	
10	0.16	ch on	versity co	Total	11	1	16	8	20	isity	coe	hier	SIL OI	nve	

[Level 4.5, UG Certificate] Semester -II

Sr.	Course	Course	ity Coep Tech Unive	rsity	Coer	Teo	h Ur	niver				Schem s in %	-
No.	Туре	Code	Course Name	L	T	Р	S	Cr		heor		Labor	
	p rec	n Universi	ity Coep Tech Unive		Poel		n Ui	iivei	MSE	TA	ESE	ISE	ESE
01	BSC	MRAIBSC201	Engineering Chemistry	rs ₂ y	COSI	2#	h	3	30	20	50	CIE:	100
02	BSC	MRAIBSC202	Ordinary Differential Equations and Multivariate Calculus	rsity 2 rsity	Coep 1 Coep		h Ur 1 h Ur	3	30	20	50	CIE:	100
03	ESC	MRAIBSC203	Biology for Engineers	2	0	0	1	2	30	20	50	ch l	Tive
04	ESC	MRAIESC204	Systems in Mechanical Engineering	rs2y	Cı0er	2	hUr	3	30	20	50	CIE:	100
05	ESC	MRAIESC205	Programming for Problem Solving	rsity	Croep	2	2	2	sit)c	IE: 10	00 Te	CIE:	100
06	ESC	MRAIESC206	Design Thinking and Idea Lab	0 V	C ₀ el	2	h Ur	nive	si <u>t</u> y	Coe	ep Te	CIE:	100
07	PCC	MRAIPCC207	Material Science	2	0	0	h Ur	2	30	20	50	c <u>h</u> L	nive
08	VSEC- II	MRAIVSEC208	Manufacturing Practices/ Fab Lab - II	0	0	2	0	nive:	sity	Cor	ep Te	CIE:	100
09	IKS	MRAIIKS209	Indian Knowledge System	2	0	0	1	2	С	IE: 10	00	<u></u>	<u> </u>
10	CCA	MRAICCA210	Co-curricular/Office Automation/ Extracurricular Activity	o 0	Coer Coer	2	0	niver niver	sity sity		ep Te	CIE:	100
Coe 11 Coe	CEA	MRAICEA211	Social Summer Internship- after Sem II-Exam in Sem III (60 Days)	0 0	Coer O Coer	0	0	0	sity		ep Te ep Te	ich L Ich L	In <u>iv</u> Iniv
	in Terr		Total	13	1	12	9	20		0	in Te	Colo I	Lister.

 # => Combined Lab for Applied Chemistry and Material Science

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 BTech (R&AI) Mechanical Engg. Dept.

Legends: L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits ISE-In-Semester-Evaluation, ESE-End-Semester-Evaluation, MSE-Mid-Semester-Evaluation, TA-Teachers' Assessment, CIE-Continuous-Internal-Evaluation

Sr.	Course	Course			-	-	_					Scheme s in %)	
No.	Туре	Code	Course Name	L		Ρ	S	Cr	Т	heory	,	Labor	atory
									MSE	TA	ESE	ISE	ESE
01	VSEC	MRAIVSEC2E1	Computer Aided Geometric Modelling	1	0	2	0	2	30	20	50	50	50
02	VSEC	MRAIVSEC2E2	Additive Manufacturing	1	0	2	0	2	30	20	50	50	50
03	VSEC	MRAIVSEC2E3	Metallurgical Lab Practice - I	1	0	2	0	2	30	20	50	50	50
04	VSEC	MRAIVSEC2E4	Basics of CNC programming	1	0	2	0	2	30	20	50	50	50
05	VSEC	MRAIVSEC2E5	Basics of Robotics & AI	1	0	2	0	2	30	20	50	50	50
			Total	18	1	22	9	30					

Summer internship (Industry / R&D / Academic Institute) after IV th semester during summer Vacation & Evaluation will be done in the starting of V th Semester

Coep Tech University Coep [Level 5, UG Regular] Semester -III asity Coep Tech Univers

Coep Tech University Coep TS.Y. BTech (Robotics & AI) versity Coep Tech Univers

Sr.	Course	University	Coep Tech Univer	sity	Coe	sb.	ec	n Un	ivers			Scheme es in %)		
No.	Туре	Course Code	Course Name	siry	T	Ρ	S	Cr	IVOIG	heory		Labor		
	o Tech		Coep Tech Univer		Coe	ep]	ec	n Un	MSE	TA	ESE	ISE	ESE	
01	PCC	MRAIPCC301	Basics of Robotics & AI	s 4	0	0	elc	4	30	20	50	Tech	Umi	
02	PCC	MRAIPCC302	Sensors for Industrial Robotics	si ₂ /	0	2	[eic	3	V30 S	20	50	50	50	
03	PCC	MRAIPCC303	Industrial Robot Programming	2	0	2		3	30	20	50	50	50	
04	OE	MRAIOE304	Open Elective - I	2	0	0	ec	2	30	20	50	Tech	Uni	
05	AEC-II	MRAIAEC305	Indian language Sanskrit/Pali	siży	0	0	ſe <u>i</u> c	2	30	20	50	Tech	Úni	
06	VEC-I	MRAIVEC306	Constitution of India and Universal Human Values	sity sity	0	0	0	ո Սո հ Սո	ivers iverS	IE: 100	oep loep	Tech Tech	Uni	
07	HSMC	MRAIHSMC307	Principles of Economics	2	0	0	erc	2	30	20	50	Tech	Uni	
08	CEA	MRAICEA308	Community Engagement Activity/ Field Project *	siov	0	4	[e _l c	2	ivers	ity C	o <u>e</u> p	CIE:	100	
0e	piech	University	Total	15	0	8	7	19	Ivers	ity U	oeh	rech	OIII	

* => Field project (Social Summer Internship) after semester II during summer vacation and evaluation will be done at the start of the III semester.
 COEP Tech
 6/90
 BTech (R&AI) Mechanical Eng. Dept.

Col	Sr. Course	University	Coep Tech Universi	ty C	pep	Tec	h Un	iver			tion S htages		
Sr. No.	Course Type	Course Code	Course Name	tyC	pep	Tec	S	Cr	sity C	Theory	Tecl	s l im	orato 'Y
Col	ep Tech	University	Coep Tech Universi	tv C	pep	Tec	h Un	iver	MSE	TA	ESE	ISE	ESE
01	PCC	MRAIPCC401	Analog & Digital Electronics	2	0	2	0	3	30	20	50	50	50
02	PCC	MRAIPCC402	Control Systems	2	0	2	0	3	30	20	50	50	50
03	PCC	MRAIPCC403	Drives for Robot Systems	3	0	0	0	3	30	20	50	l tra	vers
04	PCC	MRAIPCC404	Standards & Ethics for Robot Applications	ty2C	0 Op	T 00	2 1	2	30	20	50	ı U n	ivers
05	OE-II	MRAIOE405	Open Elective-II	2	0	0	0	2	30	20	50	ı Un	vers
06	MDM-I	MRAIMDM406	Multidisciplinary Minor -I	3	0	0	1	3	30	20	50	1.770	
07	VSEC- III	MRAIVSEC407	Numerical Methods & Programming Language	ty C ty ¹ C	0		ո Սո	2	sity C	CIE: 10	0 _{Tecl}	50	50
08	HSMC	MRAIHSMC408	Principles of Entrepreneurship	ty2C	0	0	ի կի	2	30	20	50	n Un	ivers
09	VEC-II	MRAIVEC409	Environmental Studies	tv1C	0	0	n 1 n	iv a r:		CIE: 10	0 ecl	ı Un	vers
-	1 mar 1	220 A AZ	Total	18	0	6	6	21	100		-	10.01	2

Coep Tech University Coep TS.Y. BTech (Robotics & AI) Versity Coep Tech University

Coep Tech University [Level 5, UG Diploma] Semester -III Lateral Entry

				1.1	P								
Sr.	Course				_					Evalua (Weigł			
No.	Туре	Course Code	Course Name	L	Т	Р	S	Cr		Theory	1	Labor	ratory
									MSE	TA	ESE	ISE	ESE
01	PCC	MRAIPCC301	Basics of Robotics & AI	4	0	0	1	4	30	20	50		
02	PCC	MRAIPCC302	Sensors for Industrial Robotics	2	0	2	1	3	30	20	50	50	50
03	PCC	MRAIPCC303	Industrial Robot Programming	2	0	2	1	3	30	20	50	50	50
04	OE	MRAIOE304	Open Elective - I	2	0	0	1	2	30	20	50		
05	AEC-II	MRAIAEC305	Indian language Sanskrit/Pali	2	0	0	1	2	30	20	50		
06	VEC-I	MRAIVEC306	Constitution of India and Universal Human Values	1	0	0	0	1	C	CIE: 10	0		
0 7	BSC	MRAIBSC307	Matrices, Differential, Calculus and Probability	3	0	0	1	3	30	20	50		
08	HSMC	MRAIHSMC308	Principles of Economics	2	0	0	1	2	30	20	50		
			Total	18	00	04	07	20					

Coep Tech University Coep Tech

[Level 5, UG Diploma] Semester -IV Lateral Entry

Sr.	Course	Course			_	_						Scheme s in %)	
No.	Туре	Code	Course Name	L	Т	Ρ	S	Cr	٦	Theory	,	Labo	ratory
									MSE	TA	ESE	ISE	ESE
01	PCC	MRAIPCC401	Analog & Digital Electronics	2	0	2	0	3	30	20	50	50	50
02	PCC	MRAIPCC402	Control Systems	2	0	2	0	3	30	20	50	50	50
03	PCC	MRAIPCC403	Drives for Robot Systems	3	0	0	0	3	30	20	50		
04	PCC	MRAIPCC404	Standards & Ethics for Robot Applications	2	0	0	2	2	30	20	50		
05	OE-II	MRAIOE405	Open Elective-II	2	0	0	0	2	30	20	50		
06	MDM-I	MRAIMDM406	Multidisciplinary Minor -I	3	0	0	1	3	30	20	50		
		MRAIVSEC407	Numerical Methods & Programming Language	1	0	2	1	2	C	IE: 100)	50	50
08	HSMC	MRAIHSMC408	Principles of Entrepreneurship	2	0	0	1	2	30	20	50		
09	VEC-II	MRAIVEC409	Environmental Studies	1	0	0	1	1	C	IE: 100)		
10	HSMC	MRAIHSMC410	Communication Skills	1	0	2	0	2	CIE: 100)	50	50
			Total	19	0	8	6	23					

~												chem s in %	-
Sr. No.	Course Type	Course Code	Course Name	L	т	Ρ	S	Cr	٦	Theory	'	Labo	orator v
									MSE	TA	ESE	ISE	ESE
01	VSEC	MRAIVSEC4E1-L	Robotic Simulation Laboratory	0	1	2	0	2				50	50
02	VSEC	MRAIVSEC4E2-L	Arial Robotics Programming Lab	0	1	2	2	2				50	50
03	VSEC	MRAIVSEC4E3-L	Control Systems Laboratory	0	1	2	0	2				50	50
04	VSEC	MRAIVSEC4E4	Mini Project	0	2	0	0	2				CIE	: 100
			Total	19	5	14	8	31					

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Co Sr.	Course	Course	ty Coep Tech Univers	ity C	loep	Teo	h U	niver	211.7 1	Evaluat Weight	100	E.L. 1	1 V C I I
No.	Туре	Code	y Co Course Name	ity (loep	Per	S	Cr	sity (Theory	Tec	Labor	atory
	ep Tec	h Universi	ty Coep Tech Univers	ity (loer	Ter	h U	niver	MSE	TA	ESE	ISE	ESE
01	PCC	MRAIPCC501	Artificial Intelligence & Machine Learning	3	0	2	h0 J	niv4er	30	20	50	50	50
02	PCC	MRAIPCC502	Fundamentals of Robot Manipulators	3	0	0	0	3	30	20	50	hUr	iver
03	PEC-I	MRAIPEC503	Programme Elective Course - I (Refer separate List)	3	0	0	0	3	30	20	50	h <u>U</u> r	iver
04	PEC-II	MRAIPEC504	Programme Elective Course - II (Refer separate List)	3	0	0	0	3	30	20	50	n Un	iver
05	MDM	MRAIMDM505	Multidisciplinary Minor - II	3	oler	0	0	4	30	20	50	hŪr	iver
06	OE-III	MRAIRM506	Open Elective - III	2	0	0	2	ni 2er	30	20	50	hÐn	iver
07	ELC	MRAIELC507	Internship-I ech Univers	0	00 p	4	0	niver	sity (Coop	Tec	CIE:	100
08	ELC	MRAIELC508	Project-I	0	0	4	0	ni ₂ er	sity (Coep	Tec	CIE:	100
Co	ep Tec	h Universi	ty Coep Tech Un Totals	17	oep	10	2	22	sity (Coep	Tec	h Ur	iver

Course Specialization / Track	Program Elective Course-I PEC-I	Program Elective Course-II PEC-II
Robotics	Mobile and Micro Robotics	Autonomous Robotics and Telecherics
ch Univ _{AI} rsity Coe	Data Analytics	Deep Learning
Mechatronics	Intelligent Manufacturing	Mechatronics System Design
Control Systems	Dynamic Control Systems	Robot Control Systems

Semester -VI

Sr.	Course	urse Course Code Course Name	ity C	oe	p Ter		Jniv	ersit			Scher		
No.	Туре	Course Code	Course Name	ity C	T	P	S	Cr	ersit	Theo	y	Lab	oratory
		Lut	Com Tool University		~~				MSE	TA	ESE	ISE	ESE
Y	PCC	MRAIPCC601	Kinematics & Dynamics	4	0	0	0	4	30	20	50	ecn	Unive
2	PCC	MRAIPCC602-L	Robot Simulations	ity C	0	2	2	2	ersic	CIE: 1	00	50	50
3	PCC	MRAIPCC603	Microcontrollers & It's Applications	3	0	2	2	J 4 V	30	20	50	50	U 50 V 6
4	PCC	MRAIPCC604	Robot Safety & Maintenance	2	0	0		2	30	20	50	le c h	Unive
5	PCC	MRAIPCC605	Data Science	3	0	0	2	3	30	20	50	50	50
6	PCC	MRAIPCC606	Seminar on recent advances in R & AI	0	0	2	0	Jr l iv	ersit	y C	oep	50	50 ve
7	VSEC	MRAIVSEC607-L	Arial Robotics Lab	0	0	2	0	J ₁ 1v	ersit	v-C	oep.	50	50
8	MDM	MRAIMDM608	Multidisciplinary Minor - III	3	0	0	0	3	30	20	50	Tech	Unive
9	ELC	MRAIELC609	Project-II	0	0	4	2	2	oraid	10	0.00	CIE	: 100
			v Coep Tech UniTotal	16	0	12	9	22	ersit				

COEP Tech 9/90 BTech (R&AI) Mechanical Engg. Dept.

Coep Tech University For <mark>Exit</mark> after TY-- <mark>Additional Credits</mark> for B Vocational rsity Coep Tech Univer

									Evalu	atio		eme (W %)	leightages in
Sr. No.	Course Type	Course Code	Course Name	L	т	Ρ	S	C	Tł	neory	Y	La	aboratory
NO.	туре								MSE	T A	ESE	ISE	ESE
01	VSEC	MRAIVSEC6E1-L	Robot Operating System	0	0	4	0	2				50	50
02	VSEC	MRAIVSEC6E2-L	Autonomous Navigation Lab using SLAM	0	0	4	0	2				50	50
03	VSEC	MRAIVSEC6E3	Robot System Design	2	0	0	2	2	30	2 0	50		
04	VSEC	MRAIVSEC6E4	Mini Project	2	0	0	0	2					CIE: 100
			Total	22	0	1 6	9	3 0					

*Summer internship (Industry / R&D / Academic Institute) after IV th semester during summer Vacation & Evaluation will be done in the starting of V th Semester

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Legends: L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits

ISE-In-Semester-Evaluation, ESE-End-Semester-Evaluation, MSE-Mid-Semester-Evaluation, TA-Teachers' Assessment, CIE-Continuous-Internal-Evaluation

Coep Tech University Coep Tech BTech (Robotics & AI) niversity Coep Tech University

Coep Tech University Coep Tech Univ Semester -VII Ech University Coep Tech Univers

Co Sr.	Course	urse Course Course Name	/ Coep Tech Unive	rsity rsity	ity Co ity Tr	Coep To(P)	P S	Tec		ivers			Schem s in %	
No.	Туре	Code	Course Name	rstty	T (P	S	Cr	vers	Theory	oep	Labo	ratory	
	ep Tecl	University	Coep Tech Unive		Co	ep	Tec	h Un	MSE	TA	ESE	ISE	ESE	
01	PEC-III	MRAIPEC701	Programme Elective Course -III (Refer separate List)	3	0	0	0	3	30	20	50	Tech	n Univ n Univ	
02	PEC-IV	MRAIPEC702	Programme Elective Course -IV (Refer separate List)	3	0	0	0	3	30	20	50	Tecl	univ	
03	PCC	MRAIPCC703	ROS & SLAM Laboratory	0	0	4	1	2	IVEIA	ity	Joep	50	50	
04	PCC	MRAIPCC704	Robot operating System	4	0	0	Tec.	4	30	20	50	Tecl	Uni	
05	MDM	MRAIMDM705	Multidisciplinary Minor-IV	3	0	0	Tec	3	30	20	50	Tecl	ı Uni	
06	ELC	MRAIELC707	Internship-II	0	0	4	0	n Un 1	vers	ity C	oep	CIE	: 100	
07	ELC	MRAIELC708	Project-III	0	0	10	2	6	ivers	ity c	oep	CIE	: 100	
0.0	eh tent	i oniversit,	Total	13	0	18	5	22	IVICES	my c	neb	1801	E-SALUE	

Course Specialization / Track	Program Elective Course-III PEC-III	Program Elective Course-IV PEC-IV
Robotics	Advanced Robotics Programming	Biomedical Robotics
ech Univ Al sity Coor	Advanced Artificial Intelligence	Augmented Reality and Virtual Reality
Mechatronics	Micro electromechanical Systems	Advanced Mechatronics
Control Systems	Advanced Control System	Robot Dynamics and Control

COEP Tech 10/90 BTech (R&AI) Mechanical Engg. Dept.

Coep Tech University Coep Tech University

Sr.	Course	Course	y Coep Tech Unive	rsi	ty C	oe	Te	ch l	Jnive			Scheme es in %)	
No.	Туре	Code	Course Name	irsi	tv C	Per	S	Cr	Inive	Theory	Coe	Labo	ratory
-	an Tacl	Universit	y Coop Toch Unive	rel		0.01	-	ch l	MSE	TA	ESE	ISE	ESE
01	PEC-V	MRAIPEC801	Programme Elective Course -V (Refer separate List) / MOOCS	3	0		3	3	30	20	C ₅₀ e	p Tech p Tech p Tech	n U <u>n</u> iv n Univ
02	PEC-VI	MRAIPEC802	Programme Elective Course -VI (Refer separate List) / MOOCS	3	0	0	3	3	30	20	C ₅₀ e	p T <u>ec</u> l	n U <u>n</u> iv Nuniv
03	PEC-VII	MRAIPEC803	Programme Elective Course -VII (Refer separate List) / MOOCS	3	0	0	3	3	30	20	50	o Teci	Univ
04	ELC	MRAIELC804	Internship - III	0	0	10	0	5	Juive	sity	Coe	CIE	: 100
Co	ep Tech	1 Universit	v Coep Tech LTotal	9	0	10	9	14	Inive	rsitv	Coe	o Tech	Univ

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Course Specialization / Track	Program Elective Course-V PEC-V	Program Elective Course- VI PEC-VI	Program Elective Course- VII PEC-VII
Robotics	Agricultural Robotics	Medical Robotics Technology	Defence Robotics Technology
ep e _{AI} Univ	AI based Agriculture	AI for Medical Applications	AI for Defence
Mechatronics	Mechatronics for Agriculture	Mechatronics for Medical Applications	Mechatronics for Defence Applications
Control Systems	Agricultural Plant & Device Control	Control for Biomedical Instrumentation systems	Control for Defence Systems

Legends: L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits

ISE-In-Semester-Evaluation, ESE-End-Semester-Evaluation, MSE-Mid-Semester Evaluation, TA-Teachers' Assessment, CIE-Continuous-Internal-Evaluation

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Sr.	niversity Coe	p Tech U	Teachin	g scheme	ch Unive	ersity Goe	Cualita
No.	Semester	L	Т	P	SS	Total	Credits
1	Inversity coe	11	inversity	16	6	34	20
2	niversity Coe	13	niversity	Col2 Te	oh 2nive	28	20
3	niver III v Coo	-15	0	8	5	28	- 19
4	IV	18	0	6	6	30	21
5	niversvty Coe	17	niversity	C010 10	2	30	22
6	niver VI v Coa	16	0	Co12 To	9	37	22
7	VII	13	0	18	5	36	22
8	VIII	9	0	10	9	28	14
ch Ul	Total	112	niv 3 sit	92	44	251	160

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Coep Tech Internship courses p Tech University Coep Tech University Coep Tech Univers

Sr.	Tech Course	Course	Coep Tech Univ	/ers	ity	Coe	p Te	ech				Scheme s in %)	chl
No.	Туре	Code	Course Name	/e r s	ity	CBe	S	Cr	Univ	heory	cy Co	Labora	atory
	Tech	University	Coep Tech Univ	ers	itv	Coe	o Te	ech	MSE	TA	ESE	ISE	ESE
01	CEA	MRAICEA211	Social Summer Internship-after Sem II-Exam in Sem III	2	0	Coe	0	2	U <u>n</u> iv Univ	er <u>s</u> it	y Co	CIE:	100
02	ELC	MRAIELC507	Internship-I	0	0	4	0	1			15	CIE: 100	
03	ELC	MRAIELC707	Internship-II	0	0	4	0	eqn	UNIV	ersn	y co	CIE: 100	
04	ELC	MRAIELC804	Internship - III	0	0	10	0	5	Univ	ersit	y Co	CIE: 100	

Sr.	Tech	Course	sity Coep Tech L	Iniv	ers	ity	Co	ep To	ech Ur		ation So phtages		èch l
No.	SEM	Туре	Course Name	TRA	ers	i Py	S	Cr	ech Ur	Theory	arty Co	Labo	oratory
ep	Tech	Univer	sity Coep Tech U	Iniv	ers	itv	Co	en To	MSE	TA	ESE	ISE	ESE
01	Tauh	OE- I	Mobile and Micro Robotics	2	e o s	0	2	2	30	20	sit50Co	pep 1	ech l
02	IV	OE- II	Autonomous Robotics & Telecherics	2	0	0	2	2	30	20	50	pep 1	ech l
03	VI	OE- III	Advanced Robotics Programming	2	0	0	2	2	30	20	50	lep 1	ech l

Coep Tech Open Electives (Artificial Intelligence) y Coep Tech University Coep Tech Univers

Sr.	Tech	Course	sity Coep Tech	Univ	Iniversity Coep Te		ep Te	Evaluation S (Weightage					
No.	SEM	Туре	Course Name	Univ	ers	i Py	S	Cr	ech Ur	Theory	sity C	Labo	oratory
en		Univer	sity Coen Tech	Univ	ers	ity	Ĉo	en Te	MSE	TA	ESE	ISE	ESE
01	III	OE- I	Data Analytics	2	0	0	2	2	30	20	50		
02	IV	OE- II	Deep Learning	2	0	0	2	2	30	20	50	ueh :	ecni
03	VI	OE- III	Advanced Artificial Intelligence	2	0	0	2	2	30	20	50	oep	echl

Multidisciplinary Minors – for other Branches

Sr.	Tech	Course	ity Coep Tech Uni	vers	ity	Col	ap 1	ech	Univ			ition Scheme htages in %)		
No.	SEM	Туре	Course Name	vore	a.	P	S	Cr	Univ	heory	N Co	Labo	ratory	
- P	Toon	U	ity ovep reen on			~ ~	1		MSE	TA	ESE	ISE	ESE	
01	IV	MDM I	Drives for Industrial Robotics	3	0	0	0	ech e ³ h	30	20	50	iep ie ie <u>p</u> Te	ich U	
02	Tevah	MDM II	Fundamentals of Robot Manipulators	V 3 S	0	0	0	e3h	30	20	50	ep Te	ich L	
03	VI	MDM III	Kinematics & Dynamics	4	0	0	0	eq h	30	20	50	epTe	chl	
04	VII	MDM IV	Robot Operating System	4	0	0	0	e4h	30	20	50	et r Te	chu	
		Theteren	Total	14	0	0	0	14	1 Tester		1	- T-		

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Sr.	Tech	Course	sity Coep Tech Ur	ive	rși	y C	oe	p Teo	h Un	Evaluation (Weightag		es in %)		
No.	SEM	Туре	Course Name	in v e	rgi	y P C	S	Cr	n Un	Theory	aity C	Labo	ratory	
	Tech	Unive	sity Coep Tech Un	ive	rsi	VC	oe	o Ter	MSE	TA	ESE	ISE	ESE	
01	IV	MDM I	Analog & Digital Electronics	2	0	2	2	3ec	30	20	50	50	ec50	
02	- V	MDM II	Signals & Systems	2	0	2	2	3	30	20	50	50	50	
03	VI	MDM III	Microcontrollers & It's Applications	2 ive	1 rsi	2	2	4	30	20	50	50	50	
04	VII	MDM IV	ROS & SLAM Laboratory	0	2	4	2	4	to The	1	5. .	50	50	
heb	Teci	Univer	Total	6	3	10	8	14	n on	ivers	sity c	oeb i	ecn	

Honors – Robotics Engineering – for other Branches

Sr.	Tech	ch University Coep Tech Ur	iver		T P	Coep	p Tec Cr	n Uni			Scheme s in %	
No.	SEM	Course Name	iver			S	Cr	a Lind	heory	and C.	Labo	ratory
- db	10011	University obep recirion	pep Tech University Ove		10p	-	MSE	TA	ESE	ISE	ESE	
01	III	Sensors for Industrial Robotics	2	$\frac{s_1}{1}$	2	0	4	30	20	50	50	50
02	IV	Drives for Industrial Robotics	3	sity	0	0	4	30	20	50	оер Те	ch.l
03	Teven	Fundamentals of Robot Manipulators	3	sity	0	0	T4C	30	20	50	oep Te	ch l
04	VI	Kinematics & Dynamics	4	0	0	2	4	30	20	50	oep Te	ich.l
05	VII	Robot Operating System	4	0	0	2	4	30	20	50	oe n Te	ich-l
	T	Total	16	3	2	4	20	100		10		1.1

Honors – Artificial Intelligence – for other Branches

Sr.	Tech	University Coep Tech U	nive	versit versit	ity C ity C	S	p Tec Cr p Tec	Evaluation Scheme (Weightages in %)					
No.	SEM	Course Name	nive					h Uni	heory	ty Cr	Laboratory		
	Teele	University Game Teach U						MSE	TA	ESE	ISE	ESE	
01	III	Basics of Robotics & AI	4	2	0	0	4	30	20	50	ieh ie	CIT L	
02	IV	Data Science	3	9	0	2	4	30	20	50	oe <u>p</u> Te	ch l	
03	Teych	Artificial Intelligence & Machine Learning	2	qi	2	0		30	20	50	50 ⁻⁵⁰	50	
04	VI	Robot Operating System	14 ^e	0	0	0	40	30	20	50	pe <u>p</u> Te	chl	
05	VII	Advanced Artificial Intelligence	2	2	0	2	4 0	30	20	50	e p Te	ch-l	
	Took	Total	15	6	2	4	20	a Lini	(are)	N.C.	an To	ah I	

Honors – Research

Sr.	Tech	University Coep Tech Uni	vers	sity (ty Coe	oep Te	Tech U	Evaluation Scheme (Weightages in %)					
No. SEM	Course Name	vers	ity C	bee	olle	Cr	Theory			Laboratory			
						-		MSE	TA	ESE	ISE	ESE	
01	III	Problem Identification and Definition	3	1	00	2	4	30	20	50) lec	nun	
02	IV	Literature Review	3	ity (0 <u>e</u>	2	4	30	20	50	o <u>Te</u> c	h Un	
03	Tych	Experimental Work/Analytical Tools and Prototype Development	/ 3 8	ity (20e	2	ch ₄ U	30	20	50	o Teo	h Un	
04	VI	Data Analysis	3	it 1 (ce	2	4	30	20	50	o T eo	h Un	

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05	VII	Publication	eh leon oll	3	1	106	2	4	30	20	50	161	0.00
pep	leci	University Co	Total	15	5	<u>oe</u>	10	20	niver	sity	Coel	0.160	n Un

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Sr.	p Tec	h University Coep Tech Unive	rsit	v C	0	ep To	echl				Schem s in %	
No.	SEM	Course Name	L.	Т	Ρ	S	Cr	.	heory	Laborator		ratory
ore	ap tech University Coep tech Unive	151	y c	1016		ecni	MSE	TA	ESE	ISE	ESE	
04	VI	Research Project (Part 1) Problem Identification and Definition, Literature Review, Experimental Work	rsi rsi	2	10	20	10	Jnive Jnive	rsity rsity	Coe	CIE	: 100
05	VIIC	Research Project (Part 2) Prototype Development, Data Analysis, Publication	rsi	2	0	20	10	Jn <u>i</u> ve	rs <u>i</u> ty	Coe	CIE	: 100
oe	p Tec	h University Coep Tech Utotal	rsi	4	101	40	20	Jnive	rsity	Coe	p Te	ch U

Honors- B. Tech. (Robotics & Artificial Intelligence)

For Honors in Mechanical Engineering, students should select below courses of 20 credits from the pool of electives given below. These selected courses should not be part of mandatory 160 regular credits.

Course Specialization / Track	Program Elective Course-I PEC-I	Program Elective Course-II PEC-II
Robotics	Mobile and Micro Robotics	Autonomous Robotics and Telecherics
AI	Data Analytics	Deep Learning
Mechatronics	Intelligent Manufacturing	Mechatronics System Design
Control Systems	Dynamic Control Systems	Microcontrollers Architecture and Programming

Course Specialization / Track	Program Elective Course-III PEC-III	Program Elective Course-IV PEC-IV
Robotics	Advanced Robotics Programming	Biomedical Robotics
ep lech _{Al} niversit	Advanced Artificial Intelligence	Augmented Reality and Virtual Reality
Mechatronics	Micro electromechanical Systems	Advanced Mechatronics
Control Systems	Advanced Control System	Robot Dynamics and Control

Course Specialization / Track	Program Elective Course-V PEC-V	Program Elective Course- VI PEC-VI	Program Elective Course- VII PEC-VII
Robotics	Agricultural Robotics	Medical Robotics Technology	Defence Robotics Technology
AI	AI based Agriculture	AI for Medical Applications	AI for Defence
Mechatronics	Mechatronics for Agriculture	Mechatronics for Medical Applications	Mechatronics for Defence Applications
Control Systems	Agricultural Plant & Device Control	Control for Biomedical Instrumentation systems	Control for Defence Systems

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Coep Tech University Coep Course: Basics of Robotics and AI ersity Coep Tech Univers

	ourse Code	MRAIPCC301	Scheme of Evaluation	MSE, TA & I	1SE
Tea	aching Plan	4-0-0-1	Mid Semester Exam	30	Tec
ob He	Credits	4	Teachers' Assessment	20	Tac
011 01	inversity ou	iep feelt offisel	End Semester Evaluation	50	100
Course	Outcomes:				lec
		Illy complete this cou	rse will have demonstrated an	ability to:	
			ot grippers and compare & c		
	drives & Grippe		aity Coop Tools Univ	anaitas Caras	
			understanding manipulators		
			solutions that require problement		
		and societal implication	and learning by understand	ing AI, its cuil	
		-	mental understanding of AI	techniques in i	ntellig
	agents, artificial	neural networks.	only occupitoble only		
5.	Model forward	and inverse kinematic	es of robot manipulator.		
Syllabu	the second states of the secon				
ch U	niversity Co	ep Tech Univer	sity Coep Tech Unive	ersity Coe	Tec
Unit	niversity.Co		ntents	arsity Coer	Lecture
	Introduction:	on Tools Univer	nity Coop Tech Univ	araita Caa	
CI UI			Laws & Robotics-classifica		
ch Ui	1 0		ation (Anatomy), Industria		
ch Ui	n o 🐨 a seu, na seu o dera a 🖉 🥍 seu		he Application. Controlled Parallel Manipulator. Comp	the second second of the second se	7 Hrs
ch Ut	• •	-	movement-resolution, acc		/ 1115
			Robotics Technology		
ch Ui	INGESTIVE C		sfer and machine loading/u	nloading,	
ch Ui		rations assembly and		arsity Coer	o Tec
ch U	Sensors	ep Tech Univer	sity Coep Tech Unive	ersity Coer	Tec
ah Di			Criterion for selections of s	sensors,	Too
sun ui		& applications of sen		sisity coej	
2	Types of Contr	collers and introduction	n to close loop controller.	ersity Coep	6 Hrs
ch Ui		and Languages	in to close loop controller.	ersity Coej	
ch Ur			roduction to various languag	es such	
	as RAIL and V		any acception bene	in o	
ch Ur	Drives			ersity Coep	
ch Ui			sadvantages of each type, Sel	ection / Cole	
ch ₃ Ui	1110101110	rives for Robotic appl	ication.	ersity Coer	6 Hrs
sch Ui	Grippers Classification	of Grippers M	echanical Gripper-Graspin		o Tec
			etic gripper vacuum cup	arinner-	
ach Ui		in gripper selection &		o-rr-Coei	
ch Ui		o Artificial Intellige		ersity Coer	o Tec
cl4U			roblems, and approaches		6 Hrs
	Intelligent age	nts: reactive delibera	tive, goal-driven, utility-driv	en and	51115
41.0404			ce programming techniques.	on, and	

COEP Tech 15/90 BTech (R&AI) Mechanical Engg. Dept.

	Tec	hU	Problem-solvi	ing Approaches:	sity Coep Tech Unive	srsity Co	ep Tech	Uni
	Tec Tec	5	Forward and b alpha-beta prur	backward, state-space, ning, minimax, constra	, blind, heuristic, problem r int propagation, neural, stoch		5 Hrs	Uni Uni
	Too	h		earch algorithms, samp		areity Co	on Tooh	Lini
	-			epresentation and Re	edge representation and r	easoning	ep recu	on
	lec	6			ojects, relations, events, action		6 Hrs	Uni
	Tec		and space; pre-	dicate logic, situation	calculus, description logics,	reasoning	ep Tech	Uni
	Tec	hU	with defaults, 1	easoning about knowl	edge, sample applications.	ersity Co	ep Tech	Uni
	S	ugge	sted learning re	sources:				
	Tet							Uni
					s, Pearson Education Inc., As ntal concepts & analysis, Oxf			.006
		3.	Luger " Artificia	al Intelligence", Editio	on 5, Pearson, 2008		ep Tech	
				the second	ol, TATA McGraw Hill Pub. igence: A Guide to Intelligen			
			e		tificial Intelligence & Machin	•		Uni
	R	efer	ence Books: 🔿					
					TATA McGraw Hills Educat		ep Tech	Uni
		Ζ.			cs – Analysis, Control, App			
		3.			ger N. Nagel, Nicholas Odre			
			Robotics 2nd ed	lition, SIE , McGraw H	Hill Education (India) Pvt Ltc	1, 2012		
		4.			wski, and Michael Negin, I		gineering -	- An
		hΨ	• • • • • •		all India, Pearson Education Intelligence: A Modern Appr		ice Hall 20	03
					Representation: An approac			
Coen			Academic Press	, 1990.	sity Coen Tech Unive		en Tech	
		7.			Nils J, Logical Foundation	s of Artific	ial Intellige	ence
		619 U 2012	e	ann,1987.				
				Course: Sensor	s for Industrial Robotic	s sity Co		
	Tec	C	Course Code	MRAIPCC302	Scheme of Evaluation	MSE &	ESE	
	Too	T	aching Dlan	2021	Mid Somester Exem	20	on Tech	

Course Code	MRAIPCC302	Scheme of Evaluation	MSE & ESE
Teaching Plan	2-0-2-1 ver	Mid Semester Exam	ersity 30 ep Ter
Credits	ep Tecl ² Univer	Teachers' Assessment	20 ео Те
- In I I and the Co	Terefa Hadrine	End Semester Evaluation	50
	Teaching Plan	Teaching Plan2-0-2-1	Teaching Plan2-0-2-1Mid Semester ExamCredits2Teachers' Assessment

Course Outcome:

Students who successfully complete this course will have demonstrated an ability to:

- Complete 1. Identify suitable sensor for robotic applications.
 - 2. Compare & classify types of Sensors
 - Compare & classify types of sensors
 Apply basic principles of system integration for system integration.
- 4. Demonstrate awareness and a fundamental understanding of all types robotic sensors.
- Coep TeSyllabus: ersity Coep Tech University Coep Tech University Coep Tech Univers

Соер Те	Unit	niversity Coep Tech University Coep Tech University Co	Lecture	Un
Coep Te Coep Te	ch Ui ch Ui	Sensor Fundamentals: Overview of sensors and their role in robotics, Types of sensors used in	6 Hrs	Un
Coep Te	chlb	robotics applications, Sensor characteristics: accuracy, precision, range,	en Tech	Un

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loep Te <mark>ch U</mark>	resolution. etc.	Principles of sensing	: electrical, optical, mecha	nical, etc.	ch Univ
oep Tech U	and the second sec	the second s	ontact, proximity, etc., Ser	the second se	ch Univ
ep Tech U	conditioning ar	nd amplification	ity Coep Tech Unive	ersity Coep Teo	ch Univ
oep Tech U	Sensor Types	and Applications:	, and proximity sensors (arcity Coop Toy	ch Univ
oep Tech Ui			nsors. Motion and position		ch Unit
oep Tecl2U			nvironmental sensors (ter t perception and environme	- O Hrs	ch Uni
oep Tech U			sors, Object detection and re		ch Uni
oep Tech U	Grasping and sensing	manipulation with se	nsors, Human-robot intera	action and	ch Uni
pep Tech U		ation and Calibration		ersity Coep Teo	ch Uni
pep Tech U			botic systems, Sensor fusio		ch Uni
pep Tech U	techniques for	sensor data, Filtering a	rror compensation, Signal nd noise reduction, Feature	extraction	ch Uni
ep Te <mark>ch U</mark>		ognition. sor Technologies and	Tronds	ersity Coep Teo	sh Uni
pep Te <mark>ch U</mark>			(e.g., LiDAR, depth sensor	s), MEMS	ch Uni
pep Tech U	Sensors, Senso	r networks and Interne	t of Things (IoT) in robotic	es, Sensor-	ch Uni
ep Tech U			p systems, Biomimetic tact		shilloi
Tep recir of			Advances in biomimetic	-	
pep lech U		lications of Sensors	composites as biomimetic S	ensors and	ch Uni
Textbo 1 Patr	anabis D, "Senso	ors and Transducers", 2	nd Edition, PHI, New Delhi,	2013 Coep Ter	
			 Applications and Design ontrol", Adison-Wesley Lor 		1, 2009
	niversity Co	i for wreasurement & C	ontion, Adison-westey Loi	iginali Ltd, 1998.	
	nce Books: Ien I "Handbor	ok of modern consors.	physics designs and appli	entions" Springer N	ew Vorle
			physics, designs, and applic		
2CS			tation & Measurement, John		
		or Technology Handboo		many coep let	
			Cambridge Univ Press, Can		
			ors in Manufacturing" Volur ion Technology Handbook"		
			imentation and Measureme		
	-		ity Coep Tech Unive		
	A	rse: Sensors for In	dustrial Robotics Lab	- · · · · · · · · · · · · · · · · · · ·	
oep Tech C	ourse Code	MRAIPCC302-L	Scheme of Evaluation	MSE & ESE	
and the second second second			the provide provide the second state of the se	and the second sec	
oep Tech Te	aching Plan	0-0-2-0	Term Work	50	

Course Outcome:

Students who successfully complete this course will have demonstrated an ability to:

1. Understand the principles behind various sensors used in industrial robotics.

2. Select appropriate sensors for different robotic applications.

3. Interface sensors with robotic systems and interpret their output.

4. Analyze sensor data to make decisions in robotic control systems.

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5. Troubleshoot common issues related to sensor integration in industrial robotics.

Course Contents: Assignments / Practical based on:

Detailed Content: Any six experiments / assignments from the list below (Total Min. 24 Hours)

рер Те	Expt. No.	niversity Coep Tech Unicontents Coep Tech University C	Contact Hours
p Te	ch Ui	Proximity Sensors	oep lec
ep Te		Understand principles of operation of capacitive, inductive, and optical proximity sensors and learn Calibration and testing of proximity sensors	4 Hrs
ep Te	ch UI	Vision Systems	oep lec
ep Te	c 12 Ui	Understand machine vision and image processing for object detection and recognition	4 Hrs
ep le	en oi	Force/Torque Sensors	oep iec
ар Те ар Те	3 ch Ui	Understand force and torque sensing principles and Types of force/torque sensors: strain gauge, piezoelectric, etc. and learn the force/torque sensing in industrial robotics	4 Hrs
ap Te	ch Ui	Temperature and Pressure Sensors	oep Tec
ép Te	ct4Ur	Understand temperature and pressure sensing technologies and attempt integration of temperature and pressure sensors in robotic systems.	4 Hrs
ар Те	ch Ui	Motion and Position Sensors	oep Tec
ep Te ep Te	cl5Uı ch Uı	Understand principles of motion and position sensing, Encoders, accelerometers, and gyroscopes applications of motion and position sensors in robotics	4 Hrs
p Te	ch U	Sensor Fusion and Integration	oen Tec
Te	c16 U	Understand Principles of motion and position sensing, encoders, accelerometers, and gyroscopes and implement applications of motion	4 Hrs
p Te	ch Ui	and position sensors in robotics	oep Tec
р Те		Advanced Topics and Emerging Trends Short seminar on a Recent advancement in any one specific type of sensor	оер Тес
ep Te	C 7 U I	technologies for industrial robotics, on an Integration of AI and machine	4 Hrs
p Te	ch Ui	learning with sensor data, on an Ethical considerations and challenges in sensor-enabled robotics etc	oep Tec
р Те	ch Ui	Mini Project Work	oep lec
ep Te ep Te	ch <mark>8</mark> Ui ch Ui	Students work on a mini project where they apply their knowledge of sensors in industrial robotics to solve a real-world problem or develop an innovative application.	4 Hrs

1. Sensors and Actuators in Mechatronics: Design and Applications" by Andrzej M. Pawlak, CRC Press, 2018

- 2. Introduction to Autonomous Robots: Mechanics, Sensors, Actuators, and Algorithms by Nikolaus Correll,
- Bradley Hayes, and Amirhossein Memarzadeh, Chapman and Hall/CRC, 2019
- 3. Industrial Sensors and Instrumentation by C. J. S. De Silva, CRC Press, 2017
 - 4. Sensors for Mechatronics by Paul P. L. Regtien, Elsevier, 2012

Course Code	MRAIPCC303	Scheme of Evaluation	MSE & ESE
Teaching Plan	2-0-2-1	Mid Semester Exam	30
Credits	2	Teachers' Assessment	20
n University Co	ep Tech Unive	End Semester Evaluation	rsity 50 ep

Course: Industrial Robot Programming

Coep Tecourse Outcome: Coep Tech University Coep Tech University Coep Tech Univers COEP Tech18/90BTech (R&AI) Mechanical Engg. Dept.

Students who successfully complete this course will have demonstrated an ability to: 1. Identify and explain the core principles of industrial robots. 2. Program robots using different methods. 3. Implement fundamental robot programming concepts. 4. Apply advanced robot programming techniques. Develop robot programs for industrial applications. Unit Contents Lecture **Introduction to Industrial Robotics** Fundamentals of Robotics: Definition, functions, advantages, disadvantages, applications of robots. 6 Hrs Robot Anatomy: Classification (SCARA, Cartesian, Articulated etc.), components (manipulator, end-effector, controller, sensors, actuators). Robot Specifications: Work envelope, payload capacity, repeatability, degrees of freedom. **Robot Programming Fundamentals** Programming Methods: Lead-through programming, teach pendant, offline programming, text-based programming. Robot Programming Concepts: Motion control commands (MOVE, 6 Hrs 2 WAIT, SIGNAL, DELAY), subroutines, branching, error handling. Robot Programming Languages: Generations of robot languages, introduction to specific languages (e.g., VAL, RAIL, AML) and modern trends (Python, ROS). Advanced Robot Programming Techniques Sensor Integration: Tactile, position, velocity, and force sensors for robot interaction and feedback. Path planning and Interpolation: Techniques for generating smooth robot motion paths between programmed points. 6 Hrs Vision Systems for Robotics: Introduction to robot vision systems, image processing basics for object recognition and grasping. Safety Programming: Emergency stop procedures, safety interlocks, robot programming considerations for safe operation. **Industrial Robot Programming Applications** Case Studies: Programming examples for common industrial applications (e.g., welding, painting, material handling, assembly). Simulation and Offline Programming: Utilizing robot simulation software to create, test, and debug robot programs. 6 Hrs 4 Troubleshooting and Maintenance: Identifying and resolving common robot programming errors, basic robot maintenance procedures. Future Trends in Industrial Robotics: Advanced programming techniques, collaborative robots (cobots), and the integration of artificial intelligence (AI). Suggested learning resources: Industrial Robotics by Yoram Koren (5th Edition) 1. 2. Robot Programming: Robot Languages and Robot Communication by Richard D. Wright and Matthe P. McLaughlin Robotics, Vision & Control: Fundamentals & Advanced Applications by Farid Kendoul 3. 4. Robot Programming: A Guide to Using RUIP with ABB Robots by Rick Young Course: Industrial Robot Programming Laboratory

рер Те	Course Code	MRAIPCC303-L	Scheme of Evaluation	MSE & ESE
ep Te	Teaching Plan	2-0-2-1	Term Work	ersity 50 ep

COEP Tech 19/90 BTech (R&AI) Mechanical Engg. Dept.

	Credits	1	Oral Exam	50
Course	Outcome:	Tech Univers	ity Coep Tech Univ	versity Coep Te
Studen	ts who successfully	complete this cours	e will have demonstrated	an ability to:
			dge of robot Programming	
			ndant for various application	sersity Coep Te
	Use RAPID Languag	ge and AML Industrial applicatior	ity Coep Tech Univ	
4.	Program using Robe	nidustrial application	ity Coep Tech Univ	
		ments / Practical b		
011.01			ignments from the list belo	ow (Total Min 24 Ha
cn u	a Content. Any eig	int experiments / ass	ignifients from the list beit	versity Coep le
Expt. No.	niversity Coep	n Tech UniCont	ents Coep Tech Univ	Contac Hours
ch Ui	Understand max 1 type of workspace		nits for each joint. Also i	dentify the 2 Hrs
2	Robot Programmi	ng – Walk through	programming	4 Hrs
3		ing using Teach Po ate systems of Rob	endant- Lead through pro	ogramming 4 Hrs
4	Wrist Mechanism-	-Interpolation-Inter	ock commands	2 Hrs
5		mmands motion co olications	ntrol, hand control, progra	am control, 4 Hrs
6	Palletizing applica		ing ober internet	2 Hrs
7	Object detection a	nd Sorting	ity Coep Tech Univ	2 Hrs
8	Robot welding app	plication	ity Coep Tech Univ	versity Co 4 Hrs
U	RAPID Language	and AML	1. C	2 Hrs
9 10	KAI ID Language			

Coep TeTextbooks: rsity Coep Tech University Coep Tech University Coep Tech Univers

1. Hughes Cameron, "Robot Programming", Pearson Publishers, 2016

2. J. Srinivas, "Robotics: Control and Programming", Narosa Publication, 2009 ep Tech University Coep Tech University Coep Tech Univers

Reference Books:

- 1. Lentin Joseph, "Learning Robotics Using Python", Second Edition Design, simulate, program, and prototype an autonomous mobile robot using ROS, OpenCV, PCL, and Python, Packt Publishing Paperback - 1 January 2018
- 2. Staple Danny, "Learn Robotics Programming", Packt Publishing Limited, Feb 2021

3. Kailashi Chandra Mahajan, Prashant Kumar Patnaik, Raghvendra Kumar, "Robotics for Engineers", Vikas Publishing House, 2016 Open Elective -I

Coep Tech University Coep Tec Indian language Sanskrit/Pali niversity Coep Tech Univers Coep Tech University Constitution of India and Universal Human Values

Principles of Entrepreneurship

Coep Tech Univ [Note- Above subject's syllabus will be from respective department] COEP Tech20/90BTech (R&AI) Mechanical Engg. Dept.

Coep Tech University Coep Course: Analog & Digital Electronics **Course Code** MRAIPCC401 **Scheme of Evaluation** MSE, PTE & ESE **Mid Semester Exam Teaching Plan** 2-0-2-0 30 **Teachers'** Assessment Credits 20 2 50 **End Sem Exam Course Outcomes:** At the end of the course, students will demonstrate the ability to, Design and Analyze Analog sub-circuits using BJT and FET. 2. Design & analyze modular combinational circuits with MSI devices like MUX/DEMU Decoder, Encoder, etc 3. Design the linear and non-linear applications of Op-Amp. Composition 4. Design & analyze synchronous sequential logic circuits with FFs and combinatorial circuits. 5. Design & analyze modular combinational circuits with MSI devices like MUX/DEMUX Decoder, Encoder, etc Syllabus: iversity Coep Tech Uni Contents Coep Tech University Lecture Unit **Physics of Bipolar Junction Transistors** Structure of NPN and PNP Transistors, Energy-Band Diagram, Operation of BJT, I/V characteristics, Large Signal model, small signal model, Concept of transconductance, Early Effect. Bipolar amplifier: CE, CC &CB Physics 4 Hrs 11 of MOS Transistors: Structure of N and P MOSFET, Energy-Band Diagram, Operation of MOSFET, Channel Length Modulation, CMOS Technology, Comparison of Bipolar & MOS Devices **Fundamentals of Op-Amp** Op-Amp parameters Circuits with resistive feedback: Concept of feedback & their types, Inverting & non-inverting configurations, current to voltage converters, voltage to current converters, summing amplifier, difference amplifier, instrumentation amplifier. Non-linear circuits 2 8 Hrs Schmitt trigger, Voltage comparators, comparator applications, precision rectifiers, analog switches, peak detectors, sample & hold circuits, Integrators & differentiators, Clippers and Clampers Feedback & Oscillator Circuit: Effect of positive and negative feedback, Analysis of practical feedback amplifiers, Sinusoidal Oscillators (RC, LC and Crystal), Multivibrators using 555 timers. Logic Simplification and Combinational Logic Design Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, Code Conversion. MSI devices like Multiplexers, Encoder, Decoder, Comparators, Half and Full Adders, Subtractors, BCD Adder, Barrel shifter 8 Hrs 3 and ALU. Sequential Logic Design University Coep Tech University Building blocks like S-R, JK and D latch, Master-Slave JK FF, Edge

triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM.

COEP Tech 21/90 BTech (R&AI) Mechanical Engg. Dept.

	Logic Families and Semiconductor Memories	eh leci
ch U	TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in,	ep Tech
4	fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory	4 Hrs
CIT OI	elements, Concept of PLDs like PAL, PLA, CPLDs, FPGA etc. Logic	ch icei
ch U	implementation using Programmable Devices (ROM, PLA)	ep Tech

COEP Suggested learning resources:

Coep TeTextbooks: rsity Coep Tech University Coep Tech University Coep Tech Univers

- 1. Behzad Razavi, "Fundamentals of Microelectronics", Second Edition; Wiley, 2016.
- 2. Ramakant A Gaikwad, "Op-Amps and Linear Integrated Circuits", PHI, 4th edition, 2016

Reference Books:

- 1. Thomas L Floyd, "Electronic Devices", 10th edition, Pearson, 2017
- 2. G. B. Clayton, "Operational Amplifiers", International Edition, 2nd Edition, 1979.
 - 3. Anand Kumar, "Fundamentals of Digital circuits", PHI, Fourth edition, 2016.
- 4. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, fourth edition, 2010

Course: Analog & Digital Electronics Laboratory

Course Code	MRAIPCC401-L	Scheme of Evaluation	PTW
Teaching Plan	0-0-2-0	Term Work	50
Credits	ep Tech Univers	Oral Exam	50 00

Coep Te Course Outcomes: Coep Tech University Coep Tech University Coep Tech University

At the end of the course, students will demonstrate the ability to:

- 1. Analyze and design various applications of Op-Amp.
- 2. Identify and characterize basic devices such as BJT and FET from their package information
- by referring to manufacturers' data sheets.
- 3. Design, simulate, built and debug complex sequential circuits based on an abstract functional specification.
- 4. Design, simulate, built and debug complex combinational circuits based on an abstract functional specification.

Course Contents: Assignments / Practical based on

Any Eight experiments / assignments from the list below (For Total Min. 24 Hours)

Expt. No.	niversity Coep Tech UniContents Coep Tech University C	Contact Hours
իլՍլ	Input and Output Characteristics of BJT in CE configuration.	2 Hrs
2	Transfer and Drain Characteristics of MOSFET	2 Hrs
3	Design and simulate LC and RC oscillators.	4 Hrs
4	Build and test LC or RC oscillator.	2 Hrs
5	Op-amp applications-I: Integrator, Differentiators, Comparator, Schmitt trigger.	4 Hrs
6	Design different types of multivibrators using IC 555	2 Hrs
17U	Simplification and implementation of a Boolean function using k -map technique e.g. code converter	2 Hrs
8	Use of Multiplexers, Encoders, Demultiplexer and decoders for implementing logic.	4 Hrs
90	Design and implementation of ripple and synchronous counters using JK and D FF and additional gates.	4 Hrs

COEP Tech 22/90 BTech (R&AI) Mechanical Engg. Dept.

10			ke 7490/93 (ripple) and	i sity ot	2 Hrs
	74192/193(syn	chronous)	sity Coep Tech Unive	ersity Co	21115
gges	ted learning res	sources:			ep Teo
ext Bo	ooks: sity Co	ep Tech Univers			
			icroelectronics", Second Edi		
		ikwad, "Op-Amps and	l Linear Integrated Circuits",	PHI, 4th ed	
	nce Books:				
			", 10th edition, Pearson, 201 [°] ", International Edition, 2nd		
			Digital circuits", PHI, Fourth		
			", Tata McGraw Hill, fourth		
hUr	niversity Co	ep Tech Univer		ersity Co	
h Ur		Course:	Control Systems		
	ourse Code	MRAIPCC402	Scheme of Evaluation	MSE &	ESE
Tea	ching Plan	2-0-2-0	Mid Semester Exam	30	op 10.
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 Control system analysis in frequency domain

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 BTech (R&AI) Mechanical Engg. Dept.

stability.

ep Tech U	frequency domain. Frequency domain performance specifications.	ep Tech	Uni
ep Tech U	Correlation between time domain and frequency domain specification. Nyquist Analysis	ep Tech	Uni
ep Tech U	State Space Approach	ep Tech	Uni
p Tech U	Representation of system in state space, Converting transfer function model	ep Tech	Un
ap Tecl4U	into state space model. Non uniqueness of state space model, Canonical representation,	5 Hrs	Un
ep Tech U	Eigenvalues, Solution of state equations, Concept of State feedback control, controllability, Observability.		Un

Text Books:

- Nagrath & M. Gopal "Control System Engineering", Anshan, 2008
 Norman S. Nice, "Control System Engineering", Wiley, 2008.

Coep TeReference Books: Coep Tech University Coep Tech University Coep Tech Univers

- 1. Smarajit Ghosh, "Control Systems Theory & Applications", Pearson Education 2007
- Katsuhiko Ogata," Modern Control Engineering", Prentice Hall, 2010.
 Norman S. Nise, "Control System Engineering", Wiley, 2014
- Coep Tech University Coep Tech University Coep Tech University Coep Tech Univers

Course: Control Systems Laboratory

Course Code	MRAIPCC402-L	Scheme of Evaluation	PTW
Teaching Plan	0-0-2-0	Term Work	sity 50 ep Te
Credits	1	Oral Exam	50

Coep Te Course Outcomes: Coep Tech University Coep Tech University Coep Tech Univers

- At the end of this course students will demonstrate the ability to: 1. Develop the mathematical model of different components of linear feedback control system using Tech Univers
- Complete Simulation and experiments
- 2. Analyze the transient characteristics of different first order and second order systems using simulation and experiments
- 3. Determine the performance of system using root locus
- 4. Carry out the stability analysis of linear feedback control system using Bode plot and Nyquist Coep Tech Plotiversity Coep Tech University Coep Tech University Coep Tech Univers
 - 5. Analyze the different types of controllers like PI, PD, PID and tuning of these controllers using simulation and experiments

h University Coep Tech University Coep Tech Univers **Course Contents: Assignments / Practical based on**

Detailed Content: Any six experiments / assignments from the list below (For Total Min. 24 Hours)

Expt. No.	Contents	Contact Hours
1.	To study input out characteristic of various control system components	2 Hrs
2	To obtain step response and find time response specification of electrical system, hydraulic system, pneumatic system and thermal system.	2 Hrs
3	To obtain transfer function and poles zeros of DC motor experimentally.	2 Hrs
4	To obtain root locus experimentally.	4 Hrs
5	Use Matlab to study the effect of feedback gain on system response.	2 Hrs

COEP Tech24/90BTech (R&AI) Mechanical Engg. Dept.

oep le oep Te	6	Use Matlab to study the effect of damping factor zeta on time control performance specifications.	4 Hrs
оер Те оер Те	ch U 7 ch U	Use Matlab to obtain root locus for a given system and find performance specifications there from. Study effect of addition of zero and pole on root locus	4 Hrs
oep Te	cl <mark>8</mark> U	Use Matlab to get a bode plot and obtain gain margin and phase margin for various systems.	2 Hrs
oep Te oep Te	9	Use Matlab to obtain state space representation from transfer function, find Eigenvalues, Analyze controllability, observability and stability.	4 Hrs

Coep To Suggested learning resources: https://www.coep.Tech.University Coep.Tech.University

- **Text Books:** 1. Nagrath & M. Gopal "Control System Engineering", Anshan, 2008
 - 2. Norman S. Nice, "Control System Engineering", Wiley, 2008.

Reference Books: Coep Tech University Coep Tech University Coep Tech Univers

- 1. Smarajit Ghosh, "Control Systems Theory & Applications", Pearson Education 2007
 - 2. Katsuhiko Ogata," Modern Control Engineering", Prentice Hall, 2010. niversity Coep Tech Univers
- Norman S. Nise, "Control System Engineering", Wiley, 2014

Course: Drives for Robot Systems

Course Code	MRAIPCC403	Scheme of Evaluation	MSE, PTE & ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	ep Tech3Univer	Teachers' Assessment	ersity 20 ep Te
h University Co	on Tools Linivor	End Sem Exam	50

COED Te Course outcomes: Coep Tech University Coep Tech University Coep Tech University

At the end of this course students will demonstrate the ability to:

- 1. Analyze DC drive, Induction and Synchronous Motors Drives.
- 2. Evaluate the steady state behavior and basic operating characteristics of A.C Machine.
- Understand the basics of electric drives and fundamentals of drive dynamics.
 Demonstrate analytical skills to assess machine performance in steady state.
- 5. Analyze the integration of the hydraulic drives & pneumatic drives in robotic systems

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oep Te <mark>ch U</mark> i	D.C. Motors & Other Motors	ep Tec
oep Tech Ui oep Tech Ui	Principles of working, Significance of back emf, Torque Equation, Types, Characteristics and Selection of DC Motors, Starting of DC Motors, Speed Control, Losses and Efficiency, Condition for Maximum Efficiency, Braking	
ep Tech Ui ep Tech Ui	of DC Motors, Effect of saturation and armature reaction on losses; Applications, Permanent Magnet DC Motors, Type and Routine tests.	6 Hrs
oep Te <mark>ch U</mark>		ep Tec
ep Tech Ui ep Tech Ui	Synchronous Motors and Asynchronous Motor Construction, types, armature reaction, circuit model of synchronous machine, determination of synchronous reactance, phasor diagram, power	
pep Tecl ² U	angle characteristics, parallel operation of synchronous generators, synchronizing to infinite bus bars, two axis theory, synchronous motor	6 Hrs
oep Tech Ui oep Tech Ui	operation, dynamics, modeling of synchronous machine, PM synchronous machines.	

COEP Tech25/90BTech (R&AI) Mechanical Engg. Dept.

Coep Tech Ut	Types of induction motor, flux and mmf waves, development of circuit	ep lech Unive
Coep Tech Ur	model, power across air gap, torque and power output, starting methods,	ep Tech Unive
Coep Tech Ui	speed control, induction generator, induction machine dynamics, high efficiency induction motors, Single phase IM, Modeling of induction	ep Tech Unive
Coep Tech Ui	machine. Coep Tech University Coep Tech University Co	ep Tech Unive
Coep Tech Ui	Electric Drives, Dynamics and Control	ep Tech Unive
Coep Tech Ur	Definition, Advantages of electrical drives, Components of Electric drive system, Selection Factors, speed control and drive classifications, Motor-	ep Tech Unive
Coep Tech Ur	Load Dynamics, Speed Torque conventions and multi quadrant operation,	6 Hrs
Coep Tech Ui	Equivalent values of drive parameters. Load Torque Components, Nature	ep Tech Unive
Coep Tech Ui	and classification of Load Torques, Constant Torque and Constant Power operation of a Drive, Steady state stability, Load epilation and selection	ep Tech Unive
Coep Tech U	motors	op Tech Unive
Coep Tech Ur	Performance & Control of DC Motor	en Tech Unive
	Dc motors and their performance starting, transient analysis, speed control,	6 Hrs
Coep Tecl ⁴ U	ward Leonard drives, Controlled rectifier fed drives, full controlled 3 phase rectifier control of dc separately excited motor], multi-quadrant operation,	op roon onne
Coep Tech U	Chopper controlled drives Closed loop speed control of DC motor.	ep Tech Unive
Coep Tech Ur	Performance & Control of Induction and Synchronous Motor Drives	ep Tech Unive
Coep Tech Ur	Induction motor analysis, starting and speed control methods- voltage and	ep Tech Unive
Coep Tech Ur	frequency control, current control, closed loop control of induction motor	en Tech Unive
5	drives, rotor resistance control, Slip power recovery - Static Kramer and	6 Hrs
Coep lech U	Scherbius Drive, Single phase induction motor starting, braking and speed	ep rechonive
Coep Tech Ur	control. Synchronous motor operation with fixed frequency, variable speed	ep Tech Unive
Coep Tech Ui	drives. Ity Coep Tech University Coep Tech University Co	ep Tech Unive
Coep Tech Ur	Hydraulic and Pneumatic Drives Overview of hydraulic and pneumatic drives in robot applications, Working	ep Tech Unive
Coep Tech Ur	principles and control of hydraulic and pneumatic drives, Advantages,	ep Tech Unive
Coep Tech ⁶ U	limitations, and applications of hydraulic and pneumatic drives in robots,	6 Hrs
	Advanced Drive Systems - Introduction to advanced drive systems (linear	ep recirionite
Coep Tech Ur	drives, magnetic drives, etc.), Emerging trends and technologies in robot drive systems, Integration of advanced drive systems with robot applications	ep lech Unive
Coep Telen U	inversity obep tech oniversity obep tech oniversity oc	ep lech Unive
	ted learning resources:	
Text B	ooks: P. Kothari, I. J. Nagrath, "Electric Machines", Tata McGraw Hill Publication	Fourth edition
	rint 2012.	
-	E. Fitzgerald, Charles Kingsley Jr., Stephen D. Umans, "Electric Machinery'	
Hil	Il Publication, sixth edition, 2002.	,
Coep Tech III	ll Publication, sixth edition, 2002.	
1. M.	nce Books: G. Say, "Alternating current machines", fifth edition, E.L.B.S. Publication, 19	87.
Coep Te 2. F. I	Puchstein, T.C. Lloyd, A.G. Conrad, "Alternating current machines", John Wiley	y and Sons, New
	rk 1954. ty Coep Tech University Coep Tech University Co	
	C. Sen, "Principles of Electric Machines and Power Electronics", John V	
Pul	blication second edition 1997	
	H. Rashid, "Power Electronics-Circuits, devices & Applications", 3rd Ed, PH K. Bose, "Modern Power Electronics & AC Drives", Pearson Education, Asia,	
	R. Bose, Modern Fower Electronics & AC Drives , Fearson Education, Asia,	
	26/90 BTech (R&AI) M	

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Course: Standards & Ethics for Robot Applications

Course Code	MRAIPCC404	Scheme of Evaluation	MSE, PTE & ESE
Teaching Plan	2-0-0-2	Mid Semester Exam	30
Credits	epTech2Jniver	Teachers' Assessment	20 00 0
ch University Co	en Tech Univer	End Sem Exam	prein 50 pr Te

Coep TeCourse Outcomes: Coep Tech University Coep Tech University Coep Tech Univers

Students who successfully complete this course will have demonstrated an ability to:

1. Study the fundamental concepts and terminologies related to standards and ethics in the context of robot and light

Coep Techrobot applications. Gen Tech University Coep Tech University Coep Tech University

- 2. Identify the key industry standards and regulatory frameworks governing robot design, safety, and performance.
- 3. Analyze the ethical challenges and implications associated with the development and use of robots.
 - 4. Evaluate the societal impact of robots and assess their ethical implications on various stakeholders.
 - 5. Comprehend the legal and liability considerations related to robots and their applications. ersity Coep Tech University Coep Tech University Coep Tech Univers

Syllabus:

Unit	Contents	Lecture
	Introduction	eh ien
Tech U	Introduction to Standards and Ethics in Robotics, Introduction to the field of	
Tech U	robotics and its ethical dimensions, Overview of relevant industry standards	6 Hrs
Toola U	and regulatory frameworks, The ISO (International Organization for	01113
rech o	Standardization) standard for robot safety is ISO 10218 - Robots for	
Tech U	Industrial Environments - Safety Requirements	ep Tec
Tech II	Robot Safety Standards	
2	Overview of safety standards for robots in various environments (industrial,	6 Hrs
Tech U	medical, etc.), Risk assessment and mitigation strategies for robot	ep lec
Te ch U	applications, Ethical considerations in ensuring robot safety Robot	ep Tec
	Ethical Challenges in Robot Applications	
lech U	Ethical dilemmas in robot design, deployment, and use, Privacy and data	
Tech U	protection considerations in robot applications, Ethical implications of	ep Teci
Jech II	autonomous decision-making by robots. Societal Impact Of Robots:	6 Hrs
ieun u	Understanding the social and economic implications of robots, Ethical considerations in robot automation and job displacement, Robot ethics and	eh leu
Tech U	the digital divide.	
Tech U	Standards, Regulation, and the Future	ep Tec
Real II	Standards and Regulatory Landscape: Examining existing and emerging	
rech u	standards for robot safety and responsible development (e.g., ISO standards,	
Tech U	national regulations).	ep Teci
Tech U	The Future of Robot Ethics: Exploring emerging trends in robotics and their	6 Hrs
	ethical implications (e.g., artificial general intelligence, job displacement).	
lech U	Responsible Development and Deployment: Developing a framework for	
Tech U	promoting ethical and responsible robot design, use, and governance.	ep Tecl
Sugge	sted learning resources:	
Textb	ook: eter Corke "Robotics, Vision and Control: Fundamental Algorithms in MATLAI	

Artificial Intelligence" Oxford University Press

COEP Tech27/90BTech (R&AI) Mechanical Engg. Dept.

Reference Books:

- 1. Ryan Calo, A. Michael Froomkin, and Ian Kerr (Eds.), "Robot Law" Edward Elgar publishing 2. Joseph E. Aoun, "Robot-Proof: Higher Education in the Age of Artificial Intelligence" The MIT
- Press
- 3. Joseph Migga Kizza, "Ethical and Social Issues in the Information Age" Springer
 - 4. Joe Jones, Daniel Roth, and Charles E. Irwin, "Robot Programming: A Practical Guide to Behavior-Based Robotics" A K Peters/CRC Press
- 5. Brigette Tasha Hyacinth, "The Future of Leadership: Rise of Automation, Robotics, and Artificial Intelligence" Motivational Press
 - ISO 10218-1:2011 Robots and robotic devices Safety requirements for industrial robots 6.

Course: Numerical Methods & Programming Language

Course Code	MRAIBSC407	Scheme of Evaluation	MSE & ESE	
Feaching Plan	1-0-2-1	Mid Semester Exam	CIE: 100	
Credits	ep lech2Univers	End Sem Exam	CIE: 100	

Students who successfully complete this course will have demonstrated an ability to:

- Coep Tec Understand the basic principles of numerical methods and their role in scientific and engineering computations.
- 2. Apply numerical techniques to solve mathematical problems, including root finding, interpolation, differentiation, integration, and linear systems.
- 3. Implement numerical algorithms using a programming language to solve computational problems efficiently.
 - 4. Analyze the accuracy, stability, and convergence of numerical methods.
 - 5. Apply numerical methods and programming skills to solve real-world engineering and scientific problems.

Syllabus:

Un	t Contents	Lecture
	Numerical Methods and Programming	
	Introduction to a programming language for scientific computing, Basics of	
	programming: variables, control structures, functions, and data types.	
	Root Finding Methods Bisection method, Newton-Raphson method, Secant	
1	method, Comparison and analysis of root finding methods	6 Hrs
	Numerical Differentiation and Integration	
	Finite difference approximations, Numerical integration methods	
	(Trapezoidal rule, Simpson's rule), Romberg integration, Error estimation	
	and adaptive integration	
	Linear Systems of Equations	
	Gaussian elimination, Iterative methods (Jacobi, Gauss-Seidel, and SOR),	
	Matrix factorizations and sparse systems,	
_	Numerical Solutions of Ordinary Differential Equations	
2	Euler's method, Runge-Kutta methods, Multistep methods (Adams-	6 Hrs
	Bashforth, Adams-Moulton), Stability analysis and error control	
	Numerical Linear Algebra	
	Matrix computations (Eigen-values, singular value decomposition), Iterative	
	methods for large linear systems, preconditioning techniques,	

Coep TeTextbooks: rsity Coep Tech University Coep Tech University Coep Tech Univers

- 1. Advanced Engineering Mathematics (10th edition) by Erwin Kreyszig, Wiley eastern Ltd.
- 2. George Simmons, "Differential Equations with Applications and Historical notes", Tata Mc- Graw
- Hill publishing company Ltd, New Delhi, 2006. BTech (R&AI) Mechanical Engg. Dept. COEP Tech 28/90

3. C.R. Wylie, "Advanced Engineering Mathematics", McGraw Hill Publications, New Delhi, 2017. **Reference Books**

COOP 1. Gerald, C. F. and Wheatly, P. O.," Applied Numerical Analysis", 6th Edition, Wesley.

2. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., "Numerical Methods for Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi.

3. Conte, S. D. and De Boor, C., "Elementary Numerical Analysis", Mc Graw Hill Publisher.

Course: Numerical Methods & Programming Language Laboratory

Course Code	MRAIBSC407-L	Scheme of Evaluation	TW & OE
Teaching Plan	0-0-2-1	Term Work	50 00 0
Credits	ep Tech ¹ Univers	Oral Exam	50 Te

Course Contents: Assignments / Practical based on

Unit	Contents	Contact Hours	Univer Univer
1	Interpolation and Curve Fitting Polynomial interpolation (Lagrange and Newton), Least squares approximation, Spline interpolation, Error analysis and selection of interpolation methods,	3 Hrs	Univer Univer
2	Optimization Methods Unconstrained optimization (gradient-based and gradient-free methods), Constrained optimization (linear and nonlinear programming), Introduction to optimization libraries and tools	3 Hrs	Unive Unive Unive
3	Numerical Solutions of Partial Differential Equations Finite difference methods, Finite element methods, Introduction to numerical methods for heat and wave equations,	3 Hrs	Unive Unive
4	Introduction to Numerical Probability and Statistics Random number generation, Monte Carlo methods, Statistical analysis of numerical data	3 Hrs	Unive Unive
5	Introduction to Data Visualization and Plotting Visualization libraries and tools, Data plotting and visualization techniques, Exploratory data analysis and presentation	3 Hrs	Unive Unive
6	Numerical Methods in Practice and Project Work Application of numerical methods to real-world problems, Project work: implementation of a numerical algorithm, analysis of results, and presentation	3 Hrs	Unive Unive Unive
	1 2 3 4 5	Interpolation and Curve Fitting Polynomial interpolation (Lagrange and Newton), Least squares approximation, Spline interpolation, Error analysis and selection of interpolation methods,2Optimization Methods Unconstrained optimization (gradient-based and gradient-free methods), Constrained optimization (linear and nonlinear programming), Introduction to optimization libraries and tools3Numerical Solutions of Partial Differential Equations Finite difference methods, Finite element methods, Introduction to numerical methods for heat and wave equations,4Introduction to Numerical Probability and Statistics Random number generation, Monte Carlo methods, Statistical analysis of numerical data5Introduction to Data Visualization and Plotting Visualization libraries and tools, Data plotting and visualization techniques, Exploratory data analysis and presentation6Numerical Methods in Practice and Project Work Application of numerical methods to real-world problems, Project work: implementation of a numerical algorithm, analysis of results, and	UnitContentsHours1Interpolation and Curve Fitting Polynomial interpolation (Lagrange and Newton), Least squares approximation, Spline interpolation, Error analysis and selection of interpolation methods,3 Hrs2Optimization Methods Unconstrained optimization (gradient-based and gradient-free methods), Constrained optimization (linear and nonlinear programming), Introduction to optimization libraries and tools3 Hrs3Numerical Solutions of Partial Differential Equations Finite difference methods, Finite element methods, Introduction to numerical methods for heat and wave equations,3 Hrs4Introduction to Numerical Probability and Statistics Random number generation, Monte Carlo methods, Statistical analysis of numerical data3 Hrs5Introduction to Data Visualization and Plotting Visualization libraries and tools, Data plotting and visualization techniques, Exploratory data analysis and presentation3 Hrs6Numerical Methods in Practice and Project Work Application of numerical methods to real-world problems, Project work: implementation of a numerical algorithm, analysis of results, and3 Hrs

Textbooks:

1. Peter V. O' Neil, "Advanced Engineering Mathematics", (7th edition), Thomson. Brooks / Cole,

Singapore,1991.
Michael D. Greenberg, "Advanced Engineering Mathematics", (2nd edition), Pearson Education,1998.

Coep TeReference Books Coep Tech University Coep Tech University Coep Tech Univers

1. Krishnamurthy, E. V. & Sen, S. K., "Applied Numerical Analysis", East West Publication.

COEP Tech29/90BTech (R&AI) Mechanical Engg. Dept.

Coep Tech University Coep Tech Entrepreneurship Entrepreneurship Environmental Science

Environmental Science Summer Internship-after Sem IV-Exam in Sem V

Syllabus for Exit After SY -- Additional Credits for Diploma

Coop Tech University Coo Course: Robotic Simulation Laboratory

Te	Course Code	MRAIVSEC4E1-L	Scheme of Evaluation	MSE & ESE
To	Teaching Plan	0-1-2-0	Term Work	50
N 19	Credits	2	Oral Exam	50

Course Contents: Assignments / Practical based on

Expt. No.	Contents	Contact Hrs
ch Univ	Physics simulations of Robots with Gazebo, Mujoco and Pybullet C++/Python APIs	4 Hrs
ch 2 niv	Simulation of 6-dof manipulator in ROS	C 4 Hrs
ch 3Jniv	Dynamic model development and simulation of simple mechanical systems using Matlab and Mathematical.	4 Hrs ec
4	Numerical simulation of simple mechanical systems.	4 Hrs
ch 5Iniv	Stability analysis of simple mechanical systems using linear system theory namely root locus and Bode plot	4 Hrs
6	State space model development and dynamic simulation using Simulink	4 Hrs

Coep TeReference Books: Coep Tech University Coep Tech University Coep Tech Univers

- Corke, Peter I. Robotics, vision and control: fundamental algorithms in Matlab. 1st ed. New York: Springer, 2011. ISBN 978- 3-642-20143-1.
- Devendra K Chaturvedi, —Modelling and Simulation of Systems using MATLAB and Simulink , CRC press, 2010
 - 3. Learning ROS for Robotics Programming, Aaron Martinez, Enrique Fernandez, PACKT publishing, 2013
- Programming Robots with ROS, Morgan Quigley, Brian Gerkey, & William D Smart, SPD Shroff Publishers and Distributors Pvt Ltd., 2016
- Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, Lentin Joseph, PACKT publishing, 2015

Compared to the Course: Aerial Robotics Programming Laboratory

Course Code 📀 💿	MRAIVSEC4E2-L	Scheme of Evaluation	MSE & ESE
Feaching Plan	0-1-2-2	Term Work	50
Credits	2	Oral Exam	50

Course Contents: Assignments / Practical based on

Detailed Content: Any six experiments / assignments from the list below (For Total Min. 24 Hours)

Expt. No.	niversity Coep Tech Uni ^{Contents} Coep Tech University C	Contact Hours
ach Ut	Introduction to Drone Technology Lab	oen Tecl
3133	Overview of the lab equipment and safety protocols	4 11
ch Ur	Introduction to basic drone components (frame, motors, flight controller)	4 Hrs
ch Ui	Familiarization with tools and software used in the lab	oen Tec

COEP Tech30/90BTech (R&AI) Mechanical Engg. Dept.

a Tech University Coep Tech U	embly ersity Coep Tech University C	nen Tech U
• Step-by-step assembly of a d	rone kit	4 Hrs
Understanding the purpose a	nd function of each component	oephech U
	maintenance and troubleshooting	oep Tech U
Flight Controller Configurati	THE WEATER AND WATER AND THE WEATER AND	oep Tech U
	ler software (e.g., Betaflight, Ardupilot)	4 Hrs
Basic configuration and calle	oration of the flight controller	0010100110
	fail safes	oep Tech U
Basic Flight Maneuvers	ers such as take-off, landing, and hovering	oep Tech U
4 Introduction to different flight	nt modes (e.g., stabilized, acro)	4 Hrs
Understanding control inputs		
Autonomous Flight		oep lech U
Ũ	flight modes (e.g., GPS-assisted flight)	4 Hrs
⁵ Planning and executing aut	tonomous missions using mission planning	4 Hrs oep Tech U
software, Understanding geo	fencing and no-fly zones	
Payload Integration	Iniversity Coep Tech University C	oep tech U
	s of payloads (e.g., cameras, sensors)	4 Hrs
	payloads onto the drone, Testing payload	oep Tech U
	aneuvers such as banked turns, figure-eight	oep Tech U
	acrobatic maneuvers (flips, rolls), Flight	4 Hrs
proficiency assessment		oep Tech U
Drone Maintenance and Repa		
Routine maintenance tasks (c	eleaning, propeller replacement, battery care)	4 Hrs
	ing common issues (motor failure, GPS signal	oep lech U
loss), Repairing and replacin		nen Tech U
Data Collection and Analysis		Toolio
	ction techniques (e.g., aerial photography,	4 Hrs
Applications of drone-collect	alyzing data collected by drones	oep Tech U
Tech University Coen Tech U		pep Tech U
Reference Books:		
BUILD YOUR LIMP I FORD WIT	anual: The practical guide to safely building r_{1}	
maintaining an Unmanned A		uhlisher Havne
maintaining an Unmanned A	enar vehicle (OAV), by Alex Libut, 2010, 10	ublisher: Hayne
maintaining an Unmanned A Publishing	inversity coep recir oniversity of	bep leciro
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10. Drone Operator's Handbook, by Kevin Jenkins, 2017, Independently published. Coep Tech University Coep Course: Control System Laboratory **Course Code** MRAIVSEC4E3-L **Scheme of Evaluation** MSE & ESE **Teaching Plan** 0-1-2-0 **Term Work** 50 Credits 2 **Oral Exam** 50 **Course Contents: Assignments / Practical based on** Detailed Content (Any Eight experiments / assignments from the list below) Expt. Contact sity Coep tech University No. Hours Programming of HCS12 with Code warrior for Interrupts, Clock Functions 4 Hrs 1 TIM, RTI, SPI, LCD interfacing, 2 2 Hrs 3 Use of JTAG and Hardware Debuggers, Interfacing Keypad 4 Hrs ADC, DAC, LCD, Real Time Clock 4 4 Hrs Temperature Sensors with I2C and SPI bus 5 2 Hrs 6 Interface 7 segment LED to 8051 to generate flashing action 2 Hrs Interface Analog to Digital converter to 8051 and display the result on LCD 7 4 Hrs display

Interface Digital to Analog converter to 8051 and view the output on CRO

Linear controller (P,PI,PD and PID) design for simple position control of

Perform serial communication using 8051

Interface stepper motor to 8051 it through given number of steps

Decentralized motion control and Centralized motion control

Feed-forward compensation, Force control, Visual surveying

Reference Books:

mechanical systems.

8

9

10

11

12

Electronic Control systems in Mechanical and Electrical 1. W. Bolton, Mechatronics Engineering-, 2nd Edition, Addison Wesley Longman Ltd., 1999.

4 Hrs

2 Hrs

4 Hrs

4 Hrs

4 Hrs

2. Brian Morris, Automated Manufacturing Systems - Actuators, Controls, Sensors and Robotics, Mc Graw Hill International Edition, 1995.

- 3. I.J. Nagarath and M. Gopal, Control Systems Engineering, New Age International (P) Ltd.
- 4. M. Gopal, Digital Control and State Variable Methods, Tata Mc Graw-Hill Companies, 1997

Coep Tech University Coep Tech L Course: Mini Project - University Coep Tech

Course Code	MRAIVSEC6E4	Scheme of Evaluation	MSE & ESE	
Teaching Plan	0-2-0-0	Term Work	CIE: 100	
Credits	2	Oral Exam	CIE: 100	

Course Outcomes:

Students who successfully complete this course will have an ability to:

1. Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.

Design, implement and test the prototype/algorithm in order to solve the conceived problem.

3. Write a comprehensive report on mini project work.

BTech (R&AI) Mechanical Engg. Dept. COEP Tech 32/90

Guidelines:

- 1. The mini-project is a team activity having 3-4 students in a team. Mini projects should include mainly Mechanical Engineering but can be multi disciplinary too.
 - The mini project may be a complete hardware or a combination of hardware and software. The software part in the mini project should be less than 50% of the total work.
- 3. Mini Project should cater to a small system required in laboratory or real life.
 - 4. It should encompass components, devices etc. with which functional familiarity is introduced.
 - 5. After interactions with course coordinator and based on comprehensive literature survey/ need
- analysis, the student shall identify the title and define the aim and objectives of the mini-project.
- 6. Students are expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within the first week of the semester.
- 7. The student is expected to exert on design, development and testing of the proposed work as per the Coep Tech Urschedule ty Coep Tech University Coep Tech University Coep Tech Univers
 - 8. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.

Open Elective-II

Multidisciplinary Minor - I

Coep Tech University CoeNumerical Methods & Programming Languages by Coep Tech Univers Coep Tech University Coep Tech Principles of Economics **Environmental Studies**

[Note- Above subject's syllabus will be from respective department] 33/90 BTech (R&AI) Mechanical Engg. Dept. COEP Tech

Coep Tech University Course: Artificial Intelligence & Machine Learning Coep Tech University

Course Code	MRAIPCC501	Scheme of Evaluation	MSE & ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	3	Teachers' Assessment	20
University Go	ep lech onvers	End Sem Exam	50

Course Outcomes:

- Students who successfully complete this course will have demonstrated an ability to: 1. Solve problems using heuristic search (e.g., A*).
 - 2. Implement learning and planning algorithms (e.g., goal stacks).
- Design neural networks with backpropagation for complex tasks.
- Classify data using supervised learning (K-NN, SVM).
 Evaluate models with metrics and error correction.
 - Syllabus:

	Unit	Contents	Lecture	
	1.01	Heuristic search techniques		
	chUi	Heuristic search, Hill Climbing, Best first search, mean and end analysis,	6 Hrs	
	ch Ui	Constraint Satisfaction, A* and AO* Algorithm	ep Tecl	
	ch U	Learning & Planning	en Tecl	
		What is Learning, Types of Learning (Rote, Direct instruction Analogy,	ep reun	
	CIZUI	Induction, Deduction), Planning: Block world, strips, Implementation using	6 Hrs	
	ch Ur	goal stack, Non linear planning with goal stacks, Hierarchical planning, Least commitment strategy.	ep Tec	
	chill	Neural Networks and Expert systems	en Tec	
	011 01	Neurons and biological motivation. Linear threshold units. Perceptrons:	op ico	
	ch Ui	representational limitation and gradient descent training. Multilayer	ep lec	
	ch Ur	networks and backpropagation, Hidden layers and constructing	6 Hrs	
	ch I b	intermediate, distributed representations, Overfitting, learning network	an Tacl	
	UT OI	structure, two case studies on expert systems.	ich ico	
	ch Ui	Introduction to Machine Learning	ep Tec	
	ch Ur	Introduction to Machine Learning, Learning Paradigms, PAC learning,	ep Tec	
	4	Basics of Probability, Version Spaces, Classification of Machine learning	6 Hrs	
	CIT-UI	problem, Supervised, unsupervised, Reinforcement learning. Classifiers K-	lep rec	
	ch Ur	NN classifier, Logistic regression, Perceptron, Single layer & Multi-layer,	ep Tec	
	ch Ui	Support Vector Machines, Linear & Non-linear.	en Tec	
		Evaluation Metrics and ensemble learning ROC Curves, Evaluation Metrics, Significance tests, Error correction in		
	5.01	Perceptrons- Bagging and Boosting (Random forests, Adaboost, XG boost	6 Hrs	
	ch Ur	inclusive), Machine learning process in practice	ep Tec	
	ch Ur	Hypothesis Design	en Tec	
	6	Types of variables, Types of measurement scales, Constructing the		
	CIQUI	Hypothesis, Null hypothesis, Alternative Hypothesis. Hypothesis testing,	6 Hrs	
	ch Ur	type 1 error, Type 2 error, Confidence of Interval.	ep Tec	
	Sugges	ted learning resources:		
	22 22 27			
	1 extbo	oks: Ethem Almandin "Introduction to Machine Learning", MIT Press, Prontice Hel	l of India	
		Ethem Alpaydin,"Introduction to Machine Learning, MIT Press, Prentice Hal Edition 2014.		
COFI	PTech	34/90 BTech (R&AI) M	echanical En	

Reference Books:

1. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundations of Machine Learning", MIT Press, 2012. 2. Tom Mitchell, Machine Learning^{II}, McGraw Hill, 3rd Edition,1997.

3. Charu C. Aggarwal, Data Classification Algorithms and Applications, CRC Press, 2014.

4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer Edition. 2011.

Course: Artificial Intelligence & Machine Learning Laboratory

Course Code	MRAIPCC501	Scheme of Evaluation	MSE & ESE
Feaching Plan	0-0-2-0	Term Work	50
Credits	ep lech univer	Oral Exam	50

Course Outcomes:

Students who successfully complete this course will have an ability to:

1. Develop an Explanation of what is involved in learning models from data.

2. Implement a wide variety of learning algorithms.

Apply principles and algorithms to evaluate models generated from data.

4. Apply the algorithms to a real-world problem

Compared Course Contents: Assignments / Practical based on:

Expt. No.	tiversity Coep Tech University C	Contact Hours
1	Implement A* algorithm.	4 Hrs
2	Implement AO* algorithm	4 Hrs
3	Implementation of other Searching algorithms.	4 Hrs
4	Implementation of Min/MAX search procedure for game Playing	4 Hrs
1 ⁵ Ui	Implementation of variants of Min/ Max search procedure.	4 Hrs
6	Implementation of a mini-Project using the concepts studied in the AI course.	4 Hrs

Suggested learning resources:

Textbooks:

1. Artificial Intelligence: A Modern Approach by Peter Norvig and Stuart J. Russell

2. Artificial Intelligence for Dummies by John Paul Mueller and Luca Massaron

Coep TeReference Books: Coep Tech University Coep Tech University Coep Tech University

- 1. Keith Frankish and William M. Ramsey (Eds.), "The Cambridge Handbook of Artificial Intelligence" Cambridge University Press.
- 2. Brigette Tasha Hyacinth, "The Future of Leadership: Rise of Automation, Robotics, and Artificial Intelligence" Motivational Press

Course: Fundamentals of Robot Manipulators

Course Code	MRAIPCC502	Scheme of Evaluation	MSE & ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	ep Tech3Univers	Teachers' Assessment	20
ch University Co	en Tech Univer	End Sem Exam	50

Coep TeCourse Outcomes: Coep Tech University Coep Tech University Coep Tech Univers Students who successfully complete this course will have demonstrated an ability to:

COEP Tech35/90BTech (R&AI) Mechanical Engg. Dept.

1. Understand robot kinematics and dynamics principles.

2. Gain proficiency in kinematic and dynamic modelling of robot manipulators.

3. Design and implement control strategies for robot manipulators.

oen Tech.Univers 4. Implement skills in planning and executing manipulation tasks, including trajectory planning and obstacle avoidance.

5. Apply robotic concepts to real-world scenarios in various domains.

Coep Te^{Syllabus:}versity Coep Tech University Coep Tech University Coep Tech Univers

Соер Те	Unit	viversity Coep Tech Uni Contents Coep Tech University Co	Lecture	Univers
Соер Те	ch Ui		ep Tech	Univers
Соер Те	ch Ui	Overview of Robotics: Definition, history, and evolution. Classification of Robots: Based on kinematics, functionality, application,	ep Tech	Univers
Соер Те	ch1Ui	etc., Robot Components: Sensors, actuators, end-effectors, controllers, etc.	6 Hrs	Univers
Соер Те	ch Ui	Robot Kinematics: Forward and inverse kinematics, Denavit-Hartenberg parameters (Classical & Modern), Robot Dynamics: Newton-Euler	ep Tech	Univers
Coep Te	ch Ui	equations, Lagrangian formulation.	ep Tech	Univers
Соер Те	ch Ui	Robot Manipulator Kinematics Introduction to Manipulator Kinematics: Degrees of freedom, workspace,	ep Tech	Univers
Соер Те	ch Ui	redundancy.	ep Tech	Univers
Соер Те	cl ² Ui	Forward Kinematics: Homogeneous transformations, DH convention, transformation matrices. Inverse Kinematics: Analytical and numerical	6 Hrs	Univers
Соер Те	ch Ui	methods, Jacobian matrix, singularity analysis. Velocity Kinematics: End-	ep Tech	Univers
Coep Te	ch Ui	effector velocities, Jacobian matrix, velocity control.	ep Tech	Univers
Соер Те	ch Ui	Robot Manipulator Dynamics Introduction to Manipulator Dynamics: Newton-Euler equations, Euler-	ep Tech	Univers
Соер Те	ch Ui	Lagrange equations. Lagrangian Formulation: Energy-based approach to	ep Tech	Univers
Соер Те	c 3U1	derive robot dynamics. Manipulator Dynamics: Manipulator inertia matrix, Coriolis and centrifugal	6 Hrs	Univers
Соер Те	ch Ui	forces, gravity forces.	ep Tech	Univers
Соер Те	ch Ui	Control of Robot Manipulators: PD control, PID control, computed torque control.	ep Tech	Univers
Соер Те	ch Ui	Advanced Topics in Robot Manipulation pep Tech University Co	ep Tech	Univers
Соер Те	ch Ui	Trajectory Planning: Path planning, motion planning, obstacle avoidance. Force Control: Compliance control, force/torque sensing, impedance control.	6 Hrs	Univers
Соер Те	chU	Robotic Manipulation: Grasping and manipulation, force-closure, dexterity.	ephiech	Univers
Соер Те	ch Ui	Applications of Robot Manipulators: Industrial robots, service robots, medical robots, etc.	ep Tech	Univers
	Sugges	ted learning resources:		
	Textbo	niversity Coep Tech University Coep Tech University Co wks:		
		1. Introduction to Robotics: Mechanics and Control" by John J. Craig.		
Coep Te	Refere	nce Books: Coep Tech University Coep Tech University Co		
	ch ¹ Uı	"Robotics: Modelling, Planning and Control" by Bruno Siciliano, Lorenzo Sciavicco and Giuseppe Oriolo	, Luigi Villar	ⁱ Univers
		"Robot Dynamics and Control" by Mark W. Spong, Seth Hutchinson, and M. Vidyas		
	en 4.	"Modern Robotics: Mechanics, Planning, and Control" by Kevin M. Lynch and Fran "Robot Manipulator Control: Theory and Practice" by Frank L. Lewis, Darren M. Da	wson, and	Univers
		Chaouki T. Abdallah		
		niversity Coep Tech University Coep Tech University Co		
	ch Ui	niversity Coep Tech University Coep Tech University Co		
		36/90 BTech (R&AI) M		
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Coep Tech University Coe sity Coep Tech Univers

Course: Mobile and Micro Robotics (PEC-I)

Course Code	MRAIPEC503-R	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	ep Tech3Univers	Teachers' Assessment	20
h University Cr	oon Toch Univers	End Sem Exam	50

Coep TeCourse Outcomes: Coep Tech University Coep Tech University Coep Tech University

Students who successfully complete this course will have an ability to:

- dents who successfully complete this course will have an ability to: 1. Grasp mobile robot fundamentals: Tasks, types, environments, challenges, and applications.
- COOP TOO 2. Analyze mobile robot locomotion: Kinematics and dynamics of wheeled, legged, aerial, and aquatic robots.
- aquatic robots. 3. Navigate and localize mobile robots: Sensor applications, odometry, mapping, and Kalman filtering for positioning.
- 4. Control mobile robot motion: Model-based and motion control design principles.
 - 5. Explore advanced topics: Microrobotics, mobile manipulators, and cooperative robots. ty Coep Tech University Coep Tech University Coep Tech Univers

Syllabus:

Unit	iversity Coep Tech University Co	Lecture
ch U	Introduction to Mobile Robots: Tasks of mobile robots, robots manufacturers, type of obstacles and	ep Tech
ch1U	challenges, tele-robotics, philosophy of robotics, service robotics, types of	6 Hrs
ch U	environment representation. Ground Robots: Wheeled and Legged Robots, Aerial Robots, Underwater Robots and Surface Robots.	ep Tech
ch U	Kinematics and Dynamics of Wheeled Mobile Robots:	ep lech
ch U	Two, three, four - wheeled robots, omni-directional and meccanum wheeled	ep Tech
c 2U	robots. Sensors for localization: magnetic and optic position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, GNSS and	6 Hrs
ch U	Sensors for navigation: tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual system	ep Tech
	Localization and Mapping in mobile robotics:	ep leci
ch U	Motion Control of Mobile Robots (Model and Motion based Controllers):	ep Tech
c 3U	Lyapunov-based Motion Control Designs and Case Studies. Understand the current application and limitations of Mobile Robots. Introduction to Mobile	e 7 Hrs
ch U	Manipulators and Cooperative Mobile Robots. Odometry, Dead reckoning method, Map based localisation, Kalman filtering	ep Tech
	Micro robotics: Introduction, Task specific definition of micro-robots - Size	ep leui
4 ch U	and Fabrication Technology based definition of microrobots - Mobility and Functional-based definition of micro- robots - Applications for MEMS based micro-robots.	7 Hrs
ch U	Micro-robotic actuators Design of locomotive micro-robot devices based	ep Tech
ci5U	on arrayed actuators. Micro-robotic devices: Micro grippers and other micro tools, micro-conveyers- Walking MEMS microrobots- Multi robot system:	6 Hrs
ch U	Micro-robot powering, microrobot communication.	ep Tech
ch U	Implementation of Microrobots: Arrayed actuator principles for micro- robotic applications. Micro fabrication and micro assembly: micro	ep Tech
6	fabrication principles, design selection criteria for micromachining,	4 Hrs
ch U	Packaging and integration aspects, Micro-assembly platforms and manipulators.	ep Tech
Sugges	sted learning resources:	ep leci
Jugges	niversity Coep Tech University Coep Tech University Co	

COEP Tech37/90BTech (R&AI) Mechanical Engg. Dept.

Coep Tech University Coep Tech University Coep Tech University Coep Tech University

1. Atnaik, Srikanta, "Robot Cognition and Navigation: An Experiment with Mobile Robots", Springer-Verlag Berlin and Heidelberg, 2007.

Springer-Verlag Berlin and Heidelberg, 2007. 2. Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia

COOP CONTRACTOR Kavraki, and Sebastian Thrun, -Principles of Robot Motion-Theory, Algorithms, and

Implementation, MIT Press, Cambridge, 2005.3. Margaret E. Jefferies and Wai-Kiang Yeap, "Robotics and Cognitive Approaches to Spatial Mapping", Springer-Verlag Berlin Heidelberg 2008.

Course: Autonomous Robotics and Telecherics (PEC-II)

Course Code	MRAIPEC504-R	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	ep 3-0-0-0 vers	Mid Semester Exam	ersity 30 ep T
Credits	ep Tech ³ Univers	Teachers' Assessment	20
	· · · · · · · · · · · · · · · · · · ·	End Sem Exam	50

Course Outcomes:

Students who successfully complete this course will have an ability to:

1. Learn principles of working of autonomous robots.

- 2. Demonstrate the sensing, perception, and cognition of autonomous robots.
 - 3. understand anatomy of autonomous robots. ch University Coep Tech University Coep Tech University Coep Tech Univers Syllabus:

Introduction to Mobile Robotics Fundamentals: Overview of mobile robotics principles and locomotion basics. Introduction to kinematics and mobility concepts. Classification of mobile robots and their applications.6 Hrs1AI Techniques for Robot Navigation: Introduction to AI techniques for robot navigation. Overview of modern mobile robots: Swarm robots, cooperative robots, mobile manipulators. Discussion on current challenges in mobile robotics.6 Hrs3Autonomous Mobile Robots: Understanding the need and applications of autonomous mobile robots. Sensing technologies for perception in autonomous systems. Localization techniques for self-awareness and position determination.6 Hrs4Mapping and Navigation: Mapping methods for environment representation and exploration. Navigation principles and control strategies for autonomous motion. Basics of autonomy: Motion control, vision systems, and PID controllers.6 Hrs5Introduction to Telecherics robots and teleoperation concepts. Exploring the need and applications of Telecherics robots. Overview of humanoid robots and their functionalities.6 Hrs	Unit	Contents	Lecture
2Introduction to AI techniques for robot navigation. Overview of modern mobile robots: Swarm robots, cooperative robots, mobile manipulators. Discussion on current challenges in mobile robotics.6 Hrs3Autonomous Mobile Robots: Understanding the need and applications of autonomous mobile robots. Sensing technologies for perception in autonomous systems. Localization techniques for self-awareness and position determination.6 Hrs4Mapping and Navigation: Mapping methods for environment representation and exploration. Navigation principles and control strategies for autonomous motion. Basics of autonomy: Motion control, vision systems, and PID controllers.6 Hrs5Telecherics Robots and Humanoid Robots: Introduction to Telecherics robots and teleoperation concepts. Exploring the need and applications of Telecherics robots. Overview of humanoid robots and their functionalities.6 Hrs	ch Ui ch ¹ Ui ch Ui	Overview of mobile robotics principles and locomotion basics. Introduction to kinematics and mobility concepts.	6 Hrs
3Understanding the need and applications of autonomous mobile robots. Sensing technologies for perception in autonomous systems. Localization techniques for self-awareness and position determination.6 Hrs4Mapping and Navigation: Mapping methods for environment representation and exploration. Navigation principles and control strategies for autonomous motion. Basics of autonomy: Motion control, vision systems, and PID controllers.6 Hrs5Telecherics Robots and Humanoid Robots: Introduction to Telecherics robots and teleoperation concepts. Exploring the need and applications of Telecherics robots. Overview of humanoid robots and their functionalities.6 Hrs	ch 2 ch U	Introduction to AI techniques for robot navigation. Overview of modern mobile robots: Swarm robots, cooperative robots, mobile manipulators.	6 Hrs
4Mapping methods for environment representation and exploration. Navigation principles and control strategies for autonomous motion. Basics of autonomy: Motion control, vision systems, and PID controllers.6 Hrs5Telecherics Robots and Humanoid Robots: Introduction to Telecherics robots and teleoperation concepts. Exploring the need and applications of Telecherics robots. Overview of humanoid robots and their functionalities.6 Hrs	ch U cl3U ch U	Understanding the need and applications of autonomous mobile robots. Sensing technologies for perception in autonomous systems. Localization	6 Hrs
5Telecherics Robots and Humanoid Robots: Introduction to Telecherics robots and teleoperation concepts. Exploring the need and applications of Telecherics robots. Overview of humanoid robots and their functionalities.6 Hrs	ich Ui Ici4Ui Ich Ui	Mapping and Navigation: Mapping methods for environment representation and exploration. Navigation principles and control strategies for autonomous motion. Basics	6 Hrs
Swarm Robotics and Robot Applications:	ch Ui ci ⁵ Ui	Telecherics Robots and Humanoid Robots: Introduction to Telecherics robots and teleoperation concepts. Exploring the need and applications of Telecherics robots. Overview of humanoid	6 Hrs
6 Understanding swarm robotics principles and collective behaviors. Ethical considerations in robot applications: Privacy, safety, and social impact. 6 Hrs Discussion on various robot applications in diverse fields.	6	Swarm Robotics and Robot Applications: Understanding swarm robotics principles and collective behaviors. Ethical considerations in robot applications: Privacy, safety, and social impact.	6 Hrs

- 2. Morgan Quigley, Brian Gerkey Quigley et al, "Programming Robots with ROS", O' Rielly
- Coep Tech U Publishers, Murphy 2000.
- 3. huzi Sam Ge, Frank L Lewis, "Autonomous Mobile Robots", Edited by S, Tylor and Francis, 2006.
- 4. Roland Siegwart, Illah Reza Nourbakhsh, Davide Sacramuzza, "Introduction to Autonomous Mobile Robots", MIT press,2nd edition, 2011. 5. Peter Corke, "Robotics Vision and Control", Springer 2011.

e <u>ch University C</u>	oep Tech Univers		ersity Coep To
Course Code	MRAIPEC503-A	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	ep Tech3Univers	Teachers' Assessment	20
ech University C	ep Tech Univers	End Sem Exam	ersity 50 ep Te

Course: Data Analytics (PEC-I)

Coep Te Course Outcomes: Coep Tech University Coep Tech University Coep Tech Univers

- At the end of the course students will be able to: 1. Examine and compare various datasets and features.
- 2. Analyze the business issues that analytics can address and resolve.
- Apply the basic concepts and algorithms of data analytics.
 Interpret, implement, analyze and validate data using popular data analytics tools.

Coep Tesvilabus:versity Coep Tech University Coep Tech University Coep Tech Univers

3 Data Normalization, Data Binning, Importing and Exporting Data in Python, turning categorical variables into quantitative variables in Python, Accessing Databases with Python. 6 Hrs 3 Data Visualization 6 arghic representation of data, Characteristics and charts for effective graphical displays, Chart types- Single var: Dot plot, Jitter plot, Error bar plot, Box-and whisker plot, Histogram, Two variable: Bar chart, Scatter plot, Line plot, Log-log plot, more than two variable: Stacked plots, Parallel coordinate plot. 6 Hrs 5 Descriptive and Inferential Statistics Probability distributions, Hypothesis testing, ANOVA, Regression 6 Hrs 6 Classification and Clustering, Bayes" classifier, Decision Tree, Apriori algorithm, K-Means Algorithm, Logistics regression, Support Vector Machines, Introduction to recommendation system. 6 Hrs Suggested learning resources: Textbooks: 1. Anil Maheshwari, "Data Analytics made accessible," Amazon Digital Publication, 2014	Unit	Contents	Lecture
Data Analytics Tools 6 Hrs Data Analytics using Python, Statistical Procedures, NumPy, Pandas, SciPy, Matplotlib 6 Hrs Data Pre-Processing Understanding the Data, Dealing with Missing Values, Data Formatting, Data Normalization, Data Binning, Importing and Exporting Data in Python, turning categorical variables into quantitative variables in Python, Accessing Databases with Python. 6 Hrs Data Visualization 6 Hrs Graphic representation of data, Characteristics and charts for effective graphical displays, Chart types- Single var: Dot plot, Jitter plot, Error bar plot, Box-and whisker plot, Histogram, Two variable: Bar chart, Scatter plot, Line plot, Log-log plot, more than two variables: Stacked plots, Parallel coordinate plot. 6 Hrs Descriptive and Inferential Statistics 6 Hrs Probability distributions, Hypothesis testing, ANOVA, Regression 6 Hrs Machine Learning Concepts 6 Hrs Classification and Clustering, Bayes" classifier, Decision Tree, Apriori algorithm, K-Means Algorithm, Logistics regression, Support Vector Machines, Introduction to recommendation system. 6 Hrs Suggested learning resources: 7 1 Anil Maheshwari, "Data Analytics made accessible," Amazon Digital Publication, 2014	ch Ui ch Ui	Descriptive, Predictive, and Prescriptive Analytics, Data Types, Analytics Types, Data Analytics Steps: Data Pre-Processing, Data Cleaning, Data Transformation, and Data Visualization.	6 Hrs
Data Pre-Processing Understanding the Data, Dealing with Missing Values, Data Formatting, Data Normalization, Data Binning, Importing and Exporting Data in Python, turning categorical variables into quantitative variables in Python, Accessing Databases with Python. 6 Hrs Data Visualization Graphic representation of data, Characteristics and charts for effective graphical displays, Chart types- Single var: Dot plot, Jitter plot, Error bar plot, Box-and whisker plot, Histogram, Two variable: Bar chart, Scatter plot, Line plot, Log-log plot, more than two variables: Stacked plots, Parallel coordinate plot. 6 Hrs 5 Descriptive and Inferential Statistics Probability distributions, Hypothesis testing, ANOVA, Regression 6 Hrs 6 Classification and Clustering, Bayes" classifier, Decision Tree, Apriori algorithm, K-Means Algorithm, Logistics regression, Support Vector Machines, Introduction to recommendation system. 6 Hrs Suggested learning resources: 1. Anil Maheshwari, "Data Analytics made accessible," Amazon Digital Publication, 2014	2	Data Analytics Tools Data Analytics using Python, Statistical Procedures, NumPy, Pandas, SciPy,	6 Hrs
4 Graphic representation of data, Characteristics and charts for effective graphical displays, Chart types- Single var: Dot plot, Jitter plot, Error bar plot, Box-and whisker plot, Histogram, Two variable: Bar chart, Scatter plot, Line plot, Log-log plot, more than two variables: Stacked plots, Parallel coordinate plot. 6 Hrs 5 Descriptive and Inferential Statistics Probability distributions, Hypothesis testing, ANOVA, Regression 6 Hrs 6 Machine Learning Concepts Classifier, Decision Tree, Apriori algorithm, K-Means Algorithm, Logistics regression, Support Vector Machines, Introduction to recommendation system. 6 Hrs Suggested learning resources: 1. Anil Maheshwari, "Data Analytics made accessible," Amazon Digital Publication, 2014	3	Data Pre-Processing Understanding the Data, Dealing with Missing Values, Data Formatting, Data Normalization, Data Binning, Importing and Exporting Data in Python, turning categorical variables into quantitative variables in Python, Accessing	
5 Probability distributions, Hypothesis testing, ANOVA, Regression 6 Hrs 6 Machine Learning Concepts Classification and Clustering, Bayes" classifier, Decision Tree, Apriori algorithm, K-Means Algorithm, Logistics regression, Support Vector Machines, Introduction to recommendation system. 6 Hrs Suggested learning resources: Textbooks: 1. Anil Maheshwari, "Data Analytics made accessible," Amazon Digital Publication, 2014	ch Ui ch Ui ch Ui ch Ui	Data Visualization Graphic representation of data, Characteristics and charts for effective graphical displays, Chart types- Single var: Dot plot, Jitter plot, Error bar plot, Box-and whisker plot, Histogram, Two variable: Bar chart, Scatter plot, Line plot, Log-log plot, more than two variables: Stacked plots, Parallel	ep Tech 6 Hrs ep Tech
6 Machine Learning Concepts Classification and Clustering, Bayes" classifier, Decision Tree, Apriori algorithm, K-Means Algorithm, Logistics regression, Support Vector Machines, Introduction to recommendation system. 6 Hrs Suggested learning resources: Textbooks: 1. Anil Maheshwari, "Data Analytics made accessible," Amazon Digital Publication, 2014	ch5 U	Descriptive and Inferential Statistics	6 Hrs
Textbooks: 1. Anil Maheshwari, "Data Analytics made accessible," Amazon Digital Publication, 2014	ch ₆ Ui ch Ui	Machine Learning Concepts Classification and Clustering, Bayes ^{**} classifier, Decision Tree, Apriori algorithm, K-Means Algorithm, Logistics regression, Support Vector	6 Hrs
	Textbo	niversity Coep Tech University Coep Tech University Co oks:	
P Tech 39/90 BTech (R&AI) Mechanical En	P Tech		

2. James R. Evans, "Business Analytics: Methods, Models, and Decisions", Pearson 2012

 Song, Peter X. K, "Correlated Data Analysis: Modeling, Analytics, and Applications", Springer-Verlag New York 2007.

Reference Books:

1. Glenn J. Myatt, Wayne P. Johnson, "Making Sense of Data I: A Practical Guide to

- Exploratory Data Analysis and Data Mining", Wiley 2009.
- Thomas H. Davenport, Jeanne G. Harris and Robert Morison, "Analytics at Work: Smarter Decisions, Better Results", Harvard Business Press, 2010
- Rachel Schutt, Cathy O"Neil, "Doing Data Science", O"REILLY, 2006. Shamanth Kumar Fred Morstatter Huan Liu "Twitter Data Analytics", Springer-Verlag, 2014.

Coep Tech University Coep Tourse: Deep Learning (PEC-II)

Course Code	MRAIPEC504-A	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	3	Teachers' Assessment	20
ech University Co	pep tech Univers	End Sem Exam	50

Course Outcomes:

Students who successfully complete this course will have an ability to:

- 1. Understand the fundamentals of neural networks.
 - 2. Design feed forward networks with backpropagation.
- 3. Analyze neural networks for performance.
- 4. Apply attention mechanism to the neural network

Coep TeSyllabus: versity Coep Tech University Coep Tech University Coep Tech Univers

Coep Te Unit	Contents	Lecture
coep Tech Ui	Introduction	ep Teci
oep Tech U	Biological Neuron, Idea of computational units, McCulloch-Pitts unit and	ep Tec
oep Tech Ui	Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning	6 Hrs
oep Tech Ui	Algorithm. Coep Tech University Coep Tech University Co	ер Тес
oep Tech Ui	Neural Network	an Tee
oep Tecl ² U	Introduction to neural network and multilayer perceptrons (MLPs), representation power of MLPs, sigmoid neurons, gradient descent,	6 Hrs
oep Te <mark>ch U</mark>	feedforward neural networks representation, Backpropagation.	an Tan
2 (1997) - A 1997	Gradient Descent	op ice
oep Tech Ui	Gradient Descent, Batch Optimization, Momentum Based GD, Nesterov	ер Тес
oep Tecl ³ Ui	Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Saddle point problem in neural networks, Regularization methods (dropout, drop connect,	6 Hrs
oep Tech Ui	batch normalization).	ep Tec
oep Tech Ui	Convolutional Neural Network	on Too
oep Te <mark>ci 4</mark> Ui	Introduction to CNN, Building blocks of C9NN, Transfer Learning, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing CNNs,	6 Hrs
oep Tech U	Guided Backpropagation, Fooling Convolutional Neural Network	en Tec
oep Tech Ui	Autoencoders Autoencoders, Regularization in autoencoders, Denoising autoencoders,	ep Tec
oep Tecl5U	Sparse autoencoders, Contractive autoencoders, Regularization: Bias	6 Hrs
Coep Tech Ui	Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods,	ep Tec
oep Tech Ui	niversity Coep Tech University Coep Tech University Co	ep Tec
oen Tech Ill		
COEP Tech		
	40/90 BTech (R&AI) Mo	

coep lecil o	Dropout, Greedy Layerwise Pre-training, Better activation functions, Better	ep lech	
Coep Tech U	weight initialization methods, Batch Normalization.	ep Tech	
Coep Tech U	Recurrent Neural Network Introduction to RCNN, Backpropagation through time (BPTT), Vanishing	ep Tech	
Coep TechoU	and Exploding Gradients, Truncated BPTT, Long ShortTerm Memory,	6 Hrs	
Coep Tech U	Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs, Encoder Decoder Models, Attention Mechanism.	ep Tech	

Suggested learning resources:

Textbooks:

1. Deep Learning- Ian Goodfelllow, Yoshua Benjio, Aaron Courville, The MIT Press, 2016

Coep Te Reference Books: Coep Tech University Coep Tech University Coep Tech Univers

- 1. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996
 - 2. Pattern Recognition and Machine Learning, Christopher Bishop, 2007

Course: Intelligent Manufacturing (PEC-I)

Course Code	MRAIPEC503-M	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	epitech ₃ Univers	Teachers' Assessment	20
ch University Co	ep Tech Univers	End Sem Exam	ersity 50 ep Te

Coep Te Course Outcomes: Coep Tech University Coep Tech University Coep Tech Univers

Students who successfully complete this course will have an ability to:

- Summarize the concepts of computer integrated manufacturing systems and manufacturing communication systems
- 2. Demonstrate the concepts of artificial intelligence and automated process planning
 - 3. Select the manufacturing equipment using knowledge-based system for equipment selection
- 4. Apply various methods to solve group technology problems and demonstrate the
 - 5. structure for knowledge-based system for group technology

Syllabus:

Coep TecUnit	niversity Coep Tech Univ <u>Contents</u> Coep Tech University Co	Lecture
Coep Tech U	Computer Integrated Manufacturing Systems	ep Tec
Coep Tech ¹ U	Structure and functional areas of CIM system, - CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM.	6 Hrs
coep Tech U	Manufacturing Communication Systems	ep Tec
oep Te <mark>cl</mark> 2U	MAP/TOP, OSI Model, Data Redundancy, Top- down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System	6 Hrs
Coep Tech U	Components, System Architecture and Data Flow, System Operation.	ер Тес
Coep Tech U Coep Tech Coep Tech U	Basic Components of Knowledge Based Systems Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition. Automated Process Planning - Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning.	ep Tec 6 Hrs ep Tec
loep Te <mark>ch U</mark> loep Tech <mark>4</mark> U loep Tech U	Knowledge Based System for Equipment Selection (KBSES) Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KRSES.	6 Hrs
Coep Tecl5U	Group Technology	6 Hrs

COEP Tech 41/90 BTech (R&AI) Mechanical Engg. Dept.

Coep Tech U Coep Tech U	Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster	
Coep Tech U	Identification Method, Extended CI Method. Knowledge Based Group Technology	ep Tech
Coep Tech ₆ U Coep Tech U	Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSC IT) — Data Base, Knowledge Base, Clustering Algorithm.	6 Hrs

Suggested learning resources:

Coep TeReference Books: Coep Tech University Coep Tech University Coep Tech Univers

- 1. Andrew Kusiak, "Intelligent Manufacturing Systems", 1990
- Mohammad Jamshidi, "Design and Implementation of Intelligent Manufacturing Systems: From Expert Systems, Neural Networks to Fuzzy Logic", 1st Edition,1995
- 3. Pat Langley, "Computational Intelligence and Intelligent Systems", 2006

Course: Mechatronics System Design (PEC-II)

Course Code	MRAIPEC504-M	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	ep Te 3-0-0-0 ivers	Mid Semester Exam	30
Credits	ep Tech ³ Univers	Teachers' Assessment	20
and a second second	A THE OWNER WAS A	End Sem Exam	50

Course Outcomes:

Students who successfully complete this course will have an ability to:

 Demonstrate how mechatronics integrates knowledge from different disciplines to realize engineering and consumer products that are useful in everyday life.
 Apply theoretical knowledge: understanding selection of suitable sensors and actuators; designing

- Apply theoretical knowledge: understanding selection of suitable sensors and actuators; designing electro-mechanical systems.
- 3. Work with mechanical systems that include digital and analogue electronics as a data acquisition model.

Coep Te_{Svllabus}:versity Coep Tech University Coep Tech University Coep Tech Univers

Unit	Contents	Lecture
ch Ui ch Ui ch Ui ch Ui	Mechanical Systems and Design Mechatronics approach - Control program control, adaptive control and distributed systems - Design process - Types of Design - Integrated product design - Mechanisms, load conditions, design and flexibility Structures, load conditions, flexibility and environmental isolation – Man machine interface, industrial design and ergonomics, information transfer from machine from machine to man and man to machine, safety.	e o Tec 6 Hrs
h Ui 2 sh Ui	Real time interfacing Introduction Elements of data acquisition and control Overview of I/O Process-Installation of I/O card & software - Installation of application software, Over framing.	6 Hrs
	Microcontrollers: Introduction to use of open-source hardware (Arduino & Raspberry Pi); shields/modules for GPS, GPRS/GSM, Bluetooth, RFID, and Xbee, integration with wireless networks, databases and web pages; web and mobile phone apps.	6 Hrs
4	Case studies on Data Acquisition	6 Hrs

COEP Tech42/90BTech (R&AI) Mechanical Engg. Dept.

Tech	Transducer calibration system for Automotive applications Strain Gauge	
/ leuli u	weighing system - Solenoid force - Displacement calibration system - Rotary	
p Tech U	optical encoder - Inverted pendulum control - Controlling temperature of a	
	hot/cold reservoir -Pick and place robot - Carpark barriers.	
ep Tech U	Case studies on Data Acquisition and Control	
p Tech U	Thermal cycle fatigue of a ceramic plate - pH control system - De-Icing	6 Hrs
C C	Temperature Control System - Skip control of a CD Player - Autofocus	0 1115
ap Tech U	Camera, exposure control.	ep Tech
p Tech U	Case studies on design of Mechatronics products	ep Tech
6	Motion control using D.C. Motor, A.C. Motor & Solenoids - Car engine	6 Hrs
ap Tech U	management - Barcode reader.	

Coep Terestbooks: rsity Coep Tech University Coep Tech University Coep Tech Univers

- 1. W. Bolton, Mechatronics Electronic Control systems in Mechanical and Electrical Engineering-, 2nd Edition, Addison Wesley Longman Ltd., 1999.
- Devdas Shetty, Richard A. Kolk, Mechatronics System Design, PWS Publishing company, Coep Tech Ur1997 rsity Coep Tech University Coep Tech University Coep Tech Univers
- 3. Bradley, D. Dawson, N.C. Burd and A.J. Loader, Mechatronics: Electronics in Products and Coep Tech U Processes, Chapman and Hall, London, 1991.
- 4. Brian Morris, Automated Manufacturing Systems Actuators, Controls, Sensors and Robotics, Mc Graw Hill International Edition, 1995.
- 5. Gopal, Sensors- A comprehensive Survey Vol I & Vol VIII, BCH Publisher.

Course: Dynamic Control Systems (PEC-I)

Course Code	MRAIPEC503-C	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	ep Tech3Univers	Teachers' Assessment	20 0
h University Co	en Tech Univers	End Sem Exam	50

Coep TeCourse Outcomes: Coep Tech University Coep Tech University Coep Tech Univers

Students who successfully complete this course will have an ability to:

- 1. Understand of Control System Principles
- Complete 2. Do analysis of Dynamic Systems
 - 3. Acquire knowledge and skills to design control systems using various methods
- Explore real-world applications of control systems in the field of robotics.

Coep Tesvilabus: versity Coep Tech University Coep Tech University Coep Tech Univers

Unit	Contents	Lecture
e ch u	Introduction to control and Feedback Control:	ep iec
ech U	Basic principles, Elements of the feedback Loop, Block Diagram, Control	
ech U	Performance, Measures for Common Input Changes, Selection of Variables for Control Approach to Process Control. Factors in Controller Tuning,	
echU	Determining Tuning Constants for Good Control Performance, Correlations	6 Hrs
ech U	for tuning Constants, Fine Tuning of the controller tuning Constants. The performance of feedback Systems, Practical Application of Feedback	
ech U	Control: Equipment Specification, Input Processing, Feedback Control	
ech U	Algorithm.	en Tec
	Introduction to control and Feedback Control: Cascade control, Feed forward control, feedback- feed forward control, Ratio control, Selective Control, Split range control- Basic principles, Design	6 Hrs

COEP Tech43/90BTech (R&AI) Mechanical Engg. Dept.

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	ssues, Examp ndustrial appl		features of the individual	loop and	
		ements in Loop:	ny coep teen onive	arany ocep i	
			ad Band Velocity Limiting	, Negative	
3 R	Resistance, II	mprovement in nonlin	near process performance tions, Calculations of the	through: 6 H measured	
v	variable, final	control element selecti	on, cascade control design,	Real time	
	Multivariable		ny cocpireen onne		
C	Concept of M	ultivariable Control: In	teractions and it's effects,	Modelling	
			teraction o the possibility o		
			riable system behavior Rel		rs
			ility and Multiloop Contr		
			ch: Loop Paring, tuning, Enl	hancement	
		pling, Single Loop Enh		ersity Coep T	8
		stems and Fuzzy cont		Deletion	
			y Logic, Fuzzy Sets, Fuzzy c, Fuzzy If-Then Rules, Fu	n H	rs
			Neural networks and ANN		
	ntelligent Co				ec
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Students who successfully complete this course will have an ability to:

1. This subject is useful to understand the aspects of Design, Analysis of Modern control system with the state space tool.

2. Concept of stability can be obtained for the single input, single output with the help of state space

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3. Concept of compensator/controller will help student to implement in real control system. Coep Tech University Coep Tech University Coep Tech University Coep Tech Univers

Unit	Contents	Lecture
on or	Introduction to control strategies:	ch iec
ch Ui	Adaptive control, MPC, nonlinear control.	ер Тес
ch U	Adaptive Control for Robots: Principles of adaptive control and its	6 Hrs
ah III	applications in robotics, Model reference adaptive control (MRAC) and self- tuning regulators (STR).	
CII UI		ep iec
ch Ui	Adaptive control algorithms for robot manipulators and mobile robots. Model Predictive Control:	ер Тес
ch Ui	Theory and principles of model predictive control and MPC formulations for	ep Tec
ob Ub	robot motion planning and control.	on Too
2	Implementation of MPC for trajectory tracking and obstacle avoidance in	6 Hrs
ch Ui	robot systems. Integration of adaptive control and MPC for robust and	ер Тес
ch Ui	adaptive robot control. Case studies and applications of adaptive MPC in	ep Tec
	robotics	
CII UI	Nonlinear Control Techniques:	eh lec
ch Ui	Introduction to nonlinear control theory, Coep Tech University Co	
	Lyapunov stability theory and its application to nonlinear control and	6 Hrs
ob III	Nonlinear control strategies for robot systems: Feedback linearization, sliding mode control	on Too
CHI OI	Multivariable Control Systems:	eh leo
ch Ui	Concept of multivariable control and its importance, Modeling and transfer	ep Tec
ch Ui	functions of multivariable systems,	ep Tec
4	Effects of interactions on stability and performance and Multiloop control	6 Hrs
on or	system performance enhancement techniques: loop pairing, tuning,	ch icc
ch Ui	decoupling, etc.	ep Tec
ch Ui	Discrete Time System	ep Tec
5	sampler, sampling process, Laplace transform of sampled function, z	6 Hrs
0.100	transform, z transform of some useful function, stability analysis of Sampled	- up 100
ch Ui	data control system Reinforcement learning based control.	ep lec
ch Ui	Overview of reinforcement learning and its core concepts (states, actions,	ep Tec
ch U	rewards, Q-learning). Introduction to control theory fundamentals (feedback	ep Tec
	systems, stability analysis). Comparison of traditional control methods with	
6	RL for dynamical systems. Importance of stability and safety guarantees in	6 Hrs
ch U	RL-based controllers. Techniques for ensuring stability and safety in RL	epiec
ch Ui	control algorithms. Introduction to popular software tools for implementing and simulating RL control systems (OpenAI Gym, Stable Baselines3).	ер Тес
ch Ui	Exploring RL control applications in various engineering domains (robotics,	ep Tec
	autonomous vehicles, process control).	

Coep Tech University Coep Tech Course: Internship - I University Coep Tech University

Teaching Plan	0-0-4-0	Mid Semester Exam	CIE 100
Credits	oop reen oniver	End Sem Exam	- CIE: 100

Students who successfully complete this course will have an ability to: Compared 1. Became aware of the industrial practices and working environment.

COEP Tech45/90BTech (R&AI) Mechanical Engg. Dept.

	2.	Identify various types of softwares and hardwares based knowledge skillsets.
	3.	Complete literature survey for various related technologies.
	4.	Improve knowledge and skills by engaging with the project and its various components (research, analysis, design, implementation), students gain knowledge and skills specific to
		the project topic.ep Tech University Coep Tech University Coep Tech University
	5.	Design, implement and test the prototype/algorithm in order to solve the conceived problem.
	6.	Develop project management skills by planning, organization, and time management skills
		crucial for completing the internship.
	7.	Write a comprehensive report on project work assigned during this internship.
Coep TeG	uide	lines: raity Coep Tech University Coep Tech University Coep Tech Unive
	1.	The internship is an individual activity. Internships projects should include mainly Mechanical
		Engineering but can be multi-disciplinary too.
	2.	The internship project may be a complete hardware or a combination of hardware and software. The
	4.11	software part in the project should be less than 50% of the total work.

- Internship project should cater to a small system required in laboratory or real life.
- 4. It should encompass components, devices etc. with which functional familiarity is introduced.
- 5. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title define the aim & objectives of the internship project.
- 6. Students are expected to detail out specifications, methodology, resources required, critical issues Coep Tech U involved in design and implementation and submit the proposal within the first week of the semester.
 - The student is expected to exert on design, development and testing of the proposed work as per the schedule.
- COED Tech 8. Completed internship project and documentation in the form of project report is to be submitted at Coep Tech U the end of semester. Tech University Coep Tech University Coep Tech University

Coep Tech University Coep Tech U Course: Project – Ich University Coep Tech

chi	Course Code	MRAIELC508	Scheme of Evaluation	MSE & ESE
chl	Teaching Plan	0-0-4-0	Term Work	CIE: 100
a chai	Credits	2	Oral Exam	CIE: 100

Course Outcomes:

oep Tech University Coep Tech Univers Students who successfully complete this course will have an ability to:

- Compute 1. Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.
 - Design, implement and test the prototype/algorithm in order to solve the conceived problem. 2.
- 3. Improve knowledge and skills by engaging with the project and its various components (research, Coep Tech analysis, design, implementation), students gain knowledge and skills specific to the project topic.
- 4. Develop project management skills by planning, organization, and time management skills crucial for completing the project.
- 5. Write a comprehensive report on project work.

- Coep TeGuidelines: rsity Coep Tech University Coep Tech University Coep Tech Univers The project is a team activity having 3-4 students in a team. Projects should include mainly Mechanical Coep Teci Engineering but can be multi-disciplinary too.
- 2. The project may be a complete hardware or a combination of hardware and software. The software part in the project should be less than 50% of the total work.
 - Project should cater to a small system required in laboratory or real life.
- 4. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the
- student shall identify the title define the aim and objectives of the project.

Students are expected to detail out specifications, methodology, resources required, critical issues involved Coep Tech

BTech (R&AI) Mechanical Engg. Dept. COEP Tech 46/90

in design and implementation and submit the proposal within the first week of the semester.

6. The student is expected to exert on design, development and testing of the proposed work as per the Coep schedule.

schedule.7. Completed project and documentation in the form of project report is to be submitted at the end of semester.

NOTE: - Students shall plan Project – I, Project – II and Project – III such a way that a single themebased software or hardware can be developed as <u>design, literature review and prototypes</u> in **Project** – *I*, improved design and improved prototype in **Project – II** and final version of completely developed prototype with various associated simulations and performance analysis in Project – III.

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Coep Tech University Coep Tech University Coep Tech University Coep Tech Univers Coep Tech University Coep Tech U Semester -VI h University Coep Tech University

Coep Tech University Coep T Course: Kinematics & Dynamics

Course Code	MRAIPCC601	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	4-0-0-0	Mid Semester Exam	areiny 30 en Te
Credits	4	Teachers' Assessment	20
University Gu	ep lecit offisers	End Sem Exam	50

Course Outcomes:

Students who successfully complete this course will have demonstrated an ability to:

- Comparison 1. Understand the fundamental concepts and terminologies related to the kinematics and dynamics of robotic systems.
- 2. Derive and analyze the forward and inverse kinematics equations for robot manipulators.
- 3. Analyze and calculate the velocity and acceleration of robot manipulators using the Jacobian matrix and related methods.
- 4. Comprehend the concept of robot dynamics, including the motion equations and the Newton-CoepTech U Euler equations.epTech University CoepTech University CoepTech Univers
 - 5. Understand the concept of robot control and its relationship with kinematics and dynamics.

Syllabus:

ep Te Unit	niversity Coep Tech University Coep Tech University Co	Lecture
ep Tech Ui	Introduction of the Children Sity Coep tech University Co	ep Tec
ep Tech ¹ Ui	Basic concepts of linear algebra and feedback control, Rigid bodies and homogeneous transformations, Robot modelling	6 Hrs
p Tech Ui	Forward Kinematics	ep lec
p Tech Ui p Tech Ui	Direct kinematics, Dot and cross products, Co-ordinate frames, Rotations, Homogeneous Coordinates, Link coordinates, D- H Representation, Arm equation, Two axis, three axis, four axis, five axis and six axis robots,	6 Hrs
ep Tech Ui	Forward kinematics problem	ep Tec
ep Tech Ui ep Tech Ui	Inverse Kinematics Inverse Kinematic problem, General properties of solutions, Tool configuration, Inverse Kinematics of Two axis Three axis, Four axis and	6 Hrs
ep Tech Ur	Five axis robots.	ep Tec
ep Tech ₄ Ui ep Tech Ui	Trajectory planning Trajectory planning, Geometric Jacobian / Analytical Jacobian, Singularities and redundancy, Inverse kinematics algorithms, Statics and manipulable, Kinematic solutions and trajectory planning.	6 Hrs
p Tech Ui	Robot dynamics	ер Тес
p Tech Ui p Tech Ui	Forward Dynamics and Inverse Dynamics – Importance Spatial description and transformations – Different types of dynamic formulation schemes –Lagrangian formulation for equation of motion for	
ep Tech Ui	robots and manipulators. Properties of the dynamic model, Dynamic model of simple manipulator structures, Dynamic parameters identification,	ep Tec
ep lech Ui	Operational space dynamics model, Differential kinematics.	ep lec
ep Tech Ui	Dynamic Modeling ech University Coep Tech University Co	ep Teci
ep Tecl 6 Ui ep Tech Ui	Modeling of motion of robots and manipulators using Newton – Euler equations – State space representation of equation of motion and system properties	6 Hrs
7	Simulation	6 Hrs

COEP Tech48/90BTech (R&AI) Mechanical Engg. Dept.

oep Tech L	Importance of Simulation and its types – Numeric Integration solvers and their role in numeric simulation - Numeric simulation of robots and manipulators using MATLAB / Simulink module.	oep Tech
oep Tech L oep Tech L oep Tech L	Introduction to Robot Control Introduction – Need and types of control schemes for robots – joint space control schemes with an example – task space control schemes with an example.	6 Hrs

Suggested learning resources:

Textbooks:

- 1. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019).
- 2. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014).
 - 3. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006).
- 4. J. J. Craig, "Introduction to Robotics: Mechanics and Control", 3rd edition, Addison- Wesley (2003)

Coep Te Reference Books: Coep Tech University Coep Tech University Coep Tech Univers

- 1. Siciliano, Bruno. Robotics: modelling, planning and control (online). London: Springer, 2009.
 - 2. Corke, Peter I. Robotics, vision and control: fundamental algorithms in Matlab. 1st ed. New York:
- Springer, 2011. ISBN 978- 3-642-20143-1.
- Kelly R, Santibanez V and Loria A, —Control of Robot M inanipulators in Joint Spacel, Springer, 2005.
- 4. Devendra K Chaturvedi, —Modeling and Simulation of Systems using MATLAB and Simulink,
- Coep Tech CRC press, 2010 oep Tech University Coep Tech University Coep Tech Univers

Coep Tech University Coep Te Course: Robot Simulation Lab iversity Coep Tech Univers

Course Code	MRAIPCC602	Scheme of Evaluation	MSE TA& ESE	
Teaching Plan	1-0-2-2	Mid Semester Exam	ersity Coep Teo	
Credits	Soon Tools Hutter	Teachers' Assessment	CIE: 100	
i oniversity (boep teen oniver	End Sem Exam	ersity coep rec	

Course Outcomes:

Students who successfully complete this course will have an ability to:

- COED Tech 1. Employ MATLAB for robot modeling & control (programming basics, Simulink).
 - Simulate robots (mobile/manipulator), design control (path planning, sensors).
 - 3. Analyze robot performance in simulations (motion, interaction, visualization).
- 4. Implement advanced control methods (multi-robot systems, reinforcement learning).
- 5. Utilize Gazebo for high-fidelity robot simulation environments.
 - p Te^{Syllabus:}versity Coep Tech University Coep Tech University Coep Tech Univers

Coep Te	Unit	niversity Coep Tech Uni Contents Coep Tech University Co	Lecture	Ur
Coep Te	ch Ui	Introduction to MATLAB:	ep Tech	Ur
Соер Те		MATLAB programming basics (variables, data structures, control flow) Introduction to Simulink, SimMechanics & Simscape	ep Tech	10.00
Соер Те	ch Ui	Creating robot models using Simulink blocks	6 Ura	Ur
Соер Те	1	Defining robot parameters (link lengths, masses, inertias) Setting up robot joints and actuators		Ur
Coep Te		Simulink environment for modeling dynamic systems	ep Tech	Ur
Coep Te	ob U	Various options & tools available in MATLAB Robotics System Toolbox.	on Tooh	THE
Coep Te		Robot Simulation and Analysis: Simulating robot motion in various environments Introducing sensors and sensor simulation (e.g., ultrasonic sensors, cameras)	6 Hrs	Un

COEP Tech49/90BTech (R&AI) Mechanical Engg. Dept.

Coep le ch U	Simulating robot interactions with objects	00	eb	lecn	Unive	
Coep Tech U	Performance analysis and visualization of simulation results		ep		Unive	
Coop Tech II	Advanced Topics:		an		Unive	
coep lech o	Multi-robot systems and coordination		ch		Onive	
Coep Tech U	Learning control for robots (reinforcement learning)		ep		Unive	
Coep Tech U	Gazebo co-simulation for high-fidelity environments	Cr	an	Tech	Unive	

Suggested learning resources:

Textbooks:

(books: 1. Robotics, Modeling, Planning and Control by Bruno Siciliano

Reference Books:

- 1. Robotics and Control: Fundamental Algorithms in MATLAB by Peter Corke
- 2. Modeling, Simulation and Control of Robotic Systems (2nd Edition, 2023) by Niku Hedayat
- 3. MATLAB for Engineers and Scientists (9th Edition, 2023) by Adrian Stern

Course Code	MRAIPCC602-L	Scheme of Evaluation	MSE & ESE
Teaching Plan	1-0-2-2	Term Work	50
Credits	ep Tech Univers	Oral Exam	50

Course: Robot Simulation Laboratory

Coep Te Course Outcomes: Coep Tech University Coep Tech University Coep Tech University

Students who successfully complete this course will have an ability to:

- Students will develop a solid understanding of dynamic modeling principles for simple mechanical systems using MATLAB.
- Through numerical simulation experiments, students will acquire skills in simulating and analyzing the behavior of simple mechanical systems, enabling them to predict system responses and identify dynamic characteristics.
- 3. Students will learn how to analyze the stability of simple mechanical systems using linear system theory techniques
- developing state space models and performing dynamic simulations using Simulink, students will gain familiarity with state space representation and simulation techniques.

Course Contents: Assignments / Practical based on: Any Six

Expt. No. Coep Tech Un Contents Coep Tech University		Contact Hours
ch Ui ch ¹ Ui	Dynamic model development and simulation of simple mechanical systems using Matlab and Mathematical.	3 Hrs
2	Numerical simulation of simple mechanical systems.	3 Hrs
cl3Ui	Stability analysis of simple mechanical systems using linear system theory namely root locus and Bode plot.	3 Hrs
4	State space model development and dynamic simulation using Simulink.	3 Hrs
c15Ui	Implement dynamic simulations of robot systems using Simulink, focusing on state space representation and control system design.	3 Hrs
6	Explore different robot configurations (e.g., manipulators, mobile robots) and study their motion characteristics under varying conditions.	3 Hrs
ch 7 Ui	Develop simulations of sensor fusion algorithms for integrating data from multiple sensors (e.g., cameras, LiDAR, IMU) on robots	3 Hrs
8	Simulate the execution of the pick-and-place task and analyze the robot's performance in completing the task.	3 Hrs

COEP Tech50/90BTech (R&AI) Mechanical Engg. Dept.

Suggested learning resources: Textbooks: 1. Robotics, Modeling, Planning and Control by Bruno Siciliano

Coep Te Reference Books: Coep Tech University Coep Tech University Coep Tech Univers

1. Robotics and Control: Fundamental Algorithms in MATLAB by Peter Corke

2. Modeling, Simulation and Control of Robotic Systems(2nd Edition, 2023) by Niku Hedayat

3. MATLAB for Engineers and Scientists (9th Edition, 2023) by Adrian Stern

Course: Microcontrollers & It's Applications

Course Code	MRAIPCC603	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-2-2	Mid Semester Exam	ersity 30 ep 1
Credits	ep Tech ³ Univers	Teachers' Assessment	20 en T
L Hallman R. C.	and the set of the first second	End Sem Exam	50

Course Outcomes:

Students who successfully complete this course will have an ability to:

- 1. Comprehend and analyze architectures of microprocessors, microcontroller and ARM7 processor
- 2. Comprehend the memory organization of 8051 microcontroller
 - 3. Comprehend and use peripheral serial communication and the concepts of interrupts in 8051
- Coep Tech University Coep Tech University Coep Tech University Coep Tech Univer
- 4. Interface 8051 microcontroller with the input and output devices such as LEDs, LCDs, 7- segment display and keypad
- 5. Design 8051 microcontroller based system with analog-to-digital converters and digital-to- analog converters within realistic constraints like user specification, availability of components etc.

Syllabus:

Oep Te Unit	niversity Coep Tech Uni Contents Coep Tech University Co	Lecture
oep Tech U	Fundamentals of Microprocessors	ep Tecl
	Fundamentals of Microprocessor architecture, 8-bitMicroprocessor and	
oep Tech U	Microcontroller architecture, comparison of 8-bit microcontrollers, 16-bit	6 Hrs
oep Tech U	and 32-bit microcontrollers, definition of embedded system and its	iep Tecl
	characteristics, role of microcontrollers in embedded Systems, overview of	
oep Tech U	the 8051 family, introduction to ARM7, Intel I (i3, i5, i7) series processors.	lep leci
oep Tech U	The 8051 Architecture	ep Tecl
	Internal Block Diagram, CPU, ALU, address, data and control bus, Working	
oep Tecl ₂ U	registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer,	6 Hrs
oep Tech U	Program Counter, I/O ports, RAM- ROM organization, Memory Structures,	ep Tecl
and To Lat	Data and Program Memory, Timing diagrams and Machine Cycles.	
oep Te ch U	Instruction Set	leb leci
oep Tech U	Addressing modes: Instruction syntax, Data types, Subroutines Immediate	ep Tecl
oep Tech U	addressing, Register addressing, Direct addressing, Indirect addressing,	on Tool
oep lech o	Relative addressing, Indexed addressing, Bit inherent addressing, bit direct	lep leci
oep Tech U	addressing, 8051 Instruction set, Instruction timings, Data transfer	ep Tecl
oep Tech ³ U	instructions, Arithmetic instructions, Logical instructions, Branch	6 Hrs
beh lecit of	instructions, Subroutine instructions, Bit manipulation instruction,	leb leci
oep Tech U	Interrupts. Coep Tech University Coep Tech University Co	ep Tecl
oep Tech U	Programming	on Tool
och lecil o	Assembly language programs, C language programs, Assemblers and	ch leci
oep Tech U	compilers, Programming and debugging tools.	ep Tech
	I/O and External Communication Interface:	6 Hrs

COEP Tech 51/90 BTech (R&AI) Mechanical Engg. Dept.

oep Te	Memory and	I/O expansion buses	control signals, memory w	vait states.	ch Uni
pep Te			ich as General Purpose I/	distance with the second second	ch Uni
ер Те		INTEL MALITURIAN STREET	Synchronous and Asynon, RS232, SPI, I2C. Introdu	nchronous action and	ch Uni
ер Те			h and Zig-bee		ch Uni
ер Те	Applications LED, LCD an		Stepper motor interfacing, 1		0.020.0
ер Те			log-to-Digital Convertors, 1	Digital-to-	ch Uni
ep Te	Analog Conve	ertors, Sensors with Sigr	nal conditioning Interface.	ersity Coep Ter	ch Uni
ep Te	Suggested learning re	esources:			
	Systems: Using 2. K. J. Ayala, "8 3. R. Kamal, "Em 4. R. S. Gaonkar, Penram Interna 5. D. A. Patters Hardware/Softw	g Assembly and C", Pear 3051 Microcontroller", 7 abedded System", McGr ", Microprocessor Archi ational Publishing, 1996 son and J. H. Henr ware interface", Morgan	McKinlay, "The 8051 Mich rson Education, 2007. Delmar Cengage Learning, 2 raw Hill Education, 2009. itecture: Programming and A nessy, "Computer Organiz h Kaufman Publishers, 2013. acing", McGraw Hill Higher	2004. Applications with the zation and Design	: 8085",
ep Te	Reference Books: 1. Kenneth J. Aya Penram Interna	ala, "The 8051 Microcor	ntroller Architecture, Program	mming & Applicatio	ch Uni
		mbedded Systems: Arch , 2008.	itecture, Programming and l	ersity Coep Te	aw-
ep Te ep Te ep Te	 Raj Kamal, "En Hill Education, 	mbedded Systems: Arch 2008. Course: Microcontrol	lers & It's Applications La	boratory	aw-
ep Te ep Te ep Te ep Te	2. Raj Kamal, "Er	mbedded Systems: Arch , 2008.	ity Coep Tech Unive	ersity Coep Te	aw-

Course Outcomes:

Students who successfully complete this course will have an ability to:

1. Understand and apply the fundamentals of assembly level programming of microprocessors and microcontrollers.

 Work with microcontroller real time interfaces including GPIO, serial ports, digital-to- analog converters and analog-to-digital converters.

3. Analyze problems and apply a combination of hardware and software to address the problem.

Course Contents: Assignments / Practical based on: Any Six

Expt. No.	niversity Coep Tech UniContents Coep Tech University C	Contact Hours
ep Tech U ep Tech U	Assignment exploiting the various addressing modes for accessing internal as well as external memory and unconditional/conditional branch, loop control instructions.	3 Hrs
	Stack and Stack arithmetic operations, Subroutines and parameter passing via register, stack.	3 Hrs
ep Tecl3U	Seven-Segment Display: Drive a seven-segment display to show numbers or characters.	3 Hrs

COEP Tech52/90BTech (R&AI) Mechanical Engg. Dept.

oep Te ch U	Design a program to display a running counter, temperature reading (if	oep leci
oep Tech U	interfaced with a sensor), or custom message.	oep Tec
oep Tech U	UART Communication:	oep Tecl
oep Tech ₄ U	Set up communication between two microcontrollers using UART (Universal Asynchronous Receiver Transmitter).	3 Hrs
oep Tech U oep Te <u>ch U</u>	Write code to transmit and receive simple data (characters, sensor readings) between the microcontrollers.	oep Tec oep Tec
oep Tech U	PWM Signal Generation: Implement Pulse Width Modulation (PWM) to control the brightness of	оер Тес
oep Teci5U	an LED or the speed of a DC motor.	3 Hrs
oep Tech U	Program the microcontroller to generate different PWM duty cycles for varied LED brightness or motor speeds.	оер Тес
oep Te <mark>ch U</mark>	Interfacing – Push buttons LEDs Key Matrix Seven segment display LCD ADC/DAC Stepper motor	3 Hrs
oep Te <mark>ch U</mark>	Line Follower Robot: Build a line follower robot using a microcontroller, sensors (e.g., infrared	оер Тес
pep Tech ₇ U	sensors), and motors.	3 Hrs
ep Tech U	Program the robot to follow a black line on a white surface using sensor	оер Тес
ep Tech U	feedback and motor control.	oep Tec
ep Tech U	Data Logging System: Interface a microcontroller with an SD card or external memory to log	оер Тес
pep Tecl8U	sensor data (temperature, humidity) at regular intervals.	3 Hrs
oep Tech U Dep Te ch U	Program the system to collect and store sensor readings for later analysis on a computer.	oep Tec

Coep Tech University Coep Course: Robot Safety & Maintenance

Course Code	MRAIPCC604	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	2-0-0-1	Mid Semester Exam	30
Credits	2	Teachers' Assessment	20
ch University Co	ep Tech Univers	End Sem Exam	50

Coep Te Course Outcomes: Coep Tech University Coep Tech University Coep Tech University

Students who successfully complete this course will have an ability to:

- 1. Understand the safety factors of robots.
- Understand the safety factors of robots.
 Know the safety standards in case of Robots.
- 3. Understand the concept of how to do maintenance.
 - 4. Analyze and rectify the Human errors causing accidents.

Syllabus:

Unit	Contents	Lecture
e ch U ech U ech U ech U	Introduction to Robot Safety Introduction, Safety-Related Terms and Definitions, Organizations Concerned with Safety, Introduction, Robotic Safety Problems and Hazards, Use of Robots to Promote Safety, Weak Points in Planning and Design, \Operations Causing Safety Problems, The Manufacturer's and User's Role in Robot Safety, Safety Considerations in Robot Design, Installation, Programming, and Operation and Maintenance, Robot Safeguard Methods. Robot Accidents	ep Tech 6 Hrs 6 Tech ep Tech
ech U	niversity Coep Tech University Coep Tech University Co	ep Tech
	53/90 BTech (R&AI) Mo	

Coep Tech University Coep Tech L	Iniversity Coep Tech University Co	ep Tech	
Introduction. Real-Life Exa	mples of Robot Accidents Robot Accidents in	on Toola	
	the United States Causes and Characteristics of	ep Tech	
LADRED INCLUDED AND ADDRED AND ADDRED THE LITE	Robot Accidents and Periods Off Work Due to cidents at Manufacturer and User Sites Robot	ep Tech	
Accident Analysis and Preve		ep Tech	
Robot Safety and Safety de		ep Tech	Unive
The set of	Education, Safety Considerations in Robot	on Tech	
C il i D l	Commissioning, and Acceptance, Safety	1. S. C. S.	
Coop is printered and the set	Welding Operations, Robot Safety in the	ep Tech	
	ing Grippers of Industrial Robots Not Dropping n Experiencing Energy Loss or Not Gripping on	ep Tech	
The wing work items when	t Standardization and Safety Standards, , Safety	on Toch	Unive
Devices STOP type of a	Robot, Emergency Stop, Mode select switch,	ep recil	
L'AAB LAAB LINDIAKARU L'AAB LAAB	ls, Operation inside of the safety fence, Safety	6 Hrs	
	safety fence Coep Tech University Co	ep Tech	
Robot Maintenance	Iniversity Coop Tech University Co		Unive
	tenance Functions and Types of Maintenance,	eh tecu	
	and Types, Robot Parts and Special Tools for	ep Tech	
	Robot Warranty Coverage and Preventive	ep Tech	
Maintenance Kits, Robot I	nspection, Some Guidelines for Safeguarding	1.0	
Robot Maintenance Personn Maintenance.	nel, Some Models Useful in Performing Robot	ep Tech	
Human Factors in Robotic	Iniversity Coop Tech University Co	ep Tech	
	s Humans, Human Factors' Issues During the	ep Tech	
Fastary Integration of Daha	tic Systems, Built-In Human Biases and Some	on Tools	
Design Improvement Guidel	ines for Improving Robot Operator Comfort and	ep recn	
Productivity, Benefits and I	Drawbacks of Robotization from the Standpoint	6 Hrs	
of Human Factors and Rules	s of Robotics with Respect to Humans, Humans	-	
at Risk from Robots and Gu	idelines for Safeguarding the Operator and the		
	Considerations to Robotic Safety, Training for	ep lech	
	Robotics and Human Error Data in Robotics,	ep Tech	
Cash Ta	bot System with Human Error	ep Tech	
Burety Standards for Robo	ards for Robots, Safety management system,	an Taab	
	analysis and Evaluation, Audit Programme,	ep Tech	
L'AOB IOSB I DIMORSINI L'AOB IOSB I	f Robots, Accident Prevention Techniques,	6 Hrs	
	dling, Safety management and management	ep Tech	
principles, Major accident	control, Safety Training, Robotics Safety	ep Tech	
Requirements.	hiversity coep recir oniversity co		
Suggested learning resources:	Iniversity Coep Tech University Co		
Reference Books:			
Coep Tech 1. Robot Reliability and Safety,	by B.S.Dhillon, 2015 Tech University Co		
2. Industrial Robotics - Technology	ogy, Programming and Applications, by Nicholas		
5. Industrial Robotics, written G			
	Course: Data Science		onive

Course Code	MRAIPCC605	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-2	Mid Semester Exam	30
Credits	ep Tech3Univers	Teachers' Assessment	20 0 1
ch University Co	on Toch Univer	End Sem Exam	50

COEP Tech 54/90 BTech (R&AI) Mechanical Engg. Dept.

 Course Outcomes:
 Students who successfully complete this course will have an ability to:

 1. Work with a data science platform and its analysis techniques.

 2. Design efficient algorithms for mining the data from large volumes.

 3. Model a framework for Human Activity Recognition.

 4. Development with cloud databases.

 Syllabus:

 Unit
 Contents
 Lecture

Unit	Contents	Lecture
	Introduction to Data Science	op iou
p Tech U	Introduction to Data Science - Applications - Data Science Process -	
p Tech U	Exploratory Data analysis - Collection of data, Graphical presentation of	
Tooliti	data - Classification of data - Storage and retrieval of data - Big data -	6 Hrs
p Tech U	Challenges of Conventional Systems - Web Data - Evolution Of Analytic	0 1113
p Tech U	Scalability - Analytic Processes and Tools - Analysis vs Reporting - Modern	
p Tech U	Data Analytic Tools - Statistical Concepts: Sampling Distributions - Re-	
p leun of	Sampling - Statistical Inference - Prediction Error.	op ice
p Tech U	Predictive Modeling and Machine Learning	
p Tech U	Linear Regression – Polynomial Regression, Multivariate Regression,	
	Multilevel Models – Data Warehousing Overview, Bias/Variance Trade Off,	
	K Fold Cross Validation – Data Cleaning and Normalization ,Cleaning Web	6 Hrs
p Tech U	Log Data – Normalizing Numerical Data, Detecting Outliers, Introduction	
n Teels III	to Supervised And Unsupervised Learning, Reinforcement Learning,	
p rech U	Dealing with Real World Data – Machine Learning Algorithms, Clustering,	
p Te <mark>ch U</mark>	Python Based Application.	ep Teo
p Tech U	Data Mining Techniques Rule Induction - Neural Networks: Learning and Generalization -	
p roon or	Competitive Learning - Principal Component Analysis and Neural Networks	
p lech U	- Fuzzy Logic: Extracting Fuzzy Models from Data - Fuzzy Decision Trees	6 Hrs
p Tech U	- Stochastic Search Methods- Neuro-Fuzzy Modeling – Association rule	ep Tec
n Tech III	mining – Clustering – Outlier Analysis – Sequential Pattern Mining –	
p lech U	Temporal mining – Spatial mining – Web min	eh leo
p Tech U	Frameworks And Visualization	ер Тес
p Tech U	Map Reduce - Hadoop, Hive, MapR - Sharding - NoSQL Databases -	
4	Cloud databases - S3 - Hadoop Distributed File Systems - Visualizations -	6 Hrs
p lech U	Visual Data Analysis Techniques - Interaction Techniques - Social Network	
p Tech U	Analysis – Collective Inferencing – Egonets - Systems and Applications.	ep Tec
n Tech U	Data Science Using Python	
p lech o	Introduction to Essential Data Science Packages: NumPy, SciPy, Jupyter,	
p Tech ₅ U	Stats models and Pandas Package - Data Munging: Introduction to Data	6 Hrs
p Tech U	Munging, Data Pipeline and Machine Learning in Python – Data	ep Tec
10 10 10 10 10 10 10 10 10 10 10 10 10 1	Visualization Using Matplotlib – Interactive Visualization with Advanced	
p Tech U		ep Tec
p Tech U	Natural Language Processing	
	Introduction to Human language models, ambiguity, processing paradigms;	
p TechoU	Phases in natural language processing, applications. Text representation in	6 Hrs
p Tech U	computers, encoding schemes. Ambiguity in Natural Language: Types of	
	ambiguity: lexical, syntactic, semantic. Processing Paradigms in NLP: Rule-	on Too

COEP Tech 55/90 BTech (R&AI) Mechanical Engg. Dept.

Coep Tech University Coep Tech University Coep Tech University Coep Tech Univer
Coep Tech University Coep Tech University Coep Tech University Coep Tech University
based systems. Applications of NLP: Sentiment analysis, Text classification and clustering, Named Entity Recognition (NER), Machine Translation
Coep Te Suggested learning resources:
Coep Tetextbooks: "Sity Coep Tech University Coep Tech University Coep Tech Univer
 Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
3. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
4. Jawei Han, Wienenne Kanoer Data Winning Concepts and Teeninques, Second Lettion,
 Elsevier, Reprinted 2008. 5. Rachel Schutt, Cathy O'Neil, "Doing Data Science", O'Reilly Publishers, 2013. 6. Foster Provost, Tom Fawcet, "Data Science for Business", O'Reilly Publishers, 2013.
7. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2014.
8. S. N. Sivanandam, S. N Deepa, "Introduction to Neural Networks Using Matlab 6.0", Tata
 McGraw- Hill E ducation, 2006. 9. Frank Pane, "Hands On Data Science and Python Machine Learning", Packt Publishers, 2017.
Coep Tech 10. Seema Acharya, Subhashini Chellapan, "Big Data and Analytics", Wiley, 2015.
Coep Tech University CCourse: Seminar on recent advances in R & AI Coep Tech Univer
Course Code MRAIPCC606 Scheme of Evaluation MSE & ESE
Teaching Plan 0-0-2-0 Term Work 50

Course Outcomes:

Credits

Students who successfully complete this course will have an ability to:

1

1. Gain a comprehensive understanding of the latest breakthroughs and research directions in

Oral Exam

50

- both R (Research) methodologies and AI (Artificial Intelligence) applications.
- 2. Exposed to diverse areas of R & AI, including new research tools, cutting-edge AI Coep Tech U
 - algorithms, and their practical applications in various fields.
- 3. Foster critical thinking skills by encouraging participants to evaluate the potential impact, ethical considerations, and limitations of recent advancements in R & AI.

Course Contents: Seminar by every student as per the guideline below

Seminar Format:

- Composed 1. Each student will present on a chosen topic related to recent advances in R (Research) and AI.
- 2. Presentations should be clear, concise, and engaging, targeting a broad audience (may include students from other disciplines).

3. Aim for a presentation length of 20-25 minutes, followed by a 5–10 minute discussion period. Choosing a Topic:

- 1. Focus on recent advancements within the last 1-2 years.
- Complete 2. Consider potential areas of overlap between R and AI, such as:
 - 3. Explainable AI (XAI) and its role in research transparency.
 - Utilizing AI for large-scale data analysis in research projects.
- 5. Emerging AI applications in specific research fields (e.g., drug discovery, medical imaging analysis). Coep Tech L analysis).6. Ethical considerations of using AI in research methodologies.
- COMPLET 7. Ensure your chosen topic has sufficient depth for a 20-minute presentation while remaining understandable to a broad audience.

BTech (R&AI) Mechanical Engg. Dept. COEP Tech 56/90

Coep Tech University Coep Tech University Coep Tech University Coep Tech University

1. Provide a brief introduction to the relevant background and existing knowledge in your chosen

area. 2. Clearly explain the recent advancements you're focusing on, highlighting key findings, methodologies, or applications.

3. Use visuals (diagrams, graphs, images) to enhance your explanation and audience understanding.

4. Discuss the potential impact of these advancements on research and AI as a whole.

5. Briefly touch on any limitations, challenges, or ethical considerations surrounding the topic.

Course: Arial Robotics Programming Laboratory

Course Code	MRAIVSEC607-L	Scheme of Evaluation	MSE & ESE
Teaching Plan	0-0-2-0	Term Work	ersity 50 ep T
Credits	en TechlUnivers	Oral Exam	50 on T

Course Contents: Assignments / Practical based on

Detailed Content: Any six experiments / assignments from the list below (For Total Min. 24 Hours)

Expt. No.	niversity Coep Tech UniContents Coep Tech University C	Contact Hours
ch Ur ch Ur ch Ur	Introduction to Drone Technology Lab Overview of the lab equipment and safety protocols Introduction to basic drone components (frame, motors, flight controller) Familiarization with tools and software used in the lab	4 Hrs
ch Ui	Drone Assembly and Disassembly	оер Тес
2 U	Step-by-step assembly of a drone kit in Coep Tech University C	
ch Ur	Understanding the purpose and function of each component Disassembly of the drone for maintenance and troubleshooting	oep Tec
sh ₃ Ui sh Ui	Flight Controller Configuration Introduction to flight controller software (e.g., Betaflight, Ardupilot) Basic configuration and calibration of the flight controller	4 Hrs
ch Ur ch Ur ch Ur	Basic Flight Maneuvers Practice basic flight maneuvers such as takeoff, landing, and hovering Introduction to different flight modes (e.g., stabilized, acro) Understanding control inputs (pitch, roll, yaw)	oeo Teo 9 4 Hrs
sh Ur si5Ur sh Ur	Autonomous Flight Introduction to autonomous flight modes (e.g., GPS-assisted flight) Planning and executing autonomous missions using mission planning software Understanding geofencing and no-fly zones	4 Hrs
sh Ui sh ₆ Ui sh Ui	Payload Integration Introduction to different types of payloads (e.g., cameras, sensors) Mounting and integrating payloads onto the drone Testing payload functionality in flight	4 1115
ch Ur ch Ur ch Ur ch Ur	Practice advanced flight maneuvers such as banked turns, figure-eight patterns	and the second sec
8	Drone Maintenance and Repair	4 Hrs

	Tech	Routine mainte	enance tasks (cleaning,	propeller replacement, batt	ery care)
	Tech			non issues (motor failure, G	
	Tech	loss) Repairing and	replacing damaged com	ponents	ersity Coep Tech Unive
	Tech	Data Collection	1 0 0	ity Coep Tech Univ	ersity Coep Tech Univer
	Tech	Introduction t mapping)	o data collection tech	hniques (e.g., aerial pho	crondy occup recompanie
	Tech	Processing and	l analyzing data collecte	ed by drones	ersity Co. ^{4 Hrs} ech Univer
	Tech	Applications o	f drone-collected data in	a vianiava in duratniaa	ersity Coep Tech Unive
	Ref	ference Books:	ep Tech Univers	ity Coep Tech Univ	ersity Coep Tech Unive
	Tech	I have been the state of the	wn Drone Manual: Th	ne practical guide to safe	ly building, operating and
		maintaining an Publishing	Unmanned Aerial Veh	icle (UAV), by Alex Elio	tt, 2016, Publisher: Haynes
			UAV Systems, by Pau	l Fahlstrom and Thomas (Gleason, 2012, CreateSpace
					ersity Coep Tech Univer
		3. Quadcopter and	Drone Photography: H Eric Cheng, 2014, Peac	low to Bring Your Photog	raphy or Videography to the
				1	Your Own Drones, by Ian
Coen				Fraw-Hill Education TAB	
					nd Hesham ElSayed, 2019,
					ersity Coep Tech Unive
			ed Aircraft: Theory and I University Press	Practice, by Randal W. Bea	rd and Timothy W. McLain,
				oy Brian Halliday, 2016, W	5
				Jsing Drones, by Eric Cher s, and Applications, by K	ng, 2015, Peachpit Press evin Downing, 2020, Nova
		Science Publish	ers	ity Coep Tech Univ	ersity Coep Tech Univer
				Jenkins, 2017, Independen	
			ep Tech U Course	e: Project – II h Univ	
	Tech	Course Code	MRAIELC610	Scheme of Evaluation	MSE & ESE
	Tech	Teaching Plan	0-0-4-2	Term Work	ersity Coop Tech Univer

Course Outcomes:

Credits

Course Outcomes: Students who successfully complete this course will have an ability to:

2

1. Conceive a problem statement either from rigorous literature survey or from the requirements Coep Tech University Coep Tech

Oral Exam

- 2. Design, implement and test the prototype/algorithm in order to solve the conceived problem.
- 3. Improve knowledge and skills by engaging with the project and its various components
- Coep Tech U (research, analysis, design, implementation), students gain knowledge and skills specific to the second states of the secon the project topic.
- 4. Develop project management skills by planning, organization, and time management skills crucial for completing the project.
 - 5. Write a comprehensive report on mini project work.

Guidelines:

coep leciio	The project is a team activity having 3-4 st	tudents in a team. Projects should include mainly
	Mechanical Engineering but can be multi-disci	plinary toolech University Coep Tech Unive
Coep Tech ² .	The project may be a complete hardware or a d	combination of hardware and software. The software
Coep Tech U		Coep Tech University Coep Tech Unive
COEP Tech	58/90	BTech (R&AI) Mechanical Engg. Dept.

part in the project should be less than 50% of the total work.

3. Project should cater to a small system required in laboratory or real life.

It should encompass components, devices etc. with which functional familiarity is introduced.
 After interactions with course coordinator and based on comprehensive literature survey/ need

analysis, the student shall identify the title define the aim and objectives of the project.

6. Students are expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within the first week of the semester.
7. The student is expected to exert on design, development and testing of the proposed work as per the

Tech U schedule. Y Coep Tech University Coep Tech University Coep Tech Un

8. Completed project and documentation in the form of project report is to be submitted at the end of semester.

59/90 BTech (R&AI) Mechanical Engg. Dept. COEP Tech

Complete Interst Course: Advanced Robotics Programming (PEC-III)

Course Code	MRAIPEC701-R	Scheme of Evaluation	MSE TA& ESE
Feaching Plan	3-0-0-0	Mid Semester Exam	ersity 30 en Te
Credits	3	Teachers' Assessment	20
University Go	ep recir onivers	End Sem Exam	50

Course Outcomes:

- Students who successfully complete this course will have an ability to:
- 1. Understand the basic principles of Robotics programming and development.
 - 2. Design real world applications using available software.
- Understand integration technologies and its applications.
- 4. Identify problems in integrating the system / simulations / programming.

Coep TeSyllabus: Jersity Coep Tech University Coep Tech University Coep Tech Univers

oep Te Unit	hiversity Coep Tech Univ <u>Contents</u> Coep Tech University Co	Lecture
oep Tech U	Introduction to ROS	ep Tecl
oep Tech Ur oep Tech Ur	Architectural overview of the Robot Operating System, Framework and setup with ROS environment, ROS workspace structure, essential command line utilities. ROS nodes, topics, services, parameters, actions and launch files. Programming nodes, topics, services, actions with C/C++/Python. Real	e o Tec 7 Hrs
oep lech U	time programming with ROS. Introduction to ROS2	ep lec
bep Te <mark>ch U</mark>	Robot Simulation Engines	ep Teci
oep Tech Ui oep Tech Ui	Physics simulations of Robots with Gazebo, Mujoco and Pybullet C++/Python APIs. Coding the BFS and algorithms in C++. Sample-Based and Probabilistic Path Planning and improvement using the classic approach.	7 Hrs
oep le <u>ch U</u>	Programming in Move it framework. Path Planning and Navigation	ep lec
oep Tech Ui	Introduction to Path Planning and Navigation, Classic Path Planning, Number of classic path planning approaches that can be applied to low-	5 Hrs
oep reen of	dimensional robotic systems.	ch teoi
oep le ch U	Motion Planning, Mapping	ep leci
oep Tech U	Use of the EKF ROS package to a robot to estimate its pose. Monte Carlo	ep Tecl
oep Tech ⁴ Ui	Localization:- The Monte Carlo Localization algorithm which uses particle filters to estimate a robot's pose. Build MCL in C++: - Coding the Monte	6 Hrs
oep lech U	Carlo Localization algorithm in C++.	ep lec
bep Tech U bep Tecl ⁵ U	Simultaneous Localization and Mapping (SLAM): SLAM implementation with ROS2 packages and C++. Combining mapping algorithms with the localization concepts. Introduction to the Mapping and SLAM concepts and algorithms.	6 Hrs
oep Tech U	Occupancy Grid Mapping:	ep lec
oep Tech U	Mapping an environment with the Occupancy Grid Mapping algorithm.	ep Tec
oep Tech U	Grid-based Fast SLAM: - Simultaneous mapping an environment and	ep Teci
oep Tec 16 U	localize a robot relative to the map with the Grid-based Fast SLAM algorithm.	5 Hrs
oep Tech Ui	Concepts of micros, Client library, features of micros, real time operating	
oep Tech U	systems (RTOS- Free RTOS, Zephyr), implementation of micros on ARM/ESP32 based microcontrollers.	
	niversity Coep Tech University Coep Tech University Co	
oep Tech U		
	60/90 BTech (R&AI) Mo	

Suggested learning resources: Reference Text books:

- 1. Aaron Martinez, Enrique Fernandez, "Learning ROS for Robotic Programming", PACKT publishing, 2013 2. Morgan Quigley
 - Morgan Quigley, Brian Gerkey, William D Smart, "Programming Robots with ROS", SPD
- Shroff Publishers and distributors Pvt Ltd., 2016
- 3. Lentin Joseph, "Mastering ROS for Robotics Programming: Design, Build and simulate complex robots using ROS", PACKT publishing, 2013 Coep Tech University

Course: Advanced Artificial Intelligence (PEC-III)

Course Code	MRAIPEC701-A	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	ep Tech3Univers	Teachers' Assessment	20
ech University Co	en Tech Univers	End Sem Exam	50

Coep TeCourse Outcomes: Coep Tech University Coep Tech University Coep Tech Univers

Students who successfully complete this course will have an ability to:

- 1. Explain in detail how the techniques in the perceive-inference-action loop work
- 2. Choose, compare, and apply suitable basic learning algorithms to simple applications
- 3. Explain how deep neural networks are constructed and trained, and apply deep neural networks to work with large scale datasets
- 4. Understand and develop deep reinforcement learning algorithms for suitable applications.

Coep TeSyllabus: versity Coep Tech University Coep Tech University Coep Tech Univers

p Teo	Unit	tiversity Coep Tech University Coep Tech University Co	Lecture
p Te	ch Ui	Probability Theory and Exact Inference	ep Tec
p Teo	ch Ui	Overview of Probability Theory and Bayes Networks. Independence, I-Maps, and Undirected Graphical Models.	5 Hrs
p Te	ch Ui	Local Models and Template Based Representations.	ep lec
	2	Exact Inference Techniques: Variable Elimination and Clique Trees. Belief Propagation Tree Construction.	6 Hrs
p Teo	ch Ui	Introduction to Bayes Networks and Markov Networks.	ep lec
p Teo		Approximate Inference and Optimization	ep Tec
p Te		Introduction to Optimization Techniques.	ep Tec
hier	3	Approximate inference Methods: Sampling and Markov Chains.	6 Hrs
p Teo	ch Ui	MAP Inference and Inference in Temporal Models.	ep lec
p Te		Learning Graphical Models: Parameter Estimation and Bayesian Networks with Shared Parameters.	
p Te	ch Ui	Learning and Decision Making	ep Tec
		Structure Learning and Structure Search in Graphical Models.	
p Teo		Handling Partially Observed Data in Structure Learning.	
p Te	4	Gradient Descent and Expectation-Maximization (EM) Algorithm.	7 Hrs
p Ter		Hidden Variables and Undirected Models.	
		Causality and Utility Functions.	
p Te	ch Ui	Decision Problems and Basics of Utility Theory.	ep Tec
n Te		Decision Theory and Sequential Decision Making	
	5	Introduction to Decision Theory.	6 Hrs
ple	ch Ui	Expected Utility and Value of Information.	ер Тес
p Te		Decision-Making Basics:	
	6	Utility Theory and Sequential Decision Problems.	6 Hrs
p le	en Ui	Elementary Game Theory Concepts.	ep lec

COEP Tech61/90BTech (R&AI) Mechanical Engg. Dept.

Application of Decision Theory in Sample Problems.

Suggested learning resources:

Coep TeText Books: sity Coep Tech University Coep Tech University Coep Tech Univers

1. Russell, S., & Norvig, P. Artificial Intelligence: A Modern Approach, Pearson Education.

Univers

2. Bishop, C. M. Pattern Recognition and Machine Learning, Springer, 2006.

Reference Books:

- 1. Daphne Koller and Nir Friedman probabilistic graphical Models, MIT Press, 2009
- 2. Russell and P. Norvig, Artificial Intelligence
- 3. Cristopher Bishop: pattern Recognition and machine Learning

Course: Micro Electro-Mechanical Systems (PEC-III)

Course Code	MRAIPEC701-M	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	3	Teachers' Assessment	20
ch University Co	ep Tech Univers	End Sem Exam	50 00 1

Coep Te Course Outcomes: Oep Tech University Coep Tech University Coep Tech Univers

Students who successfully complete this course will have demonstrated an ability to:

- 1. Explain MEMS technology and challenges in it.
- 2. Understand and explain micro sensors, micro actuators, their types and applications.
- 3. Explain about fabrication processes for producing micro sensors and actuators.
 - 4. Do material selection appropriately according to fabrication processes

Syllabus:

Unit	Contents	Lecture
	Introduction Overview of MEMS & Microsystems: Definition and history of MEMS Scaling laws and miniaturization effects, Evolution of microsensors, MEMS & microfabrication typical MEMS and Microsystems and miniaturization – applications of Microsystems. Micromachining of novel materials (e.g., polymers, biocompatible materials)	6 Hrs
	MEMS materials Materials demand for Extreme conditions of operation, material property mapping, Processing, strengthening methods, treatment, and properties. Overview of Smart Materials, Structures and Products Technologies Smart Materials (Physical Properties) Piezoelectric Materials, Electro strictive Materials, Magneto strictive Materials, Magneto electric Materials, Magneto rheological Fluids Electro rheological Fluids, Shape Memory Materials, Bio- Materials, metal matrix composites (MMC), their applications in aerospace and automobiles, Superplastic materials	ep Tech ep Tech 7 Hrs ep Tech ep Tech ep Tech
3 U1	MEMS Design Principles Mechanical design considerations (stress, strain, beam mechanics) Electrical design considerations (electrostatics, magnetics) Microfluidic design principles, Micro-Nano Fluidics, MEMS reliability and testing	5 Hrs
4 Ui 4 Ui h Ui	Micro manufacturing/Micro fabrication Preparation of the substrate, Physical Vapor Deposition, Chemical Vapor Deposition, Ion Implantation, Coatings for high temperature performance, Electrochemical and spark discharge and Plasma coating methods, electron	6 Hrs

Coep Tech University Coep Tech University Coep Tech University Coep Tech University

	processing, Organic and Powder coatings, Thermal	ah
barner coating, LIGA pr	ocess	CI1
Micro sensors	h University Coep Tech University Coep Te	ch
	r and Transducer Technologies, Smart Sensors: Sensors; Load Cells; Torque Sensors; Pressure 6 Hrs	ch
Sensors; Microphones; S	Sensor Arrays Micro actuators	ch
Smart Actuators:		
b	s; Force Actuators; Power Actuators; Vibration 6 Hrs	
Dampers; Shakers; micro	o–Fluidic Pumps; micro Motors Smart Transducers:	ch
Ultrasonic Transducers;	Sonic Transducers.	

Suggested learning resources:

Text Books:

- 1. Tai-Ran Hsu, MEMS and Microsystems: Design and Manufacture, Tata McGraw Hill, 2002.
 - 2. A.V. Srinivasan, Smart Structures: Analysis and Design, Cambridge University Press, 2001.

Reference Books:

- 1. M.V. Gandhi and B.S. Thompson, Smart Materials and Structures, Chapman & Hall, London; Coep Tech U New York, 1992. a Tech University Coep Tech University Coep Tech Univers
 - 2. J.H. Westbrook & R.L. Fleischer, Microsensors, MEMS, and Smart Devices by Julian W. Gardner & Vijay K. Varadan, John Wiley & Sons, 2001.
- 3. B. Culshaw, Smart Structures and Materials, Artech House, Boston, 1996.

Coep Tech University Coep Tech I Course: Advanced Control System (PEC-III)

Course Code	MRAIPEC701-M	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	ı 3-0-0-0	Mid Semester Exam	30
Credits	Coep Tech ₃ Univers	Teachers' Assessment	20 00 10
Tech University	Coep Tech Univers	End Sem Exam	ersity 50 en Te

Coep TeCourse Outcomes: Coep Tech University Coep Tech University Coep Tech Univers

Students who successfully complete this course will have an ability to:

- 1. Demonstrate non-linear system behaviour by phase plane and describing function methods
- 2. Perform the stability analysis nonlinear systems by Lyapunov method
- 3. Develop design skills in optimal control problems
- Develop design skills in optimal control problems
 Derive discrete-time mathematical models in both time domain (difference equations, state equations) and z domain (transfer function using z-transform).
- 5. Predict and analyze transient and steady-state responses and stability and sensitivity of both open-loop and closed-loop linear time inversent dispute to and closed-loop linear, time-invariant, discrete-time control systems.
- 6. Acquire knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers. Coep Tech University Coep Tech University Coep Tech

Syllabus:

Unit	Contents	Lecture
ch Ui ch Ui ch Ui	State space analysis state space representation, solution of state equation, state transition matrix, canonical forms – controllable canonical form, observable canonical form, jordan canonical form. Tests for controllability and observability for continuous time, systems – time varying case, minimum energy control, time invariant case,	ep Tec 6 Hrs ep Tec
c 2U	Principle of duality, controllability and observability form jordan canonical form and other canonical forms. Describing function analysis -introduction to nonlinear systems, types of nonlinearities, describing functions,	6 Hrs

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Coep lech U		ep Tech
Coep Tech U	describing function analysis of nonlinear control systems. Phase-plane analysis introduction to phase-plane analysis, method of isoclines.	
Coep Tech U	For constructing trajectories, singular points, phase-plane analysis of nonlinear control systems. Stability analysis stability in the sense of	ep Tech
Coep Tecl3U	lyapunov., lyapunov's stability and lypanov's instability theorems. Direct	6 Hrs
Coep Tech U	method of lyapunov for the linear and nonlinear continuous time autonomous systems.	
Coep Te <mark>ch U</mark>	Modal control effect of state feedback on controllability and observability,	ep leci
Coep Te <mark>ch U</mark> Coep Tecl 4 U	design of state feedback control through pole placement. Full order observer and reduced order observer. Calculus of variations minimization of functionals of single function, constrained minimization. Minimum	6 Hrs
Coep Tech U	principle. Control variable inequality constraints. Control and state variable inequality constraints.	
Coep Te ch U Coep Tech ⁵ U	Euler Lagrange equation. Optimal control formulation of optimal control problem. Minimum time, minimum energy, minimum fuel problems.	6 Hrs
Coep Tecl6U	State regulator problem. Output regulator problem. Tracking problem, continuous-time linear regulators	6 Hrs

Suggested learning resources:

Textbooks:

1. M. Gopal, Digital Control and State Variable Methods, Tata Mc Graw-Hill Companies, 1997.

sity Coep Tech University Coep Tech University Coep Tech Univers

2. M. Gopal Modern Control System Theory, New Age International Publishers, 2nd edition, 1996

Reference Books:

- 1. K. Ogata, "Modern Control Engineering", Prentice Hall of India, 3rd edition, 1998
- Comp Te 2. I.J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International (P) Ltd, 2017
 - Stainslaw H. Zak, "Systems and Control", Oxford Press, 2003. 3.

Course: Biomedical Robotics (PEC-IV)

Course Code	MRAIPEC702-R	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	3	Teachers' Assessment	20
University Co	ep Tech Univers	End Sem Exam	50

Course Outcomes:

- Students who successfully complete this course will have an ability to:
- COEP Tech 1. Identify and describe different types of medical robots and their potential applications
 - 2. Know basic concepts in kinematics, dynamics, and control relevant to medical robotics
- Coep Tech3. Understanding and analyzing biological signals (motion, muscle and brain activity)
- Coep Tech^{4.} Develop the analytical and experimental skills necessary to design and implement robotic assistance for different biomedical applications
- Be familiar with the state of the art in applied medical robotics and medical robotics research Coep Tech5.

Syllabus:

Unit Contents Lecture **Introduction to Robotics** Definition and history of robots Robot classifications (e.g., industrial, service, mobile) Biocompatibility and Safety in Robotics 7 Hrs ch U Biomaterials and their interaction with living tissues Sterilization and disinfection techniques for robots Safety considerations for surgical robots and patient well-being

versity Coep Tech Un ^{64/90} sity Coep Tech COEP Tech BTech (R&AI) Mechanical Engg. Dept.

ep Te <mark>ch U</mark>	Robot Kinematics	Tool Tool
ep Tech U	Introduction to forward kinematics & inverse kinematics	ep leci
ep Tecl2U	Rigid Motions, Homogeneous transformations Forward/Inverse Kinematics	e 6 Hrs
ep Tech U	Jacobian, redundant motions and singularities. Forward/Inverse Dynamics Force/Motion Control	ер Тес
ap Tech U	Biological Robot Control	ep Tec
ep Tecl3U	Biological movement control Robots for biomedical research teleoperation, cooperative manipulation, robots for endoscopy Physical human-robot	6 Hrs
ep Tech U	interaction. Issues in the Control of Prosthetic Limbs	ер Тес
ep Tech U	Surgical Robots Biomimetic systems: Biomimetic robotics Surgery robotics Neuro-Rehabilitation Robotics	ep Tecl
ep Tech U	Prosthetics Assistive robotics soft robotics for biomedical applications.	ep Tec
ep Tech U	Telepresence surgery and its benefits, Haptic feedback technologies for realistic manipulation, Computer vision and image guidance in robotic	6 Hrs
ep Tech U	surgery, Future advancements in robot-assisted surgery	ep Tec
ep Tech U	Ethics in Biomedical Robotics	en Tec
ep Tecl5U	Ethical considerations in surgical decision-making with robots, Human- robot interaction and the role of the surgeon, Job displacement in healthcare	5 Hrs
ep Tech U	due to automation, Access to robotic technologies and healthcare disparities	ep Tec
p Tech U	Medical Applications of Robotics: Minimally Invasive Surgery (MIS): Laparoscopic surgery and robotic-	ер Тес
ep Tech U	assisted laparoscopic surgery (RALS), Robotic arms and instruments for	ер Тес
p TechoU	MIS sity Coep Tech University Coep Tech University Co	6 Hrs
1221 2.422	Rehabilitation Robotics: Exoskeletons for gait training and movement	1.00
p Tech U	assistance, Robotic therapy for stroke and neurological disorders	ep Tec
p Tech U	Assistive Technologies: Robotic prosthetics and orthotics, Surgical robots for joint replacement	ep Tec
Sugge	sted learning resources:	
Text B	niversity Coen Tech University Coep Tech University Co	

2. Peter M. Pilarski, Robotics in Surgery: History, Current, and Future Applications, Springer, 2020.

Coep Tech University Coep Tech University Coep Tech University (

1. Siciliano, B., Sciavicco, L. Villani, L. and Oriolo, "Robotics. Modeling, Planning and Control", Springer. 2009

 Habib, "Handbook of Research on Biomimetics and Biomedical Robotics Advances in Computational Intelligence and Robotics" (2327-0411), Maki Publishers, 2017

Course: Augmented Reality and Virtual Reality (PEC-IV)

Course Code	MRAIPEC702-A	Scheme of Evaluation	MSE TA & ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30
Credits	3 and 18 and 3 and 18	Teachers' Assessment	20
ech University Co	ep Tech Univers	End Sem Exam	ersity 50 ep Te

Coep Te Course Outcomes: Coep Tech University Coep Tech University Coep Tech Univers

Students who successfully complete this course will have an ability to:

1. Understand and analyze the hardware requirement of AR.

Describe AR systems work and list the applications of AR.

3. Understand the design and implementation of the hardware that enables VR systems to be built.

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Explain the concepts of motion and tracking in VR systems.

4. Explain the concepts of motion and tracking in VR systems. Syllabus:

Unit	Contents	Lecture
en u	Introduction to Augmented Reality	ep ieci
ch U	Defining augmented reality, history of augmented reality, The Relationship	ep Tecl
ch U	Between Augmented Reality and Other Technologies-Media,	ep Tecl
1	Technologies, Other Ideas Related to the Spectrum Between Real and	6 Hrs
cn u	Virtual Worlds, applications of augmented reality, Working, Concepts	lep lec
ch U	Related to Augmented Reality, Ingredients of an Augmented Reality	ер Тес
chu	Experience.	en Tec
	Augmented Reality Architecture	
ch U	Audio Displays, Haptic Displays, Visual Displays, Other sensory displays,	ep lec
ch U	Visual Perception, Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture,	6 Hrs
abili	Processor Specifications. Tracking & Sensors - Tracking, Calibration, and	01115
GILO	Registration, Characteristics of Tracking Technology, Stationary Tracking	leh ter
ch U	Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.	ep Tec
ch U	AR Techniques	en Tec
1.1.1	Marker-based approach- Introduction to marker-based tracking, types of	-
cn U	markers, marker camera pose and identification, visual tracking,	ep lec
ch, U	mathematical representation of matrix multiplication Marker types-	en Tec
3	Template markers, 2D barcode markers, imperceptible markers. Marker-	0 Hrs
on o	less approach- Localization based augmentation, real world examples	eb lee
ch U	Tracking methods- Visual tracking, feature based tracking, hybrid tracking,	ep Tec
ch U	and initialisation and recovery	en Tec
1.11	Introduction to Virtual Reality	-
cnu	Defining Virtual Reality, History of VR, Human Physiology and	lep lec
cl4U	Perception, Key Elements of Virtual Reality Experience, Virtual Reality	6 Hrs
ch II	System, Interface to the Virtual World-Input & output- Visual, Aural &	an Tec
UII U	Haptic Displays, Applications of Virtual Reality	tep tec
ch U	Virtual World Motion tracking	ер Тес
ch U	Representation of the Virtual World, Visual Representation in VR, Aural	ep Tec
5	Representation in VR and Haptic Representation in VR, Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System,	6 Um
10 5 U	Physics in the Virtual World, Mismatched Motion and Vection Tracking-	6 Hrs
ch U	Tracking 2D & 3D Orientation, Tracking Position and Orientation,	ep Tec
chill	Tracking Attached Bodies	ep Tec
	Virtual Worlds & Human Vision	Sec.
ch U	Competition Models, Changing Position and Orientation, Axis Angle	ep Tec
6	Representations of Rotation, Viewing Transformations, Chaining the	6 Hrs
a la LL	Transformations, Human Eye, eye movements & implications for VR.	on Too
Sugge	sted learning resources:	tep leu
SULLO	inversity coep recir oniversity coep recir oniversity co	
Textbo	ooks:	
1.	Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2016	
2.	William R Sherman, Alan B Craig, "Understanding Virtual Reality: Interface,	Applicatio
	Design",, "The Morgan Kaufmann Series in Computer Graphics", Mo. Publishers, San Francisco, CA, 2002	rgan Kau
ch3.	Developing Virtual Reality Applications: Foundations of Effective Design	, Alan B
ch U	William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.	
ch U		
	66/90 BTech (R&AI) M	

Reference Books: Coep Tech University Coep Tech University Coep Tech University

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.

2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.

- 3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Merging Real and Virtual Worlds", 2005.4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

Coep Tech University Course: Advanced Mechatronics (PEC-IV)

Course Code	MRAIPEC702-M	Scheme of Evaluation	MSE TA & ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	ersity 30 ep T
Credits	en Tech ³ Univers	Teachers' Assessment	20
		End Sem Exam	50

Course Outcomes: Students who successfully complete this course will have an ability to:

- 1. Acquire knowledge of Mechatronic systems and its design
- 2. Gain Knowledge of Microcontrollers and its operation.
 - 3. Perform experiments on Microcontrollers. ersity Coep Tech University Coep Tech University Coep Tech Univers

Syllabus:

Unit	Contents	Lecture	
als LD	Introduction to Advanced Mechatronics:	an Tee	
	Review of fundamental mechatronic principles, Introduction to advanced		
ch U	mechatronic systems, Applications of advanced mechatronics Introduction	ер Тес	
10	to theoretical and applied mechatronics, design and operation of	7 Hrs	
	mechatronics systems; mechanical, electrical, electronic, and opto-electronic		
	components; sensors and actuators including signal conditioning and power		
h U	electronics	ep Tec	
	Advanced Control Systems:		
2	Robust control design, Adaptive control, Optimal control		
al f Ui	Microcontrollers—fundamentals, programming, and interfacing; and feedback control. Includes structured and term projects in the design and	6 Hrs	
sh U	development of proto-type integrated mechatronic systems.		
1.11	Mechatronic System Design		
	Design methodologies for mechatronic systems, Actuator and sensor		
3	selection, System integration and packaging, Mechatronic System	6 Hrs	
	Simulation and Design		
	Advanced Modelling Techniques	ep rec	
4	Nonlinear system modelling, multi-body system dynamics, Finite element	5 Hrs	
ch Ui	analysis for mechatronics	ep Tec	
-l-11	Microcontroller	- Too	
	Introduction to applications of and hands-on experience with		
	microcontrollers and single-board computers for embedded system		
5	applications. Specifically, gain familiarity with the fundamentals, anatomy,	7 Hrs	
	functionality, programming, interfacing, and protocols for the Arduino		
	microcontroller, multi-core Propeller microcontroller, and single-board		
ab Di	computer Raspberry Pi.	on Too	

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		ns machines and intelligen	-	5 Hrs
Suggested learning r	esources:			
Text Books: 1. Robert H. Bish	op, The Mechatronics H	Iandbook, 3rd Edition, CRC	C Press, 2018	ep Tecl
		undamentals, 2nd Edition,		
Reference Books:				ep Tecl
	Embedded systems Arch	troller Programming and A itecture, Programming and		
Fech University C	Course: Robot Dyna	mics and Control (PE	C-IV)	
Course Code	MRAIPEC702-C	Scheme of Evaluation	MSE TA &	& ESE
Teaching Plan	3-0-0-0	Mid Semester Exam	30	ep Tecl
Credits C	oep Tech3Univers	Teachers' Assessment	ersity 20	ep Tecl
ech University C	oep Tech Univers	End Sem Exam	50	ep Tec
robotics platfor 2. The dynamics 3. Position and for 4. How to genera	rms and applications. of robot arms, mobile ro pree control for robots.	ity Coep Tech Univ		
robotics platfor 2. The dynamics 3. Position and for 4. How to genera 5. Controller synt Syllabus:	rms and applications. of robot arms, mobile re- orce control for robots. te complex trajectories thesis and stability	bots and quadrotors	ersity Co ersity Co ersity Co ersity Co ersity Co	ep Tecl ep Tecl ep Tecl ep Tecl ep Tecl
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robotics platfor 2. The dynamics 3. Position and for 4. How to genera 5. Controller sym Syllabus: Unit Introduction Degrees of from and end-effec Forward Kin	rms and applications. of robot arms, mobile re- bree control for robots. te complex trajectories thesis and stability Cont : eedom and robot configu- tors, Robot coordinate symematics. Inverse Kin	bots and quadrotors tents urations, Robot anatomy: li	nks, joints, otation and	ep Tech ep Tech ep Tech ep Tech Lecture ep Tech 7 Hrs
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robotics platfor 2. The dynamics 3. Position and for 4. How to genera 5. Controller synt Syllabus: Unit Introduction Degrees of fro and end-effec Forward Kin Dynamics. Dy Robot Kinen Kinematics f	rms and applications. of robot arms, mobile re- bree control for robots. te complex trajectories thesis and stability Cont : eedom and robot configu- tors, Robot coordinate sy- nematics. Inverse Kin ynamics of Robot Arms natics: undamentals: position,	bots and quadrotors tents urations, Robot anatomy: li ystems Rigid-body, DoF, R nematics Workspace, Ri velocity, and acceleration	nks, joints, otation and gid Body	ep Tecl ep Tecl ep Tecl ep Tecl ep Tecl ep Tecl ep Tecl ep Tecl
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robotics platfor2. The dynamics3. Position and for4. How to general5. Controller syntSyllabus:UnitIntroductionDegrees of from1and end-effectForward KinDynamics. DyRobot KinemKinematics: calInverse kinemeffector posittransformation3Robot Dynamics3System DynamModelling con	rms and applications. of robot arms, mobile ro- bree control for robots. te complex trajectories thesis and stability Cont : eedom and robot config tors, Robot coordinate sy- nematics. Inverse Kin ynamics of Robot Arms natics: undamentals: position, alculating the position of natics: finding the required ion, Denavit-Hartenberg ns nics: o robot dynamics forces and Newtonian approache namic properties like ind mics and Control: of electrical, mechanic	boots and quadrotors tents urations, Robot anatomy: li ystems Rigid-body, DoF, R nematics Workspace, Ri velocity, and acceleration the end-effector based on je ed joint angles to achieve a d g (DH) convention and how , torques, and their effect on s to deriving robot dynamic ertia and gravity al, and electromechanica	nks, joints, otation and gid Body n, Forward oint angles, lesired end- mogeneous n motion e equations.	e p Teci e p
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COEP Tech 68/90 BTech (R&AI) Mechanical Engg. Dept.

coep recirio	Trajectory Planning and Control :	ep leui
Coep Tech U	Motion planning: specifying desired robot paths and tasks, Defining velocity	
Coep Tech U	and acceleration profiles for smooth motion, Trajectory generation	
5	techniques (e.g., joint interpolation, minimum jerk), Introduction to Linear	6 Hrs
Coep Tech U	Control, State Space Modeling and Multivariable Systems, Nonlinear	
Coep Tech U	Control, Stability Theory Quadrotor Control Trajectory Generation Planning	
	and Control of a Quadrotor design of control systems.	
Coep Tech U	Workspace Analysis and Manipulability:	
Coep Tech U	Workspace visualization: techniques for understanding the reachable space	
	of a robot, Manipulability measures: dexterity and ease of motion within the	
Coep Tech U	workspace.	7 Hrs
Coep Tech U	Dynamics and Control of Wheeled Mobile Robots	ep lech
	Kinematic and dynamic modeling of wheeled robots (differential drive,	
Coep Tech U	omni-directional), Trajectory tracking and control for wheeled robots,	
Coep Tech U	Obstacle avoidance and path planning algorithms	

Coep To Suggested learning resources: https://www.coep.Tech.University.Coep.Tech.Univers **Text Books:**

Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modeling and Control, Wiley, 2006.

2. J. J. Craig, Introduction to Robotics: Mechanics and Control, 4th Edition, Pearson, 2017.

Reference Books:

- 1. Saeed B. Niku, "Introduction to Robotics Analysis, Control, Applications", Wiley Coep Tech U India Pvt. Ltd., 2010 ech University Coep Tech University Coep Tech Univers
- 2. S. K. Saha, "Introduction to Robotics", McGraw Hill Education (India) Pvt. Ltd., 2014
 - 3. Choset, Lynch, Hutchinson, Kantor, Burgard, Kavraki and Thrun, "Principle of Robot
- Motion", PHI Learning Pvt. Ltd., 2009

Course: ROS & SLAM Laboratory

Course Code	MRAIPCC703	Scheme of Evaluation	MSE & ESE
Teaching Plan	epTe0-0-4-0 ivers	Term Work	ersity 50 ep Te
Credits	ep Tech ² Univers	Oral Exam	50 en Te

Coep TeCourse Outcomes: Coep Tech University Coep Tech University Coep Tech University

Students who successfully complete this course will have an ability to:

1. Understand core ROS concepts, tools, and patterns.

2. Model and simulate robots in Gazebo using URDF for mobile bases and 3-DOF arms.

3. Apply ROS packages for SLAM, camera integration, and OpenCV-based vision.

4. Program robots with progressively complex behaviors using ROS.

5. Integrate custom sensors, actuators, libraries, and full robots into the ROS ecosystem.

Course Contents: Assignments / Practical based on: Any Eight

Coep To Coep To	Expt. No.	Contents	Contact Hours
	1	To create a Mobile robot base URDF model.	6 Hrs
	2	To create 3-DOF robot arm URDF model.	6 Hrs
	3	To attach the robot arm to base and simulate the complete mobile robot in Gazebo.	6 Hrs
	4	To implement SLAM for industrial application using ROS open-source packages.	6 Hrs
	eci5Ui	To configure and interface a webcam with ROS & To use OpenCV with ROS for a vision application.	6 Hrs
	6	Simulation with ROS- GAZEBO	6 Hrs

COEP Tech69/90BTech (R&AI) Mechanical Engg. Dept.

7	Robot motion planning, perception & trajectory optimization using ROS	6 Hrs
8	Robot Operating System (ROS) for demonstrations and hands-on activities	6 Hrs
9	Endowing mobile autonomous robots with planning, perception, and decision- making capabilities	6 Hrs
10	Integrate perception modules into ROS-based robot systems	6 Hrs

Coep T Suggested learning resources: University Coep Tech University Coep Tech University

- Coep Te Textbooks: rsity Coep Tech University Coep Tech University Coep Tech Univers 1. Introduction to Autonomous Mobile Robots by Roland Siegwart, Nour R. Nourbakhsh, and Coep Tech University Coep Tech Univers
- Gordon A.
- 2. SLAM: From Theory to Applications by Roland Siegwart and Nour Nourbakhsh

Coep TeReference Books: Coep Tech University Coep Tech University Coep Tech University

- 1. Morgan Quigley, Brian Gerkey, and William D. Smart, Programming Robots with ROS: A Practical Introduction to the Robot Operating System, O'Reilly Media, 2015.
- 2. Sanjiv Singh, Cyrill Stachniss, and Wolfram Burgard, Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms, 2nd Edition, MIT Press, 2016. Coep Tech Universi oep Tech Univers

Course: Robot operating System

Course Code	MRAIPCC704	Scheme of Evaluation	MSE TA & ESE
Teaching Plan	4-0-0-1	Mid Semester Exam	30
Credits	ep tech ₄ univers	Teachers' Assessment	20
ch University Co	ep Tech Univers	End Sem Exam	50 ep 16

Coep Te Course Outcomes: Coep Tech University Coep Tech University Coep Tech University

- Students who successfully complete this course will have an ability to:
 - 1. Understand the core concepts of ROS, including nodes, topics, messages, services, and packages.
- 2. Install and configure ROS on a development machine.
 - 3. Write basic ROS nodes using a chosen programming language (e.g., Python, C++).
 - 4. Utilize ROS tools for communication, visualization, debugging, and logging.
- 5. Design and implement robot applications using ROS packages and tools.

Coep TeSyllabus: ersity Coep Tech University Coep Tech University Coep Tech Univers

Oep Te Unit	Contents Coep Tech University Co	Lecture
oep Tech U	Introduction to ROS:	ep Teci
oep Te <mark>ch</mark> U oep Tech U	Introduction to robotics and robot software development, Overview of ROS and its architecture, Advantages and Applications of ROS, Setting up a ROS development environment.	6 Hrs
pep Tech U	ROS Fundamentals	en Tec
oep Tech ₂ U oep Tech U	Nodes, Topics, Messages, and Services in ROS, ROS Communication: Publishers and Subscribers, Data types and message definition with ROS messages (.msg), Introduction to ROS services (request-reply communication), Introduction to packages and package management	ep Tec ep Tec
pep Te ch U	Data and Messages in ROS	eb leci
bep Tech ₃ U bep Tech U	Data types and message definition with ROS messages (.msg), Introduction to ROS services (request-reply communication), Introduction to packages and package management	ep Tecl ep Tecl
oep Tech4U	Programming with ROS:	6 Hrs

COEP Tech70/90BTech (R&AI) Mechanical Engg. Dept.

Coep Te <mark>ch U</mark> i	Introduction to ROS with a chosen programming language (e.g., Python,	ep leci
oep Tech Ui	C++), Creating simple ROS nodes in the chosen language, Publishing and	ep Tech
loep Tech Ui	subscribing to topics, Sending, and receiving ROS service requests, Working with ROS libraries and APIs	ep Tech
cep Tech Ui	Robot Navigation with ROS	ep Tech
coep Tech Ui	Explore robot navigation challenges and solutions, Discover popular ROS navigation frameworks (e.g., MoveIt), Learn about path planning,	ep Tech
coep Tech Ui	localization, and obstacle avoidance, Understand how ROS enables	ep Tech
oep Tech U	autonomous robot movement.	en Tech
	Robot Perception with ROS	
oep Tech Ui	Grasp the importance of robot perception for navigation and interaction,	ep Tech
coep Tecl6Ui	explore how ROS integrates with sensors like LiDAR and cameras,	ep Tech
oep Tech Ui	understand basic concepts in robot perception (e.g., object detection), Learn how robots "see" and interpret their environment.	ep Tech
oep Tech Ur	Advanced ROS Topic: https://www.sity.coep.tech.University.Co	ep Tech
oep Tech ₇ Ui	Introduction to ROS tools (rviz, rqt, rosbag, etc.) for visualization, debugging, and logging, Working with robot simulations in ROS (e.g.,	6 Hrs
oep Tech Ur	Gazebo), Introduction to robot navigation frameworks (e.g., Moveit)	ep Tech
oep Te <mark>ch U</mark>	Introduction to robot perception with ROS	on Tool
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Interfacing with Sensors and Actuators:	op icor
coep Tech Ui	Introduction to robot sensors and actuators, Interfacing sensors and actuators	6 Hrs
oep Tech Ui	with ROS drivers. Reading sensor data and controlling actuators through ROS nodes	ep Tech

Suggested learning resources: sity Coep Tech University Coep Tech University Coep Tech Univers

Textbooks:

- 1. Programming Robots with ROS: A Practical Introduction to the Robot Operating System -Morgan Quigley, Brian Gerkey, William D. Smart
 - 2. Learning ROS for Robotics Programming Aaron Martinez and Enrique Fernandez

Reference Books:

- 1. ROS Robotics Projects: Build and control robots powered by the Robot Operating System, machine learning, and virtual reality – Lentin Joseph
- 2. Mastering ROS for Robotics Programming Lentin Joseph and Jonathan Cacace

Course Code	MRAIELC707	Scheme of Evaluation	MSE & ESE
Teaching Plan	ep Te 0-0-4-0 ivers	Mid Semester Exam	
Credits	en Tech ^l Univers	End Sem Exam	CIE: 100

Coep TeCourse Outcomes: Coep Tech University Coep Tech University Coep Tech Univers

Students who successfully complete this course will have an ability to:

1. Became aware of the industrial practices and working environment.

2. Identify various types of softwares and hardwares based knowledge skillsets.

3. Complete literature survey for various related technologies.

Complete interature survey for various related technologies.
 Improve knowledge and skills by engaging with the project and its various components

- COOP TOCH (research, analysis, design, implementation), students gain knowledge and skills specific to the project topic.5. Design, implement and test the prototype/algorithm in order to solve the conceived problem.

6. Develop project management skills by planning, organization, and time management skills crucial for completing the internship.

COEP Tech71/90BTech (R&AI) Mechanical Engg. Dept.

Write a comprehensive report on mini project work assigned during this internship.

Guidelines:

1. The internship is an individual activity. Internships projects should include mainly Mechanical Engineering but can be multi-disciplinary too.

The internship project may be a complete hardware or a combination of hardware and software. The software part in the project should be less than 50% of the total work.

- 3. Internship project should cater to a small system required in laboratory or real life.
 - It should encompass components, devices etc. with which functional familiarity is introduced.
 - After interactions with course coordinator and based on comprehensive literature survey/ need
 - analysis, the student shall identify the title define the aim & objectives of the internship project.
 - Students are expected to detail out specifications, methodology, resources required, critical issues 6. involved in design and implementation and submit the proposal within the first week of the semester
- 7. The student is expected to exert on design, development and testing of the proposed work as per the Coep Tech U schedule. V Coep Tech University Coep Tech University Coep Tech
 - Completed internship project and documentation in the form of project report is to be submitted at the end of semester.

University Coep Tech Universi ech University Coep Tec Course: Project – III

Course Code	MRAIELC708	Scheme of Evaluation	MSE & ESE
Feaching Plan	0-0-10-2	Term Work	
Credits	p Tech ₆ Univer	Oral Exam	CIE: 100

Students who successfully complete this course will have an ability to:

- 1. Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.
- 2. Design, implement and test the prototype/algorithm in order to solve the conceived problem.
- 3. Improve knowledge and skills by engaging with the project and its various components (research, analysis, design, implementation), students gain knowledge and skills specific to the project topic.
 - 4. Develop project management skills by planning, organization, and time management skills crucial for completing the project.
- 5. Write a comprehensive report on mini project work.

Coep TeGuidelines: rsity Coep Tech University Coep Tech University Coep Tech Univers

- 1. The project is a team activity having 3-4 students in a team. Projects should include mainly Mechanical Engineering but can be multi-disciplinary too.
- Coep Tech₂ The project may be a complete hardware or a combination of hardware and software. The software
 - part in the project should be less than 50% of the total work.
 - 3. Project should cater to a small system required in laboratory or real life.
 - It should encompass components, devices etc. with which functional familiarity is introduced. 4
- 5. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title define the aim and objectives of the project.
 - Students are expected to detail out specifications, methodology, resources required, critical issues
- involved in design and implementation and submit the proposal within the first week of the semester. 7. The student is expected to exert on design, development and testing of the proposed work as per the
- schedule. Completed project and documentation in the form of project report is to be submitted at the end of Coep Tech University Coep Tech University Coep Tech University Coep

BTech (R&AI) Mechanical Engg. Dept. COEP Tech iversity Coep Tech Un ^{72/90} inv Coep Tech

Coep Tech University Coep Tech University Coep Tech University Coep Tech Univers Coep Tech University Coep Tech Semester -VIII University Coep Tech University

ourse Cod	e MRAIPEC801-R	Scheme of Evaluation	MSE TA&	z ESE
aching Pla	n 3-0-0-3	Mid Semester Exam	30	ep Tec
Credits	3	Teachers' Assessment	20	an Tar
niivei sit	y cuep recir ornivers	End Sem Exam	50	ep tec
 Gain profi Get sensin Get naviga Obtain dat 	cessfully complete this cours ciency in Agricultural Robor g and Perception Expertise: ation and Automation Skills: a Analysis and Decision-Ma	tics: king Capability		
ersit	y Coep Tech Uni Con	tents Coep Tech Univ	ersity Co	Lecture
	tion to Agricultural Robot			
	of agricultural robotics and and current trends in agri			
	g efficiency, productivity			6 Hrs
Introduct	ion to key components an	d subsystems of agricultu	ral robots,	
	ocial, and environmental con			op Too
	and Perception in Agricult ntals of sensing technologies			
LI I I VICTI CALL	for measuring soil propert			
parameter	rs, Image processing, and	computer vision technique	es for crop	6 Hrs
	ng and yield estimation,			
	n in agricultural robotics, n for agricultural robots	Challenges, and solutions	in robust	
	on and Localization in Agr	icultural Environments	ersity Co	en Tec
Navigatio	on techniques for agricultur	al robots, including GPS, G	the second second as a second second	
•	ems, Localization algorithm			6 Um
	gricultural environments, P for safe and efficient robot			6 Hrs
	ping for autonomous nav			
navigatio	n challenges in agricultural i	robotics		ер Тес
	Manipulation and Automa		ersity Co	
	arms and grippers for n cs and dynamics of robotic n			
	sting, pruning, and planting			6 Hrs
making a	lgorithms for agricultural			
	tion in agricultural settings	sity Coep Tech Univ	ersity Co	ер Тес
	alysis and Decision Making ion to precision farming an		Collection	
	ent, and analysis of agricult			ep Tec
for crop	yield prediction, disease det	ection, and pest control, O	ptimization	6 Hrs
	s for resource allocation		egration of	
robotics a	and data analytics for intellig	gent decision making	erarcy ou	ah lee

COEP Tech73/90BTech (R&AI) Mechanical Engg. Dept.

Emerging Trends and Applications in Agricultural Robotics

Coep Teci6U

6 Hrs

echoi	Advanced technologies in agricultural robotics, such as swarm robotics and	eh lecil
ech Ui	soft robotics, Robotic systems for Specific applications like greenhouse	ep Tech
ech Ili	farming and livestock management, Integration of Internet of Things (IoT)	en Tech
con or	and robotics in smart agriculture, Regulatory and policy aspects related to	op roon
ech Ui	agricultural robotics, Prospects, and challenges in the field of agricultural	ep Tech
ech U	robotics.	en Tech

Suggested learning resources:

Textbooks:

- Tech University Coep Tech Univers 1. "Agricultural Field Robotics" by Simon Blackmore, Liu Liu, K. C. Ting, and Wei Zhang
- 2. "Agricultural Robots: Mechanisms, Controls, and Applications" edited by T. S. Hong, G. S. Virk,
- Coep Tech and S. Yutaty Coep Tech University Coep Tech University Coep Tech Univers

- **Reference Books:** 1. "Agricultural Robots: Emerging Trends and Applications" edited by Sachin Kumar, S. S. Dash, S. Coep Tech Swain, and K. P. Yadav
- 2. "Robotics and Automation in the Food Industry: Current and Future Technologies" edited by
- Darwin G. Caldwell, Luca Bascetta, Vittorio Ferrari, and Hoon Soo Lee

Journals

- 1. Journal of Field Robotics Published by Wiley, United States
- 2. Precision Agriculture Published by Springer, Netherlands
- 3. Computers and Electronics in Agriculture Published by Elsevier, Netherlands
- 4. Journal of Agricultural Engineering Research –United Kingdom

Coep Tech University Coe Course: AI based Agriculture (PEC-V) sity Coep Tech Univers

Course Code	MRAIPEC801-A	Scheme of Evaluation	MSE TA & ESE
Teaching Plan	ep Te 3-0-0-3 ivers	Mid Semester Exam	ersity 30 ep Te
Credits	3	Teachers' Assessment	20
n oniversity of	op roon onivere	End Sem Exam	50

Course Outcomes:

Students who successfully complete this course will have an ability to:

COED 1. Explain the significance of agricultural robotics and its role in improving efficiency, VETS

productivity, and sustainability in agriculture.Identify key components and subsystems of agricultural robots and understand their integration

Coep Tech in real-world applications.

- 3. Apply image processing and computer vision techniques to monitor crops and estimate yield in agricultural settings.
- 4. Analyze and make intelligent decisions using data analytics in precision agriculture, integrating robotics and data-driven approaches. 5. Explore emerging trends and technologies in agricultural robotics, such as swarm robotics, soft
- robotics, and IoT integration.

Coep Tesyllabus: ersity Coep Tech University Coep Tech University Coep Tech Univers

Unit	niversity Coep Tech Uni Contents Coep Tech University Co	Lecture
ech U	Introduction to AI in Agriculture sity Coep Tech University Co	ep Tech
ech1U	Overview of artificial intelligence (AI) and its applications in agriculture, Importance of AI in addressing challenges in farming and food production,	6 Hrs
ech U	Introduction to machine learning, deep learning, and natural language	ep Tech

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processing, Ethical and social implications of AI in agricultu highlighting the impact of AI in the agricultural industry Data Collection and Analysis in Agriculture Data sources and collection methods for agricultural data. techniques for cleaning and formatting agricultural data, E	niversity Coep Tech
Data sources and collection methods for agricultural data	
	niversity Coep Tech
analysis and visualization in agriculture, Feature selection a	
for AI models in agriculture, Data-driven decision mak	
practices.	niversity Coep Tech
AI Techniques for Crop Monitoring and Disease Detection Remote sensing and satellite imagery analysis for crop mon	
classification and object detection algorithms for plant diseas	e detection. AI-
ep Tech U based methods for pest control and weed management, Predic	ction models for 6 Hrs
crop yield estimation and forecasting, Case studies on AI	applications in
precision agriculture. AI for Smart Irrigation and Resource Management	niversity Coen Tech
AI-driven models for irrigation scheduling and water manage	
based systems for soil moisture monitoring and irrigation	n optimization, 6 Hrs
Optimization algorithms for resource allocation in farming	operations, Al
techniques for nutrient management and fertilizer optim farming systems and IoT integration for efficient resource ut	
Robotics and AI in Agriculture	niversity Cdep Tech
Integration of AI with robotics for autonomous farming	I THE REPORT OF
s enabled robotic systems for seeding, planting, and harve	
vision and AI algorithms for crop yield estimation and sortin vehicles and drones for precision agriculture, Challenges and	
AI in agricultural robotics.	ind Trospects of
Textbooks: 1. "Artificial Intelligence for Precision Agriculture" edited by	Nicolas Tremblay, Muhan
Abid, and John W. Grove 2. "AI for Agriculture: Techniques and Applications" edited by	Diego M. Lopez and Emm
2. "AI for Agriculture: Techniques and Applications" edited by Jammeh	niversity Coep Tech
 "AI for Agriculture: Techniques and Applications" edited by Jammeh Reference Books: 	niversity Coep Tech niversity Coep Tech
 "AI for Agriculture: Techniques and Applications" edited by Jammeh Reference Books: "Artificial Intelligence in Agriculture: A Review" edited by I 	niversity Coep Tech niversity Coep Tech
 "AI for Agriculture: Techniques and Applications" edited by Jammeh Reference Books: "Artificial Intelligence in Agriculture: A Review" edited by J and Yanbo Huang 	Khin Thida Latt, Naresh Ku
 "AI for Agriculture: Techniques and Applications" edited by Jammeh Reference Books: "Artificial Intelligence in Agriculture: A Review" edited by I and Yanbo Huang "Advances in Artificial Intelligence for Agriculture" edited b Korytkowski 	Khin Thida Latt, Naresh Ku y Leszek Rutkowski and M
 "AI for Agriculture: Techniques and Applications" edited by Jammeh Reference Books: "Artificial Intelligence in Agriculture: A Review" edited by I and Yanbo Huang "Advances in Artificial Intelligence for Agriculture" edited b Korytkowski "Artificial Intelligence Techniques for Agriculture and Food 	Khin Thida Latt, Naresh Ku y Leszek Rutkowski and M
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Students who successfully complete this course will have an ability to:

- 1. Do Sensor-Actuator Integration.
 - 2. Implement Control Systems.
- Study about emerging Technologies

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oep le	Unit	Contents	Lecture
oep le	en ui	Introduction to Mechatronics in Agriculture	ep leci
oep Te		Overview of mechatronics and its applications in the agricultural sector,	
oen Te	1	Introduction, agricultural automation and mechanization, Interdisciplinary	6 Hrs
Sep ic		nature of mechatronics in agriculture, Role of mechatronics in improving	
oep le	ch Ui	productivity, efficiency, and sustainability in farming.	ep leci
oep Te		Sensors and Actuators in Agricultural Mechatronics	
oen Te		Fundamentals of sensors and actuators used in agricultural mechatronic systems, Types of sensors for measuring soil parameters, crop health, and	
Job Io	2	environmental conditions, Actuators for mechanized tasks such as irrigation,	6 Hrs
oep le	CIT UI	planting, and spraying, Sensor-actuator integration and interfacing	ephac
oep Te	ch Ui	techniques, Calibration and maintenance of sensors and actuators in	
oon To		agricultural applications	
peh le		Control Systems in Agricultural Mechatronics	eh ieri
рер Те		Basics of control systems and their applications in agriculture, Feedback, and	
pep Te	3	feedforward control in agricultural mechatronic systems, PID control and	6 Hrs
an To		other advanced control techniques Modeling and simulation of agricultural	
seh te		systems, Implementation of control algorithms for precision farming	eh leci
bep Te		Automation and Robotics in Agriculture pep Tech University Co	
oep Te		Introduction to agricultural robots and automation systems, Robotic	
an To	4	manipulators for tasks such as harvesting, pruning, and packaging, Automated systems for seed sowing, fertilizer application, and weed control,	6 Hrs
seb le		Navigation and localization algorithms for autonomous agricultural robots,	
pep Te		Human-machine interfaces, and interaction in agricultural automation	
ep Te	ch Ui	Data Acquisition and Analysis in Precision Agriculture	ep Tecl
To		Data acquisition methods for collecting agricultural data, Sensor networks	
pep le	E UI	and wireless communication in precision agriculture, Data analysis and	6 Um
ep Te	ch Ui	visualization techniques for decision making, Machine learning algorithms	6 Hrs
ep Te	ch Ui	for yield prediction and disease detection, Integration of data analytics with	
-	de L D	mechatronic systems in farming	on Too
pep le		Emerging Technologies and Future Trends in Agricultural	
ep Te		Mechatronics	
pep Te		Advanced technologies in agricultural mechatronics, such as Internet of Things (IoT) and cloud computing, Robotics and automation for smart	
	6	greenhouse farming Unmanned aerial vehicles (UAVs) and drones for crop	6 Hrs
		monitoring and spraying, Autonomous farming systems and autonomous	
оер Те		vehicles in agriculture, Sustainability, and environmental considerations in	
pep Te	sh Ui	future agricultural mechatronics	ep Teci
	Sugges	ted learning resources: hUniversity Coep Tech University Co	
oep Tei		ooks: "Mechatronics for Agriculture: Opportunities and Challenges" by Subhash R	ep Tecl
	chÙi	"Mechatronics for Agriculture: Opportunities and Challenges" by Subhash R	акпеја, Za
14		Islam, and Essam Radwan	
		"Agricultural Mechatronics" edited by Chao Li, Quanmin Zhu, and Xianghui (
	ch Ui		
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Reference Books:

1. "Mechatronics in Action: Case Studies in Mechatronics – Applications and Education" edited by David Bradley and David Russell

- 2. "Mechatronics: Principles and Applications" by Godfrey Onwubolu
- Mechatronics in Medicine: A Biomedical Engineering Approach" by Jan Paul, Kingshuk Bhattacharya, and Rajnikant V. Patel

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- 1. Transactions of the ASABE (American Society of Agricultural and Biological Engineers) -Published by ASABE, United States
 - 2. Computers and Electronics in Agriculture Published by Elsevier, Netherlands
- Precision Agriculture Published by Springer, Netherlands
- 4. Journal of Agricultural Machinery Science Published by Turkish Chamber of Agricultural Coep Tech U Engineers, Turkey Tech University Coep Tech University Coep Tech University

Coep Tech Universi Course: Agricultural Plant & Device Control (PEC-V) ep Tech Universi

p le	Course Code	MRAIPEC801-C	Scheme of Evaluation	MSE TA & ESE
p Te	Teaching Plan	3-0-0-3	Mid Semester Exam	ersity 30 ep Te
in To	Credits	an Tech ³ Inivers	Teachers' Assessment	20
ab io	on onnoising o	op roon onivore	End Sem Exam	50

Course Outcomes:

Students who successfully complete this course will have an ability to:

- 1. Understand Agricultural Plant & Device Control.
 - 2. Proficient in Sensors and Actuators for Agricultural Applications.
 - 3. Compete in Measurement and Data Acquisition.
- Learn advanced Control Techniques and IoT in Agriculture.

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Unit	Contents	Lecture
ch Ui ch Ui ch Ui	Introduction to Agricultural Plant & Device Control Overview of agricultural automation and control systems, Importance and benefits of plant and device control in agriculture, Introduction to plant physiology and its relationship with control system.	6 Hrs
ch Ui ch Ui ch Ui ch Ui	Sensors and Actuators for Agricultural Applications Types and selection of sensors for monitoring plant parameters (e.g., temperature, humidity, light, soil moisture), Actuators for agricultural devices and equipment (e.g., motors, valves, pumps), Integration of sensors and actuators with control systems.	6 Hrs
ch Ui ch Ui	Measurement and Data Acquisition Principles of measurement and signal conditioning, Data acquisition techniques for plant and device control, Calibration, and accuracy considerations for agricultural measurements	6 Hrs
ch Ui ch ₄ Ui ch Ui	Advanced Control Techniques in Agriculture Model-based control approaches for plant and device control, Adaptive and predictive control techniques, Optimization, and model-based decision- making for agriculture.	6 Hrs
C 5 U	Internet of Things (IoT) in Agricultural Control	6 Hrs

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ch	IoT concepts and applications in plant and device control, Wireless sensor networks and communication protocols, Cloud-based platforms for data management and remote control.	ep Tech Un
6	 Data Analysis and Decision Support Systems Data analysis techniques for plant and device control, Data-driven decision support systems in agriculture, Integration of control systems with farm management software. 	6 Hrs
Sug	gested learning resources:	
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	"Agricultural Automation: Fundamentals and Practices" by Qin Zhang, Sangjun I	Lee, and José A.
	Paredes Stry Coep Tech University Coep Tech University Co	
2.	"Precision Agriculture Technology for Crop Farming" by Ken Sudduth and Robe	rt J. Kitchen
1. 2.	rence Books: "Automation: The Future of Weed Control in Cropping Systems" by Matthew William C. Hoffmann "Robotics and Automation in the Food Industry: Current and Future Technolo Darwin G. Caldwell, Luca Bascetta, Vittorio Ferrari, and Hoon Soo Lee	ep Tech Ur
Jour	nalsversity Coep Tech University Coep Tech University Co	
	Precision Agriculture – Published by Springer, Netherlands	
	Biosystems Engineering – Published by Elsevier (on behalf of the Institution Engineers), United Kingdom	of Agricultura
	Journal of Field Robotics – Published by Wiley, United States	
4.	Computers and Electronics in Agriculture – Published by Elsevier, Netherlands	
and a	Course: Medical Robotic Technology (PEC-VI)	
CH.	Course Code MRAIPEC802-R Scheme of Evaluation MSE TA	& ESE

Te	Course Code	MRAIPEC802-R	Scheme of Evaluation	MSE TA & ESE
	Teaching Plan	3-0-0-3	Mid Semester Exam	30
16	Credits	ep rech ₃ onivers	Teachers' Assessment	20
Te	ch University Co	ep Tech Univers	End Sem Exam	ersity 50 ep Te

Coep Te Course Outcomes: Oep Tech University Coep Tech University Coep Tech University

- 1. Students who successfully complete this course will have an ability to:
 - 2. Identify and describe diverse types of medical robots and their potential applications.
- 3. Know basic concepts in kinematics, dynamics, and control relevant to medical robotics.
- 4. Be familiar with the state of the art in applied medical robotics and medical robotics research.
- Understand the various roles that robotics can play in healthcare.
 Create a compelling proposal for a new medical robot technology.

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Unit	Contents	Lecture
ech U	Introduction to medical robotics: Overview of the history and evolution of medical robotics., Different classifications of medical robots (surgical, rehabilitation, etc.) and their applications, Introduction to computer-integrated surgery (CIS) and its role in robotic procedures. Applications and paradigms, Surgery for engineers, Interventional radiology for engineers.	e 5 Hrs
2	Minimally Invasive Surgery (MIS):	5 Hrs

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n Tech II			ation, Cooperative manipul	
			concepts, Video images ve surgery training.	,
) le ch U		I Interventions:	e surgery training.	ersity Coep Teo
) Tech U	0		, MRI, US, X-ray, CT), Robot
Tecl ³ U			Image segmentation and masformations, Surgical n	
p Tech U	the second se	gid and non-rigid regis	the second	ersity Coep Tec
p Tech U		s of Robot kinematics		ersity Coep Tec
p Tech U	Kinematic mod	leling of medical robot	nverse, remote center of mo s used in surgery and interv	entions. 5 Hrs
p Tech U			s relevance in medical robo mittance),manipulability,	tics. Basic
p Tech U	analysis.	ep recir onivers	aty coep recir oniv	ersity coep rec
p Tech U		s of Robot Control:		ersity Coep Tec
p Tecl5U	planning), Des	sign and implementation	dical robots (feedback contr on of control algorithms f	> Hrc
p lech U			ack for robotic surgery.	ersity Coep led
p Tech U	Existing clinic		troversies, and outcomes	
p lech U		0 1	with teleoperated robots, O	1
p Tech U			Prostate interventions with electrophysiology. Mobile ro	
p TechoU	body, Instrume	ent-tissue interaction m	odeling, Autonomous robot	ic surgery, 10 Hrs
p Tech U			hysically assistive robotics	
	assistive robo	otics, Rehabilitation	robotice Emerging tr	ends and
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COEP Tech79/90BTech (R&AI) Mechanical Engg. Dept.

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Course Outcomes: Students who successfully complete this course will have an ability to: 1. Ethical, Legal, and Social Implications Personalized Medicine 2. 3. Intelligent Systems in Clinical Practice 4. Future Trends and Challenges Syllabus: Jersity Coep Tech University Coep Tech University Coep Tech ty Coep Tech Uni Contents Coep Tech University Lecture Unit Foundations: Introduction to Human and Artificial Intelligence: terminologies, computational models of, intelligence; conceptual frameworks from cognitive and educational psychology, neuroscience, information theory, and 5 Hrs 1 linguistics; philosophical foundations of AI, Review of relevant mathematical and statistical concepts: logarithmic loss, cross entropy, optimizing cost functions; linear and logistic regression. Machine Learning: Forms of Learning: supervised, semi-supervised, unsupervised, active, and transfer learning, Supervised Learning: (a) Decision trees, non-parametric methods for learning, support vector machines, (b) Bio-inspired Learning 7 Hrs 2 (from perceptron to deep learning): neural basis of computing, classical neural networks, deep neural networks, deep belief networks, recurrent neural networks, and convolutional neural networks. Unsupervised Learning: basic and advanced clustering techniques, dimensionality reduction (feature selection and feature extraction) **Knowledge Representation and Reasoning:** Prepositional logic, first-order logic, ontological engineering, probabilistic 3 reasoning, Time-series analysis: temporal models (probabilistic reasoning 7 Hrs over time), Emerging paradigms and concepts in artificial social and emotional intelligence **Implementation and Evaluation:** Tools and Technologies for implementing AI methods, Model evaluation and performance metrics, cross-validation, model interpretability, Ethics of 7 Hrs AI: bias, fairness, accountability, and transparency in machine learning; Ethical, Legal, and Social Issues of AI in medicine and healthcare **Applications:** Unique characteristics and challenges in medicine and healthcare; History and status quo of intelligent and expert systems in medicine. Risk stratification, patient outcome prediction, disease progression modeling, 5 5 Hrs Clinical decision-making, and intelligent systems to support evidence-based medicine, Phenotype, and clinical/bio-marker discovery, Relevance to personalized medicine, Analysis of tissue morphology and other medical imaging applications Ethical Considerations and Challenges in AI for Healthcare Biases in medical data and potential for bias in AI algorithms. Explainability and transparency issues in AI-powered medical decisions. Regulatory frameworks and ethical guidelines for using AI in healthcare. 5 Hrs The Future of AI in Medicine Emerging trends and advancements in AI for healthcare applications. The role of AI in personalized medicine and robotic surgery. COEP Tech niversity Coep Tech Uni^{80/90} BTech (R&AI) Mechanical Engg. Dept.

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Student prese	entations on proposed	AI solutions for specifi	c medical
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Suggested learning re	esources:	ity Coep Tech Unive	ersity Coep Tech
Reference	oep Tech Univers		
		ce Can Make Healthcare H	
2. "Artificial Intellig Marchette	gence in Medicine: Tec	hnical Basis and Clinical	Applications" by Day
3. "Machine Learnin		plete Overview" by Ton	
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4. Chintalapudi, and	D 1 10	ted by Dr. Adam Bohr, D	•
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Course Code Teaching Plan	MRAIPEC802-M 3-0-0-3	Scheme of Evaluation Mid Semester Exam	MSE TA & ESE 30
Credits	3-0-0-3	Teachers' Assessment	20
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Course Outcomes:	ully complete this course	e will have an ability to:	
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Syllabus:	en Tech Univers		
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	to Mechatronics and N		ersity Coep Tech
Overview of n			
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drug delivery	of medical devices and systems, prosthetics). In	THE A PART OF A PART	ents (e.g., 5 Hrs
drug delivery and developm	of medical devices and systems, prosthetics). In	their mechatronic compone troduction to medical devic	ents (e.g., 5 Hrs

 Basic transducer principal Types – source of bioelectric potentials – resistive, inductive, capacitive, fibre- optic, photoelectric and chemical transducers – their description and feature applicable for biomedical instrumentation – Bio and Nano sensors and application
 Electronics for Medical Devices Signal Conditioning, Recording and Display, Input isolation, DC amplifier, power amplifier, and differential amplifier – feedback, op-Amp-electrometer amplifier, carrier Amplifier – instrument power supply. Oscillagraphic – galvanometric, X-Y, magnetic recorder, storage oscilloscopes – electron microscope – PMMC writing systems -Telemetry principles – Bio telemetry.

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Joep let	Design and Integration of Mechatronic Systems	iep ieen	Contra la
oep Te	Computer-aided design (CAD) tools for medical device design and	ep Tech	Uni
oep Teo	4 prototyping. System integration considerations for combining mechanical, electronic, and control elements. Interfacing sensors, actuators, and control	6 Hrs	Uni
pep Tec	systems for medical devices.	ep Tech	Uni
oep Teo	Bio-Medical Diagnostic Instrumentation	ep Tech	Uni
oep Teo	5 Introduction – computers in medicine – basis of signal conversion and digital filtering data reduction technique – time and frequency domain technique –	6 Hrs	Uni
oep Ter	ECG Analysis.	en Tech	Uni
ep Tec	Safety, Regulations, and the Future of Medical Mechatronics Safety standards and regulatory requirements for medical devices (e.g., IEC	ep Tech	Uni
ep Teo	6 60601). Biocompatibility of materials used in medical devices. Emerging trends in medical mechatronics (microfluidics, nanorobotics). Student	6 Hrs	Uni
pep Teo	presentations on proposed novel mechatronic designs for medical	ep Tech	Uni
oep Teo	applications. The first of the set of the se	ep Tech	Uni

Coep TeReference Books: Coep Tech University Coep Tech University Coep Tech University

- "Mechatronics in Medicine: A Biomedical Engineering Approach" by Jan Paul, Kingshuk Coep Tech U Bhattacharya, and Rajnikant V. Patel
- 2. "Introduction to Mechatronics and Measurement Systems" by David G. Alciatore and Michael B. Histand
- "Robotics and Mechatronics for Medicine and Healthcare" edited by Naohiko Sugita
- 4. "Mechatronics for Healthcare" by Stephen P. DiBenedetto
- 5. "Medical Robotics: Principles and Systems" by Frank L. Lewis, Xiaoping Yun, and Chee Kong Chui

Coep Journals:

Coep Tech 1. IEEE Transactions on Mechatronics sity Coep Tech University Coep Tech Univers

- 2. Journal of Medical Robotics Research
 - 3. IEEE/ASME Transactions on Mechatronics
- 4. Biomedical Signal Processing and Control
- 5. Journal of Healthcare Engineering

Coep Tech Un Course: Control for Biomedical Instrumentation systems (PEC VI)

Course Code	MRAIPEC802-C	Scheme of Evaluation	MSE TA & ESE
Teaching Plan	3-0-0-3	Mid Semester Exam	30
Credits	3	Teachers' Assessment	20
ech University Co	ep Tech Univers	End Sem Exam	50

Course Outcomes:

- Students who successfully complete this course will have an ability to:
- 1. Proficiency in Modern Control Theory.
 - oep Tech University Coep Tech Univers 2. Expertise in Smart Sensors for Biomedical Applications.
- 3. Comprehensive Understanding of Biomechanics.
 - 4. Proficiency in Ultrasonic Applications in Bioengineering.

Syllabus:

Tect	Jnit	viversity Coep Tech Uni Contents Coep Tech University Co	Lecture
Tecl		Introduction to Control Systems and Biomedical Instrumentation: Overview of control systems and their role in biomedical instrumentation.	6 Hrs
lect	n UI	Classification of biomedical systems (physiological, electromechanical)	ep lech

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medical devices (vanitiators, pacematers, drug delivery systems): Transducers: dynamic behaviour, power transducers, driver circuits, pulse generator circuit, piezo generator, piezo sensors. Modern Control Theory: State variable erpresentation of linear and nonlinear systems, comparison with transfer function representation, standard forms of representation, standard forms of representation, standard forms of representation, standard forms of representation, and requency domain Specifications, Pole placement by state feedback, controllability and observability, design of observers, and separatio principle. Controller design using transfer function approach. Introduction to discrete time exystems, controller design in discrete domain analysis of biomedical systems (transfer 6 Hrs Modeling of Biomodical Systems: 6 Hrs State variable Biomodical Systems: 6 Hrs Cardiovascular, reperiatory) and electromechanical devices. Time-domain and trequency-domain analysis of biomedical system models. 6 Hrs Starso for biomedical application: Force and pressure transducers: such as piezoelectric, strain gauge. 6 Hrs 4 biomaterials engineering and processing. Properties of materials, Application or formerials in medicine, biology, and artificial organs. Piezoelectric constants, depolarizator: electrical, mechanical, thermal, Time of Hight diffraction rechnique (transit time) measurement, testing of piezo crystal, bonding techniques 6 Hrs 5 of three-point pressure. Lower limb prostheses, partal weight bearing-PTB socket, tal contact-quadrilatral socket, Upper limb prosthesis, Splinal orthoses. Biolod Versel Mechanics, Heart, Valve Dyn		ep lech
Transducers: dynamic behaviour, power transducers, driver circuits, pulse generator circuit, piczo generator, piczo senson, Image: Control Theory: State variable representation of linear and nonlinear systems, comparison with transfer function appresentation, standard forms of representation, and frequency domain Specifications, Pole placement by state feedback, controllability and observability, design of observers, and separation principle. Controller design using transfer function approach. Introduction to discrete time systems, controller design in discrete domain analysis of discrete-time systems, controller design in discrete domain analysis of screte-time systems, controller design in discrete domain analysis of biomedical system models. 6 Hrs Modeling of Biomedical Systems: 6 Hrs Transducer-domain analysis of biomedical system models. 6 Hrs Sensors for biomedical applications: 6 Hrs Sensors for biomedical applications: 6 Hrs Displacement transducers, and Biopotential Electrodes, list different biopotential signals generated in the human body, Transducers for cardiovascular measurement, Transducers for heart sound measurement, applications; depolarization: electrical, mechanical, thermal, Time of flight diffraction technique (transit time) measurement, testing of piezo crystal, bonding technique (transit time) measurement, tasting of piezo crystal, bonding techniques 6 Hrs Sociectaria Biomechanics. Overview of joints and movements, anatomical levers, Material Characterization of Tissues, Mechanics of Skeletal Museles, gait, gait parameters Prosthetics and Orthotics, Principles 6 Hrs	and their control requirements. Examples of control systems in various	on Tech
generator circuit, piezo generator, piezo sensors. Andern Control Theory: State variable representation of linear and nonlinear systems, comparison with transfer function representation, standard forms of representation. 6 Hrs and separation principle. Controller design using transfer function approach. 6 Hrs introduction to discrete time control. ztransforms, difference equations, analysis of discrete-time systems, controller design in discrete domain 6 Hrs and separation principle. Controller design to discrete time control. ztransforms, difference equations, analysis of biomedical systems (transfer function s, block diagrams). Examples of modeling physiological systems (cardiovascular, respiratory) and electromechanical devices. Time-domain and frequency-domain analysis of biomedical system models. 6 Hrs Sensors for biomedical application: Basic transducers, and Biopotential Flectrodes. Itsi different biopotential signals generated in the human body. Transducers for cardiovascular measurement, Transducers for heart sound measurement, testing of piezo crystal, bonding techniques 6 Hrs 4 biomaterials sengineering and processing. Properties of materials, phylication technique (transit time) measurement, testing of piezo crystal, bonding techniques. 6 Hrs 5 of three-point pressure. Lower limb prostheses, partial weight bearing-PTB solectric constants, depolarization: electrical measurements: Introduction to biomechanics, Overview of joints and movements, manomical levers, Material Characterization of Tissues,		
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Coep Tech,U "Biomedical Engineering Systems and Technologies: International Joint Conference, BIOSTEC 2008 Funchal, Madeira, Portugal, January 28-31, 2008 Revised Selected Papers" edited by Joaquim Filipe and Ana Fred "Biomedical Signal and Image Processing" by Kayvan Najarian and Robert Splinter 4. "Biomedical Image Analysis: Statistical and Variational Methods" by Milan Sonka, Vaclav Hlavac, and Roger Boyle 5. "Feedback Systems: An Introduction for Scientists and Engineers" by Karl J. Åström and Coep Tech Richard M. Murray Coep TeJournals ersity Coep Tech University Coep Tech University Coep Tech Univers 1. IEEE Transactions on Biomedical Engineering Tech University Coep Tech Univers

- 2. Medical & Biological Engineering & Computing (MBEC) Coep Tech University Coep Tech Univers
- 3. IEEE Control Systems Magazine
- 4. Biomedical Signal Processing and Control
 - 5. Journal of Medical Engineering & Technology

Course: Defense Robotics Technology (PEC-VII)

Course Code	MRAIPEC803-D	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-3	Mid Semester Exam	30
Credits	3	Teachers' Assessment	20
University Co	ep tech Universi	End Sem Exam	50

Students who successfully complete this course will have an ability to:

1. Explain the significance of Defense robotics and its impact on military operations, mission effectiveness, and strategic superiority.

- 2. Understand and analyze various robotic platforms and mobility systems used in ground, aerial,
- and underwater Defense applications.
 - 3. Identify and integrate sensor and actuator technologies for perception and control in complex Defense environments.
 - Apply techniques for integrating weapon systems and secure communications within robotic platforms for tactical combat scenarios.
- Coep Tec 5. Implement AI algorithms for autonomy and intelligent decision-making in surveillance, navigation, and threat response systems. **Coep Tech University Coep Tech Univers**

6. Explore emerging trends and analyze global and national case studies to understand future directions and challenges in Defense robotics.

Syllabus:

Unit	Contents	Lecture
qn U	Overview of Defense Robotics and Strategic Significance	6 Hrs
	Overview of defense robotics and its critical role in modern military operations;	lech U
	Evolution and current trends in defense robotic systems, including autonomous and semi-autonomous platforms; Importance of robotics in enhancing mission	lech U
	efficiency, troop safety, and tactical superiority; Introduction to core components	lech U
	and subsystems used in defense robots; Ethical, strategic, and geopolitical implications of deploying robotics in warfare.	lech U
2	Robotic Platforms and Locomotion Systems	6 Hrs
	Introduction to ground, aerial, and underwater defense robotic platforms; Study of locomotion mechanisms including wheeled, tracked, and legged mobility; Design	lech U
ch U	principles for robustness, stability, and adaptability in complex terrain; Overview	fech U

BTech (R&AI) Mechanical Engg. Dept. COEP Tech 84/90

of kinematics and dynamics relevant to military-grade mobility systems;	Tech	Tutiver
Challenges of energy efficiency and terrain negotiation in defense missions.	ecn	Univer
3 Sensors, Actuators, and Control Systems Types and functions of sensors used in defense robots such as LiDAR, RADAR,	6 Hrs	Univer
ultrasonic, IR, and vision systems; Actuator technologies include electric,	Tech	Univer
undusonie, n., and vision systems, reductor technologies metade electre,		
adaptive, and real-time embedded control strategies; Integration of sensory data	lech	Univer
with robotic control for autonomous decision-making in combat scenarios.		Univer
4 Robotics for Weapon Systems Integration and Communication	6 Hrs	Univer
Techniques for integrating weapon systems with robotic platforms; Target		Inducar
acquisition, anning meenanisms, and me control systems, secure communication		Univer
protocols for remote control and telemetry; Human-Robot Interface (HRI) design	Techl	Univer
for battlefield coordination; Considerations for cybersecurity, jamming resistance,	Tech	Univer
and real-time data sharing in tactical environments.	6.77	Contraction of the lateral sector
5 Artificial Intelligence in Defense Robotics	6 Hrs	Univer
Role of AI and machine learning in defense applications; Algorithms for object		Univer
detection, tracking, navigation, and threat assessment; Path planning, SLAM, and		Internet
obstacle avoidance techniques; Use of neural networks, reinforcement learning,		Univer
and swarm intelligence in mission planning; Case studies on AI-powered drones, surveillance bots, and combat robots.	Tech	Univer
6 Future Trends, Challenges, and Case Studies	6 Hrs	Univer
Exploration of cutting-edge developments such as autonomous combat units,		Iniver
robotic swarms, and drone warfare; Limitations and future challenges in terms of	lectiv	Univer
regulation, autonomy, and ethical deployment; Case studies of global defense		Univer
robotics initiatives; Indian Defense robotic projects and DRDO innovations;	Tech	Univer
Emphasis on research directions and prototype development.	Tools I	- Internet
Suggested Learning Resources		
Text Books:	lecn	
1. Introduction to Autonomous Mobile Robots – Roland Siegwart, Illah Nourbakhsh		
2. Defense Robotics: Design, Application and Challenges – Satya Prakash & B.K. Si		
TeReference Books: Coep Tech University Coep Tech University Coep		
 Robotics for Future Defense Applications – P.K. Sinha Military Robotics: Latest Trends and Technologies – James S. Davis 	lechl	
2. Wintary Robotics. Latest frends and reenhologies – James S. Davis	Tech I	
ournals.		
 Journal of Defense Modeling and Simulation — SAGE Publications 		
2. Defense Technology — Elsevier		
 Journal of Field Robotics — Wiley Journal of Military and Strategic Studies — Royal Military College of Canada 		
4. Journal of Military and Strategic Studies — Royal Military College of Canada		
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Course: AL in Defense (PEC VII)		

Coep Tech University Coep T Course: AI in Defense (PEC-VII) Versity Coep Tech Univers

Course Code	MRAIPEC803-A	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-3	Mid Semester Exam	30
Credits	ep Tech 3Jnivers	Teachers' Assessment	20=0
ch University Co	en Tech Universi	End Sem Exam	50 100

 Course Outcomes:
 Students who successfully complete this course will have an ability to:

 COEP Tech
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 BTech (R&AI) Mechanical Engg. Dept.

1. Understand core AI concepts and their importance in modern defense systems.

10012. Apply machine learning for surveillance, threat detection, and decision support.

3. Develop intelligent autonomous systems like drones and robotic platforms.

4. Use AI tools to analyze defense data for pattern recognition and situational awareness.

5. Explore AI integration with IoT, cybersecurity, and cognitive computing in defense.

- 6. Assess ethical and operational challenges of AI deployment in military contexts.
- Coep TeSyllabus: ersity Coep Tech University Coep Tech University Coep Tec

Unit Contents Lecture 1 **Introduction to AI in Defense** 6 Hrs Overview of Artificial Intelligence and its branches (Machine Learning, Deep Learning, NLP, etc.), Evolution and significance of AI in modern warfare, Key Defense applications: surveillance, logistics, and autonomous systems, Case studies of AI-based Defense systems (e.g., DRDO, DARPA), Ethical and policy considerations of AI in military contexts **Machine Learning for Military Applications** 6 Hrs 2 Types of learning: supervised, unsupervised, and reinforcement learning, Model training and validation with Defense datasets, Target detection and threat classification, Predictive maintenance of military hardware, Case studies of AI in intrusion and anomaly detection 3 **Computer Vision and Sensor Fusion** 6 Hrs Image processing for Defense surveillance and reconnaissance, Object detection in aerial and satellite imagery, Sensor data fusion: thermal, radar, infrared, and LIDAR, Target tracking and battlefield situational awareness, Real-time vision applications in UAVs and combat systems 4 Natural Language Processing (NLP) in Defense 6 Hrs Basics of NLP: text preprocessing, sentiment analysis, and topic modeling, Speech-to-text and multilingual translation systems, Applications in intelligence gathering and command interfaces, Chatbots and cognitive agents in military training, Open-source intelligence (OSINT) data mining 5 Autonomous Systems and AI-based Planning 6 Hrs AI for control and coordination in UAVs, UGVs, and AUVs, Decisionmaking in autonomous warfare, Reinforcement learning and path planning in dynamic battlefields, Swarm intelligence and cooperative behavior in multiagent systems, Simulation and testing of autonomous Defense systems AI in Cybersecurity and Electronic Warfare 6 Hrs 6 Cyber threat detection using AI algorithms, Anomaly detection and behavioral analytics, Adversarial machine learning and model robustness, electronic warfare: signal intelligence and jamming detection, in AI secure communication and encryption

- Suggested Learning Resources
- Textbooks:

Artificial Intelligence: A Guide to Intelligent Systems – Michael Negnevitsky
 Artificial Intelligence for Robotics: Build Intelligent Robots that Perform Human Tasks Using

AI Techniques – Francis X. Gover's

COEP Tech 86/90 BTech (R&AI) Mechanical Engg. Dept.

Reference Books: 1. Deep Learning – Ian Goodfellow, Yoshua Bengio, and Aaron Courville

 Deep Learning – Ian Goodernow, Toshda Denglo, and Aaron Courvine
 Artificial Intelligence and National Security – Daniel S. Hoadley & Nathan J. Lucas (Congressional Research Service)

3. Machine Learning and Data Science in the Military – Edited by D. Kott, W. Borne, and R. T. Thomas

Goep Journals and Reports:

- 1. Journal of Defense Modeling and Simulation SAGE Publications
- IEEE Transactions on Neural Networks and Learning Systems IEEE (Institute of Electrical and Electronics Engineers

3. Journal of Artificial Intelligence Research (JAIR) AI Access Foundation

Coep Technology Course: Mechatronics for Defense Applications (PEC-VII)

Course Code	MRAIPEC803-M	Scheme of Evaluation	MSE TA& ESE
Teaching Plan	3-0-0-3	Mid Semester Exam	30
Credits	ep Tech 3Jnivers	Teachers' Assessment	20
ch University Co	en Tech Universi	End Sem Exam	50

Coep T Course Outcomes: Coep Tech University Coep Tech University Coep Tech University

Students who successfully complete this course will have an ability to:

1. Understand the role of mechatronics in enhancing modern military systems.

- 2. Recognize sensor and actuator integration in harsh defense environments.
 - 3. Design embedded control systems using microcontrollers and real-time OS.
 - 4. Model and simulate dynamic mechatronic systems with engineering tools.
- 5. Apply control and navigation algorithms for autonomous defense platforms.
- 6. Explore emerging defense mechatronics technologies, including AI and cyber-physical systems.

Unit	Contents Coen Tech University Coen Tech University Coen	Lecture
1	Introduction to Mechatronics and Defense Systems	6 Hrs
cn u	Definition, scope, and significance of mechatronics in Defense applications; Key	rech U
ch U	elements: mechanical, electrical, electronic, and computer systems; Evolution of	lech U
ch U	Defense systems with embedded intelligence; Role of mechatronics in smart	lech U
ch U	weapons, autonomous platforms, and surveillance systems; Case studies on mechatronic integration in Defense equipment	lech U
2	Sensors and Actuators in Defense Mechatronics	6 Hrs
ch U	Classification and working principles of sensors: inertial, pressure, position,	fech U
ch U	thermal, and proximity sensors used in Defense; Actuators: electric, hydraulic, and	lech U
chill	pneumatic; Selection criteria for rugged and field-operable systems; Sensor fusion	lech II
ch U	techniques; Applications in unmanned systems, guided munitions, and robotics	
3	Microcontrollers, Embedded Systems, and Real-Time Control	6 Hrs
ch U	Basics of embedded systems for Defense applications; Role of microcontrollers,	lech U
ch Ui	DSPs, and FPGAs; Real-time operating systems (RTOS); Interfacing of sensors	lech U
ch U	and actuators; Control architectures in missile systems, UAVs, and ground-based robots	lech U
4	Modeling and Simulation of Mechatronic Defense Systems	6 Hrs
ch U	System-level modeling using Bond Graphs, MATLAB/Simulink, or Modelica;	lech U
ch U	Dynamic modeling of actuators, robotic arms, and Defense-grade mobility	lech U

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platforms; Simulation of electromechanical subsystems in battlefield scenarios;	lech U	rivers
Hardware-in-the-loop (HIL) testing for mission-critical applications	fech U	nivers
Coep Te 5 Control Systems and Autonomous Navigation Tech University Coep	6 Hrs	nivers
COMPTER Control theory basics: PID, state-space models, and adaptive control; Stability and	Tech U	nivers
robustness of control systems in Defense environments; Guidance, navigation, and control (GNC) systems; Integration with GPS/INS and tactical control modules;	lech U	nivers
Control applications in missiles, autonomous ground vehicles, and underwater drones	lech U lech U	nivers
6 Advanced Mechatronics and Emerging Trends in Defense	6 Hrs	river
Smart materials and actuators (SMA, piezo, MR fluids) in Defense; AI integration	Tools U	-
with mechatronics; Cyber-physical systems and IoT in battlefield intelligence;	rech U	nivers
Fault detection and diagnostics; Trends in stealth technologies, morphing	lech U	nivers
structures, and swarm robotics	lech U	nivers
 Suggested Learning Resources Textbooks: Mechatronics: Principles and Applications – Godfrey Onwubolu Introduction to Mechatronics and Measurement Systems – David G. Alciatore and Histand 		
 Textbooks: 1. Mechatronics: Principles and Applications – Godfrey Onwubolu 2. Introduction to Mechatronics and Measurement Systems – David G. Alciatore and Histand 	Michael I	nivers nivers 3. nivers
 Textbooks: Mechatronics: Principles and Applications – Godfrey Onwubolu Introduction to Mechatronics and Measurement Systems – David G. Alciatore and I Histand Reference Books: Embedded Systems: Introduction to the MSP432 Microcontroller – Jonathan W. Valvano Modern Control Engineering – Katsuhiko Ogata Mechatronics in Engineering Design and Product Development – D. Shetty and R. A. Kolk Unmanned Systems of World Wars I and II – H. R. Everett (MIT Press – Defense oriented) 	Michael I	nivers nivers nivers nivers nivers nivers
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lec	Course Code	MRAIPEC803-C	Scheme of Evaluation	MSE TA& ESE
lec	Teaching Plan	3-0-0-3	Mid Semester Exam	30
Tec	Credits	ep Tech 3 Inivers	Teachers' Assessment	20
Tor	h University Co	an Tach Univers	End Sem Exam	50

Course Outcomes: Coep Tech University Coep Tech University Coep Tech Univers Students who successfully complete this course will have an ability to:

1. Understand basic control system principles in defense applications.

- 2. Model and analyze dynamics of defense mechanical and electromechanical systems.
 - 3. Assess stability and performance using classical control methods.
 - iversity Coep Tech Univers 4. Design controllers using modern control techniques like state-space methods.
- 5. Integrate sensors and actuators into control systems for defense platforms.

on Tor 6.	Explore advanced	control strategies inclu	uding AI-based and	nonlinear control for	military systems.
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Unit Contents		Lecture

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	ch U		Fech Univer
	chÜ	Introduction to Control Systems in Defense Applications	6 Hrs
		Overview of control system principles and types (open-loop and closed-loop),	
	cnu	significance in Defense technologies, examples of control systems in weapon	lech Univer
	ch U	guidance, vehicle stabilization, and radar tracking. Fundamentals of transfer	lech Univer
	ch U	functions and feedback mechanisms in military applications.	6 Hrs
	ch U	Mathematical Modeling and Dynamic System Analysis Modeling of mechanical, electrical, and electromechanical systems used in	0 1115
	ah II	Defense. State-space representation, system dynamics using differential equations,	Took Univer
	CH U	and Laplace transforms. Real-world modeling of components such as turrets,	rech oniver
	chu	gimbal systems, and actuators.	lech Univer
	3	Stability Analysis and Classical Control Techniques	6 Hrs
	ch U	Stability criteria using Routh-Hurwitz, Bode plots, Root Locus, and Nyquist	lech Univer
	ch U	diagrams. Time-domain and frequency-domain response analysis. Application of	Tech Univer
	ch II	PID controllers in military hardware such as unmanned vehicles and missile	Tech Univer
	SIL U	systems.	recironiver
	4	Modern Control Systems and Applications	6 Hrs
	ch U	Introduction to state-space control, pole placement, observer design, robust and	fech Univer
	ch U	optimal control techniques. Use in missile guidance, drone stabilization, and	lech Univer
	ch U	advanced target acquisition systems. Digital control fundamentals for real-time	lech Univer
		implementation.	Tooh theimer
	5	Sensors, Actuators, and Embedded Control Systems	6 Hrs
	cnu	Sensor technologies (gyroscopes, accelerometers, encoders) and actuators (servo	lech Univer
	ch U	motors, hydraulic actuators) used in Defense. Embedded control using	fech Univer
	ch U	microcontrollers, DSPs, and FPGAs. Signal processing and controller integration in autonomous weapon systems.	lech Univer
	6	Emerging Technologies in Defense Control Systems	6 Hrs
Coen Te	ch U	Nonlinear control, artificial intelligence in control systems, fuzzy logic, and	01113
	ab U	machine learning applications. Cyber-physical systems, swarm robotics, and	Fooh Univer
		autonomous targeting systems. Case studies on modern control implementation in	lech Univer
	chU	Defense platforms.	Tech Univer
	Sugge	sted Learning Resources	Tech Univer
	Textbo	niversity Coen Tech University Coen Tech University Coen	
		Katsuhiko Ogata, Modern Control Engineering, 5th ed., Prentice Hall, 2010.	
		Norman S. Nise, Control Systems Engineering, 7th ed., Wiley, 2015.	
		ence Books: Coep Tech University Coep Tech University Coep	
	1	Benjamin C. Kuo and Farid Golnaraghi, Automatic Control Systems, 9th ed., Wiley	, 2000
	2.	Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 13th ed., Pearson	, 2016.
	ich ₃ .	Gene F. Franklin, J. David Powell, and Abbas Emami-Naeini, Feedback Control o	f Dynamic
		Systems, 7th ed., Pearson, 2015.	
	Journ	als:/ersity Coep Tech University Coep Tech University Coep	Tech Univer
		IEEE Transactions on Control Systems Technology – Published by IEEE, USA	
	2	Control Engineering Practice – Published by Elsevier, UK	
	3.	International Journal of Control, Automation and Systems - Published by Sprin	iger, South
		Koreasity Coep Tech University Coep Tech University Coep	
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Coep Tech University Coep Tech Course: Internship - III ch University Coep Tech

Course Code	MRAIELC804	Scheme of Evaluation	MSE & ESE
Teaching Plan	0-0-10-0	Mid Semester Exam	CIE: 100
Credits	ep Tech5Univers	End Sem Exam	CIE: 100

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Students who successfully complete this course will have an ability to:

- 1. Became aware of the industrial practices and working environment.
- 2. Identify various types of softwares and hardwares based knowledge skillsets.
- 3. Complete literature survey for various related technologies.
- 4. Improve knowledge and skills by engaging with the project and its various components (research, analysis, design, implementation), students gain knowledge and skills specific to Coep Tech U the project topic. The Character Sty Coep Tech University Coep Tech University
 - 5. Design, implement and test the prototype/algorithm in order to solve the conceived problem.
- 6. Develop project management skills by planning, organization, and time management skills Complete Completing the internship.

7. Write a comprehensive report on mini project work assigned during this internship.

Guidelines:

- The internship is an individual activity. Internships projects should include mainly Mechanical 1. Engineering but can be multi-disciplinary too.
- 2. The internship project may be a complete hardware or a combination of hardware and software. The software part in the project should be less than 50% of the total work. Coep Tech₃U
 - Internship project should cater to a small system required in laboratory or real life.
- 4. It should encompass components, devices etc. with which functional familiarity is introduced.
- 5. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title define the aim & objectives of the internship project.
- 6. Students are expected to detail out specifications, methodology, resources required, critical issues COBD Tech U involved in design and implementation and submit the proposal within the first week of the semester.
- The student is expected to exert on design, development and testing of the proposed work as per the schedule schedule.
- COED 8. Completed internship project and documentation in the form of project report is to be submitted at

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